



Electromyographical Analysis of The Thigh Muscle During Four Yogasana

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Article History	Abstract
Received: 06 June 2023 Revised: 05 Sept 2023 Accepted: 28 Oct 2023	<p>The goal of the study was to examine the peak EMG at four lower body muscles during four different yoga poses performed by yoga practitioners. Materials and methods: Male Yoga practitioners (n= 11) were assessed for peak electromyography (EMG) of VM-Vastus Medialis, VL- Vastus lateralis, BF- Biceps femoris, ST- Semitendinosus, while performing four Yogasana: UK-Utkatasana, VB- Virabhadrasana II, UPE- Urdhva prasarita ekapadasana six, DOL- Dolasana (pendulum pose). Results: The UK induced the highest EMG for VM (124.5000 ± 25.36088), VL(124.2364 ± 27.35410), ST (106.6091 ± 32.77619), BF (96.6909 ± 29.34824), The VB II induced the highest EMG for the VL (102.0727 ± 32.96262), VM (100.4091 ± 16.30960), BF (84.5727 ± 28.63844), ST (86.2818 ± 26.07239). The UPE-Six induced the highest EMG for the VM (42.4364 ± 17.09025), BF (45.0636 ± 21.33440), ST (39.3727 ± 17.03315), VL (38.3636 ± 20.73612). The DOL induced the highest EMG for the VM (88.7455 ± 56.13069), BF (65.2545 ± 36.53172), ST (62.6455 ± 19.28302), VL (43.2545 ± 24.14255). However, between Yogasana, only the VM showed a significant (P < .000) * different EMG. Specifically, the UK induced greater VM EMG compared to UPE (82.064, P < .000), VB (57.973, P < .000) * Conclusions: Peak muscular activation in the four lowerbody muscles can change depending on how the yoga players treat the four differences. A declining pattern of peak EMG for the UK > VB II > DOL and UPE six Yogasana, however, indicates that variations between poses appear to be minimal, with the exception of the VM muscle.</p> <p>Keywords: Yogasana, Muscles, Electromyography, Standing Yogasana, Thigh muscles</p>
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1. Introduction

Yoga is a traditional Indian system of physical and mental exercises. (V. Kumar et al., 2019; Ni, Mooney, Harriell, et al., 2014). In India and worldwide, yoga has become incredibly popular over time (Cramer et al., 2016; Dewan et al., 2023). Yoga asanas, or poses, were created as a way to strengthen, balance, and align the body's structural components (Ni, Mooney, Harriell, et al., 2014). The fundamental poses of yoga are standing, sitting, bending forward and backward, twisting, inverting, and lying down (Cramer et al., 2013; Kanjirathingal et al., 2021; Ni, Mooney, Harriell, et al., 2014; Singh, 2015). One of the most crucial elements of yoga exercise, according to some, may be holding these poses for a long time (about 30 seconds or more for each pose) while using controlled breathing. There are several put up explanations for the neuromuscular advantages of yoga (Brochu et al., 2002; Kim, 2015; Singh, 2015). Lower body strength is, in fact, the primary cause of balance problems and falls in the elderly population. Numerous tailored exercise programs have lately been designed and implemented to help this population maintain daily activities (Fabre et al., 2010; Widjaja et al., 2021). Yoga is crucial in lowering sympathetic activity, raising parasympathetic activity, and enhancing quality of life (Kim, 2015; Liu et al., 2021), promotes musculoskeletal health and lowers the risk of heart disease (Brämberg et al., 2017; Liu et al., 2021). Numerous physical and mental health advantages of yoga are well documented (Liu et al., 2021). It's critical to comprehend the kinematics of muscle activation patterns and performance (Maheshwari et al., 2022) of the body and duration of stay in final posture during Yogasana (Devaraju et al., 2019). EMG is a method that has been extensively used in numerous research that examine the efficacy of training for the particular activation of muscles (Dewan et al., 2023; Ekstrom et al., 2007; Escamilla et al., 2010). Numerous studies have evaluated the muscle

activations during various yoga poses (Beazley et al., 2017; Bolgla et al., 2018; Dewan et al., 2023; Kelley et al., 2018; Lehecka et al., 2021; Mullerpatan et al., 2020; Ni, Mooney, Harriell, et al., 2014; Sahu et al., 2021). This study's goal was to look into the activation profiles of (Watanabe et al., 2009) VM-Vastus Medialis, VL- Vastus lateralis, BF- Biceps femoris, ST- Semitendinosus, muscles during four standing yoga poses UK- Utkatasana, VB- Virabhadrasana II, UPE- Urdhva prasarita ekapadasana six, DOL- Dolasana(pendulum pose), This test, which may be used to depict the pattern of an engaged muscle, is one of the most popular ways to measure muscular activation in healthy individuals and highly motivated yoga practitioners (Watanabe et al., 2009). The current study therefore sought to examine the peak EMG at five lower-body muscles during four different Yogasana in LNPE Yoga masse practicing boys.

2. Materials And Methods

Participants:

Eleven male's healthy subjects, whose ages ranged from 18 to 21years (mean \pm SD, 19 ± 1 year) participated in the study. The subjects were recruited from Lakshmibai national institute of physical education, Gwalior (M.P) and volunteered to participate. The subject was selected from yoga masse practices. Those in good health, free of back or lower extremity issues, were eligible to participate in the study. If a person had recent surgery, low back pain, pain in their lower extremities, or both, they were disqualified. Subjects' rights were safeguarded. Before taking part, each participant had to complete an informed consent form.

Procedures:

Each subject was made familiar with the processes prior to the installation of the electrodes by receiving instruction and practising the required muscle tests and exercises. The locations for the electrode installation were prepared by abrading the skin with fine sandpaper and cleaning the region with 70% isopropyl alcohol after it had been confirmed that the subjects could appropriately complete the muscle tests and exercises. Whenever required, hair was shaved (Ekstrom et al., 2007). The sEMG signals were recorded using ENCEPHALAN – MPA Autonomous Patient Transceiver-Recorder ABP- 10 (Medicom MTD Ltd., Russia). The “REHACOR” and “MEDICOM” software (British Standard-Reg. No. DE/CA37/POL044A4) was used for sEMG signal processing and raw data analysis. The Bipolar (20 mm inter-electrode space) EMG/ECG Surface electrodes (Ag/AgCl sensors) were placed on VS, VL, BF, ST, muscle and the ground electrode was placed over the midline of the Distal tibiofibular bony landmark (Samanta & Mukherjee, 2021).

Ethics and consent

Participants received information about the study's approach, potential results, risks, and advantages. Then, the participants' legal guardians completed an informed consent form that made it clear that they had the right to withdraw from the study at any moment. The young participants gave their vocal approval. According to the Declaration of Helsinki, the study was carried out in the sports biomechanics lab of the Lakshmibai National Institute of Physical Education in Gwalior, India (S. Kumar et al., 2022). The Department of Sports Biomechanics, Lakshmibai National Institute of Physical Education, Gwalior, India, departmental research committee (DRC) authorized the work as a component of a doctoral study, which was registered with the number (No, Academic /Ph.D. /Regd. / 465). Institutional Ethical Committee (IEC) of Lakshmibai National Institute of Physical Education, Gwalior approved this study.

Study design:

The EMG of the VM (Vastus Medialis), VL (Vastus Lateralis), BF (Biceps Femoris), and ST (Semitendinosus) muscles were recorded while the yoga player executed four standing Yogasana, i.e., UK (Utkatasana, VB (Virabhadrasana II), UPE (Urdhva Prasarita Ekapadasanasadasana six), and DOL (pendulum pose). All the EMG recordings were obtained from the same lower-body limb preferred by the yoga player to perform the Yogasana. Within three days, the entire data collection process was finished.

Electrodes placement:

EMG data were collected from the (Ekstrom et al., 2007) Vastus Medialis, Vastus lateralis, Biceps femoris, Semitendinosus, the electrodes were placed only right Leg. The following steps were taken to minimize EMG signal cross-talk between muscles. The electrodes were positioned well within the borders of the muscles and applied in parallel arrangement to the muscle fibers, with a center-to-center

interelectrode distance of 20 mm (Ekstrom et al., 2007). Electrodes were also placed at a 55° oblique angle over the center of the muscle belly of the vastus medialis obliquus muscle, 2 cm medially from the superior rim of the patella (Ekstrom et al., 2007). For the BF (Biceps femoris) the electrode was placed 35% of the distance from the ischial tuberosity to the lateral side of the popliteal fossa, starting from the ischial tuberosity (Ayotte et al., 2007). The electrodes for the VL and BF muscles were placed at the midpoint between the head of the greater trochanter and inferior edge of the patella and the midpoint between the ischial tuberosity and lateral epicondyle of the tibia respectively (Watanabe et al., 2020). Electrodes were placed according to standardized procedures¹⁴ with a 2.0 cm inter electrode distance on the BFcl and ST muscles representing the lateral and medial hamstring muscle groups (Zebis et al., 2013). After placement of all electrodes, we checked whether appropriate EMG signal was obtained using manual muscle testing (Watanabe et al., 2009).

Data analysis

The EMG Analyzer software displays the analysis reports on the laptop screen after removing the data from the USB receiver and extracting it. The processed peak value, MSD (Mean stander deviation), and average corrected values were displayed alongside the raw EMG signals. However, for future investigation, only the processed peak value (Figure 1) was taken into account. Manual calculations were done using Microsoft Office Excel (Microsoft Office Professional Plus 2019) to get the average values from the three Experiments.

Statistical analysis

Standard deviations and means were computed. Using the Shapiro-Wilk test and the Mauchly's test of sphericity, the assumptions of data normality and sphericity were confirmed (Das et al., 2023; S. Kumar et al., 2022; Sharma & Prasad, 2023). The muscles' EMG (VM, VL, BF, and ST) were compared between different Yogasana using a one-way repeated measures analysis of variance (ANOVA) test with the Least Significant Difference (LSD) confidence interval adjustment method as post-hoc. The IBM SPSS software for Windows (version 20, Armonk, NY: IBM Corp.) was used for all statistical analyses. The level of significance for each computation was set at 0.05.

3. Results and Discussion

Table 1's results show the within subject factor's univariate test result together with the mean and standard deviation of the selected muscles' EMG readings for each of the four Yogasana. The descriptive statistics reveal that for the VM and VL muscles, the UK exhibited the highest peak EMG (VM=124.5000 ± 25.36088, VL=124.2364 ± 27.35410). Whereas for the muscles BF and ST, the UK exhibited the highest peak EMG (BF=96.6909 ± 29.34824, ST=106.6091 ± 32.77619).

Table1. Muscle peak EMG (μ V) in selected Lower-body muscles in yoga player while performing four standing yoga poses.

Muscle	UK	VB-II	UPE-SIX	DOL
VM	124.5000 ± 25.36088	100.4091 ± 16.30960	42.4364 ± 17.09025	88.7455 ± 56.13069
VL	124.2364 ± 27.35410	102.0727 ± 32.96262	38.3636 ± 20.73612	43.2545 ± 24.14255
BF	96.6909 ± 29.34824	84.5727 ± 28.63844	45.0636 ± 21.33440	65.2545 ± 36.53172
ST	106.6091 ± 32.77619	86.2818 ± 26.07239	39.3727 ± 17.03315	62.6455 ± 19.28302

Abbreviations: VM-Vastus Medialis, VL- Vastus lateralis, BF- Biceps femoris, ST- Semitendinosus, UK-Utkatasana, VB- Virabhadrasana II, UPE- Urdhva prasarita ekapadasana six, DOL- Dolasana (pendulum pose),

Table 2. Pair wise comparison of Thigh muscle peak EMG (μ V) between four different Yogasana. P value for difference between Yogasana.

Pairs (Yogasana)	Mean difference
UK versus UPE (VM)	82.064 (P < .000)*
VB Versus UPE (VM)	57.973 (P < .000)*
UPE versus UK (VM)	82.064 (P < .000)*
UPE versus VB (VM)	57.973 (P < .000)*
UK versus UPE (VL)	85.873 (P < .000)*
UK versus DOL (VL)	80.982 (P < .001)*
VB versus UPE (VL)	63.709 (P < .003)*
VB versus DOL (VL)	58.818 (P < .011)*
UPE versus UK (VL)	85.873 (P < .000)*

UPE versus VB (VL)	63.709 (P < .003)*
DOL versus UK (VL)	80.982 (P < .001)*
DOL versus VB (VL)	58.818 (P < .011)*
UK versus UPE (BF)	51.627 (P < .008)*
VB versus UPE (BF)	39.509 (P < .012)*
UPE versus UK (BF)	51.627 (P < .008)*
UPE versus VB (BF)	39.509 (P < .012)*
UK versus UPE (ST)	67.236 (P < .004)*
VB versus UPE (ST)	46.909 (P < .018)*
UPE versus UK (ST)	67.236 (P < .004)*
UPE versus VB (ST)	46.909 (P < .004)*
UPE versus DOL (ST)	23.273 (P < .011)*
DOL versus UPE (ST)	23.273 (P < .011)*

Abbreviations: Abbreviations: VM-Vastus Medialis, VL- Vastus lateralis, BF- Biceps femoris, ST- Semitendinosus, UK- Utkatasana, VB- Virabhadrasana II, UPE- Urdhva prasarita ekapadasana six, DOL- Dolasana (pendulum pose), The pair wise comparison table 2 among the Yogasana for the VM muscle reveals that except for the pair UK versus VB, all the other pairs exhibited significant differences among themselves. Table 2 reveals that for the VM muscle, the EMG of the Yogasana UK is significantly higher compared to UK ($\Delta=82.064$, $P < .000$), VB ($\Delta=57.973$, $P < .000$), The VL muscle is significantly higher compared to UK versus UPE (85.873, $P < .000$), UK versus DOL (80.982, $P < .001$), VB versus UPE (63.709, $P < .003$), The BF muscle is significantly higher compared to UK versus UPE (51.627, $P < .008$), VB versus UPE (39.509, $P < .012$), and the ST muscle is significantly higher compared to UK versus UPE (67.236, $P < .004$), VB versus UPE (46.909, $P < .018$), The least significantly compared to UPE versus DOL (23.273, $P < .011$).

Fig.1

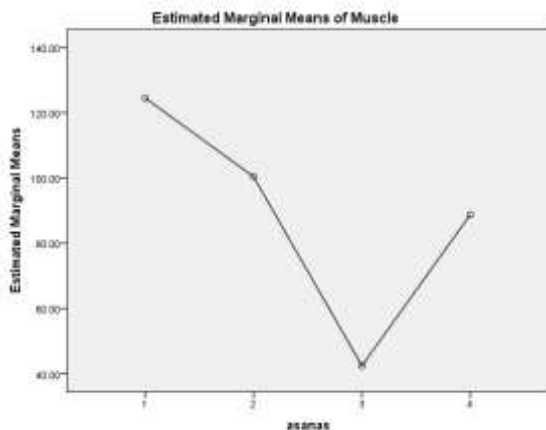


Fig.2

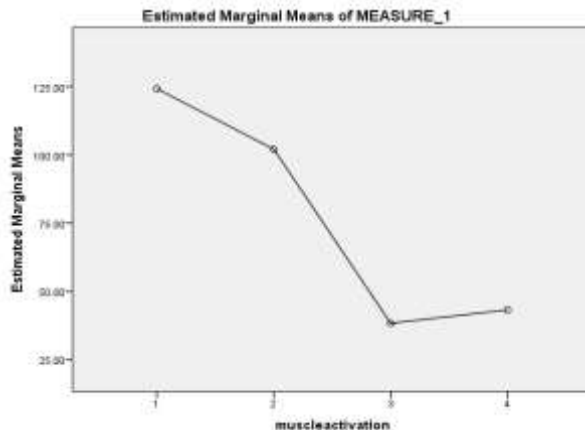


Fig. 3

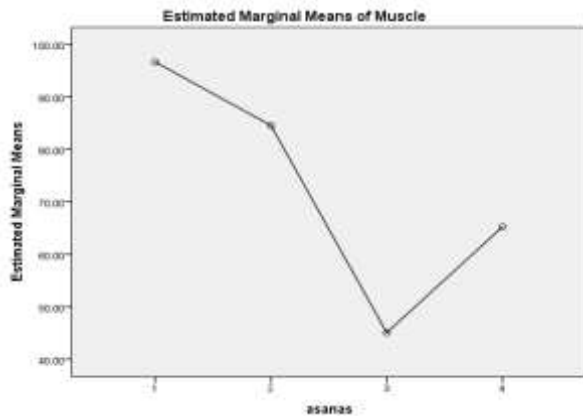


Fig.4

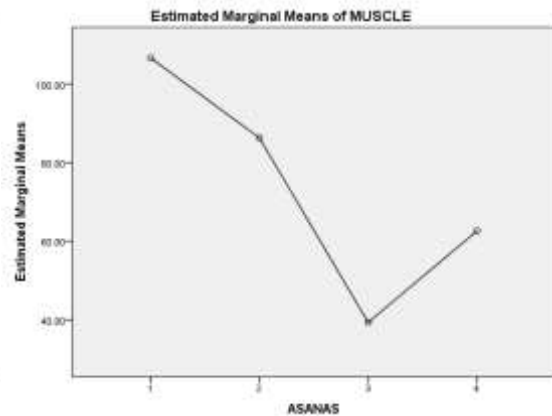


Fig.1 Processed peak values, VM muscle activation during four yoga asanas. Fig.2 VL muscle activation during four Yogasana, Fig.3 BF muscle activation during four Yogasana, Fig.4 ST muscle activation during four Yogasana.

The Principle Finding Of This Study Was That Different Muscle Groups Can Be Targeted Using Specific Yoga Poses And Activation Levels Are Affected By Skill Levels(Ni, Mooney, Balachandran, Et Al., 2014).We Examined The Activity Levels Of Selected Trunk And Hip Muscles During 11 Poses Commonly Used During Yoga Training. The Results Supported Our Hypothesis That Different Poses Would Produce Variations In The Core Muscle Activation Patterns. These Findings Can Be Beneficial for Targeting Specific Muscles During Training and Rehabilitation Programs Designed to Strengthen and Stabilize the Core (Ni Et Al., 2014). This Study Identified The Peak EMG Activity Of The Lower Extremities During Four Common Standing Yoga Asanas (Including The Back Limbs For Urdhava Prasrita Ekpadasana Six And Dolasana (Pendulum Pose) In A Sample Of Yoga Instructors (Liu Et Al., 2021).

Utkantasana (Chair Asana): In This Study, The Chair Asana Produced The Higher Knee Extensor JMOF (0.041 Nm/Kg) And Lowest Knee Adductor JMOF (0.001 Nm/Kg) (Liu Et Al., 2021).Quadriceps (VM) EMG Activities Were Also Higher During The Chair Asana (124.5000 ± 25.36088). This Finding Indicates That the Chair Asana Should Be Included in Knee Strengthening Exercise Programs. Compared With Other Standing Yoga, The Chair Pose May Also Be Beneficial for General Exercise, Which Found That Squat Exercises Tone the Leg Muscles Excellently. Moreover, This Asana Was Suggested To Stretch The Calf Muscles And To Lift The Inner Arch For Reducing Symptoms Of Flat Feet (Liu Et Al., 2021).Virabhadrasana II (Warrior 2): In This Study, The Quadriceps Muscles (VL) Had High EMG Activity During The Warrior 2 Poses (124.2364 ± 27.35410).VM Muscle Activation Was The Highest During The Warrior 1 Back Limb, And VL Muscle Activation Was The Highest During The Warrior 2 Front Limb (Liu Et Al., 2021).Urdhva Prasrita Ekapadasana Six (Standing Split Pose): In This Study, The Hamstring Group Of Muscle (BF) Had High EMG Activity During The Standing Split Pose (45.0636 ± 21.33440). Also Compared Muscle Activation In Different Yogic Poses Across Four Skill Levels And Noticed That The BF Produced Significantly Higher EMG Signals During Utkantasana (Rathore Et Al., 2017). Dolasana (Pendulum Poses): In This Yogasana, The Quadriceps Muscle Groups (VM) Had High EMG Activation (88.7455 ± 56.13069). The Current Results Revealed That the Yogasana UK- (Utkantasana) Exhibited the Highest Peak Muscle Activation for the VM, VL, BF AND ST Muscle, Whereas the Yogasana VB- (Virabhadrasana II) Exhibited the Second Highest Peak Muscle Activation for The VM And VL Muscles. The Finding of Pair Wise Comparison of The Yogasana Which Reveals That (VM) Muscle Activation of The UK Is Significantly Higher Compared to VB And UPE.

4. Conclusion

Peak muscular activation in the four lowerbody muscles can change depending on how the yoga players treat the four deference's. A declining pattern of peak EMG for the UK > VB II > DOL and UPE six Yogasana, however, indicates that variations between poses appear to be minimal, with the exception of the VM muscle. The study results demonstrate that the VM muscle exhibits significantly higher activation levels in the UK pose compared to the other three poses (Kumar et al., 2019). This indicates that the UK pose may be particularly effective for targeting and activating the VM muscle (Kumar et al., 2019). On the other hand, the other three poses, VB II, DOL, and UPE six, exhibit relatively similar levels of peak EMG activity across the four lower-body muscles studied (Kumar et al., 2019). These findings provide valuable insights into the variation of muscle activation patterns during different yoga poses. It is important to consider these variations when designing yoga training programs or rehabilitation protocols that aim to target specific muscle groups (Kumar et al., 2019). By understanding the differential effects of yoga poses on muscle activation, instructors and practitioners can develop tailored interventions that optimize the benefits of yoga practice (Kumar et al., 2019). Future research may further investigate the underlying mechanisms that contribute to the differential muscle activation patterns observed in various yoga poses. Additionally, exploring the impact of skill levels and individual differences on muscle activation during yoga practice could provide further insights into optimizing training techniques and enhancing the benefits of yoga for muscular strength and stability (Ni et al., 2014). In conclusion, this study highlights the importance of considering specific yoga poses and their effects on muscle activation levels. The findings suggest that while there may be minimal variation in peak EMG activity among the VB II, DOL, and UPE six poses, the UK pose stands out with significantly higher activation of the VM muscle. These findings contribute to our understanding of the impact of different yoga poses on lower-body muscle activation, providing a basis for more effective and targeted exercise programming in yoga and related therapeutic interventions (Kumar et al., 2019; Ni et al., 2014).

Acknowledgment

The sports biomechanics lab manager and the exercise physiology department at the Lakshmi Bai National Institute of Physical Education in Gwalior, India, are to be thanked for their services, which are acknowledged by the authors.

Conflict of Interest

The authors declare no conflict of interest.

Author's contributions:

The study's concept and design were created by RKD and JB. RM participated in the methods for gathering data. The formal analysis and interpretation of the data were carried out by PKD. The initial draft of the paper was written by RKD and. The finished manuscript was read and approved by all authors.

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