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Original Research Article

EFFECT OF RESISTANCE AND PLYOMETRIC TRAINING ON THE PERFORMANCE OF JUMPERS

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Abstract

Effect of resistant and plyometric training on the performance of Jumpers. For the purpose of the study 80 male jumpers (Mean ± SD: age 20.23±1.34 years, height 1.65± 0.032m, body mass 61.50± 2.50 kg) of district level players were randomly selected as the subjects for the study. The purpose of this study was to find out the effect of 3 different training protocols – Resistance training, plyometric training and their combination on standing broad jump, jump and reach test and long jump performance. Based on their training male jumpers were divided into 4 groups: A resistance training group (n=20), B plyometric training group (n=20), C resistance + plyometric training group (n=20) and D control group (n=20). The standing broad jump, jump and reach test and long jump performance were measured before and after the 12 weeks training period. Subjects in each of the training groups trained 3 days per week, whereas control group did their normal routine activities. The data was analyzed by analysis of co-variance. The results showed that all the training treatments elicited significant ($P<0.05$) improvement in all of the tested variables. However, the combination training groups showed signs of improvement in standing broad jump, jump and reach test and long jump performance that was significantly greater than the improvement in the other 2 training groups (resistance training and plyometric training). This study provides support for the use of a combination of resistance + plyometric training drills to improve the performance of standing broad jump, jump and reach test and long jump.

Key words: Stretch-shortening cycle, Resistance Training, Plyometric Training.

Introduction

Success in many sports depends heavily upon the athlete's explosive leg power and muscular strength. In jumping, throwing, sprinting, track and field events and other activities, the athlete must be able to use strength as quickly and forcefully as possible. This display comes in the form of speed-strength or power represents the amount of work a muscle can produce per unit of time. An increase in power (YESSIS, &

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HATFIELD,1986) gives the athlete the possibility of improved performance in sports, in which the improvement of speed-strength relationship is sought (PAUL, 2003).

In athletics, some amount of resistance has to be overcome and the greater the resistance, stronger should the sportsman. A high level of speed, endurance, technique and other coordinated abilities are impossible if the sportsman lacks the requisite amount of strength, which is regarded as the ability of the sportsman to overcome resistance or to act against it. The strength can be dynamic or static. The static (isometric) and dynamic (isotonic) strength are two principal types of strength while we come across in athletics. A more accurate measure of strength can be obtained by using dynamometers or densitometer instruments which measures force. The maximum strength which is the highest possible resistance, a sportsman can overcome through voluntary contractions of the muscles, the explosive strength which is the ability of the sportsman to overcome resistance with high speed and the strength endurance which is the ability to act against resistance under conditions of fatigue, can be developed through different weight training exercise.

To any sport that requires powerful, propulsive movements, such as football, volleyball, sprinting, high jump, long jump, and basketball, the application of plyometric or explosive jump training is applicable (MCARDLE, KATCH & KATCH, 2001). Plyometric has been a very popular training technique used by many coaches and training experts to improve speed, explosive power output, explosive reactivity and eccentric muscle control during dynamic movements (COETZEE, 2007). It is considered a high-intensity, physical training method, consisting of explosive exercises that require muscles to adapt rapidly from eccentric to concentric contractions (CHU, 1998). Plyometric training (PT) has widely been used to enhance muscular power output, force production, velocity, and aid in injury prevention (ROBINSON, 2004; POTASH & CHU, 2008).

To assess the training state and physical preparedness for explosive power performance across all of the throwing events in athletics, it is useful to use a general field test of explosive power production. Selection of the appropriate test is key in generating an accurate profile of performance readiness. The vertical jump (VJ) is one such commonly-used test (CHURCH, WIGGINS, MOODE, & CRIST, 2001; GOURGOULIS ET AL., 2003; JENSEN & EBBEN, 2003; MAYHEW ET AL., 2005; STOCKBRUGGER & HAENNEL, 2001; STOCKBRUGGER & HAENNEL, 2003; YOUNG ET AL., 1998). However, this movement focuses primarily on hip and leg function and includes little trunk or arm contribution to total power production (MAYHEW, 2005; STOCKBRUGGER & HAENNEL, 2001; STOCKBRUGGER & HAENNEL, 2003). In addition, the vertical jump focuses on accelerating body mass only and ignores the element of momentum production and transfer to an implement (STOCKBRUGGER & HAENNEL, 2001; STOCKBRUGGER & HAENNEL, 2003).

The stretch-shortening cycle is described as the combination of eccentric (muscle lengthening) and concentric (muscle shortening) actions. An eccentric muscle action is performed when an athlete lowers a weight. A concentric muscle action is the upward motion of above exercise. When an eccentric action then the resulting force output of the concentric action is increased. The stretch shortening cycle works like a rubber bend that is stretched and then snaps back together. This is the essence of the stretch shortening cycle and speed, ability and quickness training.

It seems that researcher have not common agreement about the relative effectiveness of the plyometric training compared with resistance training or combination of both in the development of sprinting ability. It seems likely that different durations of training periods,

different training statuses of the subjects, different training designs (i.e. training loads or volumes or exercises) might have caused that discrepancy in the results of previous studies. Therefore the purpose of the present study was to determine how selected variables of the jumpers performance, namely leg power, leg strength and explosiveness are affected by a typical 12 weeks plyometric training program, a typical 12 weeks resistance training program and 12 weeks training program that combines plyometric exercises and resistance training.

Material and Methods

Sample

For the purpose of the study 80 male jumpers (Mean ± SD: age 20.23±1.34 years, height 1.65± 0.032m, body mass 61.50± 2.50 kg) of district level players were randomly selected as the subjects for the study. The age of subjects ranged between 17-21 years. A medical examination of the subjects was carried out in order to check the fitness of the subjects. All the subjects were randomly assigned to four groups consisting of three experimental groups and the control group, each group consisting of 20 subjects. The group A trained with resistance training, group B with plyometric training, group C with a combination of resistance and plyometric training while group D served as Control group, which continued with regular programmed only.

Methodology

After the initial measurements, the subjects were divided into four groups; the resistance training group (N=20), the plyometric training group (N=20), the combination of plyometric + resistance training group (N=20), and the control group (N=20). The control group was continued with their regular routine work. The other three training groups were trained for 12 weeks, 3 days per week. The training programs were designed to overload the muscles involved in sprinting and explosive performance.

The subjects in resistance training group performed Split jerk, clean push press, Romanian dead lift. 10-15 repetitions in each of the 3 sets, with 40% weight of 1 repetition maximum and with 3 min recovery period in between each set. After the three weeks the weight was set at 50% of 1 R.M. and recovery period was same as it was in first three weeks. After the second three weeks the weight was raised to 60% of 1 R.M. and reducing the repetitions to 8-10 in each set for 3 sets with 2 min recovery period between the sets. Finally for last three weeks the exercises were performed with 70% weight of 1 R.M., 8-10 repetitions in each of the 3 sets with 2 min recovery period in between sets.

Figure1. (A) Split jerk; (B) Clean push press; (C) Romanian dead lift (D) Hurdle jumps; (E) Slug; (F) Side medicine ball throws

The subjects in plyometric training group performed hurdle jumps, slug and side medicine ball throws for 5 repetitions of each exercise in each set for 3 sets with a recovery period of 30 secs and 120 secs in between repetitions and sets respectively. After the first three weeks the number of repetitions of exercise in each set for second three weeks, third three weeks and finally last three weeks were 7, 8, 10 respectively. And numbers of sets for above period were 3, 4 and 4 respectively with a recovery period of 30 secs and 120 secs between repetitions and sets respectively throughout the training. The subjects performed Depth jump, fast skipping, medicine ball chest pass for 6 repetitions in each set for 3 sets with a recovery period of 30 secs and 120 secs between repetitions and sets respectively. After the first three weeks, the number of repetitions of exercises in each set and number of sets for second three weeks, third three weeks and finally for last three weeks were 8, 7, 8 respectively and number of sets for above said period were 3, 4 and 4 respectively with a recovery period of 30 secs and 120 secs between repetitions and sets respectively throughout the training programme.

The combination of plyometric training and resistance training group performed combination of two training programs, (plyometric and resistance training programs) but the volume and intensity of work was reduced. All training sessions were supervised by the researcher.

Each subject underwent measurements of his standing broad jump, jump and reach test and long jump performance. Pre-testing was conducted before the initiation of the training period. Identical measurements were performed in the same order on the completion of the complete training period.

1. Standing broad jump

The standing broad jump test is one of the tests for leg explosive power measurement. The subject (JOHNSON AND NELSON, 1988) stands behind a line marked on the ground with feet slightly apart. A two foot take-off and landing is used, with swinging of the arms and bending of the knees to provide forward drive. The subject attempts to jump as far as possible, landing on both feet without falling backwards. Three attempts were allowed. The measurement was taken from take-off line to the nearest point of contact on the landing (back of the heels). Record the longest distance jumped, the best of three attempts. The measurement was taken in meters and centimeters.

2. Jump and reach test

The Jump and reach test is one of the test for leg explosive power measurement in vertical direction. The subject stood side (KANSAL, 2008) on to a wall and reached up with the hand closest to the wall. Keeping the feet flat on the ground, the point of the fingertips was marked or recorded. This was called the standing reach height. The subject then stood away from the wall, and leaped vertically as high as possible using both arms and legs to assist in projecting the body upwards to touch the wall at the highest point of the jump. The difference in distance between the standing reach height and the jump height was the score. The best of three attempts was recorded. The jump height was recorded as a distance score. The measurement was taken in centimeters.

3. Long jump

The long jump test is one of the tests for leg explosive power measurement in horizontal direction. The subject approached the take off from running on runway, take off from single leg while takeoff, swing the arms upward to lift the body up and thrust the trunk to provide forward drive, swing the arms downward and backward, subjects attempted to jump as per as possible, landed on both feet, three attempts were allowed. The maximum distance covered recorded in meters and centimeters between the takeoff line and to the nearest mark made on the pit by any part of the subject's body as the performance in long jump. Best of three trials was recorded as the final score of the subject.

Statistical Analysis

In order to find out the effect of resistance,

plyometric and combination of resistance and plyometric training programmes on the performance of jumpers. The t-test was used to identify any significant differences between the groups at the pre and post-tests data. An analysis of co-variance was used to determine significant differences for physical/performance variables within the three experimental and a control groups. The level of significance was set at 0.05.

Results

All values of the criterion measures for the groups are presented in tables from 1 to 6.

Table-1: Analysis of Co-variance for the Experimental groups and the Control group of Standing Broad Jump

	Group Means (m)								
Test	**A**	**B**	**C**	**D**	**Source of variation**	**Sum of Squares**	**df**	**Mean sum of Squares**	**F-ratio**
Pre-test Mean	2.61	2.63	2.59	2.59	Among	0.017	3	0.005	0.449
					Within	0.979	76	0.012	
Post-test Mean	2.67	2.67	2.68	2.59	Among	0.101	3	0.033	2.775*
					Within	0.929	76	0.012	
Adjusted Post-test Mean	2.67	2.65	2.69	2.61	Among	0.073	3	0.024	13.650*
					Within	0.134	75	0.001	

*Significant at 0.05 level F.05 (3, 76) = 2.72 F.05 (3, 75) = 2.72 A – Plyometric, B – Resistance, C – Plyometric + Resistance, D – Control

As shown in table-1 that insignificant value of F-ratio's were obtained for the comparison of pre test means (0.449), the obtained value was lesser than the required value. The significant values of F-ratio's were obtained for the comparison of post test means (2.775) and adjusted post test means (13.650). The obtained values were greater than the required value for the selected degree of freedom and the significant level.

The results of the post hoc analysis and the differences between the means among the four groups are given in table-2.

Table-2: Paired adjusted final means and differences between means among the Experimental groups and Control group of Standing Broad Jump (meters)

Groups				
A	**B**	**C**	**D**	**Mean Difference**
2.67	2.65			0.020
2.67		2.69		0.020
2.67			2.61	0.060*
	2.65	2.69		0.040*
	2.65		2.61	0.040*
		2.69	2.61	0.080*

* Significance at 0.05 level.

Required value of critical difference at 0.05 level is 0.026

A – Plyometric, B – Resistance, C – Plyometric + Resistance, D - Control

The results in table-2 have shown that the mean differences of all experimental groups when compared with the control group have exhibited the significant values of critical difference at the

selected level of 0.05.

The group C which trained with the combination of plyometric and resistance training yield greater value of critical difference when compared to group B

The results have shown the insignificant values of critical difference when the experimental group A was compared with group B and group C.

Table-3: Analysis of Co-variance for the Experimental groups and the Control group of Jump and Reach test

Test	Group Means (cm) A	B	C	D	Source of variation	Sum of Squares	df	Mean sum of Squares	F-ratio
Pre-test Mean	76.1	80.8	75.45	70.6	Among	1044.6	3	348.21	
					Within	3595.8	76	47.31	7.359*
Post-test Mean	78.9	82.7	79.20	71.4	Among	1344.5	3	448.17	
					Within	3370.1	76	44.34	10.106*
Adjusted Post-test Mean	78.5	77.9	79.49	76.2	Among	108.77	3	36.26	
					Within	257.29	75	3.43	10.568*

*Significant at 0.05 level F.05 (3, 76) = 2.72 F.05 (3, 75)= 2.72

A – Plyometric, B – Resistance, C – Plyometric + Resistance, D – Control

As shown in table-3 that significant value of F-ratio's were obtained for the comparison of pre test means (7.259), post test means (10.106) and adjusted post test means (10.568). The obtained values were higher than the required value for the selected degree of freedom and the significance level. The results of the Post hoc analysis and the difference between the means among the four groups are shown in table -4.

Table-4: Paired adjusted final means and differences between means among the Experimental groups and Control group of subjects of Jump and Reach test (cm)

Groups A	B	C	D	Mean Difference
78.59	77.97			0.620
78.59		79.49		0.900
78.59			76.21	2.380*
	77.97	79.49		1.520*
	77.97		76.21	1.760*
		79.49	76.21	3.280*

*Significant at 0.05 level. Tab t .05 (19) = 1.159

A – Plyometric, B – Resistance, C – Plyometric + Resistance, D – Control

The results in table-4 have shown that the mean differences of all experimental groups when compared with the control group have exhibited the significant values of critical difference at the

selected level of 0.05.

The group C trained with the combination of plyometric and resistance training yield significant value of critical difference when compared with Group B which trained with resistance training.

The results have shown the insignificant values of critical difference when the experimental group A was compared with group B and group C.

Table-5: Analysis of Co-variance for the Experimental groups and the Control group of Long Jump Test

Test	Group Means (m) A	B	C	D	Source of variation	Sum of Squares	df	Mean sum of Squares	F-ratio
Pre-test Mean	6.24	6.47	6.39	6.46	Among	0.669	3	0.223	
					Within	2.644	76	0.034	6.418*
Post-test Mean	6.32	6.51	6.46	6.47	Among	0.428	3	0.142	
					Within	2.257	76	0.029	4.805*
Adjusted Post-test Mean	6.45	6.44	6.46	6.41	Among	0.031	3	0.010	
					Within	0.135	75	0.001	5.900*

*Significant at 0.05 level F.05 (3, 76) = 2.72 F.05 (3, 75)= 2.72

A – Plyometric, B – Resistance, C – Plyometric + Resistance, D – Control

As shown in table-5 that significant value of F-ratio's were obtained for the comparison of pre test means, post test means and adjusted post test means.

The obtained values were higher than the required value for the selected degree of freedom and the significant level. The post hoc test was conducted and the results of the Post hoc analysis and the difference between the means among the four groups are shown in table -6.

Table-6: Paired adjusted final means and differences between means among the Experimental groups and Control group of subjects of Long Jump Test (meters)

Groups A	B	C	D	Mean Difference
6.45	6.44			0.010
6.45		6.46		0.010
6.45			6.41	0.040*
	6.44	6.46		0.020
	6.44		6.41	0.030*
		6.46	6.41	0.050*

*Significant at 0.05 level. Tab t .05 (19) = 0.026

Plyometric, B – Resistance, C – Plyometric + Resistance, D - Control

The results in table-6 have shown that the mean differences of all experimental groups when compared with the control group have exhibited the significant values of critical difference at

the selected level of significance.

The group C which trained with the combination of plyometric and resistance training yield greater value of critical difference in comparison to other experimental groups (Group A and B).

The results have shown the insignificant values of critical difference when the experimental group A was compared with group B, group C and group B with group C.

Discussion

All these significant changes have shown that the short term plyometric and resistance training alone **are capable in improving the jump performance but the combination of both Plyometric and resistance** training is even have greater effects. While performing the plyometric, resistance and combination of both training, the loads have been given in developing the particular muscles of body. It is based on the understanding that concentric (shortening) muscular contraction is much stronger if it immediately follows an eccentric (lengthening) contraction of the same muscle. It is bit lit stretching out a coiled spring to its fullest extent and then letting it go. Immense levels of energy are released in a split second as the spring recoils. Muscle fiber more elastic energy and transfer more quickly and powerfully from the concentric to the eccentric phase responsible for the development of explosiveness, speed, explosive power and muscle strength, mobility and flexibility of various joints, dynamic stability and coordination of various muscles, which are the key factors in generating the most powerful stimulus by increasing hip and thighs power production of the athletes but when we see the results of combined training, these were much better than the plyometric and resistance training alone. It may be due to the fact that the muscles are trained in two different patterns. Weight training programme are conductive to develop the upper and lower extremities muscle strength, while the simultaneous application of plyometric permits effective use of this strength to produce explosiveness in sports or events demanding speed, explosiveness and quickness. Therefore, better improvement in jumping performance ability, speed, explosive power and muscle strength can be seen.

It is therefore concluded that is a choice has to be made out of three training methods namely plyometric training, resistance training and combined training of both. The combined training may be preferred for improving the speed of the athletes. The findings of this study are in consonance with the results of the study done by (RAHIMI AND BEHPUR, 2005; SULTANA ET, AL. 2008; GERMER 1987; GEHRI ET.AL. 1998; KRITPET 1989 as well as FAIGENBAUM AND MCFARLAND 2007).

Practical Application

On the basis of the findings of the study, the following conclusions are drawn:

a) Twelve weeks of Plyometric and resistance training exercises are useful program to improve the performance of jumpers.
b) The combined plyometric and resistance training programs has greater effect in comparison to resistance and plyometric training.

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