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# A study on the effects of vertical, horizontal and combination of athletic power and speed training on sprinting and jumping performance of college athletes

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**Abstract**
The Purposive sampling technique was used to select eighty men students studying in Degree Colleges in Visakhapatnam District. After preparing a list of subjects ranged from Seventeen to Twenty one years of age, the investigator checked the health record of these subjects maintained by the college and also at his own level with the help of a qualified Doctor who conducted medical tests to ensure that the subjects were medically fit to undergo the type of training programme, they were further subjected to qualify in Depth Jump and Reach performance test. From the ninety two subjects five were unable to perform depth jumping efficiently. Then eighty subjects were selected by dropping the seven extreme scores that were farthest from the median 17.4 (Appendix-A). Mean and standard deviation for 87 subjects was 17.58 and +2.54 respectively. These values were remained 17.43 and +2.02 for selected eighty subjects.

**Keywords:** vertical, horizontal jumping performance

## Introduction

Running and jumping (along with lifting and throwing) are the most fundamental of human athletic movements. The Olympic Motto of "Citius, Altius, Fortius" (faster, higher, stronger) illustrates the applicability of these basic performance attributes. However, to avoid digressing into a history lesson, suffice it to say that in sprint/jump training we strive to develop all athletic performance attributes to some extent. Every athlete is in a continual process to improve his performance. Many hours of hard training are devoted every year toward this goal. Many people realize that the only way to improve performance is through hard training. History has shown a diverse opinion on which training methods is the most effective for developing the body.

**Plyometric Training:** Plyometrics also known as jump training includes exercises that rapidly stretches the muscles and then rapidly shortens it. It is a training technique used to increase power and explosiveness. Ir helps improves your fast-twitch muscles, vertical jump performance, leg strength and agility. Plyometrics are designed to produce fst and powerful movements from your body. In addition plyometric treaing also aids in injury prevention.

**Horizontal and Vertical Plyometrics:** Plyometric exercises can have horizontal and or vertical components. Horizontal movements improve acceleration training, long jumping, triple jumping, discus throwing, shot putting and javelin throwing. Vertical movements improve maximal velocity training, high jumping and pole vaulting. Complex exercises can combine both horizontal and vertical movements. Coaches can create exercises based on specific movement patterns of an athlete's technique to improve the effectiveness of the stretch shortening cycle. Exercises include vertical and horizontal movements that can be measured based on speed, distance, eccentric load and complexity. Coaches can develop programs based on technical patterns and individual needs to optimize the effectiveness of plyometric training.

**Vertical Jump:** The vertical jump test is a test of lower body power. The test was first described nearly 100 years ago (Sargent, 1921). The procedure below describes the method used for directly measuring the vertical jump height jumped. There are other methods such as using timing systems that measure the time of the jump and from that calculates the vertical jump height.
The athlete stands side on to a wall and reaches up with the hand closest to the wall. Keeping the feet flat on the ground, the point of the fingertips is marked or recorded. This is called the standing reach height. The athlete then stands away from the wall, and leaps vertically as high as possible using both arms and legs to assist in projecting the body upwards. The jumping technique can or cannot use a countermovement (see vertical jump technique). Attempt to touch the wall at the highest point of the jump. The difference in distance between the standing reach height and the jump height is the score. The best of three attempts is recorded.

**Statement of The Problem:** The problem thus stated as follows; "A Study on the Effects of Vertical, Horizontal and Combination of Athletic Power and Speed Training on Sprinting and Jumping Performance of College Athletes

**Objectives of The Study:** This study had the following objectives.

- To evaluate the effects of Vertical Plyometric Training, Horizontal Plyometric Training and Combination of Vertical and Horizontal Plyometric Training on Elastic Power.
- To evaluate the effects of Vertical Plyometric Training, Horizontal Plyometric Training and Combination of Vertical and Horizontal Plyometric Training on Athletic Power.
- To evaluate the effects of Vertical Plyometric Training, Horizontal Plyometric Training and Combination of Vertical and Horizontal Plyometric Training on Running Speed.
- To evaluate the effect of effects of Vertical Plyometric Training, Horizontal Plyometric Training and Combination of Vertical and Horizontal Plyometric Training on Long Jump performance.
- To evaluate the comparative effects of vertical plyometric training Horizontal plyometric training and combination of vertical and horizontal plyometric training on elastic power.
- To evaluate the comparative effects of vertical plyometric training Horizontal plyometric training and combination of vertical and horizontal plyometric training on athletic power.
- To evaluate the comparative effects of vertical plyometric training Horizontal plyometric training and combination of vertical and horizontal plyometric training on Running speed.
- To evaluate the comparative effects of vertical plyometric training Horizontal plyometric training and combination of vertical and horizontal plyometric training on Long jump performance.

**Hypotheses**

- There would be no significant difference between pre and post-test scores of four groups (three experimental groups and one control group) on Athletic Power.
- There would be no significant difference between pre and post-test scores of four groups (three experimental groups and one control group) on Speed.
- There would be no significant difference between pre and post-test scores of four groups (three experimental groups and one control group) on Long Jump performance.
- There would be no significant difference among four groups (three experimental groups and one control group) on Athletic Power.
- There would be no significant difference among four groups (three experimental groups and one control group) on Speed.
- There would be no significant difference among four groups (three experimental groups and one control group) on Long Jump performance.

**Delimitations**

- The study was delimited to the men students studying in Degree Colleges in Visakhapatnam District.
- The study was delimited to the age group of 17-21years.
- The study was delimited to the students studying in Arts & Science courses.
- The study was delimited to the selected speed and jumping variables that is the Elastic Power, Athletic Power, Running Speed and Long Jump performance as dependent variables.
- The study was delimited to the Vertical Plyometric Training, Horizontal Plyometric Training and Combination of Vertical and Horizontal Plyometric Training as independent variables.

**Limitationst**

- He subjects of the study were having different nature of habits, dietary habits, socio-economic status, socio-cultural background, personal exercise routine and experiences. These were considered as limitations of the study as the investigator was unable to control these extraneous variables.
- The psychological factors like motivation, stress, tension, anxiety etc. may have an effect on the results because no special techniques were used to control these factors.

**Definitions of Terms**

**Plyometrics:** Exercise involving repeated rapid stretching and contracting of muscles (as by jumping and rebounding) to increase muscle power.

**Athletic Power:** the ability to exert maximum muscular contraction instantly in an explosive burst of movements. The two components of power are strength and speed. (e. g. jumping or a sprint start)

**Speed:** Speed is measured as the ratio of distance to the time in which the distance was covered. Speed is a scalar quantity as it has only direction and no magnitude.

**Vertical Plyometric Training:** "Plyometrics, also known as jump training or plyos, are exercises in which muscles exert maximum force in short intervals of time, with the goal of increasing power (speed-strength).

**Horizontal Plyometic Training:** "Horizontal plyometric training includes the exercises performed by jumping bouncing or hopping while horizontally progressing on one or two legs or with alternating the legs e.g. extended skip". (Mach, etal., 1979).

**Combination of Plyometric Training:** Plyometrics is a type of exercise training that uses speed and force of different movements to build muscle power. Plyometrics training can improve your physical performance and ability to do different activities.

**Significance of The Study:** The present study explored an innovative method of training based on Plyometric Training; it was the Combination of Vertical and Horizontal Plyometric Training. The study would be useful to know the effects of Vertical Plyometric Training, Horizontal Plyometric Training and their combination on selected speed and jumping variables (Elastic Power, Athletic Power, Running Speed and Long Jump performance). The study would also be useful to understand the comparative effects of Vertical Plyometric Training, Horizontal Plyometric Training and their combination on selected speed and jumping variables (Elastic Power, Athletic Power, Running Speed and Long Jump performance). Thus, the findings of this study would add to the existing knowledge in the area of sports training. It would be of great practical significance for coaches, physical educationists and sports scientists.

**Design of The Study:** This was an experimental study. Random group design was adopted to divide the eighty subjects randomly into four equal groups of twenty subjects in each. Then, the subjects were randomly assigned to three experimental groups and one control group. The four groups were named as follows:

1. VP - Vertical Plyometric Training group
2. HP - Horizontal Plyometric Training
3. CP - Combinational of Vertical and Horizontal Plyometric training group
4. CG - Control Group

**Selection of Subjects:** Purposive sampling technique was used to select eighty men students studying in Degree Colleges in Visakhapatnam District. After preparing a list of subjects ranged from Seventeen to Twenty one years of age, the investigator checked the health record of these subjects maintained by the college and also at his own level with the help of a qualified Doctor who conducted medical tests to ensure that the subjects were medically fit to undergo the type of training programme, they were further subjected to qualify in Depth Jump and Reach performance test. From the ninety two subjects five were unable to perform depth jumping efficiently. Then eighty subjects were selected by dropping the seven extreme scores that were farthest from the median 17.4 (Appendix-A). Mean and standard deviation for 87 subjects was 17.58 and +2.54 respectively. These values were remained 17.43 and +2.02 for selected eighty subjects.

**Selection of Variables**

**Dependent Variables:** The principle stimulus in power training is performing a movement dynamically linked with the force magnitude taking place in the same exertion. For instance, during sprinting an athlete's force of leg propulsion is three and one- half times that of his or her body weight, but the force used to throw a javelin is much smaller. Thus the force of acceleration is the main stimulus for power training. In acyclic sports (i.e. jumping events), power is the determinant ability for achieving a good result. On the other hand, in cyclic sports (i.e. sprinting), power is brought into action repetitively and rapidly. Considered these general characteristics of sports requiring power and reflect them in a strength training programme (Bompa, 1999). Thus, Investigator selected the following dependent variables of acyclic nature, cyclic nature and combining both acyclic and cyclic nature activities:

1. Athletic Power
2. Speed
3. Long Jump performance

**Independent Variables**

The comparative effects of vertical and Horizontal Plyometric Training were searched by various researchers (Hortobagyi *et al*. 1990) but no evidence was found about the effect of their combination. Thus, Investigator selected the following independent variables:

1. Vertical Plyometric Training
2. Horizontal Plyometric Training
3. Combination of Vertical and horizontal Training

**Procedure for Administeration of tests**

During all the testing sessions, subjects participated in a warm-up program and volume and intensity of warming up was kept constant throughout all testing sessions. All the five tests were divided into two groups based on the relatedness of skills involved and conducted in teh two days to avoid the effect of fatigue on performance as follows:

Day - 1
a. Vertical Jump
b. Depth Jump Test

Day – 2
a. 50 yard dash test
b. Standing Broad Jump test
c. Running Long Jump Test

In the day-1, Vertical Jump Test was followed by Depth Jump Test according to the level of intensity as advocated by Chu (1998); (Radcliffe and Farentinos, 1999). In the second day, 50-yard dash test was followed by Standing Broad Jump Test as Bompa (1999) described that speed training arouse the athlete's central nervous system for strength development. Running Long Jump was conducted at last due to the most time consuming as compared to other two tests and its performance was outcome of sprinting (as measured by 50-yard dash test) and horizontal jumping ability (as measured by Standing Broad Jump Test). 3-5 minutes rest was given between the tests due to the energy required was attaining from the phosphagen system (Bompa, 1999). 1-minute recovery of slowjog was given between trials for Vertical Jump Test, Standing Broad Jump Test and Depth Jump Test. 2-minutes recovery of slow jog was given between trials for Running Long Jump test.
The test re-test scores (Appendix-B) for each variable were then correlated and coefficients obtained have been presented in Table- I. It is evident from Table-I that the data pertaining to different tests were quite reliable and objective as the correlation coefficients ranging from 0.817 to 0.965 were significant at. 05 levels.

**Table 1:** Correltion Coefficients of Test Re-Test Scores

| Sl. No | Test | Correlation Coefficients |
|---|---|---|
| 01 | Vertical Jump | 0.927 |
| 02 | Depth Jump | 0.896 |
| 03 | 50 Yard dash test | 0.818 |
| 04 | Standing Broad Jump Test | 0.966 |
| 05 | Running long Jump Test | 0.900 |

**Experimental Plan:** After reviewing the literature in the field, judging ability of the subjects and establishing a reliable procedure for administration of tests, Investigator prepared the experimental plan to conduct the study as follows:

**Table 2:** Experimental Plan

| Week | Session | Day wise | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Monday | Tuesday | Wedne | Thursday | Friday | Saturday | Sunday |
| Before training | Morning | DJT | -- | PS-II | -- | CGTD1 | CGTD2 | VPTD1 |
| | Evening | -- | -- | -- | IS | -- | -- | -- |
| 1 | Morning | VPTD2 HPTD1 | HPTD2 CPTD1 | CPTD2 | -- | -- | -- | -- |
| | Evening | VPT | HPT | VPTCP | VPT | HPT | HPTCP | -- |
| 2 | Evening | VPT | HPT | VPTCP | VPT | HPT | HPTCP | -- |
| 3 | Evening | VPT | HPT | VPTCP | VPT | HPT | HPTCP | -- |
| 4 | Evening | VPT | HPT | VPTCP | VPT | HPT | HPTCP | -- |
| 5 | Evening | VPT | HPT | VPTCP | VPT | HPT | HPTCP | -- |
| 6 | Evening | VPT | HPT | VPTCP | VPT | HPT | HPTCP | -- |
| 7 | Evening | VPT | HPT | VPTCP | VPT | HPT | HPTCP | -- |
| 8 | Evening | VPT | HPT | VPTCP | VPT | HPT | HPTCP | -- |
| 9 | Evening | VPT | HPT | VPTCP | VPT | HPT | HPTCP | -- |
| 10 | Morning | -- | -- | -- | -- | CGTD1 | CGTD2 | VPTD1 |
| | Evening | VPT | HPT | VPTCP | VPT | HPT | HPTCP | -- |
| After training | Morning | VPTD2 HPTD1 | HPTD2 CPTD1 | CPTD2 | -- | -- | -- | -- |
| | Evening | -- | -- | -- | -- | -- | -- | -- |

D.J.T. = Depth Jump Testing, P.S.-ll = Pilot study-ll I.S. instruction session CGTD1= Conducting tests of day one for CG Group CGTD2=Conducting tests of day two for CG group
VPTD1= Conducting tests of day one for VP group VPTD2= Conducting tests of day two for VP group HPTD1= Conducting tests of day one for HP group HPTD2= Conducting tests of day two for HP group CPTD1= Conducting tests of day one for CP group CPTD2= Conducting tests of day two for CP group VPT= Vertical Plyometric Training; HPT= Horizontal Plyometric Training; VPTCP= Vertical Plyometric Training of CP group HPTCP= Horizontal Plyometric Training of CP group

**Training Programme:** Subjects were trained for ten weeks, twice a week. The Group-VP performed depth jump on Monday and Thursday, in which landing from the box was followed by upward jumping movement. Step off from the box and drop to land on both feet, try to anticipate the landing and spring up as quickly as possible (Chu, 1998). The Group-HP performed depth jump on Tuesday and Friday, in which landing from the box was followed by forward jumping movement. Step off from the box and land on both feet, immediately upon landing and jump as far forward as possible (Chu, 1998). The Group-CP performed Vertical Plyometric Training on Wednesday and Horizontal Plyometric Training on Saturday throughout the ten weeks of training programme. The Group-CG was not participated in any of the planned training programme. All the eighty subjects were attended their regular theory and practical classes according to the college curriculum; except the session in which any one of the experimental group participated in the planned training programme. Subjects in the experimental groups were instructed to keep the body from "settling" on the landing and make the ground contact as short as possible (Chu, 1998). Gymnastic mat was the landing surface to perform depth jumping (Radcliffe and Farentinos, 1999). All the three experimental groups participated in a warm-up programme before training and last set of depth jumping was followed by cool- down (Described in warm and cool-down section). Volume and intensity were equated for all the three experimental groups throughout the training programme to attribute any outcomes to the differences in Plyometric Training. In other words, all the three experimental programmes were equated for dropping height and number of jumps throughout the experiment (presented in Table-5). Exercise selection, intensity, volume, frequency, recovery and progression of training are explained below:

**Selection of Exercise:** Depth jumping was selected for Plyometric Training programme according to the findings of pilot study-l. Depth jump training is a common and most searched form of Plyometric drill. Its various modified forms have been developed and searched. Bobbed (1990) stated that the most impodant variable to be controlled is depth jumping technique. Depth jumps have been modified to generate greater stresses at the joints of the hip, knee, and ankle (Holcomb, Lander, Rutland, & Wilson, 1996a). Thus, it is impodant to mention the technique used in the present study. Depth jumps pedormed in the present study were based on the recommendations of Chu (1998). The procedure to pedorm the depth jumps, followed in the present study has been explained below

1. Begin by Standing on the elevated platform with toes close to the front edge; feet shoulder width a pad.
2. Drop from the elevated surface to the mat by taking Step off keep torso up right and land on both feet.
3. As the flight of drop occurred, prepared for landing by flexing at knees £ hips and dorsiflex the ankles. It was important to get the arms as far be and as straight as possible to brought rapidly forward and up as 1 concentric contraction occurs for liftoff.
4. Immediately upon landing performed jump up as high as possible Vertical Plyometric Training (Figure-3.18) and jump forward as far possible for Horizontal Plyometric Training.

**Table 3:** Load of Training Program

| Week | Box Height (in centimeters) | Sessions per week | Number of sets per session | Number of repetitions per set | Total foot contacts in a week |
|---|---|---|---|---|---|
| 1 | 20 | 2 | 6 | 10 | 2X6X10=120 |
| 2 | 25 | 2 | 6 | 10 | 2X6X10=120 |
| 3 | 30 | 2 | 6 | 10 | 2X6X10=120 |
| 4 | 25 | 2 | 6 | 10 | 2X6X10=120 |
| 5 | 30 | 2 | 6 | 10 | 2X6X10=120 |
| 6 | 35 | 2 | 6 | 10 | 2X6X10=120 |
| 7 | 30 | 2 | 6 | 10 | 2X6X10=120 |
| 8 | 35 | 2 | 6 | 10 | 2X6X10=120 |
| 9 | 40 | 2 | 6 | 10 | 2X6X10=120 |
| 10 | 35 | 2 | 6 | 10 | 2X6X10=120 |

**Administration of Training Programme:** After warm up, 20 subjects in an experimental group were trained simultaneously at four training stations under the supervision of station leader, five in each training group. A cone was placed ahead of the dropping height at the distance 11 meters for vertical depth jump training and 12.10 meters for horizontal depth jump training to gave 15 seconds rest walk between repetitions. These distances were determined according to the average of walking distances of 10 subjects covered in 15 seconds after performing vertical and horizontal depth jump. Another cone was placed at 220 meters from the first cone to give 1.5 to 2 minutes pause of slow jog between sets. After completing the depth jumping program and the recovery jog, all subjects participated in the cool-down program.

**Collection of Data:** The necessary data were collected by administering the tests for measuring Elastic Power, Athletic Power, Running Speed and Long Jump performance on the eighty subjects selected for this study. Tests were conducted in two days according to the established procedure of test administration before start of training

and after the experimental period of ten weeks for each group. All the tests were administered in play grounds men students studying in Degree Colleges in Visakhapatnam District.
The subjects participated in an instruction session before the pre-test to ensure proper technique and comprehension of the testing process. Tests were demonstrated by the trained athletes. To ensure uniformity in the testing conditions, the subjects were tested in the morning sessions by the same testers, under the supervision of the Investigator.

**Statistical Design:** Paired t-test was used to identify any significant differences between the pre-tests and post-tests means of all the groups for the dependent variables. An Analysis of Covariance was used to determine significant differences for dependent variables within the four groups. When a significant difference among the groups was observed, a pair-wise comparison of the groups was done by using the Scheffes post-hoc test to identify direction and significant differences between the groups. The level of significance was set at 0.05 in order to test the differences to be considered significant.

**Athletic power Vertical jump Test:** Study of paired t-test for the means of pre-test and post-test scores of the three experimental groups and one control group on Vertical Jump Test performance has been presented in Table-IV and the means of these groups have been exhibited in Figure-I

**Table 4:** Importance of Differences between Pre-Test and Post- Test Means of Three Experimental Groups and the Control Group With Regard To Athletic Power As Measured By Vertical Jump Test

| Groups | Pre-test | Post- test | Differences between means | Standard error of differences | 't' ratio |
|---|---|---|---|---|---|
| VP | 18.36 | 20.07 | 1.71 | 0.161 | 10.6404* |
| HP | 17.5 | 18.427 | 1.026 | 0.144 | 7.1833* |
| CP | 17.86 | 19.327 | 1.476 | 0.106 | 13.9679* |
| CG | 17.7 | 17.57 | 0.13 | 0.213 | 0.2368 |

Importance at 0.05 level t.05 (19) = 2.09

It is evident from Table-IV that all the three experimental groups had exhibited significant improvement in the variable Athletic Power as measured by Vertical Jump Test after period of ten weeks training as obtained ‘t’ ratios 10.6404, 7.1833 and 13.9679 for Groups VP, HP and CP respectively were found greater than the tabulated value 2.09 required to be significant at 0.05 level of confidence with degrees of limited 19. Also it can be observed from the Table-VI that the control group (Group-CG) has not shown significant difference between pre-test and post-test means as obtained ‘t’ ratio 0.2368 was four lesser than the tabulated value 2.09 required to be significant at 0.05 level < confidence with degrees of limited 19.
Table-IV that the control group (Group-CG) has not shown significant difference between pre-test and post-test means as obtained ‘t’ ratio 0.2367 was four lesser than the tabulated value 2.09 required to be significant at 0.05 level < confidence with degrees of limited 19.

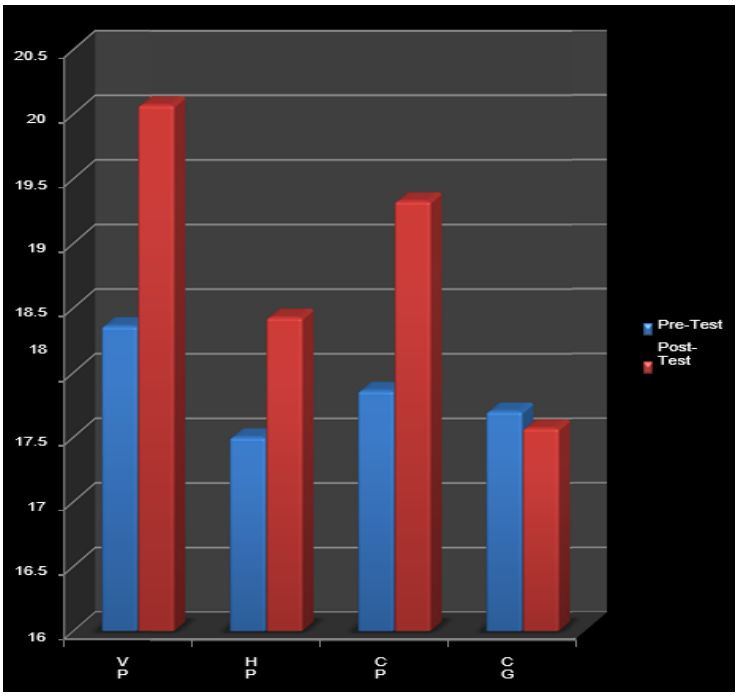


**Fig 1:** Pre-Test and Post-Test Means Of Three Experimental Groups and the Control Group in Vertical Jump Performance

Since the Random group design was employed in the Study, the data further subjected any, among the Study of Covariance, to find out significant differences, if three experimental and one control group. The Study of Covariance is presented in

**Table 5:** Study of Covariance for Three Experimental Groups and The Control Group With Regard To Athletic Power As Measured By Vertical Jump Test

| Sources of variation | Sum of squares | Degrees of limited | Mean sum of squares | F-ratio |
|---|---|---|---|---|
| Between groups | 40.43 | 3 | 13.4735 | 33.94* |
| With in groups | 29.80 | 75 | .3972 | |

Importance level 0.05 F ration 0.05 (3.75) - 2.73

It is evident from Table-V that the results of Study of Covariance (ANCOVA) among three experimental groups and control group with regard to the variable of Athletic Power as measured by Vertical Jump Test were found statistically significant after imparting ten weeks training as the obtained F-ratio 33.94 was found higher than the tabulated value 2.73 required to be significant at 0.05 level of Importance with degrees of limited (3, 75).
Since the F-ratio obtained was found to be significant, Scheffe's post-hoc test was employed to Study the direction and Importance of differences between the paired adjusted final means. The ordered paired adjusted final means and difference between means for all the four groups in vertical jump performance are presented in

**Table 6:** Importance of differences of paired adjusted final means for three experimental groups an the control group with regard to athletic power as measured by vertical jump test

| Means (Groups) | | | | Difference | Scheffe's |
|---|---|---|---|---|---|
| | | | | Between means | Critical difference |
| VP | HP | CP | CG | | |
| 19.6027 | 18.7504 | | | 0.8522* | 0.5698 |
| 19.6027 | | 19.2842 | | 0.3184 | 0.5698 |
| 19.6027 | | | 17.7125 | 1.8901* | 0.5698 |
| | 18.75.04 | 19.2842 | | 0.5337 | 0.5698 |
| | 18.75.04 | | 17.7125 | 1.0378* | 0.5698 |
| | | 19.2842 | 17.7125 | 1.5716* | 0.5698 |

* Significant at 0.05 level

Table-VI reveals that all the three experimental groups were significantly different in their adjusted final means when compared to the adjusted final mean of control group. The mean difference 0.8522 between Group-VP and Group-HP was also found significant in favor of Group-VP. However, the differences for the remaining paired means were not significant.

**Table 7:** Study of covariance for three experimental groups and the control group with regard to athletic power as measured by depth jump

| Sources of variation | Sum of squares | Degrees of limited | Mean sum of squares | F-ratio |
|---|---|---|---|---|
| Between groups | 21.56 | 3 | 7.1912 | 26.02* |
| within groups | 20.71 | 75 | .2767 | |

* Significant at 0.05 level F ratio = 0.5 (3.75) = 2.73

It is evident from Table-VII that the results of Analysis of Covariance (ANCOVA) among three experimental groups and control group with regard to the variable of Elastic Power as measured by Depth Jump Test were found statistically significant after imparting ten weeks training as the obtained F-ratio 26.02 was found higher than the tabulated value 2.73 required to be significant at 0.05 level of significance with degrees of freedom (3, 75).
Since the F-ratio obtained was found to be significant, Scheffe's post-hoc test was employed to study the direction and significance of differences between the paired adjusted final means. The ordered paired adjusted final means and difference between means for all the four groups in depth jump performance are presented in Table-XIV.

**Conclusion**

Based on the findings of this study, the following conclusions were drawn:

- Vertical Plyometric Training leads to significant improvement in Athletic Power (vertical jump and standing broad jump), Speed and Long Jump performance.
- Horizontal Plyometric Training leads to significant improvement in Athletic Power (vertical jump and standing broad jump Speed performance.
- Combination of Vertical and Horizontal Plyometric Training leads to significant improvement in Athletic Power (vertical jump and standing broad jump), Speed and Long Jump performance.

- Vertical Plyometric Training is significantly more effective for improving vertical jump performance as compared to Horizontal Plyometric Training.
- Vertical Plyometric Training is significantly more effective for improving depth jump performance as compared to Horizontal Plyometric Training and Combination of Vertical and Horizontal Plyometric Training.
- Horizontal Plyometric Training is significantly more effective for improving standing broad jump performance as compared to Vertical Plyometric Training and Combination of Vertical and Horizontal Plyometric Training.
- Vertical Plyometric Training is more effective for improving vertical jump performance as compared to Combination of Vertical and Horizontal Plyometric Training.
- Combination of Vertical and Horizontal Plyometric Training indicates higher improvement in Running Speed and Long Jump performance as compared to Vertical Plyometric Training and Horizontal Plyometric Traininc.
- Combination of Vertical and Horizontal Plyometric Training is more effective for improving vertical jump and depth jump performance as compared to Horizontal Plyometric Training.
- Combination of Vertical and Horizontal Plyometric Training is more effective for improving standing broad jump performance as compared to Vertical Plyometric Training.
- Horizontal Plyometric Training is more effective for improving Running Speed performance as compared to Vertical Plyometric Training.
- Vertical Plyometric Training is more effective for improving Long Jump performance as compared to Horizontal Plyometric Training.
- Horizontal Plyometric Training alone does not cause significant improvement in Long Jump performance.

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