Box Step-Up Movement Analysis

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Introduction

According to Ebben et al. (2012), the step-up is a unilateral, single-leg loaded movement which tests one's functional balance and stability and can help improve the quality of movement in sport performance or activities of daily life. The unilateral nature of the step-up is due to a single leg leading the body during both the concentric and eccentric phases of the movement. Unilateral training enhances strength and stability gains by indirectly stimulating the non-working side of the body while the other is working directly (Ebben et al., 2012). According to Fischer et al. (2011), the primary mover of the step-up is the rectus femoris, an important two-joint muscle connecting the knee and the hip. The role of the knee and hip joint actions are crucial to proper performance of the movement, as the trunk stabilizers and knee and hip flexors and extensors are engaged. This multi-joint movement occurs primarily in the sagittal plane and consists of three main phases: the functional starting position, the up or concentric phase, and the down or eccentric phase (Fischer et al., 2011, p. 92-94). According to *The Cooper Institute* (2015), progressions can be made to the step-up exercise, including adding free weights, changing the height of the step, or replacing the step with a jump. These progressions can be made to further improve functional strength, balance, and stability gains in more complex movements, especially in athletic populations (Fischer et al., 2011, p. 94).

Additional Image

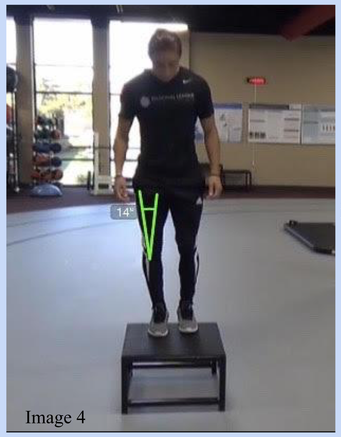

Image 4

Front View of Functional Position

- Performed in the sagittal plane.
- Q angle is at 14 degrees.
- Core is tight for balance and to maintain upright posture.
- Arm movement provides stability

According to Tillman et al (2005), it is important to maintain the q angle to avoid knee injury. While you can't change the structure of the knee, you can strengthen the muscles that maintain the q angle which is particularly important for females as they are at a higher risk for knee injury. Single leg-raises are one exercise to increase knee strength and stability, reduce knee valgus, and maintain a correct Q angle.

Phases

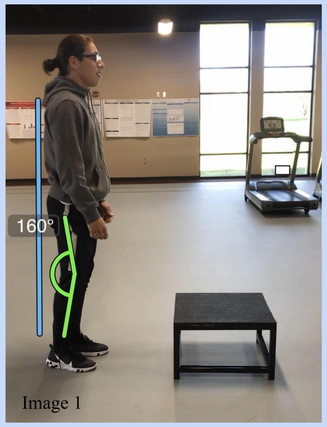

Image 1

Phase 1: Functional Starting Position

- Pelvis is neutral and body is in functional position.
- Posture is upright
- Hip is extended
- Slight flexion of the knee at 160 degrees
- Ankle is dorsiflexed

According to Kloubec (2010), pilates increases muscular endurance, flexibility and posture, which are key to avoiding injury and preventing chronic back and neck pain.

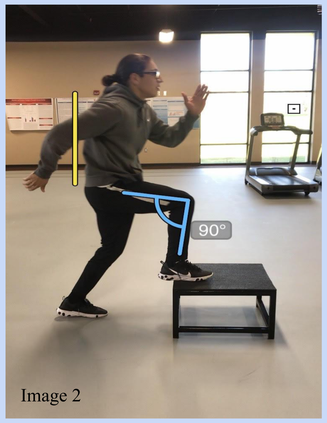

Image 2

Phase 2: Up Phase

- Right hip is flexed
- Right knee flexion at 90 degrees
- Right ankle dorsiflexion and left ankle moves into plantar flexion
- Core is tight and posture remains upright with the head looking forward
- Concentric work

According to Sata and Mokha (2009), abdominal crunch on a stability ball, back extension on a stability ball, supine opposite 1-arm/1-leg raise, hip raise on a stability ball, and Russian twist on a stability ball are exercises that are shown to improve core stability.

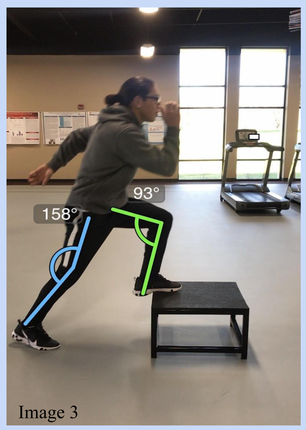

Image 3

Phase 3: Down Phase

- Left knee flexed at 93 degrees
- Left hip flexed
- Right knee extended at 158 degrees
- Both ankles are in dorsiflexion
- Core is tight and posture remains upright with the head looking forward
- Eccentric work

According to Ebben et al (2012), hamstring strength is essential to performance of the step up. Malliaropouloset al (2012) found that the nordic hamstring exercise is the most commonly used exercise to prevent injury in athletes as it strengthens the muscle eccentrically

Sequence Analysis

According to Graham (2011), the movement should be started in the functional starting position in front of a box that is approximately knee length (p. 77). The feet should be hip width apart while the torso, head, and neck should be properly extended to maintain good posture as seen in Image 1. It is crucial to have a box of proper height as to not over strain the knee by requiring more than 90° of flexion (Graham, 2011, p. 77-78). According to Fischer, Matovich, and Walter (2011), a subject should move into phase 2 by flexing the knee and hip to bring the foot onto the box without taking a step between the starting position and step-up (p. 94). This is shown in Image 2. The already extended back leg is then raised to the box and the flexed knee and hip are extended to reach the functional position on top of the box (Fischer et al., 2011, p. 94). According to Graham (2011), the subject should move into phase 3 by stepping off of the box with the right leg, leaving the left leg loaded by flexing the knee and the hip to 90° before bringing the left leg down to the starting position as well (p. 78). The upper body should remain upright and in good posture during performance of phase 3 so the core can be properly engaged, as seen in Image 3. According to Ebben, Garceau, Lutsch, Simenz, and Suchomel (2012), it is key to work on activating the hamstring group during the step-up in order to reduce strain on the knee and the risk of ACL injury. Activation of the gluteus medius muscle as well can prove useful to minimize the occurrence of knee valgus in the functional position that is sometimes seen by the front view of Image 4 (Ebben et al., 2012). According to Kowalchuk (2016), the lower extremity can be trained to mechanically restrict the medial and lateral sides of the legs during step-up performance. This will help to reduce unwanted internal rotation of the hip and improve alignment of the lower extremity in the frontal plane (Kowalchuk, 2016).

Conclusion

In conclusion, the step up can be used in diverse populations and is shown to improve activities of daily life as well as sport performance. While the movement is used in rehabilitation and sport performance settings, it is important to maintain proper alignment, stability, and balance by keeping the core tight to reduce the risk of injury. In sports performance settings, additional emphasis is placed on maintaining proper angles throughout the sequence to enhance the movements crossover benefits to the desired sport. The box step-up should be enhanced through training in order to isolate problem areas and improve overall alignment and performance.

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