DOI: 10.5958/2319-5886.2015.00002.8

International Journal of Medical Research & Health Sciences

www.ijmrhs.com Volume 4 Issue 1 Coden: IJMRHS Copyright @2014 ISSN: 2319-5886

Received: 5th May 2014 Revised: 28th Oct 2014 Accepted: 31st Dec 2014

Research article

EFFECT OF PLYOMETRIC TRAINING ON VERTICAL JUMP HEIGHT IN HIGH SCHOOL BASKETBALL PLAYERS: ARANDOMISED CONTROL TRIAL

*Chhaya Verma[1], Lakshmi Subramanium[2], Vijaya Krishnan[3]

[1]Professor of Physiotherapy, Seth G.S. Medical College & KEM Hospital, Parel, Mumbai
[2]M.P.Th, Ergonomic Consultant, Ergworks Inc, Banglore, India
[3]M.P.Th (musculoskeletal sciences), LTMMC & LTMGH, Sion, Mumbai

*Corresponding author email:victoryv2@yahoo.co.in

ABSTRACT

Background: Plyometric involve high intensity eccentric contraction immediately after a powerful concentric contraction. A vertical leap in basketball also involves rapid & repeated muscle contraction & stretching. Various methods have been used to improve the vertical leap in players, but only few studies mention about plyometrics. **Aim:** To determine the effect of Plyometric training on vertical jump height in high school basketball players & compare them with their untrained counterparts. **Methods and Materials:** 144 students were randomly selected & distributed in Group I (Pre-pubertal) & Group II (Pubertal) which was further divided into Group A (trained players) & Group B (untrained students). A gender wise distribution followed this. Plyometric training of 6 weeks was conducted & the vertical jump height pre & post training were recorded & compared. **Results:** Vertical jump height improved significantly post Plyometric in Group Bcompared to Group A. Boys showed improvement in Group B, however girls were better in Group A. Correlation of BMI with vertical jump height was negative & significant in Group B. **Conclusion:** Plyometric training brought significant change in untrained students. Boys gained more jump height while girls showed significant increase in jump height during pubertal growth spurt. Also, increased BMI reduced jump height.

Keywords: Basketball, Vertical jump height, Plyometric training, Body mass index.

INTRODUCTION

Basketball is one of the most popular team based sport played and watched throughout the world. The aim of the game is for each team to defend a goal area while trying to score goals at the opposing end of the court. The on court team of 5 players consists of 2 forwards, 2 guards and a centre with each player having to play in attack and defence. Basketball requires speed, explosive power and sustenance of maximum performance throughout the game.[1]

Vertical Jump: is the act of raising one's centre of gravity higher in the vertical plane solely with the use of one's own muscles. The vertical jump is divided into 2 types:

- Standing vertical jump: refers to vertical jump done from a standstill with no steps involved
- Running Vertical jump: refers to vertical jump after an approach or run to help add energy to the jump in an effort to improve on the standing vertical jump.[2]

Plyometric Training: Is an essential tool for improving explosive force. Plyometric exercises are defined as eccentric loading immediately followed by a concentric contraction. [3]

Neurophysiology: These exercises induce neuromuscular adaptations to the stretch reflex, elasticity of the muscle and golgi tendon organs. This

muscle action of eccentric to concentric or deceleration to rapid acceleration is known as Stretch-Shortening Cycle (SSC).[4]The conversion from the negative (eccentric) to positive (concentric) work is known as Amortization Phase. This begins at the onset of eccentric contraction and continues to the initiation of Concentric Contraction.[5,6] Wilt suggested that muscular performance gains after Plyometric training are attributed to these neural adaptations and it may enhance neuromuscular function.[6,7]

The shorter the duration of all the 3 phases, greater will be the exploratory power of the muscles exercised.Plyometric training is a training strategy designed to improve the performance by incorporating the basic needs of agility & power, allows muscle to reach exponential increase in the maximum strength & speed of movement inthe shortest duration.[8-11]

Researchers have suggested that Plyometric exercises were initially utilized to enhance sport performance and more recently used in the rehabilitation of injured athletes to help in preparation for a return to sport participation.[12] Santos et al in their study concluded that Plyometric training showed positive effects on upper & lower body explosive strength in adolescent male basketball players.[13]Saggital plane Plyometric program showed significant improvement in vertical jump height in a study conducted by King & Cipriani, on high-school basketball players. [14] A study done by Mondal & Wondirad, to assess the effect of 6-week Plyometric training on vertical jump performance demonstrated a significant improvement in the vertical jump performance of an athlete. [12] Also, Abbas Asadi, in his study concluded that a 6-week in-season Plyometric training program had positive effects for improving power & agility, performance in young male basketball players & his study further provides support for coaches & players to use this training method during competitive phase. [15]

The purpose of this study, thus, was to determine the effect of Plyometric training on vertical jump height in high school basketball players compared to their untrained counterparts around puberty. The effect of training on boys & girls were also separately noted.

Aim: To determine the effect of 6-weeks of Plyometric training on vertical jump height in high school basketball players and untrained students around puberty.

Objectives: 1. To compare the effect of Plyometric training on vertical jump height between high school basketball players and untrained students. 2. To observe the effect of training on pre pubertal & pubertal boys & girls. 3. To observe the effect of Body Mass Index on vertical jump height.

MATERIAL AND METHODS

Study design: A randomized control trial
Study duration: 6 weeks
Sample size: 144
Location: Mumbai, Maharashtra, India

Inclusion criteria: Basketball players - boys and girls from different schools in Mumbai who have been playing the sport at a competitive level. 2 groups of Pre-pubertal (10-11 yrs) and Pubertal (14-15 yrs) were taken. Healthy active students (non basketball players) of the same age and sex were included.

Exclusion criteria: Previous history of lower limb injuries. Ligament and muscle injuries, boys and girls who were unable to cope up with the training sessions

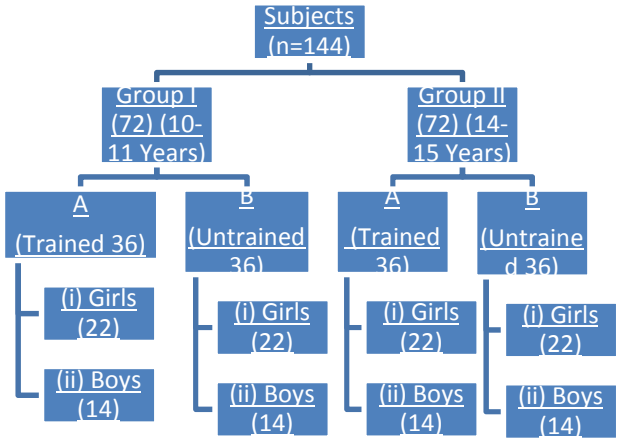

Fig. 1: Randomised distribution of subjects

Procedure: An institutional ethics committee approval was obtained. A written consent from all the participants along with prior permission from the school principals was obtained. A musculoskeletal screening of all the subjects was done. Measurement of the height and weight was done and the Body Mass Index was calculated.

Explosive power is the ability to exert a maximal force in as short time as possible. Speed is the ability to reproduce these explosive movements one after the with minimal fatigue. Running speed is very important in basketball players and it can be assessed by sprint tests, shuttle tests etc.[7]

Vertical jump height was measured pre and post training. [16-18] The athlete stands on to a wall and reaches up with the hand closest to the wall. The point of the fingertips is marked keeping feet flat on the ground. The athlete then jumps vertically as high as possible and attempts to touch the wall at the highest point of jump. The difference in the distance between the reach height and jump height is the score. The best of three attempts is recorded. Biceps and triceps, as all major muscle groups in the body are important for basketball. There are compound movements that can be done to integrate an isolated bicep or tricep exercise within other movements e.g. Pull up, press ups. The pushing exercises incorporate triceps while pulling exercises will incorporate the biceps.

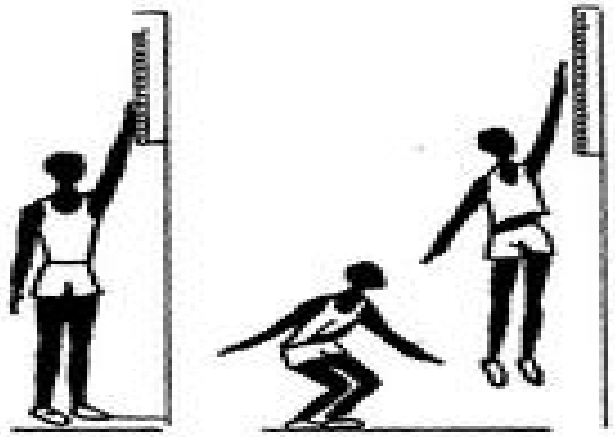

Fig 2: Vertical Jump Test

The subjects were put on a Plyometric training program of 6 weeks, constituting the lower body[19] and upper body[20] Plyometric exercise.

Duration of a session: 40 minutes.

Frequency: 3 days/week (alternate days)

The training session consisted of: Warm up exercises: 10-15 minutes including stretching of hamstrings, tendoachilles, illiopsoas, adductors and mobility exercises of the lower limb. Also, stretching of biceps, triceps, shoulder, pectorals, trunks were done. Slow skipping and marching were included too. Plyometric training: 20-25 minutes including arm Plyometric and lower body Plyometric. Cool down: 10 minutes including slow jogging, walking, lying down back stretch, deep breathing, and relaxation

Training program:

The untrained group was asked to perform the general warm up prior to the vertical jump. Cool down exercises were performed by them after the jump height was recorded.

For trained group: the exercises included were-

Upper body Plyometric: Press-ups, Chest Pass, Power Drop

Lower body Plyometric: Two-legged hops or Bunny hops, Depth jumps, Short sprints or Bounds

RESULTS

Table 1: vertical jump height – pre & post training

Vertical jump height (cms)							
Age	Trained/ untrained	Gender	Pre mean	Post mean	Post-Premean	n	mean + sd
Pre-Pubertal group I (10-11yrs)	Trained	girls	32.95	34.18	1.23	22	34.18 ±1.38
		boys	32.14	33.78	1.64	14	33.78 ±1.28
	Untrained	girls	32.77	34.09	1.32	22	34.09 ±1.46
		boys	28.14	31.07	2.93	14	31.07 ±1.49
Pubertal group II (14-15yrs)	Trained	girls	31.45	33.36	1.91	22	33.36 ±1.38
		boys	35.17	35.57	1.21	14	35.57 ±2.19
	Untrained	girls	31.36	32.09	0.73	22	32.09 ±3.51
		boys	31.78	35.21	3.43	14	35.21 ±1.99

Inference: There is an improvement seen in post training vertical jump height as compared to the pre-training in all groups.

Table 2: Comparison of effect of Plyometric training on vertical jump height (in cms) of trained players & untrained students.

	Girls		Boys	
	10-11 yrs	14-15 yrs	10-11 yrs	14-15 yrs
Trained	1.23	1.9	1.64	1.21
Untrained	1.32	0.73	2.93	3.43
p-value	0.83	0.15	0.02*	0.009*

Inference: Improvement in vertical jump height was significantly greater in untrained boyscompared to trained boys.

Table 3: Mean improvement between Boys & Girls in Vertical Jump Height(in cms)

Gender	Trained		Untrained	
	10-11 yrs	14-15 yrs	10-11 yrs	14-15 yrs
girls	1.23	1.9	1.32	0.73
boys	1.64	1.21	2.93	3.42
p-value	0.37	0.25	0.003*	0.013*

Inference: Improvement in jump height is significant in boys compared to girls in untrained group while in the trained group girls are better than boys.

Table 4: Mean difference in Vertical Jump Height between Pre Pubertal & Pubertal ages

Age	Girls		boys	
	trained	untrained	trained	untrained
pre-pubertal (10-11 yrs)	1.22	1.32	1.64	2.92
pubertal (14-15 yrs+a55)	1.9	0.73	1.21	3.42
p-value	0.1	0.47	0.5	0.45

Inference: There is no significant difference in the pre-pubertal and pubertal age groups in vertical jump height.

Table 5:Body Mass Index in Pre Pubertal & Pubertal boys and girls

Age	Girls		Boys	
	Trained	Untrained	Trained	Untrained
Pre-pubertal (10-11 yrs)	0.4(0.06)	0.49(0.02)	0.12(0.49)	0.5(0.05)
Pubertal (14-15 yrs+a55)	0.113(0.6)	0.490(0.02)	0.172(0.55)	0.32(0.2)

Inference: A significant negative correlation is seen in the untrained boys and girls of both age groups suggesting that as the BMI increases, the vertical jump height decreases.

DISCUSSION

Vertical jump measurements are used primarily in athletics to measure performance. The most common sports in which this is measured are field and track events, basketball, football, volleyball etc. This study was conducted to evaluate the effects of 6 weeks plyometric training on vertical jump height in high school basketball players. It was also aimed at determining the effect of the pre-training status, gender and pubertal age on the difference in vertical jump post plyometric training.

Kinetic forces involved during a vertical jump are[6]-

1. Contact time: Period of time for which the foot /feet are in contact with the ground during an activity. This phase is important, as the body cannot generate force to increase velocity or change directions without foot contact.
2. Ground reaction force (GRF): is the force exerted by the ground on a body in contact with it.
3. Impulse: is the rate of change of momentum.

These above factors mentioned collectively contribute to the quality of both the types of the vertical jump: standing and running which are enhanced during a plyometric training programme.

Table 1 demonstrates the significant improvement in the jump height post plyometrics. The training effect was seen to be enhanced in untrained students as compared to trained players (Table 2). Neural adaptations after training among initially untrained individuals include earlier activation and increases in maximal discharge rates of single motor neuron.[21]But, in individuals with training background, these neuromuscular adaptations have already occurred. Therefore, the players showed lesser improvements as compared to untrained students.

The jump height is usually recorded as a distance score. It can be affected by the angle of knee bending, effective use of hands, co-ordination etc. hence, to minimise these factors the students were given three attempts to perform the test and the average of the scores were recorded for analysis purpose.

Boy's demonstrated increased vertical jump height than Girls (Table3). This was due to the fact that Boys demonstrated a neuromuscular spurt evidenced by an increased vertical jump height and increased ability to attenuate the landing force. [22] Also, eccentric exercises are performed differently by girls as compared to boys as they have different activation pattern. Eccentric contractions induce a significant post-exercise force deficit. It was observed that girls showed greater loss of strength immediately after a bout of maximal eccentric contraction due to muscle

thawing. [23] Since, plyometric exercises involve this effect; the difference in activation patterns might also have affected the final outcome in girls. There are many ways to improve vertical jump, but the most effective exercises include plyometrics along with exercises that build both strength and power. For e.g. Full squats, weighted step ups, overhead walking lunges sprints, agility drills etc. the students can build strength by performing basic weight training exercise and build power with faster dynamic movements. Also, practising maximum vertical jump will increase the vertical jump.[1,6]

During and following puberty, boys have a significant increase neuromuscular performance, while most girls do not (Table 4).[24] But specialized neuromuscular training introduced at the onset of puberty can influence these neuromuscular responses in girls. These improved neuromuscular adaptations due to our plyometric training could probably have resulted in an enhanced improvement in pubertal aged girls compared to boys.

An improvement in vertical jump is said to be enhanced in the pubertal age group due to physiologic growth spurt.[23, 24] But in our study this effect was seen only in trained pubertal aged girls. On an average, girls begin the process of puberty about 1- 2 yrs earlier than boys.[25]Girls, therefore, attain their adult height and growth spurt earlier than boys. All girls in our study in the age group of 14 – 15 yrs had attained their menarche at least a year prior to the start of the study and thus would be at the peak of their growth spurt. This difference in the pubertal age between boys and girls explains the absence of significant improvement in vertical jump height in pubertal aged boys.

It is easier for one's propulsive muscles to carry one faster and further if one's body is lighter.[26] Also, greater the body mass, greater the ground reaction force and lesser will be the velocity of the vertical jump.[2] This reasons the negative correlation of BMI with the jump height. In our study, a significantly negative correlation is present in untrained students as compared to trained players (Table 5). As the BMI calculated from the weight would include both muscle and fat mass, some individuals may have a high BMI because of increased muscularity rather than increased body fat.[27-32]

Increased muscularity especially in the lower limbs would enhance power production and hence increase vertical jump. This might be the cause of a significant negative correlation seen in untrained subjects. Pearson's Correlation test was used for calculation and is depicted in table 5.

CONCLUSION

This study concludes that plyometric training of 6 weeks brought a significant change in the vertical jump height in untrained students as compared to basketball players. Boys gained more jump height compared to girls with training, however, during pubertal growth spurt girls showed significant increase in jump height. As Body Mass Index of a person increases, vertical jump height decreases. This correlation is however not significant for trained individuals who have a higher BMI due to muscle mass and not fat.

ACKNOWLEDGEMENT

We thank god almighty, the college dean, the prof & head of physiotherapy department, the school principals and all the students who participated in the study.

Conflict of Interest: Nil

REFERENCES

1. Elizabeth Quinn, How to improve vertical jump, Sports medicine.About health Newsletter, December 2014
2. Young W, Wilson G, Byrne C, Relationship between strength qualities & performance in standing & run-up vertical jumps, J Sports Med Phys Fitness, December 1999, 39 (4):285-93
3. Kevin R Ford, Gregory D Myer, Timothy E Hewett; Valgus knee motion during landing in high school female and male basketball players,J Medicine and Science in sports and exercise: 2003;35(10):1745-50
4. Nicole J. Chimera et al, Effects of plyometric training on muscle activation strategies and performance in female athletes, Journal of Athletic training, 2004; 39(1):24-31
5. Malisoux L, Francaux M, Nielens H, et al, Stretch-shortening cycle exercises: An effective training paradigm to enhance power output of human single muscle fibers. J Appl Physiology 2006; 100:771-9

6. Angus Burnett, The biomechanics of jumping, www.ahtletics.comelitetrack.com/article_files/biomechanics-of-jumping.pdf
7. Amanda M, Turner et al, improvement in the running economy after 6 weeks of training, Journal of strength and cond research, 2003, 17(1), 60-67.
8. Ramachandran S, Pradhan B, effects of short-term two weeks low intensity plyometrics combined with dynamic stretching training in improving vertical jump height & agility on trained basketball players, Indian J PhysiolPharmacol, 2014; 58(2): 133-36.
9. Santos EJ, Janeira MA, Effects of complex training on explosive strength in adolescent male basketball players, J Stren Cond Res 2008; 22(3): 903-09.
10. Carlson K, Magnusen M, walters P. Effect of various training modalities on vertical jump, Res Sports Med 2009; 17(2): 84-94
11. Matavulj D, Kukolj M, Ugarkovic D, Tihanyi J, Jaric S, Effects of plyometric training on jumping performance in junior basketball players, J Sports Med Phys Fitness 2001; 41(2): 159-64.
12. Mondol S, Wondirad S, Effect of 6-week plyometric training on vertical jump performance of maychew athletes, International J Physical Education, Health & Social Science, 2014; 3(1): 1-6
13. Santos EJ, Eduardo JAM, Janeira M, The effects of plyometric training followed by detraining & reduce training periods on explosive strength in adolescent male basketball players, 2011; 25(2): 441-52
14. King A, CiprianiJ,Comparing preseason frontal & sagittal plane plyometric programs on vertical jump height in high-school basketball players, 2010; 24(8): 2109-14.
15. Abbas Asadi, Effects of in-season short-term plyometric training on jumping & agility performance of basketball players, Sport Sciences for Healt, 2013; 9(3): 133-37
16. Ellenbecker, Effects of plyometric training in female athletes J of Athletic training 2004; 39(1):24-31.
17. Donald A Chu et al: Plyometrics in rehabilitation, 1st edition, Human kinetic publishers, 2013;chapter 1, pg no. 3-12
18. Wilt F, Plyometrics: what it is and how it works, Athletic J 1975; 55(5): 76-90.
19. Hubal MJ, Clarkson PM, Rubinstein S, Gender differences in central activation during maximal eccentric exercise. Medicine and Science in sports and exercise, 2003, 35(5)
20. Young WB, McDonald C, Heggen T and Fitzpatrick J, An evaluation of the specificity, validity of jumping tests, Journal of Sports Med and Physical Fitness, 1997, 37:240-45.
21. Smith HIC, Thomas SG, Physiology characteristics of elite female basketball player, Canadian Journal of Sports Sciences, 1997, 16:289-95
22. Gordon, Catharine M, Laufer MR, Pediatric and adolescent Gynecology, edn. 5th, Philadelphia: Lippincott, Williams & Wilkins, 2005, 120-55
23. Body Mass Index, Centres of disease control and prevention website
24. Weight watchers support network, www.healthdiscovery.com
25. Bosco, Komi PV, Vertical jump test, European Journal of Applied Physiology, 1983, 50:273-82.
26. Arm plyometrics, www.sportscoach.com
27. Judge Larry W, Moreau Chard, Burke Jeanmarie, Neural adaptations with sport-specific resistance training in highly skilled athletes, Journal of sports sciences, 2003, 21 (5): 419-27.
28. Erik E Swartz, Laura C Decoster, Pamela J Russell and Ronald V Croce, J Athletic training, 2005, 40(1); 9-14.
29. Lee Inglei, Mike Sleapi and Keith Tolfrey, Journal of Sports Sciences, Sept.2006, 24(9) 987-97.
30. Sport Performance at the Oslo Conference of the European College of Sport ScienceWill G Hopkins Sportscience 2009; 13: 28-32
31. Derek Chan, Fitness testing assignment: Basketball,www.physiowebexchange.curtin.edu.au
32. Chu DA: Jumping in to plyometrics; campaign IL, Human kinetics publishers, Chicago IL: 2nd edition,1992; 52-70