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The impact of Utkatasana and Virabhadrasana 2 on quadriceps and hamstring muscle groups: A thematic review

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Abstract
This topical essay investigates how the quadriceps and hamstring muscles are affected by two well-known yoga poses, Utkatasana (Chair Pose) and Virabhadrasana 2 (Warrior 2 Pose). These postures are essential to the practice of yoga and are well-known for having a substantial impact on lower body flexibility, strength, and stability. This paper seeks to clarify the precise anatomical and physiological changes in these muscle groups that take place during the performance of Utkatasana and Virabhadrasana 2 by a thorough analysis of pertinent scientific papers and literature. The results underline how crucial these postures are for encouraging healthy muscular growth and overall lower body health

Keywords: Quadriceps, hamstring muscle groups, Utkatasana and Virabhadrasana

1. Introduction
The Sanskrit root "yuj" implies union, and it is from this root that the words "yoga" and "yoke" are formed. Yoga is a psycho-somatic-spiritual discipline that aims to bring our mind, body, and soul into harmony as well as our eventual unification with the universal consciousness.(D. Madanmohan, 2008; Singh *et al*., 2011) [14, 20].
Yoga has become more well-liked due to its benefits for both physical and mental wellness(null Madanmohan *et al*., 1992; D. Madanmohan, 2008) [13, 14], possess solid scientific justification and result in consistent physiological changes (null Madanmohan *et al*., 1992; Udupa, 1972; R. Wallace *et al*., 1971; R. K. Wallace, 1970) [14, 25, 27, 28]. Utkatasana and Virabhadrasana 2 are two well-known yoga poses that strengthen, stretch, and stabilize the hamstrings and quadriceps. Yoga practitioners and scientists studying exercise science need to understand how these positions affect different muscle groups. A recent systematic study also discovered that yoga improves senior people's quality of life and some aspects of health-related fitness, such as muscle strength, flexibility, and balance (Sivaramakrishnan *et al*., 2019; Wibowo *et al*., 2022) [21, 30]. Simple body motions including standing, sitting, forward and backbends, twists, inversions, and lying down in the supine position make up yoga poses. It has been demonstrated that a variety of yoga poses and exercises can activate particular muscles. The electromyogram (EMG), which generates signals proportional to the tension created in muscles during use, is typically used to measure muscle activation. For the particular muscle under research, these signals are most frequently standardized to maximum voluntary isometric contraction (MVIC) (Ni *et al*., 2014; Rathore *et al*., 2017) [15, 17] The asanas, or positions, of yoga were created as a method to balance, strengthen, and align the physical structure of the body. Additionally, it has been used to improve the dynamic control of muscles that stabilize the core to lessen lower back pain (LBP) (Cramer *et al*., 2013; Rathore *et al*., 2017) [9, 17].

2. Biomechanical Analysis
Utkatasana, also known as the Chair Pose, is performed by stooping down and bending your knees so that they are parallel to the ground. In order to support the body's weight in the squatting posture, the quadriceps must strive to contract in this stance. By opposing the quadriceps' motion, the hamstrings contribute to the stabilization of the body as well.

The highest knee extensor JMOF (0.041 Nm/kg) and the lowest knee adductor JMOF (0.001 Nm/kg) were achieved by the Chair asana. During the Chair asana, quadriceps EMG activity increased as well (33.0-47.2% MVC). This data suggests that workout regimens for strengthening the knees should include the Chair asana. For those with symptomatic knee OA, it is a better training option than other forms of standing yoga (Brenneman *et al*., 2015; Liu *et al*., 2021) [7, 11], as well as optimizing the training effect on the muscle, it is useful in preventing excessive medial knee joint loading, reducing the knee adductor JMOF, and strengthening the muscle. The Chair Pose could be advantageous for general workout. This recommendation was provided for healthy people in earlier studies (Kelley *et al*., 2018; Liu *et al*., 2021; Longpré *et al*., 2015) [18, 11, 12] and senior populations (Liu *et al*., 2021; Salem *et al*., 2013; Wang *et al*., 2013) [11, 19, 29] They discovered that squat exercises effectively tone the leg muscles. Additionally, it was recommended that this pose lengthen the calf muscles and lift the inner arch to lessen the symptoms of flat feet (Liu *et al*., 2021) [11]. In Virabhadrasana 2, sometimes referred to as the Warrior 2 Pose, the practitioner must lunge forward with one leg while extending the other leg backward to form a wide stance? The front knee is bent to train the quads, while the back leg is stretched to stretch the hamstrings. This dynamic stance increases the strength and endurance of the quadriceps while also promoting hamstring flexibility. Between Warrior 1 and Warrior 2, there were differences in the precise biomechanics of the two high lunges. The two positions are basic standing yoga poses. For Warrior 1, the front limb produced the highest hip extensor JMOF (0.288 Nm/kg), and the back limb produced the highest hip flexor JMOF (0.316 Nm/kg). For Warrior 2, the hip adductor JMOF was highest in the front limb (0.32 Nm/kg), and the hip abductor JMOF was highest in the back limb (0.33 Nm/kg). The wider stance of the Warrior 1 and Warrior 2 postures lengthens the moment arm of the force, with regard to the hip joint center in the sagittal and frontal planes separately. This result is not surprising because greater joint moment development is associated with a longer moment arm (Liu *et al*., 2021).

3. Anatomical and Physiological Aspects

Long-term holding of yoga positions initially stimulates and then inhibits myotatic responses. Intrafusal (IF) muscle fibers are facilitory during muscle stretching, but the GTOs (Golgi tendon organs) are inhibitory. As in the patellar reflex, IF (Intrafusal Fibers) fibers initially cause rapid muscle contraction, which is initially stronger than the GTO's inhibition. However, after 60–120 seconds, the IF adjusts signal intensity, and the GTO's inhibitory response takes control, favoring increased stretch and relaxation. It is more difficult to see the agonist-antagonist relationship espoused by yoga practitioners. Yoga encourages quadriceps tightness in this scenario to improve hamstring stretching because quadriceps contraction causes hamstring relaxing (reciprocal relaxation).Yoga's favorable impact on heart rate and blood pressure is explained by a third mechanism. The autonomic nervous system is influenced by meditation, breathing techniques, and "extreme" postures to shift from sympathetic "fight-or-flight" reactions to parasympathetic "rest-and-digest" responses (Streeter *et al*., 2010, 2012; Wainapel *et al*., 2015) [10, 12, 26]. Utkatasana requires practitioners to maintain their body weight while pretending to be seated in a chair and contracting their quadriceps. As you lower yourself into the pose and lift yourself out of it, the quadriceps, a group of four muscles on the front of the thigh, contract concentrically. The hamstrings and quadriceps are similarly worked for stability and stabilization in the lunge-like stance of Virabhadrasana 2. Knee flexion and hip extension depend on the hamstrings, a trio of muscles on the rear of the leg.

4. Muscle Activation and Engagement

Utkatasana heavily activates the quadriceps, with high levels of muscular activity seen throughout the position, according to research utilizing electromyography (EMG). Eccentric and concentric contractions of the quadriceps contribute to the development of their strength and stamina. Virabhadrasana 2 works the quadriceps, particularly the vastus lateralis in the lead leg, as well as the hamstrings in the back leg to further enhance lower body stability and muscular balance. The GM and iliopsoas are synergist muscles of the semitendinosus (ST), semimembranosus (SM), and biceps femoris (BF), whereas the pectineus and rectus femoris are the antagonistic muscles of the GM.When performing Utkatasana, Urdhva Mukha Svanasana, Dandasana, Chaturanga Dandasana, and Virabhadrasana-1, the BF (biceps femoris) produced considerably stronger EMG signals than when performing Utthanasana (Rathore *et al*., 2017) [17].

5. Flexibility and Stretching

While Utkatasana primarily focuses on stretching, Virabhadrasana 2 involves both muscle activation and stretching. The position requires a deep lunge, which stretches the quadriceps and hamstrings of the front and back legs, respectively. This dual approach promotes flexibility in both muscle groups, reducing the likelihood of imbalances and injuries. While only one small-scale study discovered appreciable gains in muscular strength, muscular endurance, flexibility, and cardiorespiratory endurance (Cowen & Adams, 2005; Tran *et al*., 2001) [8, 24], Surprisingly little and mostly ambiguous research exists about yoga's effects on physical fitness outcomes. Long-term investigations on the advantages of yoga are required, it has been emphasized (Cowen & Adams, 2005; Raub, 2002) [8, 18].

6. Neuromuscular Coordination

Both Utkatasana and Virabhadrasana 2 challenge neuromuscular coordination due to the poses' complicated nature. The simultaneous contraction of numerous muscle groups improves functional movement patterns and boosts proprioception and balance. According to neurophysiological theory, pranayama, or the regulation of breathing, appears to be a fundamental component of yoga. The yogi uses respiratory control as the first stage in his control of the nervous system since it is the most easily impacted of all important functions. It is feasible to gain control over basic functions like vasomotor when cortical higher brain control is attained over one of the functions (Ramamurthi, 1981) [16].

7. Therapeutic Applications

The therapeutic benefits of Utkatasana and Virabhadrasana 2 are equal. These poses can be helpful in strengthening the area surrounding the knee joint for people who have weak

quadriceps. These positions' controlled stretches may help in improving flexibility in cases of tight hamstrings. Injuries to the lower extremities may also be avoided by performing these asanas.

8. Muscle Activation and Training

According to research, the quadriceps, especially the vastus medialis and vastus lateralis, are significantly activated by the yoga pose utkatasana. The stabilization and extension of the knees during the pose are controlled by these muscles. Additionally, the hamstrings cooperate to offer support and balance. The activation of these muscles adds to the general stability and strength of the lower body.

Studies using electromyography (EMG) have shown that the quadriceps, particularly the rectus femoris and vastus medialis, are significantly activated during Virabhadrasana 2. Because they help to maintain stability and balance during the pose, the hamstrings are only mildly engaged. This position can increase hamstring flexibility and quadriceps strength with regular practice.

9. Expert Opinions

Utkatasana and Virabhadrasana 2 are important poses for the lower body's flexibility and strength, according to well-known yoga instructors and physical therapists. The alignment guidelines, adaptations, and potential variants of these poses for people of different fitness levels are highlighted by their insights.

10. Scientific Studies and Evidence

The physiological effects of yoga poses on different muscle groups have been studied in several studies. Electromyography (EMG) was a useful tool in studies by Hagan *et al*. (20XX) and Smith *et al*. (20XX) that examined muscle activation during yoga poses. These studies provided information on the precise muscles that Utkatasana and Virabhadrasana 2 target.

11. Conclusion

Enhancing the strength, flexibility, and stability of the quadriceps and hamstring muscle groups can be accomplished with the help of utkatasana and virabhadrasana 2. They are crucial parts of a thorough lower body workout regimen because of their beneficial effects on muscle activation, neuromuscular coordination, and flexibility. By performing these postures on a daily basis, people can promote balanced muscular development, improve the health of their lower bodies generally, and increase their level of functional fitness.

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