A Comparative Study on the Effectiveness of Two Modes of Polymeric Training on Leg Muscle Strengthening and power production of Basketball Players

[1]ANAND KALAISELVAN, [2]KAMALAKANNAN.M, [3]SOWMYA M.V

[1,2,3]Assistant Professor
[1]Meenakshi College of Physiotherapy,Chennai
[2,3]Saveetha College of Physiotherapy,Chennai

ABSTRACT

Aim: The aim of the study is to analyze, the effect of Two Modes of Plyometric Training on Leg Muscle Strengthening and power production of Basketball Players
Objective: To examine the influence of Two Modes of Plyometric Training on Leg Muscle Strengthening and power production of Basketball Players
Sample size: Totally 30 basketball players were selected for this study and they were assigned into two groups. Each group consisting of 15 subjects.
Methodology: Male (n=30) , Age between 20 to 25,University basketball players More than 1 years of experience in the sport of basketball,Regular play of 3 to 5 days per week and Not undergone any supervised specific strength training for several weeks where included in the study Exclusion Criteria: Recent injuries in lower extremity (fractures, tears, tendonitis), Recent surgeries of lower limb,Acute sprain and strain in lower limb,Subjects with history of knee pain and Age less than 20 and more than 25 Procedure**:** 30 basketball players were selected by simple random sampling technique. Group B will receive regular training in rebound jumping conducted twice a week for 6 weeks in a basketball ground. Group A will receive regular training in squat-plyometric conducted twice a week for 6 weeks in a basketball ground.
Results: Unpaired t-test was used to determine the pre- and post-training test score means for vertical jump and squat test between the two groups. Group B was significantly better ($p<0.0001$) after training than Group A in increasing leg muscle strength and hip and thigh power production as measured by "vertical jump test" & "squat test" . Examination of pre- & post-training test mean shows that Group B increased an average 5cm.

Conclusion: From the above result, it showed the effectiveness of squat-plyometric training on leg muscle strength and power production in University Basketball Players.

Keywords: Plyometric Training, Strengthening, power and Basketball Players

INTRODUCTION

Sports science generally aims at identifying and developing performance variables essential for competitive excellence. In addition to other indices like muscle endurance and power, muscle strength plays a cardinal role in achieving athletic excellence. The final common denominator in athletic events is what the muscles can do for you - what strength they can give when it is needed, what power they can achieve in the performance of work and how long they can continue in their activity.[1.]

The leg muscles play vital roles in the successful execution of skills in basketball.
Basketball is a team of sports in which two teams of five players try to score points by throwing or "shooting" a ball through the top of a basketball hoop while following a set of rules. Basketball is a very demanding and physically challenging game. The ability of today's athletes have heard exceeded the limits of the game put on it by the original inventors. The skills required of today's player are incredibly different than those of yesterday. Basketball now allows for individual athletes to exhibit physical aptitude within the context of an offense or defense. Basketball has evolved commonly used techniques of shooting, passing and dribbling as well as specialized player positions, offensive and defensive structures (player positions techniques. the attributes of speed, changes of direction and power rule the same today[2.]

Shooting is the act of attempting to score point by throwing the ball through the basket. Methods can vary with players and situation. Typically a player faces the basket with both feet facing the basket. A player will then allow the ball to rest on the fingertips of the dominant hand {the shooting arm} slightly above the head, with the other hand supporting the side of the ball. The ball is typically short by jumping {though not always} and straightening the shooting arm. The shooting arm, fully extended with the wrist fully bent is held stationary for a movement following the release of the ball, known as a follow-through. Players often try to put a study backspin on the ball to deaden its impact with the arm. The ideal trajectory of the shot is somewhat arguable, but generally coaches recommend a proper arch[3]. A pass is a method of moving the ball between players. Most passes are accompanied by a step forward to increase power and are followed through with the hand to ensure accuracy. The pass is of 5 types; 1.chest pass 2.bounce pass, 3.overhead pass, 4.outlet pass, 5.no-look pass[2].

Dribbling is the act of bouncing the ball continuously with one hand, and is a requirement for Players to take step with the ball .To dribble, a player pushes the ball down towards the ground with the fingertips rather than patting it; this ensures greater

control. A block is performed when, after a shot is attempted, a defender succeeds in altering the shot by touching the ball[4]. The athletes should be concerned with developing agility, power and speed as well as the Endurance to enable the player to sustain maximum performance for the duration of the game. Maximum performance in basketball stresses primarily anaerobic sources available within the muscles[3].

Basketball jumping is all about explosive power. Basketball is perhaps the king of sports when it comes to needing many occasions where you can deliver explosive power to succeed. Other sports like 100 meters or football may also require explosive power but not so frequently and for such a short duration each time as in basketball[5]. An important component of a leg muscle strengthening and power production training program for basketball players is plyometric training.

Plyometric training has shown that it improves power output and increase explosiveness by training the muscles to do more work in a shorter amount of time. This is accomplished by optimizing the stretch-shortening cycle, which occurs when the active muscle switches from rapid eccentric muscle action (deceleration) to rapid concentric muscle action (acceleration).The rapid eccentric movement creates a stretch reflex that produces a more powerful concentric muscle action than could otherwise be generated from a resting position. The faster the muscle is stretched, the greater the force produced, and the more powerful the muscle movement. Plyometric exercises that exploit the stretch-shortening cycle have been shown to enhance the performance of the concentric phase of movement and increase power output[6,7]. Sharkey (1986) described plyometric exercises as explosive callisthenic-like exercises which involve the conditioning of the neuromuscular system to permit faster and more powerful changes of direction such as moving from up and down in jumping or switching leg positions as in running. The training modes adopted for this study were based on the principle of plyometric training[8].

Therefore, this study focused on the relative effect of rebound jumping and squat-plyometric (squats & double hop jumps) over a distance (two modes of plyometric training) on leg muscle strengthening and power production of university basketball players.

This study was limited to a six-week, twice per week, micro cycle for a number of reasons. From a physiological and psychological standpoint, four to six weeks of high-intensity power training is optimal length of time that the central nervous system can be stressed without excessive strain or fatigue[9,10]. It is belief of some sports physiologist that neuromuscular adaptation contributing to explosive power may occur early (within the first two to four weeks) in a power cycle[11,12,13]. Rebound jumping and squat-plyometric were performed only twice per week to allow sufficient recovery time between workout sessions. Training programs should be followed by periods of recovery that mimics specific tasks associated with basketball, known as interval training.

The important contribution of plyometrics to athletic power production can be seen in the following brief mechanical analysis. In the execution of plyometric drills, kinetic energy is generated and stored within the muscles to be used during the subsequent positive phase in the form of mechanical work which improves performance[14]. When performing plyometrics, the athlete uses the force of gravity to store energy within the muscle structure of the body. This storing of energy is immediately followed by an equal and opposite reaction, using the elastic properties of the muscles to produce a kinetic energy system[15]. Thus by using the myotatic stretch reflex of the muscle to produce an explosive reaction, plyometric is believed to be the link between speed and strength[16,17]. Plyometric training drills are to develop explosiveness, the ability to use strength as quickly and forcefully as possible. By bridging the gap between strength and speed, the athlete can optimize power production, and gain strength[17].

The purpose of this research was to investigate the effectiveness of two training programs – rebound jumping and squat-plyometric (squats & double hop jumps) in improving leg muscle strengthening and power production as measured by vertical jump test and squat test and to discover which program optimizes leg muscle strength and power production.

MATERIALS AND METHODOLOGY

STUDY DESIGN: The design used in this study is a Comparative study

SAMPLE SIZE: Totally 30 basketball players were selected for this study and they were assigned into two groups. Each group consisting of 15 subjects.

SAMPLING TECHNIQUE: The sampling technique used to assign subjects in this study was convenience sampling Technique.

STUDY DURATION: The duration of the study is 6 weeks

INCLUSION CRITERIA: Male (n=30) , Age between 20 to 25,University basketball players

More than 1 years of experience in the sport of basketball, Regular play of 3 to 5 days per week and Not undergone any supervised specific strength training for several weeks

EXCLUSION CRITERIA: Recent injuries in lower extremity (fractures, tears, tendonitis), recent surgeries of lower limb, Acute sprain and strain in lower limb, Subjects with history of knee pain and Age less than 20 and more than 25

PROCEDURE: Participants in the training program were selected based on the selection criteria. 30 basketball players were selected by simple random sampling technique.

The subjects were instructed that in any case any subject discontinued the training program or if he developed any pain or injury in the legs during the training period then the will be excluded from the study.in this study none of the subjects discontinued the training program and none developed any injury. The initial measurements were taken. The pre-test scores for vertical jumps height and squat test were taken before the initiation of training period. All players are instructed to do general warm up before every training session and cool down exercise after every training session.

This study was designed to investigate, to find out which plyometric training is better in increasing leg muscle strength and power production in young basketball players.

The subjects (n=30) will be selected by using convinience sampling technique and will be divided in two groups. Informed concerned will be obtained from all the subjects .Subjects anthropometric data will be collected initially and will be recruited for the study. Subjects who meet the criteria of 'vertical jump test' and 'squat test' will be allocated. 'Vertical jump test' and 'squat test' will be done in both the groups as a pre-test and post-test measure.

GROUP A – subjects (n=15) will perform squat-plyometric

GROUP B– subjects (n=15) will perform rebound jumping

Group B will receive regular training in rebound jumping conducted twice a week for 6 weeks in a basketball ground .Each training session will last for approximately 1 hour consist of warm up stretches and rest. It will involve continuous jumping with the two feet leaving the ground at the same time. The subjects are expected to rebound after landing from each jump.

Group A will receive regular training in squat-plyometric conducted twice a week for 6 weeks in a basketball ground .Each training session will last for approximately 1 hour consist of warm up stretches and rest. First allotted day of the week, the subjects will perform squats followed by plyometric (double leg hops), and next allotted day of the week the subjects will perform plyometric (double leg hops) followed by squats.

Squats – subjects have to stand with feet slightly wider than hip-width apart, back straight, shoulders down, toes pointed slightly out. Keeping the back straight, the body is lowered down as sitting down in a chair, until thighs are parallel to the ground and body is kept tight and again risen back up slowly. Repeated for specified reps. **Plyometric (double hop jumps) –** subjects will have to assume athletic stance with a single cone in front. Then hoping forward and back over cone is done as quickly as possible. Repeated for specified reps.

The intensity of the exercise will be gradually increased, when training will be assumed to have become less challenging to the leg muscles of the subjects.

Measurement of vertical jump: Testing procedures included having the subjects standing flat-footed and erect facing a wall while extending the dominant arm. The highest height at maximum effort was used for data collection. The total vertical jump score was calculated in centimeters as the standing height score from the marked wall subtracted from the jumping height score.

Squat test: Testing procedures included having the subjects standing in front of a chair or bench with their feet at shoulder's width apart, facing away from it, and placing their hands on their hips. They should squat down and lightly touch the chair before standing back up. Noting down how many squats they can do. After they work out for a while, the test is taken again to see how much their lower body strength has improved.

Pre and post-test measurement will be taken at the beginning of 1st and end of the 6th week.

TRAINING PROTOCOL

SQUAT –PLYOMETRIC TRAINING PROTOCOL

WARM UP

Back and leg stretch – 5min

SQUAT PROGRAM

Table : 1

	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
TEUSDAY	2	2	3	3	4	4
FRIDAY	2	2	3	3	4	4

PLYOMETRIC PROGRAM

Table : 2

	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
TEUSDAY	2	2	3	3	4	4
FRIDAY	2	2	3	3	4	4

Table : 3
REBOUND JUMPING TRAINING PROGRAM

	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
TEUSDAY	2	2	3	3	4	4
FRIDAY	2	2	3	3	4	4

Cool down- 5 min

SQUAT – PLYOMETRIC TRAINING TECHNIQUE

Equipment: none
Starting position: stand with feet slightly wider than hip-width apart, back straight, shoulders down, toes pointed slightly out.
Action: Keeping the back straight, the body is lowered down as sitting down in a chair, until thighs are parallel to the ground and body is kept tight and again risen back up slowly.

PLYOMETRIC:

Equipment: vinex cone
Starting position: to assume athletic stance with a single cone in front
Action: Then hoping forward and back over cone is done as quickly as possible.

REBOUND JUMPING TRAINING TECHNIQUE

Equipment: bench or any equipment where the athlete can do jumping
Starting position: stand on ground, toes close to front edge, feet slightly more than shoulder –width apart
Action: continuous jumping with the two feet leaving the ground at the same time, and rebound after landing from each jump.

STATISTICAL ANALYSIS

COMPARISION BETWEEN PRE TEST & POST TEST OF VERTICAL JUMP

STATISTICAL METHOD

The collected data was tabulated and analyzed using descriptive statistics - mean and standard deviation was used. To find out significant changes between in both groups , unpaired t-test was used.

Table 4

	MEAN	**SD**	**'t' value**
GROUP A	**49.00**	**6.94**	**3.4371**
GROUP B	**41.14**	**5.17**	

The statistical analysis of pre test and post test mean in GROUP B is 41.14 and standard deviation was 5.17.

The statistical analysis of pre test and post test mean in GROUP A is 49.00 and standard deviation was 6.94

From the above results it is observed that the mean value and standard deviation of VERTICAL JUMP TEST is found to be increased indicating an increase in VERTICAL JUMP HEIGHT , In GROUP A the p values ($p<0.001$) there is significant improvement in GROUP A because of squat plyometric training program.

Table 5

COMPARISION BETWEEN PRE TEST & POST TEST OF SQUAT TEST

	MEAN	**SD**	**'t' value**
GROUP A	**54.00**	**31.92**	**2.7774**
GROUP B	**29.86**	**6.29**	

The statistical analysis of pre test and post test mean in GROUP B is 29.86 and standard deviation was 6.29

The statistical analysis of pre test and post test mean in GROUP A is 54.00 and standard deviation is 31.92

From the above results it is observed that the mean value of SQUAT TEST is found to be increased, In GROUP A the p values ($p<0.001$) there is significant improvement in GROUP A because of squat plyometric training program.

Table 6

COMPARISION BETWEEN POST TEST OF VERTICAL JUMP

	MEAN	SD	't' value
GROUP A	**53.13**	**7.00**	**3.4483**
GROUP B	**45.07**	**5.43**	

The post test mean for GROUP A is 53.13 and standard deviation was 7.00. The post test mean for GROUP B is 45.07 and standard deviation is 5.43

From the above result it observed that GROUP A post value of VERTICAL JUMP TEST is found to be increased in GROUP A. The p values ($p<0.001$) there is a significant improvement in GROUP A because of SQUAT PLYOMETRIC training program.

Table 7

COMPARISION BETWEEN POST TEST OF SQUAT TEST

	MEAN	SD	't' value
GROUP A	**66.40**	**35.91**	**2.8011**
GROUP B	**39.07**	**6.55**	

The post test mean for GROUP A is 66.40 and standard deviation was 35.91. The post test mean for GROUP B is 39.07 and standard deviation is 6.55

From the above result it observed that mean value of SQUAT TEST is found to be increased in GROUP A. The p values ($p<0.001$) there is a significant improvement in GROUP A because of SQUAT PLYOMETRIC training program.

RESULTS

Unpaired t-test was used to determine the pre- and post-training test score means for vertical jump and squat test between the two groups. Group B was significantly better ($p<0.0001$) after training than Group A in increasing leg muscle strength and hip and thigh power production as measured by "vertical jump test" & "squat test" . Examination of pre- & post-training test mean shows that Group B increased an average 5cm .

Examination of pre and post training test scores shows that GROUP A increased an average of 5 cm in vertical jump, and GROUP B increased an average of 4cm

Examination of pre and post training test scores shows that GROUP A increased an average of 15 times more in squat test, and GROUP B increased an average of 10 times.

Examination of post training of VERTICAL JUMP TEST mean for, GROUP A is 53.13 and standard deviation 7.00. The post test mean for GROUP B is 45.07 and standard deviation 5.43, shows that GROUP A (squat-plyometric training), there is improvement on leg muscle strength and power in basketball players than GROUP B

Examination of post training of SQUAT TEST mean for, GROUP A is 66.40 and standard deviation 35.91. The post test mean for GROUP B is 39.07 and standard deviation 6.55, shows that GROUP A (squat-plyometric training), there is improvement on leg muscle strength and power in basketball players than GROUP B

DISCUSSION

In this study 30 basketball players were selected, divided into two groups and they were tested by using the pre test and post test of vertical jump and squat test, assessed before and after doing plyometric training for 6 weeks.

From the results I have found that there is a significant improvement of the vertical jump after squat-plyometric, the p-value of the test is less than 0.01 which shows that there is 99.9% of significance. Previous studies has proven that both rebound jumping plyometric training and squat-plyometric training best in increasing leg muscle strengthening and power production, so I have taken both best plyometric training from their respective studies and found out which is more better.

Previous studies has indicated that neuromuscular adaptations such as an increased inhibition of antagonist muscles as well as better activation and co-contraction of synergistic muscles may account for improvements in power output(komi, 1984;lytte,199). During a plyometric movement, the muscles undergo a very rapid switch from the eccentric phase to the concentric phase. This stretch shortening cycle decreases the time of the amortization phase that in turn allows for more power production (holcomba, 1996;potteigr,et.al.,1999.).the muscle store elastic energy and stretch reflex responses are essentially exploited in this manner, permitting more work to be done by the muscles during the concentric phase of movement (Harman,et.al.,1991;holcomba,1996)

(Ademola Olasupo Abass) compared three plyometric training proramme.Based on the findings of his study, it was concluded that all the three plyometrics training protocols adopted for the study are capable of increasing leg muscle strength, but those with rebound jumping movements increased leg muscle strength significantly.

(Kent Adams , john p.o) study illustrates that a combined athletic parallel squat and plyometric training program increases hip and thigh power production significantly more, as measured by the vertical jump.

This study clearly illustrates the close working relationship between neuromuscular efficacy (e.g multiple fiber recruitment and facilitating the stretch reflex) and dynamic strength performance. With reasonable confidence it can be said that parallel squats are conductive to the development of hip and thigh strength, while the simultaneous application of plyometrics permits effective use of this strength to produce explosiveness in sports or events demanding speed and quickness. In other words, the role of plyometrics is to facilitate the neuromuscular system into making more rapid transmission from eccentric to concentric contraction, whereby maximal ballistic force is generated. This lends support to the theories of Gambetta , o'shea, and yessis and hatfield ,who believe that plyometric training is the link between speed and strength.

LIMITATIONS

- Only males are selected for this study,Sample size was small,Study was conducted in the months of April and May (summer),This study was done only basket ball players,This study was only done in a minimum duration (6 weeks) and Follow up not done to study the retention work.

RECOMMENDATIONS

Further studies need to be conducted to prove the efficacy of the procedure and techniques involved in this study with

- This study can be done in longer duration.
- This study can done in other sports players also.
- This study can be done in larger samples.
- Different fields of players and sports.
- This study can be done by comparing two groups of sports players.

CONCLUSION

From the above result, it showed the effectiveness of squat-plyometric training on leg muscle strength and power production in 15 University Basketball Players. Statistical analysis reveals that there is improvement in squat-plyometric training on leg muscle strength and power in basketball players causes changes in physiological adaptation of basket ball players. Hence the squat-plyometric training program can successfully incorporated in a sports specific training program to improve the lower extremity muscle power and strength in basketball players. This support the experimental hypothesis.

REFERENCE

[1] Cheung K, Hume P, Maxwell L. Delayed onset muscle soreness : treatment strategies and performance factors. *Sports Med. 2003;33(2):145-64.*

[2] Hough T. Ergographic studies in muscular soreness. Am J Physiol 1902;7:76–92.

[3] Connolly DAJ, Sayers SP, McHugh MP. Treatment and prevention of delayed onset muscle soreness. J Strength Cond Res 2003;17:197–8.

[4] Dierking, Jenny K, Bemben, et al. Delayed Onset Muscle Soreness. Strength and Conditioning 1998;20:44–50.

[5] McHugh MP, Connolly J, Eston RG, et al. Exercise induced muscle damage and potential mechanisms for the repeated bout effect. Sports Med 1999;27:158–70.

[6] Nosaka K, Clarkson PM. Changes in indicators of inflammation after eccentric Exercise of the elbow flexors. Med Sci Sports Exs 1996;28:953–61.

[7] Nosaka K, Newton M. Repeated eccentric exercise bouts do not exacerbate muscle damage and repair. J Strength Cond Res 2002;16:117–22.

[8] Smith LL, Fulmer MG, Holbert MR, et al. The impact of a repeated bout of eccentric exercise on muscular strength, muscle soreness and creatine kinase. Br J Sports Med 1994;28:267–71.

[9] Smith LL. Acute inflammation: The underlying mechanism in delayed onset muscle soreness. Med Sci Sports Exerc 1991;23:542–51.
[10] Cleak MJ, Eston RG. Muscle soreness, swelling, stiffness and strength loss after intense eccentric exercise. Br J Sports Med 1992;26:267–72.
[11] Szymanski DJ. Recommendations for the avoidance of delayed-onset muscle soreness. J Strength Cond Res 2001;23:7–13.
[12] Donna L. MacIntyre et all, Different effects of strenuous eccentric exercise on the accumulation of neutrophils in muscle in women and men. european journal of applied physiology Volume 81, Numbers 1-2, 47-53, DOI: 10.1007/PL00013796.
[13] Johnston RM, Bishop B, Coffey GH. Mechanical vibration of skeletal muscles.
Physical Therapy 1970;50:499–505.
[14] Samuelson B, Jorfeldt L, Ahlborg B. Influence of vibration on endurance of maximal isometric contraction. Clinical Physiology 1989;9:21–5.