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Effect of Single-Leg Compound Training Program on the Power of College Student High-Level Basketball Player

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Abstract

Background and Aims: There is a widespread asymmetry in the body of athletes, which can affect and limit their performance in training and competition, leading to the potential and realistic risk of injury. This paper aims to improve the asymmetry of athletes improve their performance and prevent injuries. The single-leg compound training method was used to explore the effect and degree of the improvement of the lower limb asymmetry in basketball players.

Methodology: The experimental method, measurement method, and questionnaire survey method are divided into pre-experiment and formal experiment. The measurement takes 38 male high-level basketball players to measure and evaluate the strength index. The formal experiment was designed with a one-factor completely randomized experiment. High-level basketball players were randomly selected as the main subjects and randomly divided into an experimental group and a control group. The experimental group conducted single-leg compound training intervention for 8 weeks, and the control group conducted normal teaching training. The Pre-and post-tests tested the degree of lower limb asymmetry and physical fitness performance of the lower limb asymmetry and physical fitness performance indicators between the experimental group and the control group before and after the intervention.

Result: The results found that: (1) Male college basketball second-level players have the asymmetry of the lower limb strength, and the asymmetry degree of the strength index on both sides of the lower limbs is more obvious. (2) 8-week single-leg compound training can effectively improve the asymmetry of lower limb strength in male college basketball players. (3) The decrease of lower limb asymmetry in male college basketball players can significantly improve the explosive force of lower limbs. This shows that the improvement of lower limb asymmetry can improve the physical performance of basketball players.

Conclusion: The study shows that male college basketball players' explosive force and overall physical performance on the court can be greatly improved by targeting their lower limb strength asymmetry through targeted training. More balanced strength distribution can result from effective training interventions, which will ultimately enhance athletic performance.

Keywords: College student high-level basketball player; Single-leg compound training; Body asymmetry

Introduction

The study of asymmetry dates back to the 19th century. The definition of asymmetry varies widely among scholars in different disciplines. Anatomically, asymmetry refers to any phenomenon or factor that deviates from the balance, coordination, and symmetry between the right and left sides of the body (Rynkiewicz & Zurek, 2013). The study of asymmetry in the field of sport only emerged gradually in the early 20th century and was mainly based on the study of limb asymmetry in athletes... According to statistics, approximately 96% of individuals are habituated to the dominant limb as a movement causing limb asymmetry adaptation (Annett, 1998). Therefore, to adapt to the requirements of specialized mechanical loads, competitive athletes show more obvious asymmetrical phenomena in the morphology and composition of muscles and bones on both sides of the body, and the asymmetrical adaptation of athletes' body morphology and composition reveals the negative effects of sports training.

(1) Limb asymmetry affects sports performance: Limb asymmetry is mainly reflected in sports where the dominant side is very obvious(Hart et al, 2014; Schiltz et al, 2009), research data show that limb asymmetry hurts cycling performance(Rannama et al, 2015), and large magnitude asymmetry will lead to a decrease in jumping ability(Bailey et al, 2013), higher asymmetry hurts kicking accuracy in football players(Hart et al, 2014), some studies have also shown contradictory results. Many scholars have reported the phenomenon of the presence of limb asymmetry in athletes and the magnitude, however, few scholars have bothered to analyze the effects of the presence of asymmetry on physical function and sports performance (Bishoi et al, 2017).

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(2) Limb asymmetry indicates the risk of injury: For athletes, after years of training, the degree of limb asymmetry is greater than that of normal people, especially in sports where unilateral force generation is obvious, such as badminton and tennis, etc. With the increase of years of sports experience, unilateral loading joints are over-used, the pressure they bear is increasing, and the phenomenon of asymmetry becomes more and more obvious. It has been suggested that athletes and non-athletes with limb asymmetry greater than 10%-15% are strongly associated with increased injury rates (Barber, Noyes & Mangine, 1990; Impellizzeri et al, 2007) and that the deterioration of the non-dominant limb has a significant impact on the physical skeleton of young athletes at a sensitive period. Growth and development of the body's skeletal and muscular tissues in adolescent athletes during sensitive periods is extremely detrimental. Functional tests measuring lower limb asymmetry can help healthy athletes to identify increased risk of lower limb injury (Hewett et al, 2005; Klein, 1970; Noyes et al, 1991), and to better prevent injuries from occurring by evaluating, and monitoring, the relationship between asymmetric adaptations and sports injuries.

(3) Lack of practical research to improve limb asymmetry on both sides of the body: In most sports, the core movements are not performed by one side of the body, and the non-dominant side plays an important role in maintaining body balance, and only when the two sides of the body cooperate can a certain technical movement or several technical movements be performed. To improve sports performance, it is necessary to seek to reduce the dominant side of the non-dominant side of the complement, therefore, the need to adopt compensatory strategies to eliminate or take effective training means to limit and reduce the degree of asymmetry between the two sides of the body limbs, to avoid the adverse effects of limb asymmetry on the body. Although a few scholars at home and abroad have studied interventional training using strength training to equalize the difference between the left and right limbs, such studies are rare. Therefore, strengthening and attaching importance to the targeted and specialized training of the non-dominant side, strengthening the training of the non-dominant side, and reducing the symmetry gap between the two sides of the limbs to achieve a higher level of balance are of great theoretical value and practical significance for athletes to prevent injuries, promote rehabilitation, improve the training effect, and enhance the performance of the game.

(4) The effect of compound training in improving athletes' performance is outstanding: How to improve the physical performance of athletes quickly and efficiently is one of the most important issues for coaches and research teams in many sports. From Resistance Training to Plyometrics to the current complex training, a series of training methods have been explored to maximize athletic performance. Complex training, which combines traditional resistance training with Plyometrics (Carter et al, 2014; Ebben & Watts, 1998), has been favored for its efficacy in improving levels of strength and explosiveness and is of high value for explosive power events. Studies have confirmed that compared with single-strength training or single Plyometric training, compound training produces more prominent adaptive changes, better development, and maintenance of strength and explosiveness in athletes, and has the characteristics of high efficiency and reduced potential for injuries.

(5) An asymmetrical phenomenon exists in basketball players: In basketball, a large number of athletes have a "weak-side hand" and "weak-side foot", and use one side of the body for running, jumping, throwing, and passing. Both sides of the limbs in the accumulation invisible in the different loads of training, so that one side of the limbs in the strength, shape, nerve innervation, and motor unit collection than the other side of the limbs have a great advantage, so the dominant side of the generation, breaking the symmetrical balance of the body on both sides of the initial. Basketball is a same-court rivalry sport, the situation on the court changes rapidly, only to give full play to both sides of the strength to improve performance, improve the physical quality of the non-dominant side of the limbs is essential to enable basketball players to better It is important to improve the physical quality of the non-dominant side of the body so that basketball players can better use their skills to win the game.

In summary, to investigate the relationship between single-leg complex training and limb asymmetry of high-level college basketball players, we determined the limb asymmetry indexes related to the measurement of high-level college basketball players through the literature and expert interviews, chose scientific and reasonable limb asymmetry test methods and athletes' explosive power test methods, and designed the limb asymmetry test methods for lower limb asymmetry and explosive power test methods for athletes according to expert questionnaires and training principles and methods. Based on the expert questionnaire and training principles and methods, a training program for lower limb asymmetry was designed, an intervention experiment was carried out on the subjects, and a comparative test of the effect was conducted after 8 weeks.

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Objectives

To construct a single-leg compound training program and to study the effects of a single-leg compound training program on the strength of college basketball players.

Literature Review

Single-Leg Compound Training Program on the Power of High-Level Basketball Player

Single-leg compound training refers to exercises that involve multiple joints and muscles on a single leg, typically focusing on improving balance, stability, and power. In high-level basketball players, where explosive power and agility are critical, single-leg exercises are particularly beneficial. These exercises, such as single-leg squats, lunges, and step-ups, mimic the dynamic, unilateral movements common in basketball, helping athletes develop the strength and coordination needed to perform at their best during games (Kraemer & Fleck, 2007).

Impact on Lower Limb Strength and Power

Single-leg compound training has been shown to significantly impact the power output of high-level basketball players by targeting muscle groups that contribute to lower limb strength. This type of training is crucial for improving unilateral strength, which is essential in basketball for jumping, sprinting, and changing direction. Studies have found that athletes who engage in regular single-leg compound training exhibit greater improvements in lower limb power compared to those who focus solely on bilateral exercises (McCurdy et al., 2005). The unilateral nature of these exercises also aids in correcting imbalances between the legs, leading to more balanced power distribution and reduced injury risk.

Enhancing Explosive Force and Agility

The development of explosive force is a primary goal in strength and conditioning programs for basketball players. Single-leg compound exercises are particularly effective in this regard because they train the muscles involved in jumping and sprinting in a way that closely resembles the actual movement patterns used in the sport. Research indicates that incorporating single-leg compound exercises into a training regimen can lead to significant gains in vertical jump height and sprint speed, both of which are critical for high-level basketball performance (Ronnestad, Kvamme, Sunde, & Raastad, 2008).

Correcting Lower Limb Asymmetry

Lower limb asymmetry, where one leg is stronger than the other, is a common issue in basketball players due to the sport's repetitive, unilateral movements. This asymmetry can lead to decreased performance and an increased risk of injury. Single-leg compound training specifically addresses this issue by allowing athletes to target and strengthen each leg independently, thereby reducing imbalances. Studies have demonstrated that an 8-week program focusing on single-leg exercises can significantly improve the symmetry of lower limb strength and power, ultimately leading to better overall performance on the court (Patterson & Wikstrom, 2015).

Conclusion and Practical Implications

Incorporating a single-leg compound training program into the conditioning regimen of high-level basketball players is essential for enhancing lower limb power, correcting asymmetry, and improving overall performance. Coaches and trainers should consider integrating these exercises into their athletes' training routines to ensure balanced development and maximize the explosive capabilities that are crucial in basketball. The evidence supports the use of single-leg compound exercises as a key component of strength and conditioning programs, particularly for athletes looking to improve their on-court performance (Sato & Mokha, 2009).

Conceptual Framework

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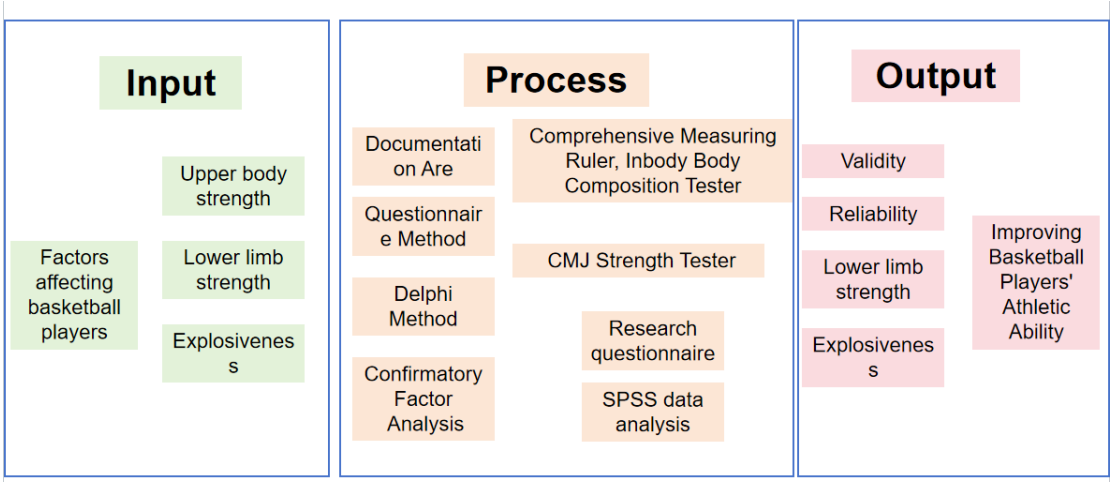

Figure 1 Conceptual Framework

Methodology

Population and samples: Expert group: 13 experts. Using Purposeful Sampling. It is selected from various sports colleges and professional basketball clubs through snowball. They are experts in basketball teaching and training, physical training, statistics, sports training, and sports human science. They have served as basketball director and majors for more than 10 years and made certain achievements (published articles or achieved competition results).

Research Instrument: (1) Semi-structured questionnaire. Through Semi-structured questionnaires, experts are consulted to provide better opinions and suggestions on the selection of training plan indicators. (2) Training Program by referring to scholars 'literature and consulting experts' semi-structured questionnaires to construct a single-leg compound training program, The content validity with index of item-objective congruence (IOC) of the program was .88, and a tryout with 5 simples found that exercise drills, intensity, and recovery times were appropriate.

Data Analysis: (1) Mean and Standard Deviation. Descriptive statistics were made for the age, height, weight, body fat, percentage, body shape, and test rest in the form of mean, standard deviation, and left and right difference. (2) T-test. Independent t-tests were used for pre-tests and post-tests of the same subjects. Paired t-tests were used for pre-tests or post-tests of different subjects. And (3) The significant difference was .05

Research process: Build the single-leg compound training program

Step 1: Review the literature and research: Review the literature and research on A summary of single-leg composite training, composite training, resistance training, and Plyometrics;

Step 2: Expert interview questionnaire: According to the reference literature, a Semi-structured questionnaire was constructed, and consultation and interview questionnaires were given to 13 experts to provide opinions and suggestions for the next training plan.

Step 3: Build the Training Program: According to the results of the expert interview questionnaire, the experimental indicators were determined and the Training Program.

Step 4: reliability validity test of the experimental protocol: The preliminary Training Program was tested for IOC, and pre-experiments were performed.

Results

Based on the references to the scholarly literature, the results of the interviews with 13 experts and the results of the questionnaire were synthesized to arrive at the final Single-leg compound training program of the experimental group（Table 1）

Table 1 Single-leg compound training program of the experimental group (8 weeks)

Divide into groups	Training means	Training content	Load strength	Number and number of groups	Rest time	Time
		1. Squat your legs			30s	

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experimental group (Single-leg compound Type training Single--leg complex training)	resistance exercise (Resistance Training)	2. One foot follows 3. Squat on one leg 4. Bulgaria lunges down and squats 5. Squat on one leg on the box	Body-Weight	Non-dominant leg movements Group 3 * 6 times Advantage leg group 1 * 6 Times		13 min
	Rapid Expansion and Compound Training (Plyometrics)	1 Single-foot side jump 2 Bow step jump 3. Jump straight on one foot 4 One-leg push (box method) 5 Continuous jump on one foot		Non-dominant leg group 3 * 10 Times Dominant leg/group 1 * 10 Times	50s	12 min

Table 2 Content validity of single-leg compound training expert review form and summary table

Questionnaire questions	Experts Opinion			IOC
	Exp1	Exp2	Exp3	
Objective				
1. Single-leg compound training can enhance an athlete's symmetry	+1	+1	+1	1.00
2. Single-leg compound training is effective in improving the athlete's balance	+1	0	+1	0.67
3. Single-leg compound training is effective in increasing the explosive power of the lower limbs	+1	+1	+1	1.00
Principle of training				
4. Training duration is appropriate	+1	+1	+1	1.00
5. Training loads are appropriate followed by intensity and rest time	+1	+1	0	0.67
6. The training load of single-leg compound training is appropriate.	0	+1	+1	0.67
7. Single-leg compound training is targeted at reducing limb asymmetry.	+1	+1	+1	1.00
8. Training frequency is appropriate, 2 days/week	+1	+1	+1	1.00
IOC				0.88

The IOC equivalent is 0.88

The single-leg composite training underwent the Validity test (Table 4.3) by three experts, and IOC=0.88> 0.05. The training program can implement the Pretest.

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According to the literature of reference scholars, the specific training scheme of single-leg composite training was constructed through the expert questionnaire and interview outline, and the Validity and validity were tested through IOC, which met the requirements of the experiment.

Discussion

1. A study on the measurement and evaluation of the asymmetrical characteristics of the lower limbs of basketball players.

The leg is the part that initiates movement, and in most sports, movement is initiated by applying force to the ground. Basketball is no exception. A good basketball player will apply absolute force to the ground in the shortest possible time. Lower extremity strength is a key physical component in achieving optimal performance through the application of force. The recovery of force from the initial force output is critical in athletic situations such as jumping, landing, stopping and starting, turning, and stepping, as well as in physical contact and confrontation where high speeds are required for running, jumping, accelerating, decelerating, and changing direction because these tasks are initiated by the lower extremities and are dependent on the strength of the lower extremities, and therefore lower extremity strength is critical to basketball. Strength is essential to the game of basketball. The legs are considered to be the foundation of all basketball skill improvement. Basketball is a same-court game, and the situation on the court is ever-changing, so it is not possible to use the dominant limb only to cope with the unpredictable changes on the court, and all aspects of the non-dominant limb need to play an active role as well. If subjects can use both sides flexibly, they can better cope with sudden changes and reduce unnecessary regrets caused by the deficiency of the non-dominant limb, so that they can better use basketball techniques and tactics to win the game. Human movement is carried out by the muscles pulling the bones around the joints, in the field of sports science, especially the lower limb movement is the most important. Therefore, the lower limbs were chosen as the focus of this experiment. The results of the pre-experimental test showed that the asymmetric difference in strength between the two sides of the lower limbs was more obvious, and the difference in the asymmetric degree between the two sides of the lower limbs was more obvious, therefore, the lower limbs with large differences in the degree of asymmetry were the focus of the study. In basketball training, the goal is to use strength training to enhance physical fitness to improve athletic quality and performance. Domestic and international studies have confirmed that compared with single-leg strength training or single-leg Plyometric training, compound training produces more prominent adaptive changes, better development and maintenance of athletes' strength and explosiveness, and has the characteristics of high efficiency and reduction of injury potential.

2. Research on the effect of single-leg compound training on lower limb asymmetry in basketball players

The study shows that strength is the most commonly used index for the comparison of asymmetry between two sides of the body, and the peak force of the force platform is the most commonly used test equipment and index for the comparison of asymmetry between two sides of the body strength, the test index of the force platform test comprehensively reflects the difference of the force of both sides of the lower limb from the whole, the function of the muscle is different in single-joint and multi-joint sports, to comprehensively reflect the difference of the asymmetry of the athlete's limbs, the test index of the force platform test To fully reflect the asymmetric differences of the athletes, all the index data were collected in this paper. Among the test indexes of the ergometer, the vertical jump, peak force, and peak power indexes in the CMJ test reflect the level of lower limb explosive power, while the vertical jump index is the most intuitive form of expression, and according to the concept of the exercise physiology of explosive power, the vertical jump is the most accurate form of evaluation of explosive power.

Resistance training can improve the strength level of athletes, but the maximum strength and explosive force are not completely related, although it can improve the maximum strength in a relatively short period, resistance training can not guarantee the continuous improvement of the output of explosive force, Plyometric training using the elongation-shortening cycle of the tensile reflexes and elastic potential, which can improve the power output level of the organism, the prerequisite is that the practitioner has a certain level of strength. The prerequisite for this is a certain level of strength. The combination of the two not only increases the level of strength but also ensures that the rate of movement is trained to obtain a greater increase in performance. Unilateral training stimulates the activation of the neuromuscular system, recruiting more motor units and building core stability. As a result, single-leg training can improve the strength of the weak leg and improve the asymmetry between the two lower limbs. When the nondominant

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leg was exercised for two more sets than the dominant leg, jumping ability such as strength indexes improved on both sides, but more so on the nondominant side. As a result, compound training has been introduced into many collective ball sports and has attracted the attention of coaches and researchers in basketball, football, volleyball, and rugby (Ebben & Watts, 1998).

3. Improvement of limb asymmetry on explosive strength of basketball players

From the analysis of the test data reflecting the explosive power, Pretest, there is no significant difference between the two groups in the CMJ long jump, touch height, and Stranding long jump indexes, Posttest, the experimental group and the control group have different magnitudes of improvement in the performance of various indexes, and from the difference, the experimental group has a significantly greater magnitude of improvement than the control group, single-leg The single-leg longitudinal jump can give full play to the explosive power of the lower limb. Under the same load, the stimulation effect of the single-leg longitudinal jump on the lower limb, i.e., the level of explosive power, is significantly higher than that of the double-leg longitudinal jump, which may be attributed to the interactive inhibition of the force exerted by the legs on both sides of the double-leg longitudinal jump, and the emergence of double-leg longitudinal jump on the lower limb. This may be due to the reciprocal inhibition of the force between the two legs in the double-leg vertical jump, resulting in a bilateral force deficit in the lower limbs. Therefore, for basketball and other sports that often require single-leg jumping and stomping, it is necessary to increase the unilateral leg exercises. The stranding long jump test evaluates the subject's lower limb explosive force, the ability of lower limb coordination, and the ability to jump burst (Smith et al, 2015), a form of movement that combines the physical qualities of bouncing, explosive power, body coordination, and technique, which is matched with the swing of the upper limbs and requires the lower limbs and hip muscles to quickly coordinate the force. The single leg power test (CMJ) is also a test that demonstrates the strength of the leg muscles and the ankle joints, and the ability to bounce in the lower limbs. Explosive power is the product of strength and speed. Resistance training can effectively mobilize the motor units and neurons to increase their excitability to counter resistance, and then centrifugal contraction is performed with Plyometric training to generate elastic potential energy, and at the same time induce the detachment reflex so that the perfect combination of strength and speed can be effectively exercised. Throughout the three tests of CMJ long jump, touch height, and Stranding long jump, the muscle force, and the coordinated work of knee, ankle, and hip joints are all in line with the characteristics of the development of explosive power of the lower limbs, which are all based on the strength to improve the coordination of the force and the explosive ability. Therefore, the compound training developed the subjects' explosive power level and improved the experimental group's performance in CMJ long jump, touch height, and Stranding long jump effectively.

Recommendation

In future basketball training and teaching practice, coaches, team doctors, researchers, and athletes themselves should pay attention to the asymmetry difference between the right and left lower limbs of the athletes and the severity of the difference, especially for athletes with a larger percentage of asymmetry, they should try to reduce the asymmetry difference between the two limbs of the athletes through targeted and specialized training to improve the athletes' performance as much as possible, and at the same time to anticipate the improvement of the athletes' sports performance.

In future basketball training and teaching, we should pay attention to the application and in-depth research of single-leg compound training method in improving the asymmetry of basketball players' limbs, and actively try to introduce more advanced training concepts and methods, to make the athletes' two limbs develop in a balanced manner, improve the efficiency and effect of training, and enhance the athletes' sports performance and athletic performance.

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