International Journal of Applied Exercise Physiology
2322-3537 www.ijaep.com
Vol.8 No.1
Received: September 2018 , Accepted: December 2018 , Available online: March 2019

DOI: 10. 30472 /ijaep.v8i1.367

Effects of Plyometrics and Plyometrics Combined with Dynamic Stretching on Vertical Jump in Male Collegiate Volleyball Players

Usman T [1 *] & K B Shenoy [2]

1. *Professor, Department of Sports Injury& Rehabilitation, Batterjee Medical College, Jeddah, KSA. 2. Professor, Department of Applied* Zoology, *Mangalore University, Mangalore, Karnataka, India*

[*] *Corresponding author: Usman T*

usmuptb@gmail.com

Mob : +966563546554

ABSTRACT:

Vertical jump ability is a crucial component for success in volleyball. Plyometric training is used to generate and enhance explosive power of athletes in various sport activities. The purpose of this study was to find out the effects of lower body plyometric exercises training and lower body Plyometrics combined with dynamic stretching and also to compare the effects of both on vertical jump performance in male collegiate volleyball players. The study was conducted for an eight weeks period on 90 male collegiate volleyball players of 18-22 years of age. Players were divided randomly into a control and two experimental groups of 30 players in each group. All players were tested for vertical jump height using the sergeant jump test prior to start of the training program. The assessments of vertical jump performance were repeated at the end of every two weeks till eight weeks. The results of the study showed significant changes in vertical jump height from 2nd week onwards in both the experimental groups and the highest effects were observed at the end of 8th weeks. The effects were significantly higher as compared to the control group ($p<0.05$). However, the lower body plyometrics combined with dynamic stretching group showed significantly more effect on vertical jump performance than the lower body plyometrics alone group ($p<0.05$). From the study, it can be concluded that both lower body plyometrics training and lower body plyometrics combined with dynamic stretching program twice a week for eight weeks showed significant improvement on vertical jump performance. However, the lower body plyometrics combined with dynamic stretching training can be the better effective program to improve vertical jump ability for the male collegiate volleyball players.

KEY WORDS: Dynamic stretching, Lower body Plyometrics, Male volleyball players, Vertical jump

INTRODUCTION

Muscle power plays an important role in most sports games .The ultimate goal of any athlete is to perform well in their sport. Leg muscle power especially vertical jump is the critical element for successful athletic performance [5, 6, 22]. Although various training methods have been effectively used for the enhancement of vertical jump height, the plyometric training is a method of choice when aiming to improve vertical jump ability and leg muscle power [8, 9, 17, 26].

The plyometrics procedure involves a rapid deceleration of the body followed immediately a rapid acceleration in the opposite direction [1, 2]. The rapid combination of this muscular activity of plyometrics involves the stretch-shortening cycle which plays a key role in improving strength, power, speed, joint function, stability, balance and neuromuscular control during landing [7, 18, 19]. Lehnert *et al (2009)* conducted a plyometric training programme for a group of female youth volleyball players twice a week for an eight-week period and reported that plyometric exercises were an effective tool in the development of explosive power and speed in young athletes [15]. Six week plyometric training, with 2-3 sessions per week, made significant contribution to jumping agility [27]. Four week plyometric training can improve the single leg vertical jumping ability and overall power endurance ability of basketball players [31].

The effect of plyometric exercises may differ with dynamic stretching. Dynamic stretching increases power and endurance, balance and co-ordination, speed of muscle contraction and mental preparedness. These improvements with dynamic stretching are due to the result of enhanced neuromuscular function [21, 24]. Dynamic stretching enhances muscular performance [30]. It has been demonstrated to have a significant positive effect on vertical jump performance [14]. The mechanism for improvements in power production following dynamic stretching is due to increased muscle temperature, increased range of motion and post activation potentiation [4, 11]. Dynamic stretching enhances muscular performance of lower extremity power in children and college age males [10]. Some studies on dynamic stretching have reported that enhancement of power and jump performance [13, 16] as well as no adverse effect [29].

Various studies have been conducted to find the effects of plyometric training and dynamic stretching, but no study has discussed about the combined and comparative effects of lower body plyometrics and lower body dynamic stretching on vertical jump performance in collegiate volleyball players. Therefore, the purpose of conducting this study was to determine the effects of lower body plyometrics and the combined and comparative effects of lower body plyometrics and lower body dynamic stretching program on vertical jump performance in a sample of male collegiate volleyball players.

METHODS

The study was carried out on a group of male collegiate volleyball players (n=90; average age: 19.6±0.89; height: 176±8cm; weight: 66±6kg). The players were recruited for the study only after approval from the institutional ethical committee and also written consent form was signed by all the participants, prior to starting the training program. None of the players had previously undergone plyometric training. They had no history of any musculoskeletal, neurological and cardio pulmonary impairments or recent injuries. The players were randomly assigned to one of three groups with thirty players in each group.

Group-1 (n=30): Control group (CG)

Group-2 (n=30): Lower body Plyometrics group (LPG)

Group-3 (n=30): Lower body Plyometrics with dynamic stretching group (LPDG)

All the players of group 2 & 3 had a preparatory training program and an orientation about the principles and techniques of lower body plyometric exercises. The group-3 (LPDG) underwent an additional training about the techniques and protocols of dynamic stretching exercises. The lower body plyometric exercises protocols were performed as per the guidelines described in high powered Plyometrics [23]. The lower body plyometric training started with a low intensity exercises consists of 3 sets of 10 repetitions, followed by moderate intensity plyometrics involves 3 sets of 8 repetitions and ended up with high intensity exercises consists of 3 sets of 6 repetitions (Table 1). The rest period between the lower body plyometric exercise series was 1-2 minutes for low intensity, 2-3 minutes for moderate intensity, 3-5 minutes for high intensity, 5-10 seconds rest between repetitions and 10 minutes rest between the set. The box height for low and high intensity exercises were maintained at 30 cm and 80cm respectively. For dynamic stretching protocols, the procedure was performed according to Yamaguchi and Ishii [30]. The group three players (LPDG) underwent the dynamic stretching exercises to dynamically stretch the lower limb muscles which are mainly required for vertical jumping such as gluteal muscles, hip adductors, quadriceps, hamstrings and calf muscles (Table 2) before the plyometric exercises. The dynamic stretching protocols consisted of 10 stretches of each muscle groups performed for 20 seconds. The procedure was performed on the right leg first followed by the left leg with a rest period of 10 seconds. However, the control group players (CG) were strictly not allowed to perform any type of plyometric and dynamic stretching exercises, other than their routine volleyball games. All the groups underwent a ten minutes warm up exercises prior to training and ended with an eight minutes cool down session (both warm up and cool down includes jogging, calisthenics and breathing exercises). The training sessions were performed twice in a week for an eight weeks period. All the players were tested for vertical jump height (VJH) using Sargent Jump test [25] prior to start of the training program. The assessments of vertical jump height were repeated at the end of 2, 4, 6 & 8 weeks of the training period.

Table 1: Lower body plyometric exercises performed by group 2 & 3

Sl.No.	Plyometric exercises	Intensity
1	Squat jump	Low
2	Jump to box	Low
3	Tuck jump	Medium
4	Split squat jump	Medium
5	Lateral hurdle jump	Medium
6	Zigzag jump	High
7	Single leg tuck jump	High
8	Depth jump	High

Table 2: Dynamic stretching exercises performed by group 3

Muscle groups	**Stretching techniques**
Gluteus	While walking, lift the knee towards the chest & raise the body on the toes of the opposite extended leg
Hip adductors	While walking forward, raise the trailing leg and place the hip in flexion (90^0) in an adducted and externally rotated position, with the knee flexed at 90^0. In this position , the limb is displaced forward as though the participants are stepping over an object just below their waist height and returned to normal walking stride position
Quadriceps	Heel ups. Rapidly kick heels towards buttocks while moving forward.
Hamstrings	While walking, swing the leg actively to be stretched forward into hip flexion until a stretch is felt in the posterior thigh while keeping the knee extended and the ankle in plantar flexion.
Calf muscles	Tip toe walking. Walking forward while completing alternating plantar flexion (tip toe) with every step forward. The aim is to raise the body as high as possible through tip toeing.

STATISTICAL RESULTS

All the data are presented as Mean±SD. Statistical analysis was calculated via a two way ANOVA with post hoc analysis by Bonferroni test. The significance level was set at *($p<0.05$).*

Table-3 shows the effect of vertical jump performance. The significant change in vertical jump height (VJH) was observed earliest at the end of 2nd week of training in both the experimental groups (LBP & LPDS) and these effects enhanced significantly with the training duration. The highest response was noticed at the end of 8th weeks. Compared to the control group (CG), the effect was significantly higher in both the experimental groups *(p<0.05).* However, the increased effect of VJH was more in group-3 (LPDS) from week 2 onwards *(p<0.05).* Signifying that, the effect of exercise on VJH was more in lower body plyometrics combined with dynamic stretching training program (Fig-1).

Table 3: Change in VJH of male volleyball players during 8 weeks study period.

Groups	VJH at different time points (in cm's)				
	Baseline	2 weeks	4 weeks	6 weeks	8 weeks
Group-1 (CG)	56.67 ± 1.17	56.01 ± 1.01	56.18 ± 1.00	56.21 ± 1.03	56.22 ± 1.06
Group-2 (LPG)	56.23 ± 1.28	57.43 ± 1.41*#	60.87 ± 1.64*#	63.31 ±1.97*#	66.33 ± 1.64*#
Group-3 (LPDG)	56.40 ± 0.88	58.13 ± 0.91*#	62.33 ± 0.88*#	66.17 ±0.84*#	69.15 ± 0.91*#

Mean ± SD of 30 subjects in each group.* *p<0.05* (significant), when compared with baseline (pre *v/s* post). *#p<0.05* (significant), when compared between groups (group-1 *v/s* group-2).

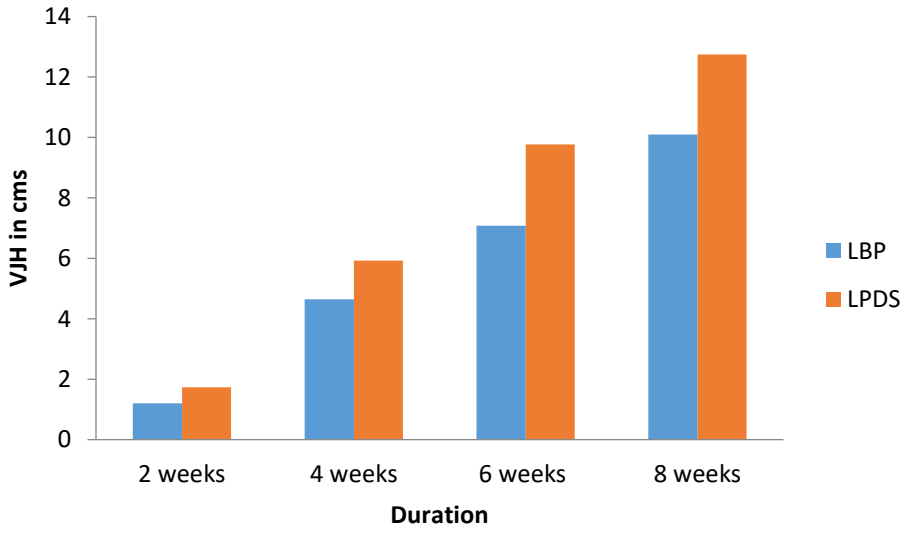

Fig.1: Comparison of mean change in VJH of LBP (G-2) and LPDS (G-3).

DISCUSSION

The purpose of this study was to determine whether eight weeks lower body plyometric training had any effect on vertical jump performance in collegiate male volley ball players and the aims further extended to find out whether any more advantageous effects when the dynamic stretching program is combined with lower body plyometric exercises. The result of the study proved that the lower body plyometric training twice in a week for an eight weeks period provides statistically significant enhancement in vertical jump height from week-2 onwards. These changes increased with the training duration throughout the study period. Vertical jump height increased only for the experimental training groups (Group-2 & 3) while no significant changes were found in the control group (Group-1).

Our study results are in line with the published results [5], which concludes that plyometric training improves vertical jumping ability. Another study on plyometrics reported that plyometric training significantly improves vertical jump height [17]. Usman & Shenoy (2015) reported that lower body plyometric training twice in a week for eight weeks showed significant improvement of vertical jump performance in male and female collegiate volleyball players [28]. The gained improvement on vertical jump height in our study indicates that neural adaptations have occurred because these predominate in the early stages of strength and power training [3]. Other factors may have contributed for the enhancement of vertical jump performance including a better synchronization of body segments, increased co-ordination levels and a greater muscular force [32]. Thus, the reported vertical jump enhancement in our study could be of practical relevance for trained athletes who participate in sports which involves vertical jump.

Interestingly, the results of the present study also showed a higher effect on vertical jump height in players who underwent dynamic stretching exercises prior to lower body plyometrics. This enhancement of VJH may be due to the result of increased neuromuscular function. The occurrence of post activation potentiation is believed to increase the rate of force development, thereby increasing speed and power production [2]. The mechanism associated with improvements in jump height following dynamic stretching is an increase in muscle spindle activity due to repeated stretch causing an agonist muscle to increase length and contract with greater force [12].

The results of this study are in accordance with earlier studies, Yamaguchi & Ishii (2005) which concluded that dynamic stretching of hip and knee flexors and extensors for five minutes (5 exercises of 1 x 30 seconds) resulting in greater leg extension power when compared to static stretching and non-stretching [30]. McMillan *et al* (2005) reported that dynamic stretching of major muscle groups for eight minutes (8 exercises of 1 x 20-30 seconds) demonstrated higher 5-step jump performance compared to a static stretch and no stretch condition [20].

In conclusion, the present study demonstrates that lower body plyometric training twice a week for an eight weeks period significantly improves the vertical jump height. However, the lower body plyometrics combined with dynamic stretching exercises provides better effects on vertical jump height in male collegiate volleyball players. Limitations of this study include the fact that all participants were male volleyball players. Future investigations should focus on determining any modification on the effects of lower body plyometrics with lower body dynamic stretching training program in female collegiate volleyball players. From this perspective, dynamic stretching exercises of lower limb musculature, which addresses the major muscle groups required for vertical jumping in prior to lower

body plyometrics can be recommended as an effective form of physical conditioning for augmenting the vertical jump performance of collegiate volleyball players and also for other athletes involved in sports with vertical jump performance.

ACKNOWLEDGEMENT

The authors would like to thank the volleyball players for their active participation. No financial support was received for this study and the authors have no professional relationship with a for – profit organization that would benefit from this study.

REFERENCES

1. Arazi H and Asadi A. *The effect of aquatic and land plyometric training on strength, sprint, and balance in young basketball players*. *Hum sport Exs*. 2011;6:101-111.
2. Asadi A and Arazi H. *Effects of high-intensity plyometric training on dynamic balance, agility, vertical jump and sprint performance in young male basketball players*. *Journal of Sport Health Research*. 2012;4(1):34-44.
3. Billot M, Martin A, Paizis C, Cometti C, and Babault N. *Effects of an electrostimulation training program on strength, jumping, and kicking capacities in soccer players*. *J Strength Cond Res*. 2010;24(5):1407-1413.
4. Bishop D. *Warm up II: performance changes following active warm up and how to structure the warm up*. *Sports Med*. 2003;33(7):483-498.
5. Bobbert MF. *Drop jumping as a training method for jumping ability*. *Sports Med*. 1990;9(1):7-22.
6. Canavan PK and Vescovi JD. *Evaluation of power prediction equations: peak vertical jumping power in women. Med Sci Sports Exerc*. 2004;36(9):1589-1593.
7. Donoghue OA, Shimojo H, and Takagi H. *Impact forces of plyometric exercises performed on land and in water. Sports Health*. 2011;3(3):303-309.
8. Ebben WP and Blackard DO. *Strength and conditioning practices of National Football League strength and conditioning coaches. J Strength Cond Res*. 2001;15(1):48-58.
9. Ebben WP, Carroll RM, and Simenz CJ. *Strength and conditioning practices of National Hockey League strength and conditioning coaches. J Strength Cond Res*. 2004;18(4):889-897.
10. Faigenbaum AD, Bellucci M, Bernieri A, Bakker B, and Hoorens K. *Acute effects of different warm-up protocols on fitness performance in children*. *J Strength Cond Res*. 2005;19(2):376-381.
11. Fredrick GA and Szymanski D. *Baseball (part I): dynamic flexibility*. *National strength cond j*. 2001;23(1):21.
12. Guissard N and Duchateau J. *Neural aspects of muscle stretching*. *Exerc Sport Sci Rev*. 2006;34(4):154-158.
13. Holt BW and Lambourne K. *The impact of different warm-up protocols on vertical jump performance in male collegiate athletes*. *J Strength Cond Res*. 2008;22(1):226-229.
14. Hough PA, Ross EZ, and Howatson G. *Effects of dynamic and static stretching on vertical jump performance and electromyographic activity*. *J Strength Cond Res*. 2009;23(2):507-512.
15. Lehnert M, Lamrová I, and Elfmark M. C*hanges in speed and strength in female volleyball players during and after a plyometric training program*. *Acta Univ Palacki Gymn*. 2009;39(1):59-73.
16. Manoel ME, Harris-Love MO, Danoff JV, and Miller TA. *Acute effects of static, dynamic, and proprioceptive neuromuscular facilitation stretching on muscle power in women. J Strength Cond Res*. 2008;22(5):1528-1534.
17. Markovic G, Jukic I, Milanovic D, and Metikos D. *Effects of sprint and plyometric training on muscle function and athletic performance*. *J Strength Cond Res*. 2007;21(2):543-549.
18. Markovic G and Mikulic P. *Neuro-musculoskeletal and performance adaptations to lower-extremity plyometric training*. *Sports Med*. 2010;40(10):859-895.
19. Martel GF, Harmer ML, Logan JM, and Parker CB. *Aquatic plyometric training increases vertical jump in female volleyball players. Med Sci Sports Exerc*. 2005;37(10):1814-1819.
20. McMillian DJ, Moore JH, Hatler BS, Taylor DC. *Dynamic vs. static-stretching warm up: the effect on power and agility performance*. *Br J Sports Med*. 2006;20(3):492-499.
21. Perrier ET, Pavol MJ, and Hoffman MA. *The acute effects of a warm-up including static or dynamic stretching on countermovement jump height, reaction time, and flexibility*. *J Strength Cond Res*. 2011;25(7):1925-1931.
22. Potteiger JA, et al. *Muscle Power and Fiber Characteristics Following 8 Weeks of Plyometric Training. J strength cond Res*. 1999;13(3):275-279.

23. Radcliffe J and Farentinos R. *High-Powered Plyometrics*, 2E: Human Kinetics; 2015.
24. Sale DG. *Postactivation potentiation: role in human performance*. *Exerc Sport Sci Rev*. 2002;30(3):138-143.
25. Sargent DA. *The physical test of a man. Am Physic Edu Rev*. 1921;26(4):188-194.
26. Simenz CJ, Dugan CA, and Ebben WP. *Strength and conditioning practices of National Basketball Association strength and conditioning coaches*. *J Strength Cond Res*. 2005;19(3):495-504.
27. Stojanović N, Jovanović N, Stojanović T. *The effects of plyometric training on the development of the jumping agility in volleyball players. Facta Univ Phys Edu and Sport*. 2012;10(1):59-73.
28. Usman T and Shenoy K. *Effects of lower body plyometric training on vertical jump performance and pulmonary function in male and female collegiate volleyball players. International J Appl Exs Physio*. 2015;4(2):9-19.
29. Wong PL, et al. T*hree days of static stretching within a warm-up does not affect repeated-sprint ability in youth soccer players*. *J Strength Cond Res*. 2011;25(3):838-845.
30. Yamaguchi T and Ishii K. *Effects of static stretching for 30 seconds and dynamic stretching on leg extension power. J Strength Cond Res*. 2005;19(3):677-683.
31. Zhang X. *Research of jumping ability and explosive power based on plyometric training*,in: *Informatics and Management Science III*: Springer; 2013.
32. Ziv G and Lidor R. *Vertical jump in female and male volleyball players: a review of observational and experimental studies. Scand J Med Sci Sports*. 2010;20(4):556-567.