European Journal of Scientific Research
ISSN 1450-216X Vol.31 No.4 (2009), pp.577-582

http://www.eurojournals.com/ejsr.htm

Comparative Effect of Three Modes of Plyometric Training on Leg Muscle Strength of University Male Students

Ademola Olasupo Abass
Department of Human Kinetics and Health Education
Faculty Of Education, University of Ibadan, Nigeria
E-mail: dokidemo@yahoo.com

Abstract

This study determined the comparative effect of three modes of Plyometrics training [depth jumping, rebound jumping and horizontal jumping] on leg muscle strength of untrained University male students. Participants were forty untrained male University students within the age range of 18-27 years. The randomized pretest-posttest control group design was adopted. Subjects were randomly assigned to control group, and three experimental groups based on the types of plyometrics training adopted for the study. The training programme consisted of twelve weeks of interval training administered three times a week. Data collected were analyzed using the mean score, standard deviation and range. Analysis of Covariance [ANCOVA] was used to test for significant differences in the post-test measures among the treatment and control groups using the pretest score variation as covariates. Scheffe post hoc analysis was used to determine which of the means were significantly different. All hypotheses for the study were tested at 0.05 critical level.

Findings revealed that only the depth jumping and rebound jumping training significantly altered leg muscle strength of subjects ($P<0.05$). Based on the findings, it was concluded that plyometrics exercises with depth jumping and rebound jumping characteristics are best used in developing muscle strength of the lower extremities.

Introduction

Sports science generally aims at identifying and developing performance variables essential for competitive excellence. In addition to other indices like muscle endurance and power, muscle strength plays a cardinal role in achieving athletic excellence. The final common denominator in athletic events is what the muscles can do for you - what strength they can give when it is needed, what power they can achieve in the performance of work and how long they can continue in their activity [Guyton (1991),.

The leg muscles play vital roles in the successful execution of skills in many games and sports. Although, apart from soccer, combat sports, running and jumping events in athletics, direct use of the leg is not common to most other sports. However, most of these other sports, which depend mainly on the arm and other parts of the body, still require strength, and endurance of the leg muscle to generate force and carry them through the stress and duration of their activity.

Muscular strength is the maximal force or toque a muscle or muscle group can generate at a specified or determined velocity. It is also the ability of a muscle or a group of muscles to sustain contraction in one maximum repetition.[Komi,,1992; Hockey,1993). Muscle strength is considered to be a basic component in the performance of physical skills and in almost all competitive activities the performer with the greater amount of strength has the advantage. All sports require a certain amount of

strength, but strength becomes a priority in sports where heavy weights such as the body must be lifted, carried or thrown (Sharkey, 1986).

Plyometric exercises have been used successfully over the years to elicit training responses from athletes. Plyometrics training is almost exclusively applied to extensor Muscle of the legs, and consists of a vigorous lengthening of the active extensor muscles (eccentric contraction) immediately followed by a maximal concentric contraction. They are most frequently used as a means of increasing speed and anaerobic power output in sprinters and jumpers, but the techniques may also be of value to other types of sportsmen (Watson, 1993; Wausen, 1990). Sharkey (1986) described plyometric exercises as explosive callisthenic-like exercises which involve the conditioning of the neuromuscular system to permit faster and more powerful changes of direction such as moving from up and down in jumping or switching leg positions as in running. The training modes adopted for this study were based on the principle of plyometrics training.

Therefore, this study focused on the relative effect of depth jumping, rebound jumping and horizontal jumping over a distance (three modes of plyometrics training) on the leg muscle strength development of untrained University males.

It was hypothesized that there no significant differences exist in the pretest - posttest leg muscle strength of subject following a twelve-week depth jumping, rebound jumping and horizontal jumping over a distance plyometrics programme.

Method and Procedures

Participants

Forty apparently healthy untrained male undergraduates of the University of Ibadan, Nigeria, participated in the study. Subjects were volunteers, certified medically and physically fit to take part in the training programme. They were randomly divided into four groups of 10 participants each. Three of these groups served as the experimental groups that participated in the depth jumping, rebound jumping and horizontal jumping exercises, while the fourth was the control group.

Instrument and Measures

The main variable measured in this study was the leg muscle strength. Additional variables include age, height and weight of participants. Leg muscle strength of participants was measured using the back and leg dynamometer. The test protocol for using the instrument was followed as described by Johnson and Nelson, (1986) They also reported a reliability value of .86 to .90 for the instrument. The stadiometre and its weighing scale were used to measure height and weight; three locally manufactured boxes, each of which were, 35cm, 40cm, and 45cm in height were used for depth jumping training, a training wall was used for rebound jumping training; a marked ground of nine metres in length with 6 rings placed alternately on the ground were used for horizontal jumping training; while stopwatches and measuring tape were used to measure time and distance respectively.

Data Collection

All the tests were administered by the researcher with the help of four research assistants who helped in recording, observing and timing the subjects as the need arose. Subjects were informed of the nature of the test and each of them signed an informed consent form before commencement of training.

Training

The training programme for this study lasted for a period of 12 – weeks. Participants were trained three times a week between 3 pm and.6pm. Subjects were randomly divided into four groups of ten subjects each. Group one engaged in depth jumping as their training mode, participants in groups two and three

engaged in rebound jumping and horizontal bounding with rings respectively, while the fourth group served as the control group which received no treatment.

The training programme was based on the interval training principle, which comprised series of plyometrics exercise work intervals, interspersed with relief intervals with a work - relief ratio of 1:3. The progressive resistance training principle was used in determining the dosage at every period of training. The intensity and duration of exercise were gradually increased every two weeks, when training was assumed to have become less challenging to the leg muscles of the subjects.

The plyometrics - training modes, developed for this study are described as follows:

***Depth Jumping*:** This exercise was performed by using three wooden boxes that were 60cm in width, and 35cm, 40cm and 45cm in height. The subject was expected to climb the box and stand straight in the front edge of the box. He steps down and rebound from his jump after landing to the height of the box. He then moves quickly to the back of the box and repeats the exercise all over until the stipulated time.

***Rebound Jumping*:-** This exercise was performed near a training wall. It involved continuous jumping with the two feet leaving the ground at the same time. The subject was expected to rebound after landing from each jump. To ensure efficiency in this exercise, a 20cm distance from the standing - reach height of the performer was marked against the wall in front of the performer. This served as the minimum height he can get to with his arms raised when he is jumping.

***Horizontal Bounding with Rings*:-** This exercise was performed on a marked ground of 9-metres in distance. Six rings were alternately placed on each side of the marked line. The subject jogs into the start of the drill for forward momentum. After a few feet, forcefully push off with the left foot and bring the right leg forward. At same time swing left arm forward and land into the first ring, which is 3-4 feet out and to the left, with the right foot..He continue and repeat with other leg and arm into the second ring, which is now 3-4 feet up and to the right.This exercise is an exaggerated running motion focusing on foot push-off and air time.

Design and Data Analysis

The randomized pre- test - posttest control group design was adopted for this study. Participants were randomly assigned to experimental and control groups after the selection.

The descriptive statistics of mean standard deviation were used in analyzing the data collected for the study. Analysis of covariance (ANCOVA) was computed on the pretest - posttest values for each experimental groups and control group to determine the effects of each training mode on the leg muscle strength performance of subjects in each group. Results were subjected to further analysis using the Scheffe test to locate where significant differences existed among the groups. All variables were tested at 0.05 level of significance.

Results

Table 1: Descriptive Data on Age, Height, Weight and Strength Characteristics of Subjects.

Groups		Age [Years]	Height [Metres]	Weight [kg]	Strength [kg]]	
					Posttest	Pretest
Depth Jumping Group	X ± SD	24.90±3.07	1.74±0.05	65.27± 6.48	37.20 ± 14.21	64.00 ±21.18
Rebound Jumping Group	X ± SD	24.90 ± 4.82	1.76 ± 0.06	64.90 ± 3.74	34.90 ± 13.92	34.90±13.92
Horizontal bounding with rings Group	X ± SD	27.50 ±2.01	1.70+ 0.07	64.54 ± 6.24	28.80 ±16.57	41.00 90± 25.95
Control Group	X ± SD	27.30 ±5.48	1.69 ± 0.07	66.42 ± 8.05	34.60 ± 10.67	46.55±6.11

Age, height, and Weight of Participants

Table 1 shows the mean, standard deviation and range of age, height and weight of participants. The horizontal bounding with rings group was the oldest with a mean age of 24.50 ± 2.01 years. The depth jumping and rebound-jumping group had the lowest age (21.90± 3.07years and 21.90±4.82years respectively. The rebound jumping group was tallest with a mean height of 1.76± 0.06 metres, followed by the depth-jumping group with 1.74± 0.05 metres. The horizontal bounding with rings group had a mean height of 1.70± 0.07 metres, while the control group had the lowest mean height of 1.69± 0.07 metres.

The control group recorded the heaviest mean weight of 66.42±8 05kg, followed by the depth - jumping group[65.27±6.48kg], the rebound jumping group [64.90±3.74kg] and the horizontal bounding with rings group [64.54±6.24kg] respectively. This showed that the control group was heaviest, while the horizontal bounding with rings group recorded the lowest weight.

Leg Muscle Strength

The mean pretest leg muscle strength value of participants in the depth jumping group was 37.20± 14.21kg, with a posttest value of 64.00 ±21.18kg, while a pretest mean of 64.90 ± 3.047kg; and a posttest value of 55.60± 16.57kg with a range of 0.62kg was recorded as the pretest leg muscle strength value of subjects in the horizontal bounding with rings group, while the posttest value was 41.0± 25.95kg. The control group recorded a pretest leg muscle strength of 34.60± 10.60kg, and a mean posttest value of 34.90 ±10.59kg.

The pretest - posttest leg muscle strength mean difference for the depth jumping, rebound jumping, horizontal bounding with rings and control groups were 26.8kg, 20.7kg, 12.2 and 0.3kg respectively. At posttest, the leg muscle strength of participants increased by 72.04 percent for depth jumping group, 59.31percent for rebound jumping group, 42.36percent for horizontal bounding with rings group respectively, while the control group increased by 0.87 percent.

Table 2: Summary Table of Analysis of Covariance for the Effects of all the Plyometric Training Programmes Across the Groups on Leg Muscle Strength
Posttest leg muscle strength by group (1, 2,3 & 4) with pretest leg
Muscle strength variation as covariate.

Source of Variation	SS	DF	MS	F	Sig.
Covariates (VI)	**7360**.59	1	7360.59	30.978	. 000
Main Effects (Groups)	3995.638	3	1331.879	5.605*	0.003
Explained	1156.228	4	2839.057	11.949	0
Residual	8316.147	35	337.604		
Total	1972.375	39	504.42		

• = Significant at 0.05 level

The ANCOVA in Table 2 on the effects of all the three plyometrics training programme on the leg muscle strength of participants in all the groups show that the F- ratio of the main effects of treatment (5.605) was higher than the critical value of 2.84 (df, 3, 35) and was found to be statistically significant at 0.05 level of significance. Therefore the null hypothetical assumption that no significant differences existed in the pretest - posttest leg muscle strength of subject in all the groups following 12 weeks plyometrics training programme was rejected.

Table 3: Scheffe post- hoc Analysis for leg muscle strength

Mean	Groups	4	3	2	1
34.90	4	-	-	-	-
41.00	3	-	-	-	-
55.60	2	*	-	-	-
64.00	1	*	-	-	-

Significant level = 0.05

Scheffe post - hoc analysis in table 3 shows that significant differences were found only between the means of the depth jumping group and control group and that of the rebound jumping group and control group ($p<0.05$). However, the difference between the means of horizontal bounding with rings group and control group, and also the difference between the three experimental groups were not significant.

Discussion

Result of this study revealed that of the three - plyometric training programmes, only the depth jumping and the rebound jumping training significantly improved leg muscle strength of participants. Although, horizontal bounding with rings group had a posttest mean increase of 42.36 percent, it was not significant at 0.05 level of significance. The control group expectedly had a slight increase of 0.87 percent in leg muscle strength at posttest.

Scheffe post hoc analysis revealed that the significant difference recorded in mean leg strength among the groups was between the depth jumping and the control group. There were no significant differences between the means of the horizontal bounding with rings and control group and also between the means of the three experimental groups.

This result is consistent with the findings of Brown, Mayhew and Boleach (1986) who reported a 43 percent increase in leg strength gains following a 12 week period of depth jumping and leg bounding plyometric training carried out on a group of 26 college male students. Reilly (1992) also found that depth jumping drills are capable of improving power and explosive strength, and concluded that plyometric drills could be included in a strength - training programme because it emphasizes elastic properties of muscle in their execution and tend to develop muscle strength. Klausen (1990) reported a modest increase in isometric and concentric maximal strength of participants following plyometric training with depth jumping characteristics; he concluded that the effect of plyometrics training is highly specific.

The depth jumping group probably performed better than the other training groups because of the nature of the exercise and the advantages it has in storing sufficient potential energy during the eccentric phase of the movement and converting it to kinetic energy during the concentric phase of movement which leads to rapid explosive movement that characterizes the exercise (Brzycki, 1986).

Conclusion

Based on the findings of this study, it was concluded that all the three plyometrics training protocols adopted for the study are capable of increasing leg muscle strength, but those with depth jumping and rebound jumping movements increased leg muscle strength significantly. It is therefore recommended that coaches, trainers, and athletes interested in developing leg strength should adopt these types of plyometric exercises in training their at.

References

[1] Brown,M.E,Garbutt, G Reilly, T.Linge, K & Troup, J.D.G (1988). The effects of gravity inversion on exercise induced spinal loading. Ergonomics, 31,(1631-1637)

[2] Brzyckim M (1986), Plyometrics: A giant step backwards. Athletics Journal,72, (86), 22-23.

[3] Guyton, A.C. (1991). Textbook of medical physiology (8th ed.) Philadelphia:W.B.Saunders co.

[4] Hockey, R.V.(1993). Physical fitness: the pathway to healthful living (7th ed). London: the C.V. Mosby Co.

[5] Johnson, B.L & Nelson, J.K (1974) Practical measurement for evaluation in physical Education (2nd ed).Minnesota:Burgess publishing Company.

[6] Klausen, k.(1990).Strength and weight training. In T, Reilly,N.Secher, P. Snell & C. Williams (Eds)Physiology of sports. London: E & F.N. SPON.

[7] Komi, P.V, Tesch, P.A,Suominen, H.& Heikkinen E.(1992).Effects of heavy resistance and explosive type strength training methods on mechanical functional and metabolic aspects of performance. In P.Komi (Ed) Exercise and Sport Biology, International series on sports sciences, 12, 90-102. Champaign: Human Kinetics.

[8] Magunsson, S.P.(1993).Clinical strength testing REHAB management. Pp.138-145.

[9] Reilly,T. (1992) Strength training for injury prevention. In T.Reilly (Ed) Sports fitness and sports injuries London: Wolfe Publishing.