International Journal of Scientific Research & Engineering Trends
Volume 6, Issue 1, Jan-Feb-2020, ISSN (Online): 2395-566X

Vertical Jump Height and Sprint Performance In State Level Soccer Players

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***Abstract* – Plyometric training (PT) is a widely used method to improve muscles' ability to generate explosive power. Plyometric is a type of exercise training designed to produce fast, powerful movements, and improve the functions of the nervous system, generally for the purpose of improving performance in a specific sport. Purpose of study: To find out the better plyometric training protocol for Soccer players to improve their vertical jump height performance on headed the ball and to improve their sprint performance. Methodology Sixty healthy soccer players (forty females and twenty males) within a age group of 18-22 years were randomly selected after testing the inclusive and exclusive criteria and divided into group A (n= 30, females= 20, males= 10) and group B (n= 30, females= 20 and males= 10). Both groups underwent two different plyometric protocols; each for 6 weeks, 2 times per week. The pre and post testing of Sargent jump test and 40- meter maximal sprint test were taken 0 week and 6 week for measuring the vertical jump height performance and sprint performance respectively. Result Both groups showed significant improvement in vertical jump height performance and sprint performance but there was no significant difference in both groups on vertical jump height performance and sprint performance. Both types of plyometric training are equally effective in improving the vertical jump height performance and sprint performance state level soccer players.**

***Keywords*- plyometric, vertical jump height, sprint, soccer.**

I. INTRODUCTION

Next generation communications systems are expected to Soccer has its roots in ancient China, Europe, and the Americas. People kicked a ball to prepare for war, to honor their gods, or just to entertain themselves. For centuries, different versions of ball-kicking games existed. In Europe, they were tests of courage and strength; in China and other Eastern countries, the games were rituals of grace and skill. The rules of the modern game of soccer were not drawn up until 1863, but the qualities that we admire in it – speed, agility, bravery, and spirit – have been present in many cultures for more than 2,000 years. 14

"Heading" is a special technique used in soccer. A well-headed ball is struck with the upper part of the forehead and the ball essentially bounces from the head. The types of header are characterized by the way in which momentum is transferred between the head and the ball. When a defender heads away a long ball his neck is braced and the bounce of the ball from his head transfers momentum to his body. Another situation in which momentum is taken by the body is in the diving header. In this case the whole body is launched at the ball and it is the speed of the body which determines the resulting Motion of the ball. 37 In the game of soccer, teams manipulate space and time in order to score and prevent goals. The concept of creating space often is difficult for young players to grasp. Intelligent movement off the ball creates both time and space. Players need to learn that making runs without the ball opens space for teammates and creates opportunities to score. Players must have good aerobic fitness, speed, strength, ball skills and understanding of basic Soccer strategies. The various components of play in soccer are strength, power, endurance and agility.

These can be developed through weight training, calisthenics, plyometric exercises and running. 33 During a 90-minute soccer match, professional soccer player makes numerous explosive bursts, like kicking, tackling, jumping, turning, sprinting, and changing pace.13 During a typical game, a 2- to 4- second sprint occurs every 90 seconds; sprinting occupies some 3% of playing time and accounts for 1–11% of the distance covered during a match.

Some 96% of sprints are shorter than 30 m, and 49% are 10 m. Thus, the performance over distances of 10 m or less, and the velocity attained during the first step are key indicators of player potential. A soccer match also demands numerous explosive movements, including some 15 tackles, 10 headings, frequent kicking, and changes of pace. Jumping ability and anaerobic performance are critical to the soccer player, and high scores for the squat counter movement jumps (CMJs) are to be anticipated in top players (0.40 and 0.65 m, respectively, in 1 study. Soccer is becoming progressively more athletic, and short-term muscle power has become crucial in many game situations.8

Plyometric training (PT) is a widely used method to improve muscles' ability to generate explosive power. Plyometric is a type of exercise training designed to produce fast, powerful movements, and improve the functions of the nervous system, generally for the purpose of improving performance in a specific sport. PT, in which a muscle is loaded and then contracted in rapid sequence, use the strength, elasticity and innervations of muscle and surrounding tissues to jump higher, run faster, throw farther, or hit harder, depending on the desired training goal. PT has been shown to increase power, jumping height and sprint performance. 13

It has been reported that, when myotendinous tissue is stretched, energy is stored and then released during muscle shortening. This type of exercise (plyometric or jumping) causes higher muscle tension compared to conventional resistance training. For this reason, plyometric (jumping) exercises are widely recommended for power enhancement in jumping and running velocity (RV). 17

Evidence states that plyometric training improves agility and vertical jump height. Plyometric exercises that involve stretching an active muscle prior to its shortening have been shown to enhance performance during the concentric phase of muscular contraction.5,10 Fewer studies exist on the use of traditional training factors and their interaction, such as programme duration, frequency, recovery time, volume and intensity. Training programme durations and frequencies vary considerably. Volume is usually defined as foot contacts or time spent performing the exercise. 29

It is widely accepted that jumping ability constitutes an integral component of explosive performance. It has also been stated that as competition and performance enhancement motivation levels increase, activity and sport specific movement patterns require increased power, agility and speed. Potteiger et al report that explosive leg power and vertical jump height are critical components of successful performance in many different athletic events. 21

The vertical jump is an essential skill that is utilized in most highly competitive sports. Many training regimens strive to maximize vertical jump ability to improve an athlete's performance in their respective sports; the skill used to reach a point high above the ground from a jump can often determine the difference between success and failure, wins and losses. 24

PT includes performance of various types of body weight jumping-type exercise, like drop jumps (DJs), countermovement jumps (CMJs), alternate-leg bounding, hopping and other SSC jumping exercises. Effects of PT on vertical jump performance have been extensively studied. Numerous studies on PT have demonstrated improvements in the vertical jump height. In contrast, a number of authors failed to report significant positive effects of PT on vertical jump height, and some of them even reported negative effects. Thus, at present, definitive conclusions regarding the effects of PT on vertical jump performance cannot be drawn.22

It is well known that soccer players rarely achieve maximal speed during play, but the initial starting phase and acceleration phase have a higher value in a soccer performance. Also, elite soccer players have greater values of high-intensity running when compared with total distance covered during a game. This results in the necessity for methods that enhance power performance in soccer players. 15

In regard to sprint training, a variety of methods have been used to improve RV, such as speed training, sprinting against resistances, combined resistance and speed training, and plyometric training. However, the existing information concerning the effectiveness of plyometric training on RV in adults is conflicting. Some studies have found that plyometric training had a significant effect on RV, whereas others have reported no significant improvements. Additionally, positive results were obtained for RV when resistance training was combined with plyometric training on consecutive days. 17

II. METHODOLOGY

Participants: Pre and Post test experimental design was chosen for the study. 60 state level soccer players (40 females and 20 males) voluntarily participated in the study. Subjects were randomly assigned to two groups, group A (20 females and 10 males) and group B (20 females and 10 males) after screening themon the basis of inclusion criteria and exclusion criteria. Subjects were taken from Subhash Stadium, Sonipat. Inclusion criteria: males and females subjects: age group of 18-22 years involved in regular practice and competition for last 1 year and playing at state level but should not be performing a fixed, supervised protocol of plyometric training. Subjects should without any history of pain and injury of lower limbs and tested for Battery of Stabilization strength test. Exclusion criteria: presented

International Journal of Scientific Research & Engineering Trends
Volume 6, Issue 1, Jan-Feb-2020, ISSN (Online): 2395-566X

with any musculoskeletal injury to lower- limbs within 6 months, any lower limb reconstructive surgery in past 2 years, any lower limb deformity and joint instability, any neurological or cardio- respiratory problem.

Procedure: Before enrolling the subjects in the study, consent was being taken from them. Plyometric training was done 2 times per week for 6 weeks in both groups. The subjects had to perform the Sargent standard jump test and 40 meter maximal run test that would assess the vertical jump height performance and sprint performance respectively. These tests were conducted at beginning of the session at day 0 and by the end of training session of 6 week period.
Group A- Plyometric training protocol 1 (Chimera N.J et al.) 9 30 Sec. rest between sets and 2 min between exercises.

Week	Exercise*
1	Wall touches (3x 30 s) Split squat jumps (2x40) Lateral cone jumps(2x30) Cone hops with 180° turn (4 cones x 10)
2	Wall touches (4x 30 s) Split squat jumps (2x50) Lateral cone jumps(2x40) Cone hops with 180° turn (4 cones x 20)
3	Wall touches (5x 30 s) Split squat jumps (2x60) Lateral cone jumps(2x50) Cone hops with 180° turn (4 cones x 30)
4	Wall touches (5x 30 s) Split squat jumps (2x60) Lateral cone jumps(2x50) Cone hops with 180° turn (4 cones x 30) Drop jumps: 45.72 cm(20)
5	Wall touches (5x 30 s) Split squat jumps (2x60) Lateral cone jumps(2x50) Cone hops with 180° turn (4 cones x 30) Drop jumps: 45.72 cm(30)
6	Wall touches (6x 30 s) Split squat jumps(2x70) Lateral cone jumps(2x60) Cone hops with 180° turn (4 cones x 40) Drop jumps: 45.72 cm(40)

Group B- Plyometric Training Protocol 2 (Sankey et al.) 30 The platform was used in all plyometric drills will of 0.4 m (40cm) in height.

Week	Exercise
1 and 2	Ankle Hops (2 x 15) Alternate leg push offs (2 x 25) Standing vertical jumps (2 x 20) Squat Jumps (2x 10) (30 – 60 s recoveries between sets)
3 and 4	Tuck jumps (2 x 10) Alternate leg bounds (2 x 10) Two-footed bench hops (2 x 15) Rim Jumps (2 x 20) (60 – 90 s recoveries between sets)
5 and 6	Bench Depth Jumps (2 x 10) Box to box jumps (2 x 10) Single leg vertical jumps (2 x 10) Box to box squat jumps (2 x 10) – 10 s between reps / 120 – 180 s between sets)

1. Data Analysis: The data was managed on an excel sheet and was analyzed using SPSS software (version- 21) with a difference of $p \leq 0.05$ considered statically significant. Statistical tests used were: Paired t – test for pre and post intervention sprint performance and vertical jump height performance for each group. Independent t test for inter group comparison difference in sprint performance and vertical jump height performance.

2. Results: On comparing the demographics of both groups, there was no significance difference in age, gender, height and weight.

Table I: Comparison of demographics between Group A, n= 30 and Group B, n=30

Variable	Gp.-1		Gp.-2		t-value	p-value
	Mean	±SD	Mean	±SD		
Age (Years)	18.86	0.89	19.16	1.23	1.076	0.286[NS]
Gender	3.33	0.47	3.33	0.47	0.001	1.000[NS]
Height(cm)	164.40	5.32	162.73	5.85	1.154	0.253[NS]
Weight(KG)	51.63	5.56	52.66	5.72	0.709	0.481[NS]

Keywords – n: Number of subjects, S.D: Standard Deviation, NS: Non Significant, *: Significant ($p \leq 0.05$), **: Highly significant ($p \leq 0.01$) On comparing the sprint performance in group A between pre- intervention and post- intervention, showed highly significant difference at $p \leq 0.01$ level indicating that there was improvement in the sprint performance.

Table II: Comparison of Sprint Performance (sec.) in Group A, n= 30 between pre and post intervention

sprint performance	Mean	±SD	t-value	p-value
Pre test	10.70	1.14	10.49	0.001**
Post test	9.75	0.78		

Keywords – n: Number of subjects, S.D: Standard Deviation, NS: Non Significant, *: Significant ($p \leq 0.05$), **: Highly significant ($p \leq 0.01$) On comparing the vertical jump height performance in group A between pre-intervention and post- intervention, showed highly significant difference at $p \leq 0.01$ level indicating that there was improvement in the vertical jump performance.

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Table III: Comparison of Vertical Jump Height Performance (cm) in Group A, n= 30 between pre and post intervention

Vertical jump performance	Mean	±SD	|t|-value	p-value
Pre test	35.00	8.69	13.22	0.001**
Post test	38.73	8.81		

Keywords – n: Number of subjects, S.D: Standard Deviation, NS: Non Significant , *: Significant ($p \leq 0.05$), **: Highly significant ($p \leq 0.01$)

On comparing the sprint performance in group B between pre- intervention and post- intervention, showed highly significant difference at $p \leq 0.01$ level indicating that there was improvement in the sprint performance.

Table IV: Comparison of Sprint Performance (sec.) in Group B, n= 30 between pre and post intervention

Sprint performance	Mean	±SD	t-value	p-value
Pre test	10.73	0.97	9.3	0.001**
Post test	9.88	0.53		

Keywords – n: Number of subjects, S.D: Standard Deviation, NS: Non Significant, *: Significant ($p \leq 0.05$), **: Highly significant ($p \leq 0.01$)

On comparing the vertical jump height performance in group B between pre- intervention and post- intervention, showed highly significant difference at $p \leq 0.01$ level indicating that there was improvement in the vertical jump height performance.

Table V: Comparison of Vertical Jump Height Performance (cm) in Group B, n= 30 between pre and post intervention.

Vertical jump performance	Mean	±SD	|t|-value	p-value
Pre test	33.10	6.64	20.00	0.001**
Post test	35.91	6.61		

Keywords – n: Number of subjects, S.D: Standard Deviation, NS: Non Significant , *: Significant ($p \leq 0.05$), **: Highly significant ($p \leq 0.01$)

On Group comparison of sprint performance (pre and post intervention) in Group A and Group B, there was no significant difference at pre- testing and post- testing in between both groups.

Table VI: Group comparison of sprint performance (sec.) (pre and post intervention) in Group A, n= 30 and Group B, n= 30

Sprint performance	Gp.-1		Gp.-2		|t|-value	p-value
	Mean	±SD	Mean	±SD		
Pre test	10.70	1.14	10.73	0.97	0.091	0.928^{NS}
Post test	9.75	0.97	9.88	0.53	0.755	0.454^{NS}

Keywords – n: Number of subjects, S.D: Standard Deviation, NS: Non Significant , *: Significant ($p \leq 0.05$), **: Highly significant ($p \leq 0.01$)

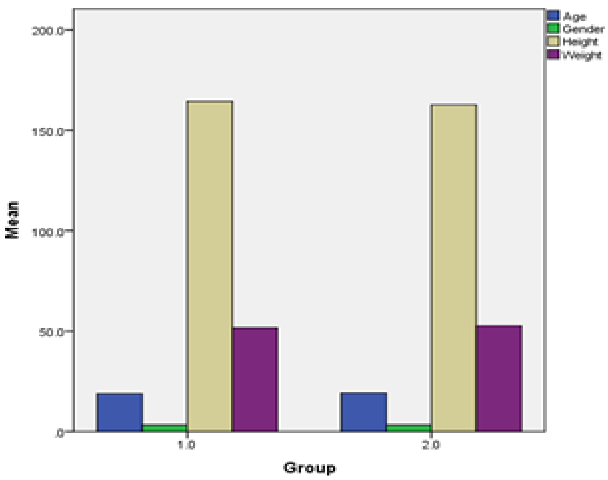
On Group comparison of vertical jump height performance pre and post intervention) in Group A and Group B, there was no significant difference at pre-testing and post- testing in between both groups.

Table VII: Group comparison of vertical jump heigh performance (cm) (pre and post intervention) in Group A, n= 30 and Group B, n= 30

Vertical jump height	Gp.-1		Gp.-2		t-value	p-value
	Mean	±SD	Mean	±SD		
Pre test	35.00	8.69	33.10	6.64	0.949	0.347^{NS}
Post test	38.73	8.81	35.91	6.61	1.400	0.167^{NS}

Keywords – n: Number of subjects, S.D: Standard Deviation, NS: Non Significant, *: Significant ($p \leq 0.05$), **: Highly significant ($p \leq 0.01$)

Fig. 1 Comparison of demographics between Group A= 1 and Group B= 2.



International Journal of Scientific Research & Engineering Trends
Volume 6, Issue 1, Jan-Feb-2020, ISSN (Online): 2395-566X

Fig. 2 Comparison of Sprint Performance (sec.) in Group A= 1 & Group B= 2 between pre and post intervention

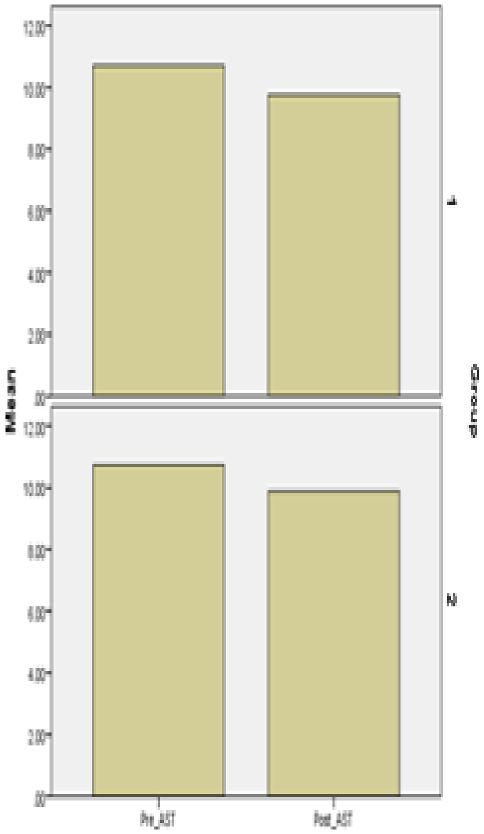


Fig. 3 Comparison of Vertical Jump Height Performance (cm) in Group A= 1 & Group B= 2 between pre and post intervention

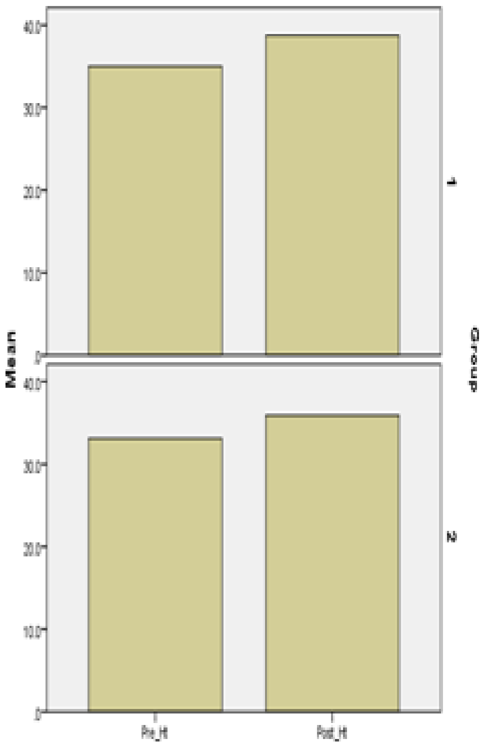


Fig. 4 Group comparison of sprint performance (sec.) (pre and post intervention) in Group A=1 and Group B= 2

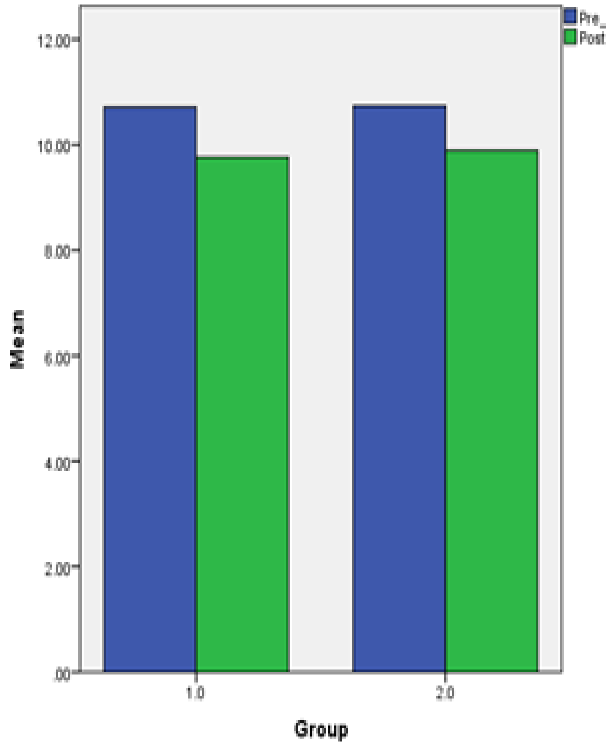
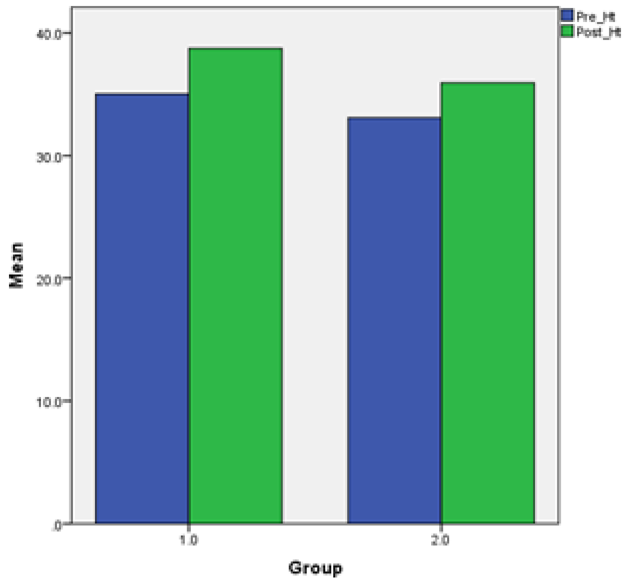


Fig. 5 Group comparison of vertical jump height performance (cm) (pre and post intervention) in Group A=1 and Group B= 2.



3. Discussion:

The purpose of the present study was to compare the effects of two plyometric training programs on the performance of the sprint and the vertical jump height among state level soccer players. Subjects were divided into 2 groups. The 'group - A plyometric training' group consisted of 30 players. The 'group - B plyometric training' group consisted of 30 players.

Data analysis revealed that post intervention there was an improvement in sprint and vertical jump height within the groups ($p \leq 0.05$). Within group analysis revealed that there was a significant improvement ($p \leq 0.05$) invertical jump height when pre and post intervention scores were compared in both the groups. The pretesting vertical jump height in 'group – A plyometric training' group was 35.00±8.69 cm and post testing was 38.73±8.81 cm. The pretesting vertical jump height in 'group – B plyometric training' group was 33.10±6.64 cm and post testing was 35.91±6.61 cm.

The reason for increase in vertical height jump performance could be due to elastic and neural benefits of stretch- shortening cycle.21 This stretch- shortening cycle decreases the time of the amortization phase that in turn allows for greater than normal power production29 which increases the store kinetic energy in elastic components of muscles of hip and thigh specific to vertical jumping. 1

In group - A, the other reason could be due to the effect of plyometric protocol on increase in co activation of adductor to abductor and quadriceps to hamstrings muscle around the hips and thigh, as Chimera et al. found positive result similar to our study in female athletes. 9

As in this group, there was a progression of protocol by increasing the foot contacts of exercise after each week completion of training 3,9,10, which would lead to improvement on vertical jump height performance.

The improvement in vertical jump height were 10.65% in group - A and 8.48% in group - B as compared to previous studies done by Markovic et al. used drop jump and squat jump plyometric found 4.7% improvement on vertical jump performance 22 and Chimera et al. had found 5.8% improvement on vertical jump performance with similar protocols. 9

The reason for increase in vertical jump height performance in groups - A due to state level players both male and female samples whereas Chimera et al. used only female players. 9

In group - B the progression of protocol by increasing the intensity of exercise by changing the exercise techniques like adding of depth jumps, box to box squat jumps and single leg jump (using the body weight on single limb for adding the load) etc. These types of changes increased the stretch load (kinetic energy) 10, which could also enhance the vertical jump height performance. And Thomas et al. had found depth jump from 40 cm height have a significant positive effect on vertical jump height performance. 36

The reason for increase in vertical jump height performance in group - B due to adult age group (19.16± 1.23 years) whereas Sankey et al. used adolescent age group (14.5± 0.5 years). 30

Within group analysis revealed that there was a significant improvement ($p \leq 0.05$) in sprint performance when pre and post intervention scores were compared in all the groups. The pretesting sprint time in 'group - A plyometric training' group was 10.70±1.14 second and post testing was 9.75±0.78 seconds. The pretesting sprint time in 'group - B plyometric training' group was 10.73±0.97 seconds and post testing was 9.88±0.53 seconds.

The reason for improvement in sprint performance could be due to increase in lower limb power and explosive strength. Previous researchers had shown that vertical jump height performance is significance of lower limb power and explosive strength, 28 there would be transfer of lower limb power to biomechanically similar movement in running that require a powerful thrust from hips and thighs 29, which would lead to improvement on sprint performance. In our results, there was significant improvement on vertical jump height performance in both groups. So, this reason would be same for both groups. Other reason may be due to increased in neuromuscular adaptation due to plyometric training. Researchers shown that increase in neuromuscular adaptation contributed to enhance sprint performance. 8

The other potential reason on sprint performance in group - A could be due to of plyometric box that raise the height of drop jump. Which was also been used by Mero et al. had found that there is an effect of rise in centre of gravity in drop jump on enhancing maximal running velocity.8

Moreover for rise in sprint performance could be due to the effect of specific hip flexor exercise used in both protocols. 13 As in group - A was used wall touches, split squat etc. and in group B was used depth jumps, rim jumps, box to box jumps etc. When we analysed between the group, it was found that there was no significant difference in both groups at pre- testing ($p \geq 0.347$) and post - testing ($p \geq 0.167$) on vertical jump height performance. And there was no significant difference in both groups at pre- testing ($p \geq 0.928$) and post - testing ($p \geq 0.454$) on sprint performance too.

The reason for the similar result could be the "progression of both protocols". The interventions were given for same period i.e. twice in a week for 6 weeks. For the progression in group - A the increase in the foot contacts was done. While in group - B the progression was done by manipulating the intensity by increasing the loading of legs. Hence it can be summarised that these progression have produced statistically non – significant difference between the groups.

V. CLINICAL RELEVANCE OF STUDY

Six weeks of plyometric training in two sessions per week can enhance the vertical jump height and sprint performance in adult age group, either by increasing the volume or intensity study shows equal improvement in both.It is suggested that it may be possible to reduce the stress on the muscle tendon unit caused by high intensity plyometric exercises while achieving the same mechanical and neurophysiologic conditioning benefits.

VI. LIMITATIONS OF THE STUDY

This study included the both types of genders in both groups. But the numbers of females were more than males. Sample included was population with age 18-22 years, so, results cannot be generalized to population of other age groups. The monotonous nature of the training required high levels of motivating skills on the part of the therapist. Since the study was done only 60 subjects, the smaller size used cannot be generalised for larger population group.

VII. FUTURE RESEARCH

Both plyometric protocols can be compared on the performance of vertical jump height and sprint measured by video analyser. Both plyometric protocols can be compared on performance of different variables like dynamic balance and agility. Effect of both plyometric protocols on muscle activation strategies can be compared. Different better designed protocols on manipulation of volume and intensity can be compared on performance of vertical jump height and sprint performance.

VIII. CONCLUSION

It can be concluded from the research that both plyometric training protocols are equally effective on vertical jump height and sprint performance in state level soccer players.

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