# Effect of Plyometric Training on Vertical and Horizontal Jump in Recreational Athletes Indulging in Jumping Activities

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## Abstract

**Background:** Plyometric training is effective to improve the performance of the athletes by increasing the speed power and ability to do the activity. Most of the recreational athletes have no idea about the proper training in the field and they are very prone to get injury. This study was designed to provide the proper training and prevent further injuries in the athletes.

**Objectives:** To find out the effect of plyometric training on vertical jump height and horizontal jump height in recreational athletes indulging in jumping activities according to age, gender, body mass index and years of playing.

**Methodology:** 61 subjects participated in this study according inclusion and exclusion criteria. Prior consent was taken. Pre and post assessment of the vertical and horizontal jump height was taken. The protocol was for 3 days per week for 6 weeks. Later evaluation and interpretation of data was done.

**Result:** There is significant comparison between the pre and post treatment ($p=<0.0001$) of horizontal and vertical jump height. Even there is positive correlation of years of playing in week 6($p=0.58$) for horizontal jump height and in week 6 ($p=0.43$) for vertical jump height. There is negative correlation of age in week 6($p=0.002$) of horizontal jump height in week 6($p=0.31$) of vertical jump height .

**Conculsion:** This study concluded that the effect of plyometric training was seen in recreational atheletes indulging in jumping activities.

***Keywords:*** *Athletes, plyometric training, vertical jump height, horizontal jump height.*

## Introduction

Athletes involved in jumping activities are greater risk for sustaining non-contact injuries when compared with other counter-parts[1]. During the maximum running speed phase, forward propulsion of the body is determined mainly by the action of the hip extensors and ankle extensors[2]. There are various type of jumps that athletes do during their practices which can use the muscle power of the leg mostly , so the clinician use better prognostic or diagnostic value[3].

Recently, weighted-vest jumping has shown to enhance jump performance in athletic populations[4]. Recent findings from training studies of kinematic and kinetic data suggest that lower extremity malalignment is related to inefficient neuromuscular control strategies[1]. The application of the strength and power occur under condition by the type of posture , contraction type and movement pattern during the activity[3].

Vertical jump is the act of raising one's centre of gravity higher in the vertical plane solely with the use of one's own muscle[5]. It is divided into two types:

a) Standing vertical jump: It refers to vertical jump done from a stand still with no steps involved.

b) Running vertical jump: It refers to vertical jump after an approach or run to help add energy to the jump in an effort to improve on the standing vertical jump[5].

Sometimes seem that horizontal assessment, which involved both vertical and horizontal propulsive forces

which predict those activities that involve horizontal linear motion[3].In training the players there are many factors which can be used to improve their performances in the challenging phase. The most challenging for them is the physical fitness and capacities of the player to adapt the exercises. Thus it is important to evaluate the current training and practices to provide sport-specific temporal and kinetic parameters[7].

Plyometric exercises are defined as eccentric loading immediately followed by a concentric contraction[5]. Plyometric exercises involved stretching the muscle immediately before making a rapid concentric contraction. The combined action is called as stretch-shortening cycle[6]. The rapid eccentric loading phase is called stretch phase and concentric phase is called shortening phase and the period between the stretch and shortening is called amortization phase. During this phase the muscle reverses its action, switching from deceleration to acceleration of the load[14].In power-related sports, plyometric training is an important component of athletic preparation to increase muscle power[7].

Plyometric training is thought to utilize the series-elastic properties of connective tissues and the stretch reflex of the neuromuscular unit. During the initial stretch phase the muscle contracts eccentrically and lengthens under tension.the eccentric contraction is thought to prepare the contractile elements of the musclefor the concentric contraction by stimulaton and activationof the monosynaptic stretch reflex.then the receptors send the information to the central nervous system through afferent pathways. From the efferent pathways the signal return and the reflex facilitated the activation of the shortening contration[14].

Plyometric training increases performances and decreases the risk of injury in players[1]. There are very rare studies done on the horizontal jump in player indulging in jumping activities. Tobin and Delahunt said that plyometric exercises were able to elicit a potential response in professional rugby players[15]. Complex training is considered by strength and conditioning coaches to be a superior way to develop athletic strength, speed, and power[12].Plyometric should not be given in presence of inflammation, pain or significant joint instability[14].

Plyometric training has been proposed for the development of explosive-power performance and specifically for the improvement of vertical jump ability[4]. As the lower extremity is subjected to high joint loads and velocities during plyometric activites, so these exercises are ideal for encouraging the reflexive pathways of feedback motor control[1]. Plyometric training is an established technique for enhancing athletic performance but may also facilitate beneficial adaptation in sensorimotor system that enhance dynamic restraint mechanisms and correct faulty jumping mechanisms[1]. Researches have suggested that plyometric exercises were initially utilized to enhanced sports performance and more recently used in the rehabilitation of the injured athletes to help in participation for a return to sports[5].

Researches have investigated the relationship between leg power and functional performance have mostly used bilateral vertical jump assessment to predict the activities[3].Basically there are various component are used to assess the body fat in context to the physical fitness, which are commonly used to determine health related physical fitness[9].

Wilt suggested that muscular performance gains after plyometric training are attributed to these neural adaptation and it may enhances neuromuscular function[16,17]. Plyometric training program had positive effect in improving power and agility, and players use this training method during competitive phase.[5]

Gambetta even suggested that using plyometric exercise in athletics training is essential, as it has become an important part in physical preparation programs utilized to developed leg explosive power especially for long and high jump which require the combination of speed and strength[18]. In general, plyometric training is commonly thought to be more effective training exercise than training including countermovement jumps due to an increased stress for the lower leg muscle[8].

Loturco et al. compared the effect of unloaded vertical vs. horizontal plyometrics on sprint performance in soccer players and found out that horizontal jump group gave greater improvement in speed capacity over short duration, where as vertical jump showed superior improvement over long distances [13]. Luebbers et al. showed that short-term plyometric training result in significant in vertical jump performance in physically active college-aged men[19].

Rosas et al. analyzed the effect of jumping with or without haltere type handheld loading on vertical and horizontal jump performance in youth soccer player and

the found out that they improved jump performance after 6 week, however loaded jump group showed greater improvement in jump capacities[20].

## Methodology

61 subject were taken for the study according to inclusion and exclusion criteria. Inclusion criteria were age group was between 15-30 years and recreational athletes indulging in jumping activities like hurdle jump, long jump. Exclusion criteria were Players have previous injuries in lower extremity or have gone through previous surgeries or having ankle instability. Prior consent was taken. Pre and post assessment of vertical and horizontal jump height was taken. The protocol was for 3 days per week for 6 weeks. Each session was of 60 min.

Exercise protocol was started with warm-up exercise that is jogging, stretching, shoulder exercise, skipping. Then Landing drills, take off drills ,full speed 30-50 meter, squat jumps, depth jumps, box jumps, lateral jumps, ankle hops, double leg jump forward and backward, double leg zig-zag hops, cone jumps. Cool down period was 15 minute.

### Statistical Analysis

Statistical analysis of the recorded data was done by using the software SPSS version 2.0. mean± standard deviation and paired t-test were used for analysis of data. Correlation of the result with age, body mass index and years of playing were determined by using Spearmen's correlation coefficient.

## Findings

**Table 1: Comparison of horizontal between pre and post for week1 and week6**

| Horizontal | Pre | Post | Mean difference | 95% CI | Z-value | p-value | Interference |
|---|---|---|---|---|---|---|---|
| Week1 | 208.75 ± 21.21 | 211.60 ± 21.19 | 2.84 | 2.73 – 2.96 | 6.93 | <0.0001 | Significant |
| Week6 | 226.93 ± 21.3 | 230.2 ± 21.5 | 3.28 | 3.14 – 3.42 | 6.85 | <0.0001 | Significant |

**Interpretation:** In the present study pre interventional mean and standard deviation of horizontal jump height of week 1 is 208.75±21.21 and of week 6 is 226.93±21.3 whereas post interventional mean and standard deviation was 211.60±21.19 of week 1 and 230.2±21.5 of week 6. It concluded that p-value was <0.0001 and interference was considered significantly. This was calculated by paired t-test.

**TABLE 2 : Comparison of vertical between pre and post for week1 and week6**

| Vertical | Pre | Post | Mean difference | 95% CI | Z-value | p-value | Remarks |
|---|---|---|---|---|---|---|---|
| Week1 | 28.14 ± 4.31 | 30.89 ± 4.23 | 2.75 | 2.67 – 2.83 | 6.97 | <0.0001 | Significant |
| Week6 | 46.16 ± 4.31 | 49.29 ± 4.42 | 3.14 | 3.0 – 3.28 | 6.86 | <0.0001 | Significant |

INTERPRETATION: in the present study pre interventional mean and standard deviation of vertical jump height of week 1 is 28.14±4.31 and of week 6 is 46.16±4.31 whereas post interventional mean and standard deviation was 30.89±4.23 of week 1 and 49.29±4.42 of week 6. It concluded that p-value was <0.0001 and interference was considered significantly. This was calculated by paired t-test.

**TABLE 3: Correlation of year of playing with horizontal jump height**

| Year of playing | Z-value | p-value |
|---|---|---|
| Week1 – post | 0.16 | 0.23 |
| Week6 – post | 0.26 | 0.05 |

INTERPRETATION: In the present study the correlation of the years of playing with horizontal jump height is positive by using paired test. The finding showed that years of playing in relation with the players is equally effective.

**TABLE 4 : Correlation of year of playing with vertical jump height**

| Year of playing | Z-value | p-value |
|---|---|---|
| Week1 – post | 0.024 | 0.86 |
| Week6 – post | 0.104 | 0.43 |

INTERPRETATION: In the present study the correlation of years of playing with vertical jump height is positive using paired test. The finding showed that years of playing in relation with the players is equally effective.

**TABLE 5: Age correlation with vertical jump height**

| Age | Z-value | p-value |
|---|---|---|
| Week 1- post | -0.234 | 0.069 |
| Week 6- post | -0.312 | 0.015 |

INTREPRETATION: In the present study the correlation of age with vertical jump height is negative.

**TABLE 6: Age correlation with horizontal jump height**

| Age | Z-value | p-value |
|---|---|---|
| Week 1- post | -0.128 | 0.326 |
| Week 6- post | -0.392 | 0.002 |

INTREPRETATION: In the present study the correlation of age with horizontal jump height is negative.

## Discussion

Vertical jump height and horizontal jump height are used to measure the athletes performances[5] .The distance achieved during the jump are dependent on the athletes ability to transfer the linear momentum force directly from the ground to athletes body's center of mass which is critical to break the inertia and attain high velocities over short-distances. Plyometric training is helpful in increases performances and decreases injury in players[1]. During the maximum running speed phase, forward propulsion of the body is determined mainly by the action of the hip extensors and ankle extensors[2].

The jump height is recorded as distance score. It can be affected by the angle of knee bending, effective use of hands, coordination etc.[5]. To achieve the maximum height during jump the athletes center of mass need to be as high as possible in relation to the ground to attain the highest velocity at the take-off. At these moment the subject follow the sequence pattern of the lower limb rotation result in increase in amount of external force

which applied to overcome the inertia and accelerate the body vertically . as the ground force increases the jump height increases[13]. In previous study they found out that sprint training produces similar or greater training effects than does plyometric training[2].

Several studies showed that muscle power and overall muscle strength correlate negatively with the obesity in children and positively in adults with functional status and bone health. Even they suggest that there are many factor which can contribute to the decrease in the performance in relation to the horizontal jump like changes in the body and lifestyle which can be improved. Further studies should include the invasive technique that dependent on the individual's subjectivity and cultural factors for proper use[9].

In present study we find out that the maximum age group is around 21-25 years where they have achieved the maximum level of maturity. Even there is negative correlation of the age with both result of vertical and horizontal jump height. In previous study they stated that during and following the puberty there has been seen marked difference and unable to explain the absence of significant improvement [5].

The result of the present study showed that there is significant effect of the training in recreational athletes indulging in jumping activities which increases both vertical and horizontal jump height of the players (p=<0.0001). Loturco et al. observe a meaningful increase in vertical and horizontal performances of elite U-20 players who executed short-term program for 3-week composed of vertical or horizontal. The reason behind this is the player's both horizontal and vertical jump height being fully related to the body's vertical as well as horizontal acceleration; and the acceleration is equal to force divided by mass. Sprint training increased the body's vertical as well as horizontal acceleration thus increasing the capacity to accelerate the player's own body weight. [13]

Even in this study we found out the positive result of the athletes years of playing in relation with both vertical jump height week 1(p=0.86) and week 6(p=0.43) and horizontal jump height week 1(p=0.23) and week 6(p=0.05) which shows that have increased their performances for competitive level. This study has some limitation but majorly due to small sample size. Further studies can be done on larger sample size and also on the horizontal jump height as there as there are very rare studies done.

## Result

There is significant comparison between the pre and post treatment (p=<0.0001) of horizontal and vertical jump height. Even there is positive correlation of years of playing in week 1 (p= 0.31) and week 6(p=0.58) for horizontal jump height and in week 1(p=0.86) and week 6 (p=0.43) for vertical jump height but we found out that there is negative correlation of age in week 1(p=0.326) and week 6(p=0.002) of horizontal jump height and week 1p=(0.64) and week 6(p=0.31) of vertical jump height .

## Conculsion

This study concluded that the effect of plyometric training was seen in recreational atheletes indulging in jumping activities.

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**Conflicts of Interest:** There is no conflict of interests in this study.

**Ethical Clerance:** This study has undergone ethical clearance through the university level ethical committee of Krishna institute of medical science, deemed to be university, Karad.

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