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Effect of twelve weeks plyometric training on leg explosive strength for 14 to 19 year old athletes

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Abstract
Introduction: Plyometric training helps athletes to build muscle power. Several studies on the different sports disciplines proved that plyometric training activates the stretch reflex mechanism in the muscle and improves the leg explosive strength. The goal of this study was to determine whether systematic plyometric training improved explosive leg strength.
Objective: To know the effect of plyometric training on leg explosive strength for 14–19-year-old athletes.
Methods: Forty state level athletes (Age:15±2.37 years, Height:160±6.9cm, Weight:50±7.4 kg) from Barasat Athletic Club, North 24 Parganas district, West Bengal, India, were purposively selected as subjects for the present study. The subjects (n=40) were randomly assigned to three groups of ten subjects each groups- Group-I, II, III: Experimental (sprinters, jumpers and throwers) Group and Group-IV: Control Group which was formed randomly by taking 10 subjects. Pre-test was conducted for all the subjects on selected leg explosive strength (power) parameters. The leg explosive strength (power) parameters were measured by standing broad jump (meter) Test. The initial test score formed the pre-test score for the subjects. Experimental Groups-I, II, III (sprinter, jumper, thrower) were exposed to plyometric training (hurdles hops, squat jump, box jump, depth jump) and while the Control Group was not exposed to plyometric training other than their regular daily activities. The duration of the experimental period was 12 weeks. After the experimental treatment, all forty subjects in the form of three experimental and one control group were tested on leg explosive strength (power) parameters. These final test scores formed the post-test. The pre-test and post-test scores were subjected to statistical analysis using the t-test. The level of significance was judged at 0.05 level of significance.
Result and Discussion: The above table indicates a significant difference between pre-test and post-test leg explosive strength (power) performance for the experimental group (sprinters, jumpers and throwers) who were involved in the plyometric training programme, whereas the table indicates an insignificant difference for the control group.

Mean and SD of Leg Explosive Strength for Experimental (Sprinter, Jumper, Thrower) and Control Groups between Pre-test and Post-test.

Group	Test	Mean	SD	df	Cal. "t" value
Experimental (Sprinter)	Pre-test	2.49	0.25	9	3.78
	Post-test	2.57	0.27		
Experimental (Jumper)	Pre-test	2.67	0.28	9	2.21
	Post-test	2.79	0.31		
Experimental (Thrower)	Pre-test	2.10	0.16	9	3.05
	Post-test	2.40	0.17		
Control group	Pre-test	2.43	0.29	9	1.59
	Post-test	2.47	024		

∗level of significance was judged at 0.05 level Tab. "t" =2.14

Conclusion: After twelve weeks of plyometric training compares the experimental group with control group; the results showed that the plyometric training was more effective for the all experimental groups. The plyometric training of twelve weeks training duration leads to a significant effect on the leg explosive strength of 14-19 year old athletes.

Keywords: Plyometric, training, leg explosive strength, athlete, sprinter, jumper, thrower

Introduction
The term "plyometric" was introduced by Fred Wilt after following Soviet athletes' preparation for their sports in track and field. He began discussing with trainer Michael Yeses on the contribution of plyometric. It was primarily adjusted by Soviet Olympians in the 1950s, and then sporting worldwide. Plyometric training involves explosive practises to activate the first response and an elastic proportion of the main muscles.

Sports that utilise the plyometric include basketball, squash and football as well as the different codes of football.

Plyometric training helps athlete to build muscle power. Several researches on the different sports disciplines proved that plyometric training activates the stretch reflex mechanism in the muscle and improves the leg explosive strength. The goal of this study was to determine whether systematic plyometric training improved explosive leg strength in 14–19-year-old athletes.

Plyometric training is a type of training designed to increase muscle power. Athletes, basketball players, footballers and sometimes boxers incorporate plyometric training into their training schedule. Plyometric training includes high intensity drills such as jump hops and bounds which result in explosive bursts of power and speed.

Sprint success is determined largely by the power-mass ratio, so sprinters aim to increase muscle mass and power (Tipton KD., 2009) [8]. Sprinting is running over a short distance at the top most speed of the body in a limited period of time. It is used in many sports that incorporate running, typically as a way of quickly reaching a target or goal or avoiding or catching an opponent.

The jumping and throwing events are won by the athlete who achieves the greatest distance or height. Regular jumping events include long jump, triple jump, high jump and pole vault, while the most common throwing events are shot put, javelin, discus and hammer (Wikipedia.org).

Thomas, *et al*. (2009) [7] Conducted a study "Effects of two plyometric trainings on power and agility" on twelve males from semi-professional football club's academy who were randomly selected and subjected to plyometric training for 6 weeks. Pre-test and post-test were conducted to the subjects belong to depth jump and counter movement jump group. Finally it was concluded that depth jump and counter movement jump plyometric improved power and agility.

Campillo, *et al*. (2013) [6] Conducted a study "Plyometric training on different volume and training surfaces on neuromuscular performance" on 4 groups: moderate volume group (n=9), moderate volume hard surface group (n=8), high volume group (n=7) and control group (n=5). The results reveal that high training volume significantly increased the explosive performance

For the present study the intention was to find out the improvement of the leg explosive strength for the 14-19year old athlete due to plyometric training programme.

Objective of study

1. To know the effect of plyometric training on leg explosive strength for the 14-19year old sprinters.
2. To understand the effect of twelve weeks of plyometric training on leg explosive strength for 14-19year old jumpers.
3. To understand the effect of twelve weeks of plyometric training on leg explosive strength for 14-19year old throwers.
4. To judge the effectiveness of plyometric training in case of 14-19year old sprinters, jumpers and throwers.

Methodology

For the study, 40 athletes (Age: 15±2.37 years, Height: 160±6.9 cm, Weight: 50±7.4 kg) were randomly selected as subjects. The age of the subjects ranged between 14 to 19 years' and they belong to state levels athletes. The selected subjects were divided into three experimental groups namely sprinters, jumpers and throwers groups & one control group with ten subjects in (10) each groups. Three experimental groups (sprinters, jumpers and throwers) were trained by plyometric training protocol for the twelve weeks with daily normal activities but the control group didn't receive plyometric training protocol.

All the subjects were instructed about the nature and purpose of the study and their consent was obtained to help till the end of the experiment and testing time. All experimental groups and the control group practise the daily normal exercise. Qualified coaches examined the subject's physical fitness for the study. All subjects were fit for the study because everyone had achieved at state level school games competition.

The study was formulated by using a true random group design and single pre-test and post-test research design. Forty state level athletes from the Barasat Athletic Club, North 24 Parganas district, West Bengal, India were selected as subjects a randomly and their ages ranged from 14-19 years. The subjects (n=40) were randomly selected from the sprinters, jumpers and throwers. One control was formed randomly by selecting 10 subjects from the different discipline. The leg explosive strength was measured by the standing broad jump test. Pre-test was conducted for all the subjects on leg explosive strength. The initial test score formed the pre-test scores for the subjects. The group was assigned as experimental Group-I (sprinter), Group-II (jumper) and Group-III (throwers) were exposed to plyometric training. The duration of the training period was 12 weeks. After the experimental treatment, all forty subjects in the form of three experimental and one control group were tested on their leg explosive strength. The pre-test and post test scores were subjected to statistical analysis using 't-test' for the study. In all cases 0.05 level of significance was fixed to judge the significance.

The plyometric training programme was designed on the basis of resources collected from books, periodicals, e-materials and discussions with the experts. The duration of plyometric training was planned for 60 minutes. The subjects reported for plyometric training between 3.00 pm and 4.00 pm. All the subjects involved in this study were carefully monitored throughout the training programme and 90 percent attendance of them was considered.

Plyometric Training Protocol:
Total duration: 12 weeks
Frequency: 3 days per week
Duration of a training session: 1 hours

Exercise Name	Sets &Reps	Rest
1.Box Jump	2x4	2 min
2.Squat Jump	2x4	2 min
3.Depth Jump	3x4	4 min
4.Hurdles Hops	3x4	4 min

Mean and Standard Deviation were calculated as descriptive statistics and to find out the differences between the pre-test and post-test of each groups, paired sample 't-test' was used.

Results and Discussion

Table 1: Mean and SD of Leg Explosive Strength for Sprinters between Pre-test and Post-test.

Group	Test	Mean	SD	df	Calculated "t" value
Experimental-I (Sprinters)	Pre-test	2.49	0.25	9	3.78
	Post-test	2.57	0.27		

∗level of significance was judged at 0.05 level. Tab. "t" =2.14

From the above table, the mean and SD value of the standing broad jump (meter) of the pre-test and post-test of the experimental group (sprinter) are 2.49 and 2.57& 0.25 and 0.27 respectively. The calculated't' value of the experimental group is 3.78 and table value is 2.14. On the basis of the result, the 't' value of experimental group (3.78) is greater than the table value (2.14). So it may be stated that a twelve week plyometric training programme had a significant effect on leg explosive strength for sprinters. The present study clearly showed that the post-test performances were significantly better than the pre-test performances by the treatment of plyometric training on the sprinters.

Table 2: Mean and SD of Leg Explosive Strength for Jumpers between Pre-test and Post-test

Group	Test	Mean	SD	df	Calculated 't' value
Experimental –II (Jumpers)	Pre-test	2.67	0.28	9	2.21
	Post-test	2.79	0.31		

∗level of significance was judged at 0.05 level. Tab. "t" =2.14

From the above table, the mean and SD value of the standing broad jump(meter) of the pre-test and the post-test of the experimental group (jumper) are 2.67 and 2.79& 0.28 and 0.31 respectively. The calculated 't' value of the experimental group is 2.21 and table value is 2.14. On the basis of the result, the't' value of the experimental group (2.21) is greater than the table value (2.14). So it may be stated that a twelve week plyometric training programme had a significant effect on leg explosive strength of jumpers. The present study clearly showed that the post-test performances were significantly better than pre-test performance by the treatment of plyometric training on the jumpers.

Table 3: Mean and SD of Leg Explosive Strength for Throwers between Pre-test and Post-test

Group	Test	Mean	SD	df	Calculated 't' value
Experimental –II (Throwers)	Pre-test	2.10	0.16	9	3.05
	Post-test	2.40	0.17		

∗level of significance was judged at 0.05 level. Tab. "t" =2.14

From the above table, the mean and SD value of the standing broad jump (meter) of the pre-test and the post-test of experimental group (throwers) are 2.10 and 2.40& 0.16 and 0.17 respectively. The calculated 't' value of the experimental group is 2.21 and table value is 2.14. On the basis of the result, the 't' value of experimental group (3.05) is greater than the table value (2.14). So it may be stated that a twelve week plyometric training programme had a significant effect on the leg explosive strength for throwers. The present study clearly showed that the post-test performances were significantly better than the pre-test performances by the treatment of plyometric training on the throwers.

Table 4: Mean and SD of leg explosive strength for Control Group between Pre-test and Post-test

Group	Test	Mean	SD	df	Calculated 't' value
Control Group	Pre-test	2.43	0.29	9	1.59
	Post-test	2.47	0.24		

∗level of significance was judged at 0.05 level. Tab. "t" =2.14

From the above table, the mean and SD value of the standing broad jump (meter) of pre-test and post-test for the control group are 2.43 and 2.47& 0.29 and 0.24 respectively. The calculated 't' value of the control group is 1.59 and the table value is 2.14. On the basis of the result, the 't' value of the control group (1.59) is lower than the table value (2.14). So it may be stated that due to the lack of twelve weeks plyometric training programme in the control group, there was no significant effect on leg explosive strength for the control group. The present study clearly showed that the post-test performances were not significantly better than the pre-test performances for the control group.

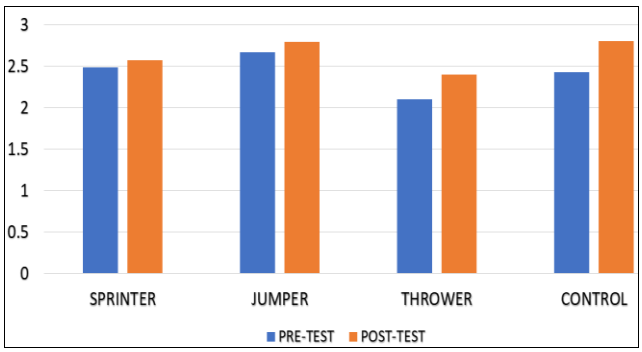

Fig 1: Graphical Representation of Mean on Standing Broad Jump (meter) Performance at Pre-test and Post-test for Different Groups.

Adams, T., *et al.* (1984) [1] through the investigation on selected plyometric training exercises on muscular leg strength and power concluded that plyometric training in the short term is effective to the development of muscle power and contributes to the achievement of physical education and sports activities using explosive muscle contractions. In the present study plyometric training of 12 twelve week duration also significantly improved the standing broad jump performance of the different experimental groups. Ford, H.T., *et al.* (2013) [4] conducted a study entitled **"**Effects of three combinations of plyometric and weight training programs on selected physical fitness test items". Reported that plyometric training induced a significant decrease in the stiffness of the active portion of the series elastic component (cross-bridges or myofibrils), but also reported an increase in passive muscle properties. The result of the present study is due to the above stated explanation.

The present study clearly showed that the post-test performances were significantly better than the pre-test performances as a result of 12-week plyometric training for each experimental group. In this context, increased distance indicates improved standing broad jump performance for 14-19 year old athletes. In the post-test, an increase in distance means an improvement in the performance of the standing broad jump (sprinters, jumpers, and throwers) except in the control group. As the control group didn't receive any plyometric training except their daily scheduled exercise, it is clear that the plyometric training is the only factor resulting in the significant improvement in leg explosive strength for 14–19-year-old sprinters, jumpers, and throwers. The present study showed that the explosive leg strength for all experimental groups showed much more improvement between the pre-test and the post-test than the explosive leg strength for the control group. It may be stated that the strength of the legs increased due to the improvement of muscle fibre in sprinters, jumpers, and throwers. In this research, application of a plyometric training programme increased overall muscular power, particularly more effectively for sprinters

Conclusion

On the basis of the results obtained from the present study the following conclusions may be drawn:

1. The performance of the leg explosive strength improves by a plyometric training programme.
2. The leg explosive strength for 14-19year old sprinters, jumpers and throwers are improved by the treatment of 12 week plyometric training programme.
3. The explosive leg strength of the 14-19year old sprinters is most effectively improved as compared to the 14-19year old jumpers and throwers.
4. Plyometric training should be included in the normal training program for the athlete to achieve the better athletic performance for 14–19-year-old sprinters, jumpers, and throwers.

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