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# Effect of Depth Jumps on Performance Indices among University Level Athletic Population

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## ABSTRACT

**Background:** Jump is regarded as a crucial physical fitness indicator when measuring an athlete's performance, hence it's crucial to analyse and train while assessing the fitness level. **Purpose:** The purpose of the study was to determine the effect of 4-week depth Jump plyometric exercise program on knee flexor and extensor strength using isokinetic dynamometer, additionally effect on hamstring and lower back flexibility, agility and speed among university level athletes. **Methods and materials:** 30 male university level athletes mean ± SD (age 22.29 ± 2.96 years; height 1.73 ± 0.08 meters; mass 66.74 ± 8.47 kg) volunteered to participate in the study. Subjects were assessed for strength (isokinetic dynamometer), agility (Illinois agility test), speed (40-meter sprint test) and flexibility (sit and reach test). Athletes were received progressive depth jump training for 4-weeks period. **Result:** After 4 weeks of period post measures were recorded. Significant changes ($p<0.05$) were observed in all the variables tested except for speed. **Conclusion:** This program significantly improved the isokinetic strength, flexibility and agility among athletes and can therefore may be implemented as a regular part of the training schedule.

**Keywords:** Depth Jump, Isokinetic Strength, Agility, Flexibility, Speed, Plyometrics.

## INTRODUCTION

In rehabilitation, numerous plyometric exercises with varied difficulty and demand on the musculoskeletal system can be implemented. Plyometric exercises begin at a lower intensity and progressed to more difficult, higher intensity levels. The progression of plyometric exercise to higher intensity is thought to resolve postinjury neuromuscular impairments and to also prepare the musculoskeletal system for rapid movements and high forces that may be functionally similar to the demands imposed during sport participation, thus assisting the athlete with a return to full function [1].

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Drop jump also known as Depth jump can be defined as a plyometric or stretch-shortening cycle exercise and has been shown to be effective for the improvement of jumping ability and muscular performance. Depth jump is one of the most popular plyometric drills [2].

The procedure requires athletes to drop from a height and, upon landing, immediately perform a jumping movement. Depth jumps, like other plyometric exercises have been shown to increase strength and nerve reactive ability which is considered vital for sports performance [3]. This makes Depth jump a potent tool to improve sporting performance [3,6].

An athlete's overall performance is improved with greater muscular strength which is associated with improved force-time characteristics. Greater muscular strength can enhance the general sport skills such as jumping, sprinting, and agility, this notion is supported by much research [3,4,6]. Superior performances during sport specific tasks are produced by stronger athletes. Greater muscular strength allows an individual to potentiate earlier and to a greater extent, Greater muscular strength not only decreases the risk of injury but also allows an individual to potentiate earlier and a greater extent [4].

Enhanced motor neuron excitability, increased motor unit recruitment, or increased activation of synergists or all resulted in improved strength via plyometric training such as resulting from the Depth Jump leading to improvement in overall muscular strength, which shows the effectiveness of the Depth Jump in improving the muscular strength which contributes to overall improvement in athletic performance and injury reduction [5-7].

Number of individual and team sports demands ability to accelerate rapidly and reach high levels of maximum velocity. In field sports such as soccer and rugby, senior international players possess significantly greater acceleration abilities than their junior counterparts [8,9]. Plyometric exercises as compared to conventional lifting exercises have a greater biomechanical specificity to sprinting (e.g., similar ground contact times to the acceleration phase etc [10].

Depth jumps improved speed through acute potentiating effect as measured by 20 m sprint test when 3 depth jumps where added to a dynamic warm up as compared with the use of dynamic warm up protocol and a cardiovascular warm up [11].

Rapid force development and high-power output, as well as the ability to efficiently utilize the stretch shortening cycle in ballistic movements are required by agility [12]. Plyometric training has been shown to improve these requirements leading to improvement in agility [13,14]. Depth jump training has also shown to improve agility among sportsperson [15,14].

One of the common intrinsic factors postulated for muscular injuries is the lack of muscle flexibility [16-18]. Plyometric training improved flexibility in untrained female college athletes thus reducing the risk of muscular injuries [19]. Previous studies have focused on effect of plyometric protocol comprising various exercises or plyometric in combination with strength training suggesting that combining plyometric training with resistance training may be useful for enhancing muscular performance [20,21] and effect of depth jump alone hasn't been conducted previously to best of our knowledge except for one study conducted by Wilson et al, (1996) [22]. Therefore, the aim of the study is to assess the changes in knee flexor and extensor strength, flexibility of the hamstring and lower back, speed and agility of the athlete before and after the 4 weeks intervention of exclusive depth jump protocol.

## MATERIAL AND METHODS

Total 30 male university level athletes were recruited in the study upon fulfilling the inclusion criteria for the study. The inclusion criteria of the athletes were age ranged from 18 to 28 years and playing sports from past two years. None of the participants had pathological or traumatic history of the lower limbs. Demographic information in the form of subjective data questionnaire was taken from each subject. All procedures were performed with relevant laws and institutional guidelines and approval was taken from the Institutional Ethics Committee of Guru Nanak Dev University Amritsar, Punjab, India. Participants were informed of the purpose of the study and their signed informed consent was taken before enrollment in the study.

Body Weight (kg), Height (cm) and BMI (kg/m2) of the subjects were recorded. Evaluation was performed at Department of sports sciences, Amritsar, which included:

1. Assessment of knee flexor and extensor strength using isokinetic dynamometer.
2. Assessment of speed by 40 metre sprint test.
3. Assessment of agility by Illinois agility test.

4. Assessment of hamstring and lumbar spine flexibility by sit and reach test.

Protocol Prescription: The Exercise Protocol consisted of Progressive depth jumps and exercise sessions were conducted 3 times a week with rest period of 48 hours between each session for 4 weeks. Height of the box was kept 20 cm for initial two weeks and increased to 30 cm for last two weeks. Subjects performed warm up exercises for 10 minutes before attempting the Depth Jump Protocol. Subjects performed 4 sets of 8 repetitions each on 20 cm and 30 cm heighted box over a period of 4 weeks for total number of 12 sessions. During each session, after the completion of exercise, subjects cooled down with light jog and static stretches of the lower body. Post data was recorded after 4 weeks of depth jumps protocol in the similar manner as the pre data was recorded [11,14,15].

**Procedure:** Subjects were tested for knee extensor and flexor strength using Biodex V.4X (Biodex Medical System, Shirley, NY, USA) dynamometer in the strength analysis lab of the Myas-Gndu Department of Sports Sciences and Medicine, Amritsar, Punjab, India.

Peak torque was assessed for knee flexion and extension bilaterally in concentric/concentric mode at $60^0$/s. The subjects were informed prior about the procedure before testing. Movements were demonstrated to the subjects as how they have to push and pull the device and how to exert maximum force while performing the test. The knee joint was placed in most appropriate position for ideal testing with adjusting back rest, chair height, chair distance from dynamometer. The rotational axis of the dynamometer shaft was aligned with the rotational axis of the knee joint (lateral femoral condyle) with hip flexion at $85^0$. The knee adaptor of the dynamometer was attached to the extremity, in which the measurements were performed, 3cm above the dorsal surface of the foot and was strapped. For stabilization, belts were tied across the pelvis, chest and on thigh of the testing leg. The calibration and gravity correction were done. ROM was limited between $90^0$ of flexion and $0^0$ of extension. Extension ROM for each subject was defined in accordance of their individual limits. Initially 3 warm-up sets were performed at $60^0$/s angular velocity to accommodate with testing procedure. Isokinetic testing consisted of 1 set of 3 reps at $60^0$/s. The data obtained were evaluated by the investigator. Verbal encouragement was given for the production of maximal effort of the athlete.

**40 Meter Sprint Test:** Prior to the test the subjects were asked to do warm-up. The test involved running a single maximum sprint over 40 meters with the time recorded using stop watch at the University athletic ground [31].

**Flexibility Test:** Flexibility was assessed using Sit and Reach test. The test involved sitting on the floor with the legs stretched out straight ahead. Shoes were removed by subjects the soles of the feet were placed flat against the box. Both knees were locked and pressed flat to the floor by the tester. With the palms facing downwards and the hands on the top of each other and the subject reached forward along the measuring line as far as possible. Using Sit and Reach Test box, best of three attempts was recorded [18].

**Illinois Agility Test:** subjects were asked to lie on their front (head to the start line) and hands by their shoulders. On the "go" command the stopwatch was started, and the athletes got up as quickly as possible and ran forward 10 meters, then run around a cone, then back 10 meters, then run up and back through a slalom course of 4 cones. Then the athletes ran another 10 meters up and back past the finishing cone at which the timing is noted stopping the stopwatch. Best of 3 attempts was noted [14].

### Statistical analysis

The statistical analysis of the data was performed using the SPSS software 21 version (IBM, CHICAGO, IL). When the significance value is > 0.05 then parametric test is applied and if the value is < 0.05 then non- parametric is applied. For comparison of the anthropometric and isokinetic peak torque, speed, agility and flexibility; paired t-test and non-parametric test was used after verification of the equality of variance errors (Shapiro wilk test).

## RESULTS

**Table1.** Demographic characteristics of the participants.

| | Age(years) | Height(m) | Weight(kg) | BMI (kg/m$^2$) |
|---|---|---|---|---|
| Mean | 22.29 | 1.73 | 66.74 | 22.14 |
| SD | 2.96 | 0.08 | 8.47 | 2.45 |

m: meters, kg: kilograms, BMI: body mass index, SD: standard deviation

Age, Height, Weight and BMI are described in Mean and Standard Deviation.

**Table 2.** Peak torque of left quadriceps and left hamstring at 60$^0$/s speed of dynamometer, Speed (40-meter sprint test), Flexibility and Agility of Athlete's pre-and post-measurements evaluated through paired t test.

| Variables | Pre Mean ± SD | Post Mean ± SD | t-value | p- value |
|---|---|---|---|---|
| Left Quadriceps (PT in FT-LBS) | 130.07 ± 40.50 | 135.48 ± 33.94 | -1.006 | 0.322 |
| Left Hamstring (PT in FT-LBS) | 77.35 ± 25.51 | 99.94 ± 34.31 | -3.583 | 0.001* |
| Speed (sec) | 6.22 ± 0.56 | 6.12 ± 0.51 | 1.825 | 0.078 |
| Flexibility (cm) | 27.09 ± 7.11 | 29.27 ± 7.54 | -6.005 | 0.000* |
| Agility (sec) | 19.59 ± 0.75 | 17.52 ± 1.29 | 11.523 | 0.000* |

PT: Peak Torque, FT-LBS: Feet Pounds, cm: centimetres, sec: seconds

**Table3.** Peak torque of right quadriceps and right hamstring at 60$^0$/s speed of dynamometer for pre- and post-measurements.

| Variable | Pre Median ± IQR | Post Median ± IQR | Z | A symptomatic sign |
|---|---|---|---|---|
| RT Quads (PT in FT-LBS) | 114.00 ± 51.80 | 126.60 ± 27.70 | -2.890 | 0.004* |
| RT Hams (PT in FT-LBS) | 68.80 ± 24.20 | 72.50 ± 21.50 | -1.491 | 0.136 |

PT: Peak Torque, FT-LBS: Feet Pounds, IQR: interquartile range

The pre-and post-values are described in Median and Inter-Quartile range.

## DISCUSSION AND CONCLUSION

This study measure knee flexor and extensor strength bilaterally in concentric/concentric mode at 60$^0$/s, flexibility of the hamstring and lower back, speed, and assess the change in agility of the athlete before and after 4 weeks depth jump exercise intervention.

During elite-level competitions, one of the most important factors that give players an advantage is muscular strength [23,24]. In terms of isokinetic peak torque plyometric training was found to improve strength on both the dominant side (26%) and non-dominant side (13%) in under-15 women [25]. Arazi et al, (2011) [5] Villarreal et al, (2008) [6] have demonstrated that enhanced motor neuron excitability, increased motor unit recruitment, or increased activation of synergists or all resulted in improved strength via plyometric training such as resulting from the Depth Jumps leading to improvement in overall muscular strength which could be the potential reason for strength augmentation in the present study as well. The results of the present study indicate statically significant improvement in left hamstring ($p<0.05$)) and right quadriceps ($z<0.05$) after completion of 4 weeks of Depth jump protocol, these improvements in lower limb strength are in line with previous studies conducted by Blakey et al, (1987) [26] Fatouros et al, (2000) [21] showing effectiveness of plyometric training in strength gains.

All chosen physical and physiological measures (speed, muscular endurance, flexibility, and explosive power) significantly improved in the plyometric training group among male volleyball players (strength, agility, vital capacity, and anaerobic capacity).

There was no improvement in sprint speed performance as measured by the 40-meter sprint test. These findings are in consistency with these previous studies which showed no improvement in sprint speed after a plyometric program conducted by Chaudhary and Jhajharia (2010) [27]; Thomas et al, (2009) [14]. Ground-contact times in plyometric bounce Depth Jump have been reported according to Bobbert et al, (1987) [2] from 300 milliseconds to less than 200 milliseconds and more than 400 milliseconds respectively [28]. Plisk SS, (2000) [12] demonstrated that during sprinting, ground-contact times decrease from, 200 milliseconds at acceleration to, 100 milliseconds at top speed. To generate explosive ground-reaction forces during sprinting, the ground contact times should be shorter to fulfil velocity specificity principle of training, which is not the case when performing depth jumps as demonstrated by Thomas et al, (2009) [14] which could be the likely reason for the lack of improvement in speed.

Time to complete the illinois agility test decreased in the post-test data in the current study. Overall improvement in the agility after the completion of the exercise program can largely be attributed to the neural adaptation, specifically when it comes to intermuscular coordination [29]. Improvement in agility in the current study was significant ($p<0.05$) consistent with the previous research studies conducted by Miller et al, (2006) [30] Thomas et al, (2009) [13] Aalizadeh et al, 2015 [31].

Present study showed improvement in the hamstring and lumbar flexibility (0.05) after the completion of the exercise protocol similar results has been seen in previous studies conducted by Silva et al, (2019) [24] Tahsin and Daglioglu (2018) [32] Chaudhary and Jhajharia (2010) [27] which demonstrated the effect of plyometrics in improvement of flexibility. The result of the previous studies supports the implementation of combination of various Plyometric exercises or Depth Jump alone as seen in the current study to improve flexibility in athletic population.

Studies also found that the majority of athletic performances include plyometric training, which helped the athletes, coaches, and trainers in a number of sporting disciplines. Plyometrics has been incorporated into the entire training programme because it has been recognised by coaches and athletes as a significant aspect in the planning of the scope of athletic growth [34,36]. All the physical and physiological measures like speed, muscular endurance, flexibility, anaerobic power, vital capacity and explosive power significantly improved in the plyometric training group among players, hence improvement of overall performance of the athletes [34-36]. Although in this study sample size was small and included only male players which leads to further analysis of physical parameters with a larger sample size, across a variety of sports, and among both male and female populations.

The finding of the present study indicated that depth jumps can be effective exercise in improving the muscle strength, agility and flexibility of the hamstring and lumbar spine. There was no significant difference in speed. Depth jumps can be effectively used for training and in rehabilitation setup with the aim of achieving greater strength, flexibility and agility among athletic population.

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## CONFLICT OF INTEREST

There is no conflict of interest.

## AUTHORS' CONTRIBUTION

All authors contributed to the fulfilment of the study.

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