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EFFECT OF PLYOMETRIC AND CIRCUIT TRAINING ON LEG STRENGTH, HORIZONTAL AND VERTICAL EXPLOSIVE POWER

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Abstract

This study compared ***the effects of plyometric training and Circuit training program on the following functional tests:*** *leg strength – leg strength test, horizontal explosive power-(standing broad jump), Vertical explosive power (sergeant jump test).To achieve the purpose of the study, 60 male school athletes were selected from the Government Higher Secondary School, Thuvarankurichy, Trichy District at randomly. They were randomly assigned in to Plyometric training group (n = 20), Circuit Training group (n = 20), and a control group (n = 20). Experimental groups trained three days a week for 12 weeks. The collected data were statistically analyzed with paired sample't' test was used to find out significant improvement and analysis of covariance (ANCOVA) was used to find out the significant difference among experimental and control groups and the Scheffe's test was applied as post-hoc test to find out paired mean difference was significant. In all the cases 0.05 level of confidence was fixed to test the hypothesis. This study concluded that the plyometric training was significantly effective in improving the Elastic leg strength,horizontal and Vertical explosive power than Circuit training group of school athletes.*

Keywords: *plyometric training, circuit training,leg strength, horizontal and vertical explosive power.*

Introduction

Strength and power have importance in many types of sports. They are the key factors involved in weight lifting, throwing, jumping, and sprinting events. A high level of strength and power is usually associated with a greater ability to accelerate the body mass or propel external objects (MacDougall, Wenger & Green, 1982). Plyometrics are training techniques used by athletes in all types of sports to increase strength and explosiveness (Chu,

1998). There are a lot of different training methods for different training purposes. In the recent years, a more advanced training, called the plyometric training, has been suggested to improve the muscular power of athletes (Moran & McGlynn, 1997). Originally, plyometric training is used to improve the explosive power of athletes (Blattner & Noble, 1979; Brown et al, 1986; Clutch et al, 1983).

Plyometrics is a type of training methodology that can increase power output and explosiveness. Plyometrics involves an active muscle switching from a rapid eccentric muscle action to a rapid concentric muscle action or from a rapid deceleration to a rapid acceleration. A greater power output can be found when the stretch – shortening cycle is used because of the efficiency gained by releasing elastic energy in the muscles. This type of training can improve performance in explosive sports that rely on moving speed and power such as hockey, basketball, Track and field, football and volleyball.

The term "plyometrics" refers to specific exercises which encompass a rapid stretching of muscle that is undergoing eccentric stress followed by a concentric, rapid contraction of that muscle for the purpose of developing a forceful movement over a short period of time (Chu, 1983). One particular plyometric activity, the depth jump, has been shown to improve power in the vertical jump (Batholemew, 1985; Miller, 1982; Parcells, 1977; Verkhoshanski & Tatyan, 1983). Plyometrics 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 (Baechle and Earle, 2000). Researchers have shown that plyometric training, when used with a per-iodized strength training program, can contribute to improvements in vertical jump performance, acceleration, leg strength, muscular power, increased joint awareness, and overall Proprioception (Adams et al., 1992; Anderst et al., 1994; Miller et al., 2002).

Elements of circuit-style training programs were present early on in history. The modern form of circuit training was developed by R.E. Morgan and G.T. Anderson in 1953 at the University of Leeds in England. Fundamentally, circuit training consists of a series of different training exercises. The training exercises may be grouped into different stations where different parts of body are trained. This type of training is simple and easy to handle and participants can perform the tasks at each station in rotation. It helps to improve the general fitness of athletes with the limit of space, time and equipment (Pauletto, 1991). Traditionally. The training exercises of circuit training include push-up, sit-up, bench lifting, Squat thrusts, stepping and dumbbell rising. These exercises are performed with or without Apparatus. Circuit training aims at the development of the basic components of physical Fitness including muscular and cardio respiratory fitness. It was initially examined as a 9 to 12 exercise protocol where participants performed exercises at a moderate intensity (about 40% to 60% of 1 RM values) for a specified number of repetitions or amount of time. Once the repetitions were performed or time expired, the participant would move to the next exercise station with very little rest. Improvements in muscle strength and endurance were observed, as well as components of aerobic fitness. (Morgan & Adamson, 1961).

According to the purposes of training, there are many variations in circuit training. Scholich (1992) suggests that circuit training can be based on the endurance method, the Extensive

interval method, the intensive interval method and the repetition method. Basically, these methods vary with the stimulus intensity, density, volume and duration of Exercise depending on the purposes of training. Each method leads to different physiological and psychological effects. For example, athletes are trained at about 90% to 100% of their Maximal performance ability with a few minutes of recovery in the repetition method in order to develop the anaerobic capacity. Although plyometric training and circuit training has been shown to increase performance variables, little scientific information is available to determine if plyometric and circuit training actually enhances strength and power. Therefore, the purpose of the present study was to determine the effect of plyometric and circuit training on leg strength, horizontal and vertical explosive power of school athletes.

Materials and Methods

Sixty school athletes participating at zone level volunteered for this study, they were selected from the Government Higher Secondary School, Thuvarankurichy, Trichy District at randomly (Table 1).

Table 1 Descriptive group data

Subject details	Plyometric training group	Circuit training group	Control group
Number	20	20	20
Height (cm)	165 ± 5.8	165 ± 6.6	164 ± 5.5
Mass(kg)	56 ± 4.5	58 - 5	55 – 5.2
Age (yr)	13 - 17	13 - 17	13 - 17

The participants did not perform either Plyometric or Circuit training of their training schedule for a period of at least three months prior to the study. ***Elastic Leg strength*** - Leg Strength test (leg strength test- 25 mts hop), ***Horizontal explosive power*** - Standing Broad Jump test, ***Vertical explosive power*** – Sergeant Jump test was used as experimental variables. All subjects agreed not to change or increase their current exercise and food habits during the course of the Study and a regular care on their health was maintained.

The Plyometric training group and circuit training group participated in a 12-week training program performing a variety of exercises designed for the lower extremity, while the control group did not participate in any Plyometric and circuit training exercises. The intensity of training was tapered so that fatigue would not be a factor during post-testing. The Plyometric training group and circuit training group trained at the same time of day, three days a week, over a period of 12 weeks. During the training, all subjects were under direct supervision and were instructed on how to perform each exercise.

The pre test and post test randomized control group design was used as an experimental design. The collected data from the three groups prior to and immediately after the training programme on

selected criterion variables was statistically analyzed with paired sample't' test was used to find out significant improvement and analysis of covariance (ANCOVA) was used to find out the significant difference among experimental and control groups. Whenever the 'F' ratio for adjusted post test means was found to be significant, the Scheffe's test was applied as post-hoc test to find out paired mean difference was significant. In all the cases 0.05 level of confidence was fixed to test the hypothesis.

Analysis of data

Table II

Computation of Mean, SD and 'T' Ratio of Pre & Post Tests of Training & control Groups on Elastic leg strength and Horizontal explosive power of high school sports students

Criterion Variables	Group	test	Mean	SD	t'- Ratio
Elastic leg strength	Plyometric	Pre test	8.56	0.3766	8.81*
		Post test	7.85	0.3377	
	circuit	Pre test	8.58	0.3766	5.54*
		Post test	8.21	0.3377	
	Control	Pre test	8.65	0.4246	1.29
		Post test	8.64	0.4258	
Horizontal explosive power	Plyometric	Pre test	1.94	0.0935	10.52*
		Post test	2.11	0.0738	
	circuit	Pre test	1.99	0.0647	4.59*
		Post test	2.03	0.0629	
	Control	Pre test	1.92	0.111469	0.19
		Post test	1.92	0.107922	
Vertical explosive power	Plyometric	Pre test	47.45	3.8317	10.51*
		Post test	61.25	4.9404	
	circuit	Pre test	44.75	3.5075	4.59*
		Post test	51.65	5.05	
	Control	Pre test	43.7	2.8855	0.35
		Post test	43.8	2.7067	

Significant at 0.05 levels. Degrees of freedom n-1=19 is 2.09.

Table II shows that the obtained't' ratio value of experimental groups on Elastic leg strength, horizontal & vertical explosive power are 8.81*, 5.54*, 10.52*, 4.59*, 10.51* and 4.59* which are higher than the table value of 2.09 with df 19 at 0.05 level of significance and the table value of control group on dependent variables are 1.29, 0.19, and 0.35 which are not higher than the table value of 2.09 with df 19 at 0.05 level of significance. Therefore, the results of the study indicate that there was a significant improvement between pre and post test means of both experimental groups on the development of Elastic leg strength, horizontal & vertical explosive power school sports students. The results of the study also indicate that there was no significant improvement between the pre and post test means of control group

on the development of Elastic leg strength, Horizontal & vertical explosive power of school athletes.

Table III

ANALYSIS OF COVARIANCE ON CRITERION VARIABLES OF EXPERIMENTAL GROUPS

Criterion Variables	Adjusted post test means			Source of variance	Sum of Squares	df	Mean Squares	'F'-Ratio
	Plyometric training	circuit training	Control group					
Elastic leg strength	7.88	8.22	8.60	B	5.09	2	2.54	39.17*
				W	3.64	56	0.06	
Horizontal explosive power	2.11	2.00	1.95	B	0.29	2	0.15	76.62*
				W	0.11	56	0.001	
Vertical explosive power	60.91	51.74	44.05	B	2349.77	2	1174.89	61.44*
				W	1070.82	56	19.12	

*Significant at 0.05 level of confidence.

(The table value required for significance at 0.05 levels with df 2 and 56 is 3.15).

From the table III, the obtained F- ratio of *Elastic leg strength, Horizontal and vertical explosive power* for adjusted post test means were 39.17* , 76.62* and 61.44* respectively which are more than the table value of 3.15 for df 2 and 56 required for significant at .05 level of confidence. The results of the study indicate that there is significant difference among the adjusted post test means of Plyometric training, circuit training and control groups on *Elastic leg strength, Horizontal and vertical explosive power* due to the effect of training.

TABLE IV

Scheffe's Paired Mean Difference of Experimental and Control Groups on Elastic leg strength

Plyometric training group	circuit training group	Control Group	Paired mean Difference	C.I.Value
7.88	8.22		0.34	0.19
7.88		8.60	0.72	0.19
	8.22	8.60	0.38	0.19

*Significant at .05 level of confidence.

Table IV shows that the paired mean differences of Elastic leg strength between Plyometric training group and circuit training group, Plyometric training group and control groups, circuit training group and control groups are 0.34*, 0.72*, and 0.38*respectively. These values are greater

than the confidence interval value 0.19.The result of the study shows that there were significant differences between Plyometric training group and circuit training group, Plyometric training group and control groups, circuit training group and control groups since the mean differences were greater than the confidence interval value of 0.21.

While considering the two groups, from the results presented in table –IV it was found that Plyometric training group was better than circuit training group on Elastic leg strength.

TABLE V

Scheffe's Paired Mean Difference of Experimental and Control Groups on Horizontal explosive power

Plyometric training group	circuit training group	Control Group	Paired mean Difference	C.I.Value
2.11	2.00		0.11	0.025
2.11		1.95	0.16	0.025
	2.00	1.95	0.05	0.025

*Significant at .05 level of confidence.

Table V shows that the paired mean differences of Horizontal explosive power between Plyometric training group and circuit training group, Plyometric training group and control groups, circuit training group and control groups are 0.11*, 0.16*, and 0.05*respectively. These values are greater than the confidence interval value 0.025.The result of the study shows that there were significant differences between Plyometric training group and circuit training group, Plyometric training group and control groups, circuit training group and control groups since the mean differences were greater than the confidence interval value of 0.025.

While considering the two groups, from the results presented in table –V it was found that Plyometric training group was better than circuit training group on Horizontal explosive power.

TABLE VI

Scheffe's Paired Mean Difference of Experimental and Control Groups on Vertical explosive power

Plyometric training group	circuit training group	Control Group	Paired mean Difference	C.I.Value
60.91	51.74		9.17	3.47
60.91		44.05	16.86	3.47
	51.74	44.05	7.69	3.47

*Significant at .05 level of confidence.

Table VI shows that the paired mean differences of Vertical explosive power between Plyometric training group and circuit training group, Plyometric training group and control groups, circuit training group and control groups are 9.17*, 16.86*, and 7.69*respectively. These values are greater than the confidence interval value 3.47.The result of the study shows that there were significant differences between Plyometric training group and circuit training group, Plyometric training group and control groups, circuit training group and control groups since the mean differences were greater than the confidence interval value of 3.47.

While considering the two groups, from the results presented in table –VI it was found that Plyometric training group was better than circuit training group on Vertical explosive power.

Findings

The following findings were obtained from the results:

- There was significant improvement on Elastic leg strength, Horizontal and vertical explosive power of school athletes due to the effect of plyometric training and circuit training.
- The plyometric training was significantly effective in improving the Elastic leg strength, Horizontal and vertical explosive power than circuit training group of school athletes.
- The results of the study indicate that there is significant difference among the adjusted post test means of plyometric training, circuit training and control groups on Elastic leg strength, Horizontal and vertical explosive power due to the effect of training.

The result of Scheffe's Paired Mean Differences of Experimental and Control Groups on dependent variables.

- While considering the two training groups, from the results presented in the Scheffe's Paired Mean Difference tables it was found that Plyometric training group were significantly improved on Elastic leg strength, Horizontal and vertical explosive power than compare to circuit training group.

Conclusions

From the analysis of the results, the following conclusions were drawn.

The results from our study are very encouraging and demonstrate the benefits of plyometric training and circuit training on the development on Elastic leg strength, Horizontal and vertical explosive power. In addition, our results support that improvements in Elastic leg strength, Horizontal and vertical explosive power can occur in as little as 12 weeks of plyometric training, circuit training which can be useful during the last preparatory phase before in-season competition for athletes.

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