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2. Effects of Plyometric Training on Physical and Physiological Parameters

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Abstract:

The purpose of the study was to find out the effects of 12 weeks of plyometric training programme on selected physical and physiological variables among high school boys. Plyometrics refers to exercise that enable muscles to reach maximal strength in as short a time as possible (power) by eliciting the stretch shortened cycle of a muscle fiber. To achieve this purpose of the study, 40 boys have been selected randomly at Govt. Higher Secondary School, Gangavalli, Salem (Dt), Tamil Nadu and India on the age group between fourteen to sixteen. The selected subjects were divided into two equal groups of twenty each, namely plyometric training group and control group. The experimental group has undergone twelve weeks of plyometric training, whereas the control group maintained their daily routine activities and no special training was given. All the subjects of two groups were tested on selected criterion variables namely Power, Abdomen muscle strength, Cardio-respiratory endurance and Resting pulse rate using standardized tests, namely Standing vertical jump, Bent-knee sit-ups, Cooper's 12 minutes' walk/run test and counting on radial artery/minute test at prior to and immediately after the training period. The collected data were analyzed statistically through one way analysis of variance (ANOVA) to find out the significant difference, if any among the groups. .05 level of confidence was fixed to test the level of a significance which was considered as an appropriate. The results of the study that there was significant difference among plyometric training group and control group. And also, plyometric training group showed significant improvement on Power, Abdomen muscle strength, Cardio-respiratory endurance and Resting pulse rate compared to control group.

Keywords:

Plyometric training, Power, Abdomen muscle strength, Cardio-respiratory endurance and Resting pulse rate, One way analysis of variance (ANOVA).

2.1 Introduction:

The word plyometric is derived from the Greek word 'pleythyein; mean to 'increase'. Plyometrics refers to exercise that enable muscles to reach maximal strength in as short a time as possible (power) by eliciting the stretch shortened cycle of a muscle fibre. The sequence of events begins by having the muscle stretch and therefore store elastic energy prior to firing.

The harder and faster that the pre-stretch phase of the muscle is in a harder and faster muscle contraction and therefore a more powerful movement! Plyometric exercises are a vital component in aiding an athlete's maximal speed and should be included in any of conditioning program for sprinters (Paul Wanlass, 2014).

Plyometric is a form of power training that consists of an eccentric contraction followed by a concentric contraction (i.e., a vigorous stretch shortening cycle). It has been sports such as basketball, volley ball, throwing, jumping and sprinting. Theoretically the advantages of plyometric training may reside in adaptations both in the central Nervous System (CNS) and in the muscle.

The neural adaptation may be in the reaction to high stretch loads. In drop jumps from a height of 110cm, an untrained person responds with a period of reduced electromyographic activity in the muscles that are stretched during the eccentric phase, whereas trained jumper responds with facilitation and increased activation of the muscle.

In the muscle itself the high tension is a stimulus to increased strength and in addition the stretch imposed on the muscle fibres can increase the fibre length which

besides possibly increasing strength can result in higher maximal velocity of shortening on the whole fibre level. In turn this may allow a lower velocity of shortening on the sarcomere level (intrinsic velocity of shortening) in the longer muscle fibres composed with shorter ones.

Assuming the same velocity of shortening on the whole muscle level this possibly can alleviate the negative effect of high intrinsic velocity of shortening on the power output of the muscle (Per- olt Astrand et al., 2003).

Plyometric activity refers to that type of exercise where there is rapid exchange between eccentric and concentric contraction. Skipping, hopping, rebound jumping, catching and returning medicine balls and jump press ups are all examples of this. The term 'plyometrics' was coined in the United States to cover this sort of training. Plyometrics aims to bridge the gap between strength and speed.

Plyometric exercises accentuate the eccentric phase of muscles contraction thus increasing the relationship between maximum strength and power. By achieving this, explosive movements and quicker reaction are developed. During plyometric activities the stretch-shortening cycle (SSC) is activated.

By using plyometrics to develop the SSC, athletes are better able to accelerate their bodies or sports implements and generate greater force at high velocities therefore improving performance (Frank Dick, 2003).

2.1.1 Stretch-Shorten Cycle for Sport:

The stretch reflex is utilized frequently during sport because most movements involve the two phases of muscular contraction. An eccentric phase, which is the muscle lengthening under tension, is followed by a concentric phase in which the muscle is shortened. Attaining a pre-stretch of the muscle causes it to be lengthened eccentrically so tension is developed in the muscle, similar to a rubber band.

This stored energy created by the tension can be used to help increase the strength of the following concentric contraction. This concentric contraction must immediately follow being stretched or the tension created will dissipate as heat.

An example is a quick countermovement before jumping which allows the quadriceps to be stretched eccentrically so that the following concentric contraction can be stronger.

The amount of tension created by stretching the muscle is dependent on the degree and the speed of the muscle's pre-stretch. Exploiting the elasticity of the muscle and the stretch reflex is referred to as using the stretch-shortening cycle. It has been shown that the faster the muscle is stretched eccentrically, the greater the force will be on the following concentric contraction

(http://www.rxbound.com/2012_02_01_archive.html).

2.1.2 Statement of the Problem:

The purpose of this study was to investigate the effect of 12-week plyometric exercise program on selected physical and physiological variables of high school boys of 14 to 16 years of age.

2.2 Materials and Methods:

The purpose for this study subjects were randomly selected from Govt. Higher Secondary School, Gangavalli, Salem (Dt), Tamil Nadu and India. In total 40 subjects were selected at random and they were divided into two equal groups that is experimental and control group in each group consist of 20 subjects their age ranged from fourteen to sixteen.

The experimental group has undergone plyometric exercises such as bounding, hopping, split jump, jump and reach, jump to box, jump from box, squat jump,

skipping exercises etc., three days in a week for the period of 12 weeks and the control group was not undergoing plyometric training other than their routine work.

To find out the Power, Abdomen muscle strength, Cardio- respiratory endurance and Resting pulse rate the investigator conducted the Standing vertical jump, Bent-knee sit-ups, Cooper's 12 minutes' walk/run test and counting on radial artery/minute test.

Testers' competency, subject reliability and reliability of tests were established by using test and retest method and the reliability coefficient were found to be satisfactory high.

The data were analyzed using one way analysis of variance (ANOVA) for determine the effect of 12 weeks of plyometric training programme on selected physical and physiological variables among high school boys on the age group between fourteen to sixteen.

2.2.1 Selection of Variables and Tests:

The research scholar reviewed the available scientific literature pertaining to available the present study, the following variables were selected.

Table 2.1: Selection of Variables and Tests

Sr. No	Variables	Test Items
1.	Power	Standing vertical jump
2.	Abdomen muscle strength	Bent-knee sit-ups
3.	Cardio-respiratory endurance	Cooper's 12 minutes' walk/run test
4.	Resting pulse rate	Counting on radial artery/minute

Table 2.2: One way analysis of variance (ANOVA) for pretest scores of Vertical Jump of control and experimental group

Sources of variance	Sum of squares	Degrees of freedom	Mean squares	F
Between	9.025	1	9.025	
Within	97.35	38	2.562	3.523
Total	106.375	39		

Table value of (1, 38) at 0.05 level is 4.08.

Table 2.3: One way analysis of variance (ANOVA) for post test scores of Vertical Jump of control and experimental group

Sources of variance	Sum of squares	Degrees of freedom	Mean squares	F
Between	22.5	1	22.5	
Within	171.1	38	4.5	5
Total	193.6	39		

Table value of (1, 38) at 0.05 level is 4.08.

Table 2.4: One way analysis of variance (ANOVA) for pretest scores of Bent-knee sit-ups of control and experimental group

Sources of variance	Sum of squares	Degrees of freedom	Mean squares	F
Between	10	1	10	
Within	114.4	38	3.011	3.322
Total	124.4	39		

Table value of (1, 38) at 0.05 level is 4.08.

Table 2.5: One way analysis of variance (ANOVA) for post test scores of Bent-knee sit-ups of control and experimental group

Sources of variance	Sum of squares	Degrees of freedom	Mean squares	F
Between	10	1	10	
Within	63.9	38	1.682	5.945
Total	73.9	39		

Table value of (1, 38) at 0.05 level is 4.08.

Table 2.6. One way analysis of variance (ANOVA) for pretest scores of Coopers 12 minutes' walk/run test of control and experimental group

Sources of variance	Sum of squares	Degrees of freedom	Mean squares	F
Between	0.0511	1	0.0511	
Within	4.369	38	0.11497	0.445
Total	4.4201	39		

Table value of (1, 38) at 0.05 level is 4.10.

Table 2.7: One way analysis of variance (ANOVA) for post test scores of Coopers 12 minutes' walk/run test of control and experimental group

Sources of variance	Sum of squares	Degrees of freedom	Mean squares	F
Between	0.229	1	0.229	
Within	0.547	38	0.0144	15.903
Total	0.776	39		

Table value of (1, 38) at 0.05 level is 4.10.

Table 2.8: One way analysis of variance (ANOVA) for pretest scores of Resting pulse rate of control and experimental group

Sources of variance	Sum of squares	Degrees of freedom	Mean squares	F
Between	21.025	1	21.025	
Within	591180.75	38	6436.0197	0.00135
Total	591201.775	39		

Table value of (1, 38) at 0.05 level is 4.08.

Table 2.9: One way analysis of variance (ANOVA) for post test scores of Resting pulse rate of control and experimental group

Sources of variance	Sum of squares	Degrees of freedom	Mean squares	F
Between	60.025	1	60.025	
Within	172.75	38	4.546	13.204
Total	232.775	39		

Table value of (1, 38) at 0.05 level is 4.08.

2.2.2 Statistical Techniques:

The data collected from the experimental group and control group, the selected variables on Leg strength and Shoulder strength was statistically examined by using the "F" ratio used to find out the significance difference between experimental group and control group, the level of significance was fixed at

0.05 level of confidence. The mean difference of the criterion measures for the control and experimental groups is presented in tables. The calculated value of F ratio (3.523) is lesser than the table value of 4.08 at 0.05 level.

Hence it is not significant. Therefore, there is no statistically significance difference between Control and Experimental group scores of Vertical Jump performance. The calculated value of F ratio (5.000) is greater than the table value of 4.08 at 0.05 level. Hence it is significant.

Therefore, there is statistical significance difference between Control and Experimental scores of Vertical Jump performance. The calculated value of F ratio (3.22) is lesser than the table value of 4.08 at 0.05 level.

Hence it is not significant. Therefore, there is no statistically significance difference between Control and Experimental group scores of Bent-knee sit-ups. The calculated value of F ratio (5.945) is greater than the table value of 4.08 at 0.05 level. Hence it is significant. Therefore, there is statistical significance difference between Control and Experimental scores of Bent-knee sit-ups.

The calculated value of F ratio (0.445) is lesser than the table value of 4.08 at 0.05 level. Hence it is not significant. Therefore, there is no statistically significance difference between Control and Experimental scores of 1mile walk/run test.

The calculated value of F ratio (15.903) is greater than the table value of 4.08 at 0.05 level. Hence it is significant. Therefore, there is statistical significance difference between Control and Experimental scores of 1mile walk/run test. The calculated value of F ratio (0.00135) is lesser than the table value of 4.08 at 0.05 level Hence it is not significant.

Therefore, there is no statistically significance difference between Control and Experimental scores of Resting pulse rate. The calculated value of F ratio (13.204) is greater than the table value of 4.08 at 0.05 level.

Hence it is significant. Therefore, there is statistical significance difference between Control and Experimental scores of Resting pulse rate.

2.3 Discussion on Findings:

Avery D. Faigenbaum et al. (2007) investigated to compare the effects of a six-week training period of combined plyometric and resistance training (PRT, n = 13) or resistance training alone (RT, n = 14) on fitness performance in boys (12- 15 yr). The findings suggest that the addition of plyometric training to a resistance training program may be more beneficial than resistance training and static stretching for enhancing selected measures of upper and lower body power in boys. Hamid Arazi et al. (2013) conducted research to compare the effects of high, moderate and low intensity plyometric exercise on the post-exercise systolic and diastolic blood pressure and heart rate responses.

The conclusion that a plyometric exercise (PE) can reduce SBP and DBP post-exercise and therefore we can say that PE has significant effects for reducing BP and HR or post- exercise hypotension. Gi Duck Park, (2014) PhD et al., conducted study about the physical strength elements required for athletic throwing events include muscle strength, swiftness, agility, speed, flexibility, and physical balance. Although plyometric training and weight training are implemented as representative training methods for improving swiftness and agility, most studies of it have been conducted with players of other sports. They concluded that Plyometric training positively affected high school throwing event athletes. To summarize the study findings, the application of plyometric training with high intensity and loads improved the results of athletes who perform highly intensive exercises at normal times.

2.4 Conclusions:

- It would be concluded that the 12-weeks of plyometric exercise programme significantly improved the power.
- It would be concluded that the 12-weeks of plyometric exercise programme significantly improved the abdomen muscle strength.

- It would be concluded that the 12-weeks of plyometric exercise programme significantly improved the cardio respiratory endurance.
- It would be concluded that the 12-weeks of plyometric exercise programme significantly improved by reduction in resting pulse rate.

2.5 References:

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