

A Study to Find Out the Effect of Plyometric Training on Power and Agility Performance in High School Basketball Players: An Interventional Study

Upadhyay Namrata¹, Maniyar Surabhi²

^{1,2}Assistant Professor at Shree Sahajanand Institute of Physiotherapy, Bhavnagar, Gujarat.

How to cite this article: Upadhyay Namrata, Maniyar Surabhi. A Study to Find Out the Effect of Plyometric Training on Power and Agility Performance in High School Basketball Players: An Interventional Study, Indian Journal of Physiotherapy and Occupational Therapy 2023;17(1).

Abstract

Introduction: Plyometric training is a training strategy designed to improve the performance by incorporating the basic needs of agility and power, allows muscle to reach exponential increase in the maximum strength and speed of movement in the shortest duration. Basketball requires players to move forward, backward, laterally, diagonally and need to change Directions in a split second.

Methodology: This study was an interventional study, where 30 high school basketball players with age group 14-20 years were selected by inclusion and exclusion criteria. Players who were willing to participate in the study were requested to fill the consent form. 30 high school basketball players received plyometric training. Outcome measurements vertical jump height and T-agility measured before 5 weeks and after of the training. RESULT &

Conclusion: Data were analyzed by Statistical package of social science (SPSS) 20.0 software applying paired t test for pre treatment and post treatment comparison of vertical jump height and wilcoxon sign ranked test used for T-agility. The results revealed that vertical jump height showed significant improvement after training ($t=-10.679$, $p<0.05$), and T-agility test also showed significant improvement after training ($t=-5.295$, $p<0.05$) in high school basketball players. The result showed significant difference of pre and post training. So, it can be concluded that plyometric training effective on power and agility in high school basketball players.

Key Words: Basketball players, Plyometric, T-agility test, vertical jump height.

Introduction

The "plyometrics" comes from the Greek word "plethyein". In 1964 plyometrics has published new type of training accustomed increase the speed and explosiveness of Russian track and field athletes and utilized in major athletic programs in 1970. Within the early 1990s, George Davies and Kevin Wilk introduced plyometrics into rehabilitation.¹

Plyometric training also called stretch shortening

drills or stretch strengthening drills. There are three phases of plyometric training (a) Rapid eccentric loading phase, (b) Concentric phase and (c) amortization phase - Time between eccentric and Concentric phase. During the initial phase of eccentric contraction muscle-tendon units create potential energy which is stored and so retrieved to be used during the concentric contraction. Furthermore advantages of plyometric are to stimulate the proprioceptors of muscles, tendons,

Corresponding Author: Upadhyay Namrata, Assistant Professor at Shree Sahajanand Institute of Physiotherapy, Bhavnagar, Gujarat.

Email Id: nrupadhyay29@yahoo.com

ligaments, and joints, increase the excitability of the neuromuscular receptors, and improve the reactivity of the neuromuscular system. Even some evidences suggested that plyometric training is related to a decreased incidence of lower extremity injury and also utilized in the later stage of rehabilitation of active individuals who must achieve a high level of physical performance in specific, high-demand activities.²

Vertical jump test used in physical education, Fitness or Sports programs, as a method to assess lower limb "power". Johnson & Nelson (1974) report a reliability of 0.93 for this test.³ The vertical jump may be a movement commonly performed in a number of sports. In certain sports like basketball and volleyball, success largely depends on vertical jump.⁴

Agility has been defined as simply the power to vary direction rapidly, include whole-body change of direction yet as rapid movement and direction change of limbs. The fundamental movement patterns of the many team sports require the player to perform sudden changes in body direction together with rapid movement of limbs. Other factors like visual processing, timing, latency, perception, and anticipation which are helpful to the players successfully within the actual game with the utilization of agility maneuvers, that the purpose of most agility tests is solely to live the flexibility to rapidly change body direction and position within the horizontal plane.⁵

There are many tests which measure agility for e.g. Illinois agility test ,5-0-5 agility test, Pro-agility shuttle test, Three-cone shuttle test, Four corners test, T-agility test, Hexagon test but among that during this study used T-agility test. The T-test appears to be 0.98 reliable and measures a mix of components, including leg speed, leg power, and agility.⁶

Basketball may be a very demanding and challenging game which needs sustenance of maximum performance throughout the sport. The fundamental requirement of the play is that the ability to come up with lower body power, that may include the adequate strength, endurance of the muscles in sustenance of activity; speed of movement; power of the muscles in delivering the movement (sprinting and jumping); agility (exploratory power with

changing and varied demands of the game) and also the ability to form multi-directional changes.⁷

Participation of kids and adolescent in a minimum of 1 hour of moderate to heavy intensity physical activities which are developmentally appropriate is suggested. Studies have mentioned great benefits of physical activity in children, including control of weight by increasing energy expenditure, avoiding developing adult obesity, reducing the chance of developing premature disorder, type-2 diabetes, metabolic syndrome, bone formation and remodelling, reducing depression and anxiety, enhancing mood, self-esteem and quality of life, reducing rule-breaking behavior and improving academic performance.⁸ So purpose of the study was to find out the effect of plyometric training on power and agility performance in high school basketball players and objectives were 1. To evaluate the effect of plyometric training on power in high school basketball players. 2. To evaluate the effect of plyometric training on agility in high school basketball players.

Material and Method

Source of data: Various schools and sports institutes of Rajkot

Study setting: Sports academic Balbhavan, Rajkot.

Study design: An Interventional Study

Sampling technique: Purposive sampling

Sample size: 30 basketball players.

Study duration: 1 session in a week for 5 weeks.

SELECTION CRITERIA:

Inclusion Criteria:

- Age group: 14-20 years.⁹
- Healthy male basketball players.
- Players playing basketball 1 year and more than that for 5 days in a week.

Exclusion Criteria:

- Players with any musculoskeletal and neurological impairment, any pathological condition of spine, hip, knee and pelvis, any traumatic condition in past 6 months.³

- History of any cardiovascular problem.
- History of metabolic disorders.⁹
- Uncooperative athletes

Materials to be used:

- Pen
- Paper
- Chalk
- Inch tape
- Weight machine
- Cones
- Barrier
- Stop watch
- Record or data collection sheet
- Consent form

MEASUREMENT PROCEDURE:

The proposed title and procedure has been approved by ethical committee members. Basketball players from various school and sports institutions from Rajkot were screened and amongst them those who fulfilled inclusion and exclusion criteria were requested to participate in study. 30 players were selected from them by convenient sampling method. Procedure, potential risks and benefits were explained in brief and written consent was taken from all and then Baseline measurements were taken for all players for power by vertical jump test and agility by T-agility test.

The training program is based on recommendation of training intensity, volume, training drills, sets and repetitions. The number of foot contacts per exercise session is indicated training volume of lower body. In this study in 1st and 5th week training volume range was used from 60 to 80 foot contact per training session. And in 2nd, 3rd and 4th week training volume range from 100 to 120 foot contact per session.

Starting of every session warm up exercise: 10 to 15 minutes, included dynamic stretching of hip flexors, gluteus maximus, quadriceps, hamstrings and calf muscle, and slow jogging. End of every session cool down exercise: 10 minute includes dynamic stretching. Total session duration time was 90 minutes. Outcome measurements vertical jump height and T-agility test were checked before and after training.

PROCEDURE FOR VERTICAL JUMP TEST¹⁰ (POWER):

The player stands with the shoulder adjacent to a wall with the feet flat on the floor before reaching up as high as possible touch the wall with the middle finger. Measure the distance (in cm) from the wall mark to floor. Bend the knees to roughly a 90 degree angle and place both the arms back in winged position. Thrust forward and upward, touching as high as possible on the wall; no leg movement is permitted before jumping. Perform three trials of the jump test and use the highest score to represent the player's best vertical jump height. Compute the vertical jump height as the difference between the standing reach height and the vertical jump height in centimeter.

PROCEDURE FOR T AGILITY TEST ¹¹(AGILITY):

In this test three cones placed at set five meters apart on a straight line and a fourth cone placed ten meters from the middle cone, forming a T Shape. Player starts at cone A. On the command of the timer, the player sprints to cone B and touches the base of the cone B with their right hand. Then turn left and shuffle sideways to cone C and this time touch its base with their left hand. Then shuffling sideways to the right to cone D and touching the base with the right hand. Then shuffle back to cone B touching with left hand and run backwards to cone A. The stopwatch stopped as they pass cone A. The test was repeated 3 times. Best of three was recorded.

Results

STATISTICAL ANALYSIS

- Statistical software:

All statistical analysis was done by SPSS version 20.0 for windows software. Microsoft word were used to generate tables.

- Statistical test:

Mean was calculated as a measure of central tendency for vertical jump height and T agility test and Standard Deviation (SD) was calculated as a measure of dispersion. Shapiro-wilk test using for checked normality of data. Difference of pre and post training value of vertical jump height follow

normal distribution so for that used paired t test, and Difference of pre and post training value of T-agility test not follow normal distribution so for that used wilcoxon sign ranked test. Level of significance (p value) was set to 0.05.

30 high school basketball players between the age group of 14 to 20 years 14.8 ± 0.76 (SD) were included. Outcome measures vertical jump test and t agility test were taken before and after Completion of five sessions of training (1 session / week for 5 weeks).

Result

Table (a): Mean and SD of pre training and post training of vertical jump height and T agility test.

OUTCOME MEASUREMENTS		MEAN	SD
VERTICAL JUMP HEIGHT (cm)	Pre training	35.49	8.78
	Post training	39.62	8.94
T-AGILITY TEST (Sec)	Pre training	14.28	0.92
	Post training	13.46	1.2

Interpretation of table (a): The above table shows the mean value of pre training vertical jump test i.e. 35.49 ± 8.78 (SD) and post training i.e. 39.62 ± 8.94 (SD). The mean value of pre training i.e. 14.28 ± 0.92 (SD) and post training T-agility test i.e. 13.46 ± 1.2 (SD).

Paired t test was used for pre training and post training comparison of vertical jump height and Result shows significant difference for pre & post training of vertical jump height ($t = -10.679, p < 0.05$). Wilcoxon sign rank test was used for comparison of pre and post training of T-agility test and Result shows significant difference for pre & post training of T-agility test ($Z = -5.295, p < 0.05$).

These above findings suggest that there is statistically significant difference for pre training and post training comparison of vertical jump height and T-agility test. Hence, null hypothesis was rejected and experimental hypothesis was accepted.

Discussions

The intention of the study was to find out effect of plyometric training on power and agility in high school basketball players. In present study when the

values of pre training and post training vertical jump height and T-agility were analyzed, it absolutely was statistically significant in both the outcomes. Plyometric exercises are specialized exercises that enable a muscle to achieve maximal strength within the shortest space of time. This works by stretching a muscle so hoping on its elastic properties to provide greater forces than are normally possible within the reflex contraction (as the muscle returns to its resting length). So as to attain this greater muscular force, the muscle must contract with within the shortest possible time following lengthening.¹²

Neural components of adaptation: specifically with an increased neural drive to the agonist muscles and changes within the muscle activation strategies (i.e. improved inter muscular coordination), or changes within the mechanical characteristics of the muscle tendon complex. These neurophysiologic changes together may improve the flexibility to store and release potential energy during the stretch shortening cycle. Specifically, upon landing after a depth jump, an increased level of pre-activation enables the muscle sarcomeres to keep up their length, while the tendons keep elongating and store potential energy.¹³ Improve motor unit recruitment may account for the foremost important adaptation encountered during plyometric training regimens. Since larger motor units (composed predominantly of type 2 muscle fibers or fast twitch) have higher neural thresholds than do smaller motor units, therefore they're stimulated only under greater intensity training; plyometric training achieves this demand, leading to recruitment of the larger more powerful motor units. Training explosively may lead to adaptation that allow the athlete the power to recruit larger motor units sooner or more efficiently.¹⁴

The study shows increase in vertical jump height that may be explained well with an example of a "dig" just before vertical jump. By lowering the centre of gravity quickly, the muscles involved within the jump are momentarily stretched producing more powerful movements. Other theory relies on a neurophysiological model, which explains the instinctive reflex. The reflex increases the activity within the muscle more forcefully. The result is a power braking effect on the potential for a robust concentric muscle action. The flexibility to

use the stored potential energy is affected with three variables - time, magnitude of stretch and velocity of stretch. The quick change in direction is that the important factor when using the elastic component of the muscle.¹²

Selvam Ramachandran et al (2014)⁷ which reported that short term period plyometrics educational program combined with dynamic stretching program shows statistically significant improvements in vertical jump height and agility and no changes in muscle girth and isometric muscle strength. John Shaji et al (2009)¹⁵ also suggested that two days of plyometric training every week together with dynamic stretching for four weeks is sufficient enough to indicate improvements in vertical jump height but not sufficient enough to indicate improvements in agility while plyometric training was sufficient.

Conclusion

The result suggested that plyometric training effective on power (vertical jump height) and agility (T-agility) in high school basketball players.

Limitations

- Small sample size.
- Short duration training.
- Only male players were included.
- No anthropometric data was measured in this study and there was no tracking of Changes in body structure over the study.
- Blinding was not done in the study.

FURTHER RECOMMENDATIONS

- To form a sport specific plyometric training protocol for different sport.
- Influences of variety of surfaces and plyometric training on performance.

PRACTICAL IMPLICATION

- The results of this study suggest that 5 weeks plyometric training program once a week into the training regime of adolescent male basketball players may be beneficial for improving power production and agility.

These improvements may yield a significant transfer of training effect to on court performance.

- It is necessary to raise awareness of the trainers/coach with the importance of the plyometric exercises because of their significant influence on improving the vertical jump performance in basketball players.

Source Of Funding self funding

Conflict Of Interest Nil

References

1. Namrata n. Patel. plyometric training- a review article. *Int J Cur Res Rev.* 2014 August; 6 (15):33-37.
2. Carolyn Kisner and Lynn Allen Colby. *Therapeutic exercise: foundations and techniques.* 5th ed;F.A.Davis; 2012;ch no-6:208-210.
3. Luis F. Aragón-Vargas. Evaluation of four vertical jump tests: methodology, reliability, validity, and accuracy. *Researchgate. Measurement in Physical Education and Exercise Science.* 2000 December: 1-26.
4. Brian r umberger. Mechanics of the vertical jump and two joint muscle: implications for training. *National strength and conditioning association.* 1998 oct: 70-74.
5. J. m. Sheppard, w. b. Young. Agility literature review: Classifications, training and testing. 2005 November 4.
6. kainoa pauole, kent madole, john garhammer, michael lacourse, and ralph rozenek. Reliability and Validity of the T-Test as a Measure of Agility, Leg Power, and Leg Speed in College-Aged Men and Women. *Journal of Strength and Conditioning Research.* 2000; 14(4):443-450.
7. Selvam Ramachandran and Binita Pradhan. effects of short-term two weeks low intensity plyometrics combined with dynamic stretching training in improving vertical jump height and agility on trained basketball players. *Indian J Physiol Pharmacol.*2014; 58(2):133-136.
8. Ali Fattahi, Heydar Sadeghi. Resistance, plyometrics and combined training in children and adolescents volleyball players-A review study. *Journal of Scientific Research & Reports.* 2014; 3(20): 2584-2610.
9. Purvi K. Changela, Sarla Bhatt. The correlational study of the vertical jump test and wingate cycle test as a method to assess anaerobic power in high school

- Basketball players. *International Journal of Scientific and Research Publications*. 2012 June;2(6):1-6.
10. Victor I katch, William d mcardle, frank l katch; essential of exercise physiology; 4th edi; 2011; ch no.7:206.
 11. Baljinder Singh Bal1, Parminder Jeet Kaur, Davinder Singh. Effects of a short term plyometric training program of agility in young basketball players. *Brazilian Journal of Biomotricity*. 2011; 5(4):271-278.
 12. Shankar, R., Rajpal, H. and Arora, M. Effect of high intensity and low intensity plyometric on vertical jump height and maximum voluntary isometric contraction in football players. *Journal of Exercise Science and Physiotherapy*. 2008; 4(2):81-87.
 13. Ali Aalizadeh, SedigheShirkhani, Ali Foroughi Borazjani, SaeedChangizi Ashtiyani, NajmehMobaseri, Adel Daneshi and SedigheRahimi. The effect of Short-term Plyometric Training Program on Sprint, Strength, Power and Agility Performance in non-athletic Men. *Bioscience biotechnology research asia*. 2015 August; 12(2):1389-1395.
 14. G. Gregory Haff, Adrian Whitley, Jeffery A. Potteiger. A Brief Review: Explosive Exercises and Sports Performance. *National Strength & Conditioning Association*.2001; 23(3):13-20.
 15. John Shaji and Saluja Isha. Comparative Analysis of Plyometric Training Program and Dynamic Stretching on Vertical Jump and Agility in Male Collegiate Basketball Player. *Al Ameen J Med Sci*. 2009; 2(1):36-46.