# EFFECTS OF SIX WEEKS DEPTH JUMP AND COUNTERMOVEMENT JUMP TRAINING ON AGILITY PERFORMANCE

**Abbas Asadi**

*Roudbar Branch Islamic Azad University, Roudbar, Iran*

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**Abstract**

*The purpose of this investigation was to compare the effects of six weeks of depth jump and countermovement jump training on agility performance. Eighteen male collegiate students participated in the present study and were randomly assigned to two groups: depth jump (DJ) and countermovement jump (CMJ). Subjects in the DJ and CMJ groups performed 5 sets of 20 repetition jumps from an 18-inch box at two days a week for six weeks. The Illinois agility test and T test were measured a week pre and post six weeks of training. A 2×2 analyses of variance was used for the statistical analyses. Both groups indicated significant improvement than pre training in Illinois agility test and T test (P<0.05); likewise, there were no significant differences between the DJ and CMJ training on agility performance after 6 weeks of training (P>0.05). In conclusion, the DJ and CMJ training improved agility performance, and it can be recommended that, coaches and athletes design these types of plyometric training for improving the ability of acceleration, deceleration and agility movements.*

***Key words**: stretch shortening cycle, quickness, jumping*

## Introduction

Plyometric training such as jumping, bounding, and hopping exercises that exploit the stretch-shortening cycle have been shown to enhance the performance of the concentric phase of movement and increase power output (Gehri, et al., 1998). Plyometric exercises evoke the elastic properties of the muscle fibers and connective tissue in a way that allows the muscle to store energy during the deceleration phase and release that energy during the acceleration period (Asmussen & Bonde-Peterson, 1974). Several studies reported that, plyometric training can contribute to improvements in vertical jump performance, leg strength, muscular power, increase joint awareness, and overall proprioception (Harrison & Gaffney, 2001; Bobbert, et al., 1996; Stemm & Jacobsen, 2007; Saez Saez de Villarreal, et al., 2009; Hewett, et al., 1996; Myer, et al., 2006). Plyometric drills usually involve stopping, starting, and changing directions in an explosive manner. These movements are components that can assist in developing agility (Miller, Hilbert, & Brown, 2001). Agility is the ability to maintain or control body position while quickly changing direction during a series of movements (Twist & Benicky, 1996). Agility requires rapid force development and high power output, as well as the ability to efficiently utilize the stretch shortening cycle in ballistic movements (Plisk, 2000; Thomas, French, & Philip, 2009). Plyometric training has been shown to improve these requirements (Stemm & Jacobse, 2007; Pilsk, 2000; Thomas, French, & Philip, 2009). Although plyometric training has been shown to increase performance variables, little scientific information is available to determine if plyometric training actually enhances agility. Moreover, previous studies (Thomas, French, & Philip, 2009; Miller, et al., 2006; Parsons & Jones, 1998; Renfro, 1999; Robinson & Owens, 2004) used general plyometric training such as, squat jump, single leg bounding, double leg hops, and etc on agility, but the effects of stretch shortening cycle (SSC) plyometric training like depth jump (fast SSC) and countermovement jump (slow SSC) (Saez Saez de Villarreal, et al., 2009) on agility performance are unknown. Therefore, the purpose of this study was to determine the effects of a 6-week depth jump and countermovement jump training on agility performance in healthy male students.

## Methods

*Subjects*
Sixteen healthy college male students volunteered to participate in this study. Subjects were randomly assigned either depth jump (DJ; n = 8, age 20.2 ± 1.2 yr; weight 73.6 ± 3.4 kg; height 177.6 ± 5.8 cm) or countermovement jump (CMJ; n=8, age 20.3 ± 1 yr; weight 71.5 ± 4.7 kg; height 176.4 ± 5.7 cm). Subjects were informed about the nature, benefit, and potential risks of the study, and signed a written informed consent form before beginning the study and the University Human Subjects Institutional Review Board approved all testing and training protocols. Subjects were screened for any medical or orthopedic concern that would limit participation. No subject performed strength training or plyometric exercises for the lower body during the study period.

*Plyometric protocols*
Plyometric training was performed 2 days a week for 6 weeks (on Sunday and Wednesday). The training program was based on recommendations of intensity and volume from Miyama & Nosaka (2004) and Ebben (2009). Training sessions for both groups lasted 35 min; and began with a standard 10 min warm-up, 5 min of jogging, 5 min ballistic exercises and stretching; 20 min DJ or CMJ training, and 5 min cool-down.

Both group subjects were instructed to perform exercises in each training session with maximal effort. During the training, all subjects were under direct supervision and were instructed on how to perform correct technique of exercise. The DJ group began by standing on an 18-inch box and was instructed to lead with one foot as they stopped down from the box and land with two feet on the land. After contact, subjects were instructed to explode off the land by jumping as quickly and as high as possible (Thomas, French, & Philip, 2009). Participants in the CMJ group stood on the box and were instructed to drop on the land with two feet. After contact, subjects were instructed to flex their knees (countermovement, approximately 90°) and then rebound upward in a maximal vertical jump (Thomas, French, & Philip, 2009). A 2 min rest was given for the sufficient recovery between sets.

*Agility testing*

Agility were assessed using standard Illinois agility test and T test. The Illinois agility test was used to determine the ability to accelerate, decelerate, turn in different directions, and run at different angles (Figure 1). A hand-held stopwatch was used to take the subjects' time to the nearest 0.01 sec. The run started with a standing start on the command "Go" and subjects sprinted 10 m, turned, and returned to the starting line. When the subjects reached the starting line they zigzagged in between four markers and completed two 10 m sprints (Bloomfield, Ackland, & Elliot, 1994). The fastest time of the three trials was noted as the final agility time. A 5-minute rest period was allowed between each trial. The T test was used to determine speed with directional changes such as forward sprinting, left and right side shuffling, and backpedaling (Figure 2). The subjects were instructed to sprint from a standing starting position to a cone 10 m away, followed by a side-shuffle left to a cone 5 m away. After touching the cone the subjects side-shuffled to the cone 10 m away and then side-shuffled back to the middle cone. The test was concluded by back-pedalling to the starting line (Vanheest, et al., 2002). The test score was recorded as the best time of three trials, to the nearest 0.01 s. A 5-minute rest period was allowed between each trial. Subjects were disqualified if they failed to touch the base of any cone, crossed the one foot in front of the other or failed to face forward for the entire test.

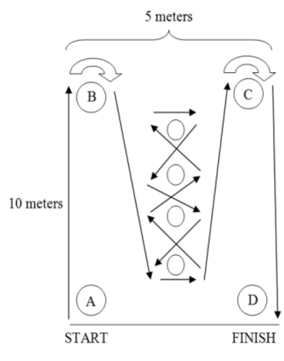


Figure 1. Illinois agility test procedure

*Statistical analyses*

Descriptive statistics (mean ± SD) were reported for all dependent variables. A 2 × 2 analysis of variance was used to analyze Illinois agility test and T test. Tukey's post hoc analyses were used to determine pairwise differences when significant main effects or interactions were observed. Statistical significant was set at $P<0.05$.

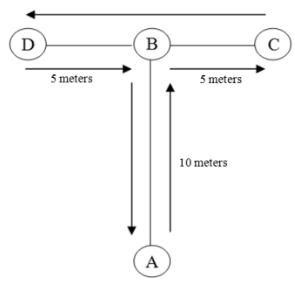


Figure 2. T test procedure

**Results**

Changes in Illinois agility test and T test are presented in Figure 3. Illinois agility test increased significantly in DJ (from 19.63±1.1 to 17.94±0.7 sec, %8.6) and CMJ (from 19.53±1.1 to 17.4±0.9 sec, %10), with no difference observed between groups. Likewise, T test performance increased significantly in DJ (from 12.3±0.4 to 11.3±0.5 sec, %8.3) and CMJ (from 12.5±0.8 to 11.2±0.7 sec, %10), with no difference observed between groups.

**Discussion and conclusions**

However, little has been known about the response of plyometric training especially depth jump (DJ) and countermovement jump (CMJ) on agility performance, therefore, this study was designed to examine the effects of six weeks of DJ and CMJ training on Illinois agility test and T test. In this investigation, participants who underwent DJ and CMJ training were able to improve their times significantly on both the Illinois agility test and T test. These findings are in agreement with Miller, et al. (2006) who examined the effects of 6 weeks plyometric training on T test and Illinois agility test, and found 4.86 and 2.93% improvement, respectively.

Another studies reported plyometric training can lead to significant improvement on agility performance (Parsons & Jones, 1998; Renfro, 1999; Robinson & Owens, 2004). In a study of tennis players, the authors used a T test and dot drill test to determine speed and agility. They found that the players became quicker and more agile; enabling them to get to more balls and be more effective tennis players (Parsons & Jones, 1998). Renfro (1999) measured agility using the T test with plyometric training, while Robinson & Owens (2004) used vertical, lateral and horizontal plyometric jumps and showed improvements in agility. There was a little information about the effects of DJ and CMJ plyometric training on agility.

In this study, positive effects of DJ and CMJ training on agility performance were found. Agility improvement requires rapid force development and high power output, and it seems that DJ and CMJ training can improve these requirements (Thomas, French, & Philip, 2009). In addition, the DJ and CMJ training may have improved the eccentric strength of the thigh muscles, a prevalent component in change of direction during the deceleration phase (Sheffard & Young, 2006).

Neural adaptations and enhancement of motor unit recruitment are other mechanisms can lead to increase for the agility tests (Thomas, French, & Philip, 2009; Miller, et al., 2006). Moreover, agility tasks require a rapid switch from eccentric to concentric muscle action in the leg extensor muscles (the SSC muscle function). Thus, it has been suggested that SSC training (DJ and CMJ) can decrease ground reaction test times through the increase in muscular force output and movement efficiency, therefore positively affecting agility performance (Marković & Mikulić, 2010).

However, we could not exactly determine that neural adaptations occurred or better facilitation of neural impulse to spinal cord; therefore, further studies are needed to determine mechanisms of agility improvement by plyometric training. Overall, these findings demonstrate the necessity of plyometric training program especially DJ and CMJ for enhancing performance in activities which involve acceleration, deceleration and a change of direction. In summary, the result of this study highlights the potential of using DJ and CMJ plyometric training to improve agility. It is recommended that, coaches design DJ and CMJ plyometrics, because these types of training can be effective for improving agility. In addition, our results support that improvements in agility can occur in as little as 6 weeks of plyometric training which can be useful during the last preparatory phase before in-season competition for athletes. Since coaches and athletes are often restricted to a short preseason, this is beneficial for coaches or athletes before competition such as collegiate or logical competitions.

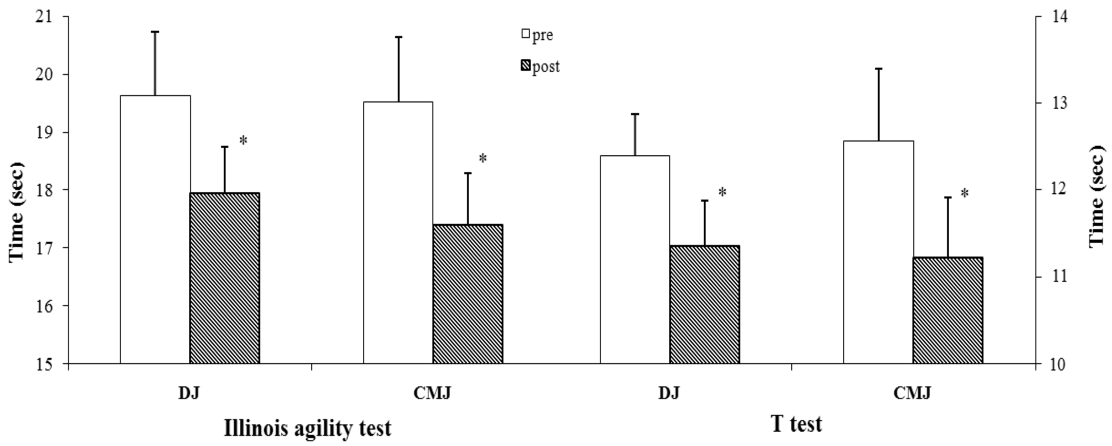


Figure 3. Changes in Illinois agility test and T test following 6 weeks plyometric training. Values are mean ± SD. * significantly different ($P$<0.05) from the corresponding pre training value.

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## EFEKTI ŠEST TJEDANA TRENINGA DUBOKIH SKOKOVA I POVRATNIH SKOKOVA NA IZVEDBU AGILNOSTI

**Sažetak**

*Svrha ove studije bila je usporedba efekata treninga šest tjedana dubokih skokova i povratnih skokova na izvedbu agilnosti. Osamnaest muških studenata koledža sudjelovalo je u prikazanoj studiji i slučajno su raspoređeni u dviej grupe: duboki skok (DJ) i povratni skok (CMJ). Subjekti u DJ i CMJ grupama izveli su 5 serija po 20 ponovljenih skokovasa 18-inčne kutije dva puta tjedno u trajanju 6 tjedana. Illinois test agilnosti i T test su izmjereni tjedan prije i nakon 6 tjedana treninga. Analiza varijance 2x2 je korištena za statističku analizu. Obje grupe su pokazale značajan napredak u odnosu na stanje prije treninga u Illinois testu agilnosti i T testu (P<0.05); također, nije bilo značajnih razlika između DJ i CMJ treninga u izvođenju agilnosti nakon 6 tjedana treninga (P>0.05). Zaključno, DJ i CMJ trening poboljšava izvođenje agilnosti i može se preporučiti da treneri i sportaši dizajniraju njihove tipove pliometrijskog treninga za poboljšanje sposobnosti ubrzanja, usporenja i agilnih gibanja.*

***Ključne riječi**: rastezanje skraćivanja ciklusa, brzina, skočnost*

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*Correspondence to:*
*Abbas Asadi, MSc.*
*Roudbar Branch Islamic Azad University*
*Physical Education and Sport Sciences*
*Khomeini Street 44615-1146, Roudbar Branch, Iran*
*Phone: +(98) 9113213041*
*E-mail: Abbas_Asadi1175@yahoo.com*