EFFECT OF LOW-INTENSITY PLYOMETRICS ALONG WITH CORE STABILITY TRAINING TO IMPROVE LONG JUMP DISTANCE IN HIGH SCHOOL AMATEUR LONG JUMP PLAYERS

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Abstract:

Background - Long jump is one of the oldest track and field event, where athletes consolidate speed, strength and agility in an attempt to jump as far as possible from a take-off point. Plyometrics assists in the development of power, a foundation from which the athlete can refine the skills of their sports. Core muscle strength is a major prerequisite for many sporting activities, and also day to day activities. Purpose of the study was to assess effectiveness of low-intensity plyometrics training along with core stability training on long jump distance and core endurance in high school amateur long jump players. **Methodology** - Forty amateur long jump players both male and female with 6 months of training were included in the study. Inclusion and exclusion criteria were assessed, informed consent was taken and ethical clearance was obtained from the institution. Subjects were then divided into 2 groups, group A(n = 20:low-intensity plyometrics along with core stability exercise) and group B(n = 20 :low intensity plyometrics) pre and post measurement was taken by standing jump test to measure long jump distance and core endurance test to measure core stability. **Results**- The base line mean score for standing jump test between Group A and B was 52.11 and 53.17 respectively. The post training mean score for standing jump test between Group A and B was 69.22 and 64.72 respectively which was statistically significant(p= 0.037).**Conclusion**- low-intensity plyometrics along with core stability training resulted in improving standing jump distance and core endurance more significantly when compared with low-intensity plyometrics only.

Keywords: Long jump, Plyometric, Core stability, Core endurance, SLJ, SSC.

I.INTRODUCTION:

Long jump athletes consolidate speed, strength, and agility in an attempt to jump as far as possible from a takeoff point. The long jump has four unmistakable components: the approach, the takeoff, the jump and the landing.[1] Basic Training required for the long jump: - Speed work, Jumping, Over- distance, Weight training Plyometric, Flexibility. (2)Plyometrics refers to exercise that link strength with speed of movement to create power. Plyometrics training utilizes the stretch shortening cycle (SSC) which consists of a rapid stretching of a muscle (eccentric action) immediately followed by a concentric or shortening action of the same muscle and connective tissue. These movements are components that can help in developing agility, among the numerous types of available exercise plyometrics assists in the development of power, a foundation from which the athlete can refine the skills of their sports. (3, 4)Research has demonstrated that plyometric training can increase bone strength, enhance muscular power and improve speed and agility .Movement skills which involve lower limbs are extremely important in developing athleticism therefore, plyometric can play a critical role in the development of athletic ability in the young athlete (5, 6)

Core stability relates specifically to the bodily area which is bounded by the abdominal wall in the front, the lower back, the diaphragm at the top and the pelvis that forms the floor, muscle and its capability to stabilize the body during movement. The stabilizing system consists of passive (ligaments and bones), active (muscles) and neural structures. (7)Core musculature can be divided into local and global categories. Local muscles are defined as those attaching to the lumbar vertebrae and influencing inter-segmental motion, while global muscles attach to the hips and pelvis and promote mobility and proper orientation of the spine. Main muscles which are involved are rectus abdominis, transverses abdominis, internal and external oblique, quadratus lumborum, erector spinae, iliopsoas and multifidus lumbar. (8)The core works in

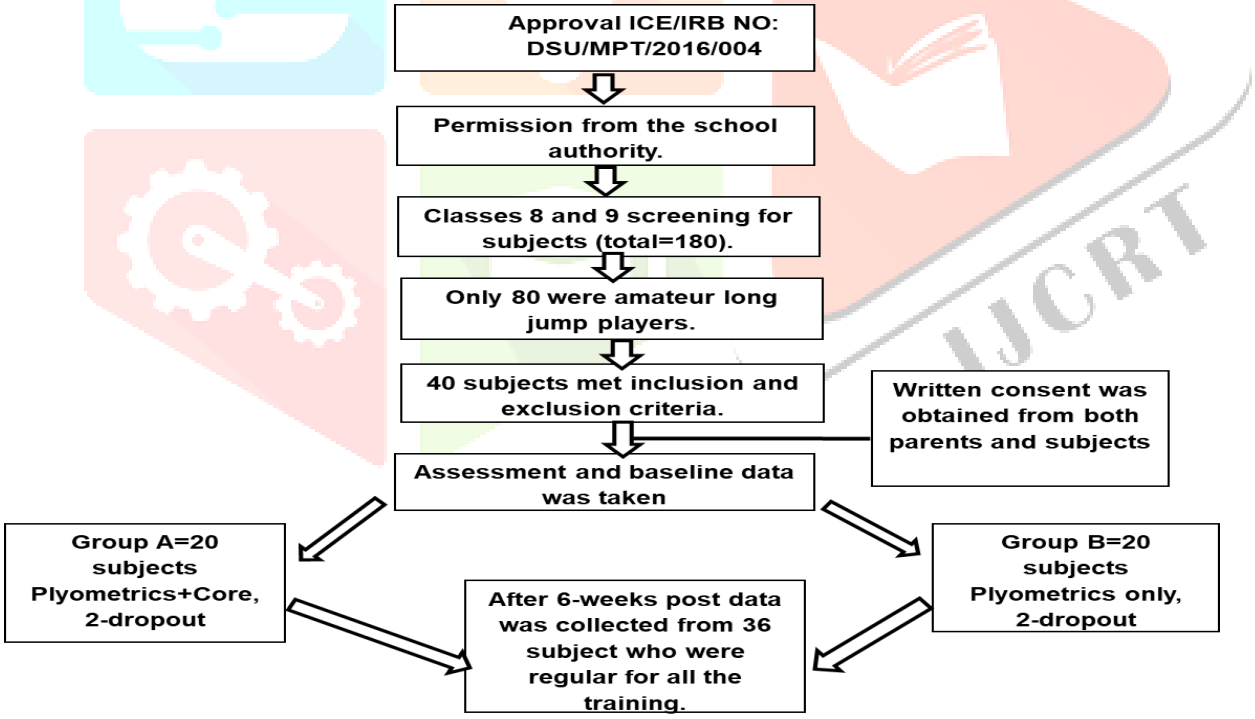
stabilizing the body and spine both with and without limb movement as it is like a muscular corset. It serves as the center of the functional kinetic chain an also known as the 'powerhouse' or the engine of all limb movement, all the movements are usually generated from the core and translated to the extremities. (9)

Core muscle strength is a major prerequisite for many sporting activities (e.g., track and field, climbing, soccer), and also day-to-day activities (e.g., sitting, standing, walking in an upright position). Core stability can help athletes to enhance the ability to control the position and motion of the trunk over the pelvis in integrated athletic activities by allowing maximum production, transfer, and control of force and motion to the terminal segment. (10)In the recent days, training the core musculature has become popular among sports coaches and personal trainers as a means to enhance performance and decrease the chance of injury. (11, 16)As far as literature search there have been no studies done to compare the combination of both (Plyometrics and core stability) in enhancing of horizontal jump ability, which is required to improve the performance in long jump. In case of long jump athletes they requisite strength in lower limb and core for upgrading their performance. Hence this study is intended to find out if plyometrics training followed by core stability training would enhance long jump distance.

Objectives of the study:

a) To find out the effect of low- intensity Plyometrics training along with core stability training on long jump distance and core endurance in high school amateur long jump players.
b) To find out the effect of low- intensity Plyometrics training on long jump distance and core endurance in high school amateur long jump players.
c) To compare the difference between low- intensity Plyometrics training along with core stability training and with Plyometrics training alone on jump distance and core endurance in high school amateur long jump players.

II. Methodology and procedure



- Study was conducted, in which 40 subjects both male and female between age group 12-15 years with normal BMI (15) were included in the study using convenience sampling. Exclusion criteria included any history of present or recent (Within 12 months) lower back pain, musculoskeletal or abdominal injury that requires treatment or that might have inhibited performance or become exacerbated with testing or training, Contraindication for Plyometrics (pain, inflammation, acute or sub-acute sprains, acute or sub-acute strains, joint instability, joint laxity, deformities and soft tissue limitations),Cardiovascular or neurological disease, Actively training with the type of core stability and Plyometrics training. (7, 11, 15).The study was approved by institutional ethical committee Dayananda Sagar college of physiotherapy, Bangalore. Study setting was done in school and consent were taken from the school authority, subjects and parents of the respective subjects. Subjective and

objective assessment of each participant was recorded. Their demographic data was taken along with long jump distance was measured by standing long jump test and core endurance test was conducted to check the core stability. Convenience sampling was done and subjects divided into two groups. All the tests were performed in the same order with identical equipment, positioning, and technique. The Pre-test was performed one day before the training period and post testings was performed 1day after the training period. All subjects participated in a 10 min warm up period which includes static stretching and jogging and 10 min cool down period which includes static stretching.

Group A- Plyometrics along with core stability training for 6 weeks.

Group B- Plyometrics training alone for 6 weeks.

2.1 BMI:

Subject's height and weight was calculated. Weight was calculated using the weighing machine. Height was calculated using the measuring tape The BMI was calculated as per formula mentioned below. (7, 12)

$$\text{Body Mass Index (BMI)} = \frac{\text{Weight (kg)}}{\text{Height (m}^2\text{)}}$$

2.2Standing Jump test:

The subjects were made to warm up for 10 minutes, place their feet right behind the straight line and jump horizontally as far as possible landing with both feet into the pit. During the test, they were allowed for arm swing. Distance from the edge of the sandpit to the nearest impression made by the subject in the pit was measured using measuring tape. Three attempts were allowed with a 2min rest between each trial. The longest distance was used for statistical analysis. (12, 13, 16)

2.3 Measuring core endurance:

The test was done according to McGill's protocol to determine the endurance of trunk stabilizer muscles by isometric tests (of trunk flexor, Trunk extensor and right and left lateral flexor musculature). A handheld stop watch was used to measure the time taken by the subjects to hold each muscle's isometric contraction. Minimum 5 minutes rest period was given between each muscle's contractions.

Trunk flexor endurance test: The subject was positioned sitting up without back support, knees and hips were made to flex at 90 degrees, arms folded across chest and hands placed over opposite shoulders and feet secured with a belt. The subject was asked to hold the isometric position for as long as possible. The test was terminated when the upper body loses the 60-degree angle which was checked using goniometer.

Trunk extensor endurance test: The subject was positioned prone lying. The upper body was positioned such that the body proximal to the upper border of the iliac crest was projected out over the end of the bench with the pelvis, hips, and knees secured. Upper limbs were made to be held across the chest with the hands placed on the opposite shoulders. The test was terminated when back fails below horizontal level.

Lateral flexors endurance test: The subject was made to lie in side lying position (each side individually). Legs were extended with the foot which was at the top placed in front of the foot that was at the bottom for support. The subjects were asked to support themselves on their flexed elbow making an angle of approximately 90 degrees with the arm and feet while lifting their hips off the mat to make a straight line from hip to toe. The uninvolved arm was made to fold across the chest and the hand was made to place on the opposite shoulder. The test was terminated when subject loses the straight back posture or touches the plinth. (7, 14)

2.4Plyometrics training

Plyometrics was performed only twice a week for 6 weeks as recommended by the earlier researchers. During the study, all participants were under direct supervision and were instructed on the method of performing each exercise.

Summary of the plyometric training program.

Weeks 1 and 2(10 repetitions)

- Double leg jump forward

- Double leg jump backward
- Double leg "X" hop
- Standing jump & reach

Weeks 3 and 4(10 repetitions)

- Ankle jumps
- Hurdle Hops
- Lateral cone hops
- Jump & turn 90°

Weeks 5 and 6(10 repetitions)

- Single leg cone hops
- Jump and turn 180°
- Tuck jump
- Split squat jump. (15)

2.5 Core stability training

The core stability training was performed twice a week for 6 weeks, that comprised of Mc Gill's protocol "big 3" exercise (curl-up, side bridge, bird dog).

Curl up: Subjects was made to lie in the supine position, hands with the fingers interlocking at the back of the neck, elbows pointed to the sides, knees in a flexed position, feet rested on a fitness mat; subjects were made to curl-up until the scapulae cleared the fitness mat.

Side bridge (both side): Subjects was made to lie in a side lying position, the supporting arm making an approximately 90 degree angle with the corresponding elbow, the uninvolved arm placed across the chest holding the supporting shoulder. Subjects were made to raise their hips along with the trunk until a straight line was achieved from the knee to the shoulder.

Birddog (both side): Subjects was made to be in quadrupedal stance with both hands and knees flat on the surface; subjects lift the leg and the contra lateral arm in horizontal position and repeat the same with the other side.

Summary of core stability training

During training weeks 1-2

- Big 3 exercises
- 3 sets per exercise
- 40 sec contraction time
- 40 sec rest time between sets
- 2-3 min rest between all 3 exercises

During training weeks 3-4

- Big 3 exercises
- 3 sets per exercise
- 45sec contraction time
- 45 sec rest time between sets
- 2-3 min rest between all 3 exercises

During training session 5-6

- 3 sets per exercise
- 50sec contraction time
- 50 sec rest time between sets
- 2-3 min rest between all 3 exercises. (16)

III. STATISTICAL ANALYSIS

Descriptive and inferential statistical analysis has been carried out in the present study. Results on continuous measurements are presented on Mean and SD (Min-Max).Results on categorical measurements are presented in Number (%).Alpha value was set at 0.05.Student t test (two tailed, independent) has been used to find the significance of study parameters on a continuous scale between two groups (Inter group analysis) on metric parameters. Chi-square/ Fisher Exact test has been used to find the significance of study parameters on a categorical scale between two or more groups, the Non-parametric setting for Qualitative data analysis. The Statistical software namely SPSS 18.0 and R environment ver.3.2.2 were used for the analysis of the data. Microsoft Word and Excel have been used to generate graphs, tables etc.

IV.RESULTS

Table 1 Age distribution of subjects studied.

Age in years	Group A	Group B	Total
13	13 (72.2%)	13 (72.2%)	26 (72.2%)
14	5 (27.8%)	5 (27.8%)	10 (27.8%)
Total	18 (100%)	18 (100%)	36 (100%)
Mean ± SD	13.28±0.46	13.28±0.46	13.28±0.45
Samples are age matched with P=1.000, student t test			

Table 2 Gender distribution of subjects studied.

Gender	Group A	Group B	Total
Female	9 (50%)	9 (50%)	18 (50%)
Male	9 (50%)	9 (50%)	18 (50%)
Total	18 (100%)	18 (100%)	36 (100%)
Samples are gender matched with P=1.000			

Table 3 Comparison of weight, height and BMI distribution between groups of subjects studied.

Variables	Group A	Group B	Total	p value
Weight (kg)	43.66±7.80	43.27±8.67	43.46±8.13	0.888
Height (cm)	153.31±8.10	154.17±8.72	153.74±8.30	0.761
BMI (kg/m^2)	18.37±2.04	18.03±2.35	18.20±2.18	0.647

Table 4 Baseline data for outcome variables in group A and group B.

Variables	Group A	Group B	Total	P value
Standing Jump Test	52.11±5.77	53.17±6.27	52.64±5.96	0.603
Trunk Flexors Test (min)	1.98±1.00	1.79±1.00	1.89±0.99	0.588
Trunk Extensors (min)	1.12±0.52	1.19±0.66	1.16±0.59	0.712
LTF* left (min)	0.99±0.49	1.06±0.53	1.03±0.50	0.707
LTF* right (min)	0.93±0.42	1.29±0.82	1.11±0.67	0.105
Student t test				

Table 5 Pre-Post data for outcome variables within Group A

Variables	Pre	Post	difference	t value	P value
Standing Jump Test	52.11±5.77	69.22±6.36	17.111	22.449	<0.001**
Trunk Flexors (min)	1.98±1.00	3.45±0.90	1.477	18.465	<0.001**
Trunk Extensors	1.12±0.52	2.98±0.59	1.865	31.052	<0.001**
LTF* left	0.99±0.49	2.70±0.49	1.702	27.911	<0.001**

LTF* right	0.93±0.42	2.75±0.44	1.822	24.351	<0.001**
Student t test					

Table 6 Pre-Post data for outcome variables within Group B

Variables	Pre	Post	difference	t value	P value
Standing Jump Test	53.17±6.2	64.72±6.1	11.556	39.308	<0.001**
Trunk Flexors (mins)	1.79±1.00	2.60±1.01	0.806	21.594	<0.001**
Trunk Extensors	1.19±0.66	1.88±0.75	0.687	19.845	<0.001**
LTF* left	1.06±0.53	1.41±0.53	0.349	7.518	<0.001**
LTF* right	1.29±0.82	1.85±0.77	0.561	14.751	<0.001**
Student t test					

Table 7 Difference between the groups post measurement

Variables	Group A	Group B	Total	P value
Standing Jump Test (Inches)	69.22±6.36	64.72±6.11	66.97±6.55	0.037*
Trunk Flexors (mins)	3.45±0.90	2.60±1.01	3.03±1.03	0.011*
Trunk Extensors (mins)	2.98±0.59	1.88±0.75	2.43±0.87	<0.001**
LTF* left (mins)	2.70±0.49	1.41±0.53	2.05±0.82	<0.001**
LTF* right (mins)	2.75±0.44	1.85±0.77	2.30±0.77	<0.001**
Student t test			Note: mins=minutes	

V.DISCUSSION

The purpose of the study was to evaluate the effectiveness of low-intensity plyometrics along with core stability training for 6 weeks to improve long jump distance among high school amateur long jump players. In this study, there was no significant difference in subjects for demographic and baseline outcome variables which was determined by the descriptive statistics. It has been observed that in group A, the baseline score for the standing jump test was 52.11 inches. Following training the post standing jump test score was 69.22 inches and was statistically significant with p-value < 0.001. The trunk flexors test pre and post measurement was 1.98 mins and 3.45 mins respectively which was statistically significant with p-value < 0.001. The trunk extensors test pre and post measurements were 1.12 mins and 2.98 mins respectively with a statistical significance of p-value < 0.001. The left lateral trunk flexors test pre-measurement was 0.99 mins and post measurement was 2.70 mins and was statistically significant with p-value < 0.001. The right lateral trunk flexors test pre-measurement was 0.93 mins and post measurement was 2.75 mins and was statistically significant with p-value < 0.001.

The results are in consensus with the study done by Urs Granacher et al core stability training was found to improve the physical fitness in adolescents. (16) Heydar Sadeghi et al which showed that core stability and plyometric exercise group significantly increased the performance (Standing Broad Jump, Vertical Jump, 9.1 m Sprint, Shuttle Run) but core stability training alone was found to have more benefits than plyometric training alone for enhancing the standing broad jump distance. Hence the authors recommended that the core stability and plyometric exercises could improve general performance of athletes. (17) Allen et al found that core conditioning intervention on tests of endurance of trunk muscles showed a significant enhancement in the performance in 5 different trunk muscles which were assessed with the help of endurance tests in healthy untrained children with a mean age of 11 years. (18)Considering all the above mentioned literatures that studied the relationship between plyometrics and core strength, it may be noted that plyometrics increases the strength as well as power in the lower limbs. The exercises used in the present study for plyometrics was found to improve core stability as well as core control. Core being the base for the upper and lower limb movements and enhancing its endurance credits it to have a role in generating additional force production during the lower limb activities which in turn enhance long jump distance by increasing strength and the explosiveness of the lower limb.

In this study, it has been observed that in group B where plyometric training was introduced alone, there was an improvement in the standing jump test and core endurance tests. Pre-measurement for the standing jump test was 53.17 inches and following training, the post test score was 64.72 inches and was statistically significant with p-value < 0.001. The trunk flexors test pre and post measurements were 1.79 mins and 2.60

mins respectively with the statistical significance of p-value < 0.001 and the trunk extensors test pre and post measurements were 1.19 min and 1.88 mins respectively which was statistically significant with p-value < 0.001. The left lateral trunk flexors test pre-measurement was 1.06 mins and post measurement was 1.41 mins with the statistical significance of p-value < 0.001. The right lateral trunk flexors test pre and post measurement was 1.29 mins and 1.85 mins which were statistically significant with p-value < 0.001.The results are consistent with the previous studies like that of Jennifer L. Hunnicutt et.al. And Maamer Slimani et al which showed that standing long jump distance increased with plyometric training. Hence this statistically significant value could be due to the facilitation of the joint mobility and strength by the plyometric training. (19)

In this study, it has been observed that in comparison between group A and group B, the post measurement for the standing jump test of group A was 69.22 inches whereas in group B post measurement test was 64.72 inches and was statistically significant with the p-value > 0.037. The post measurement for the trunk flexors test of group A was 3.45 mins whereas in group B post measurement test was 2.60mins and was statistically significant with the p-value > 0.011. The post measurement for the trunk extensors test of group A was 2.98 mins whereas in group B post measurement test was 1.88 mins and was statistically significant with P value < 0.001. The post measurement for the left lateral trunk flexors test of group A was 2.70 mins whereas in group B post measurement test was 1.41mins and was statistically significant with P value < 0.001. The post measurement for the right lateral trunk flexors test of group A was 2.75 mins whereas in group B post measurement test was 1.85 mins and was statistically significant with P value < 0.001. This is in accordance with the study done by Dr. Deepak Kumar Dogra that showed plyometrics along with core stability training program was an effective training method to improve a cricketers' muscular strength. (20) According to our findings based on the literature review, the above quoted study is the only one which has used a combination of core stability training as well as plyometrics as an intervention among cricketers.

The results of the present study reveal a statistically significant improvement in the outcome in both the groups. The 6-week plyometric exercise training combined with core stability exercises improved the performance of long jump distance when compared to plyometric exercise training alone. In group A where core stability exercises were combined with plyometric training, there was a statistically significant improvement in core endurance as well as in standing long jump distance. This could be due to the nature of the core muscles which act as a bridge between the upper and lower limbs and help the forces transfer to the limbs through it. Core stability training has the potential to improve the strength of core muscles as well as health and skill related components of physical fitness in youth. Lack of randomization control trail and inability to do long term follow up is the limitation of this study.

VI.CONCLUSION

The result shows a significant improvement in both group A and group B, but the results when compared between the groups, group A showed more significant improvement compared to Group B in standing jump distance and core endurance test. Hence this study proves that low intensity plyometrics along with core stability training is more effective in improving long jump distance in high school amateur long jump players.

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