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Electromyography Comparisons Of Lower Extremity Muscles During Warrior Two Yoga Pose

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Abstract
The study purpose was to analyse the *RMS EMG value at three lower-body muscles during warrior two yogasana.*
Materials and methods. *In this study, nine male (n=9) university yoga players who were right-foot dominant were included. The subjects had a minimum playing experience of five or more years during the collection of data. Data were assessed for RMS electromyography (EMG) value of vastus lateralis (VL), vastus medialis (VM), bicep femoris (BF) muscle during warrior two yogasana.*
Results. *The warrior two yoga pose induced the highest EMG for VM (249.5578 ±124.68359), BF (157.4700±110.95126) and VL (126.8533±44.02298). However, between muscle Post hoc comparison of means using LSD, mean difference VL and VM (-122.70444*) (P < .015) There is a significant. VL and BF (-30.61667) (P > 0521). Further, the greater RMS EMG value compared to VM and VL (122.70444*) (P < .015). VM and BF (92.08778) (P >.062).*
Conclusions. *RMS EMG value at three lower-body muscles activation varies during warrior two yogasana. However, the differences seem relatively small, with a descending pattern of peak EMG for the VM > BF > VL Warrior Two Yogasana.*
Keywords: *EMG; Warrior two yoga; muscle activation; yogasana; quadriceps muscle.*

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I. Introduction

Yoga is a special kind of exercise that integrates the mind, body, and spirit to enhance fitness and wellness (Deshi & Das, 2023; Deshi & Pujari, 2023; Govindaraj et al., 2016). Yoga is said to have advantages for enhanced breathing, heart health, and circulation (Ross & Thomas, 2010), enhanced flexibility, increased muscle strength(Kumar Deshi & Bajpai Mishra, 2022), and enhanced mental clarity and well-being(Deshi et al., 2023; Deshi & Mishra, 2023) (Anantamek & Hnoohom, 2019; Bukowski et al., 2006; K. K. Kelley et al., 2014, 2019; Liu et al., 2021), and improves musculoskeletal health (McCaffrey, 2012)

Electromyography (EMG) is a new area of research in dynamic sports actions where muscle activity is examined during the execution of particular techniques. (Thapa & Kumar, 2020). Surface electromyography (sEMG) allows for the monitoring of muscle activity and the evaluation of muscle quality (Baggen et al., 2018; Jang et al., 2018; Ling et al., 2007). Monitoring muscle activity during daily activities can help prevent sarcopenia and estimate the degree of frailty. Muscle quality may be more significant than muscle size in estimating the risk of falling (Anderson et al., 2016; Theou et al., 2010). It is imperative to assess the quality of muscles in older adults in good health both prior to and following physical activity, taking age into account (Gaszynska et al., 2017; Radaelli et al., 2013). There have been reports of benefits for older adults' muscle activity from standing yoga poses. Muscle activation was found to be higher in unsupported asanas than in supported asanas (Salem et al., 2013). In comparison to walk activity, the majority of standing asanas activated the quadriceps femoris, gluteus medius, erector spinae, and rectus abdominis (Mullerpatan et al., 2020; Salem et al., 2013). Similar to this, single-limb standing poses cause the tibialis anterior and gastrocnemius to contract more than they do in resting poses (Mountain Pose)(K. K. Kelley et al., 2019; Wang et al., 2013). Yogasana trunk and pelvic positions have been found to influence the variation in muscle activation patterns in standing poses (Ni et al., 2014). In order to investigate the patterns of muscle activation during yoga poses, a mathematical model utilizing surface electromyography (sEMG) and optical motion capture was recently developed (A. Kumar et al., 2018). Studies on the muscle activity of yoga poses are scarce. In order to improve strength and endurance of particular muscle groups, such as the erector spinae, rectus abdominis, gluteus maximus, hamstrings, and scapular stabilizers, information on muscle activity helps guide prescription in musculoskeletal conditions (De Luca, 1997; Janda, 1980; Mullerpatan et al., 2020) .A recent review states that although there are over 840 000 yoga poses, Iyengar only outlines 57 fundamental poses in his book. These poses are based on traditional Iyengar Yoga, from which thousands of variations can be created. To describe the motion pattern of these yoga poses, the Crescent lunge pose (Alasana), Warrior II pose (Virbradasana II), and Triangle pose (Trikonasana) were examined. These three poses were selected because they are widely used in many yoga practices and have extensive descriptions in textbooks for Hatha yoga. These five basic standing yoga postures can be used to create a variety of variations. For example, the Extended Side Angle pose resembles a cross between Warrior II and Triangle pose, and there are several lunge variations that all resemble the Crescent lunge pose. These poses are taught as an intermediate step between more advanced poses in many beginner Hatha yoga classes and are closely linked to the majority of standing yoga poses (Whissell, 2015). Given that the initial steps of warrior two, also known as virabhadrasana II, are identical to those of warrior one, warrior two offers nearly identical features and advantages to warrior one. There's a distinction in the subsequent steps, though, as virabhadrasana ii tones the stomach, relieves cramps in the legs and back, and tightens the arms and ankles. This pose affects a number of muscles, including the deltoids, adductors, anterior thigh, and gluteus medius (Bajaj & Sinha, 2021). While there are numerous advantages to yoga, researchers are trying to find poses that optimize knee strength without putting undue strain on the knee joint (K. Kelley et al., 2018). It is advised to strengthen your quadriceps in order to manage knee pathologies like osteoarthritis (OA) (Segal et al., 2012; Slemenda et al., 1998). Another factor linked to the start and development of symptomatic knee OA is loss of quadriceps strength. Studies utilizing surface electromyography (sEMG) have evaluated lower extremity muscles (K. K. Kelley et al., 2019). Prior research has compared different programs for balance exercises to find the best exercise for improving knee joint balance (Park et al., 2017). Programs for balance exercises have been shown to improve the strength of the hamstring and quadriceps muscles (Park et al., 2017). The aim of this study was to determine which muscle—the vastus lateralis, vastus medialis, or biceps femoris—contributes most to strengthening the quadriceps muscle groups during the warrior two yoga pose. A different analysis of the roles played by those three muscles in the yoga pose was also carried out.

II. Materials and Methods

Subjects

Nine male (n = 9) right-foot dominant university yoga practitioners were included in this study. During the time of data collection, the subjects had a minimum of five or more years of playing experience. Only athletes who engaged in physical activity and had no recent history of neurological, spinal, or lower extremity injuries were chosen to serve as subjects. Before any data were collected, the subjects were given a detailed explanation of the EMG recording process and asked to sign written consent forms. The departmental research committee of Lakshmibai National Institute of Physical Education gave its approval for the study's conduct in accordance with the Helsinki Declaration.

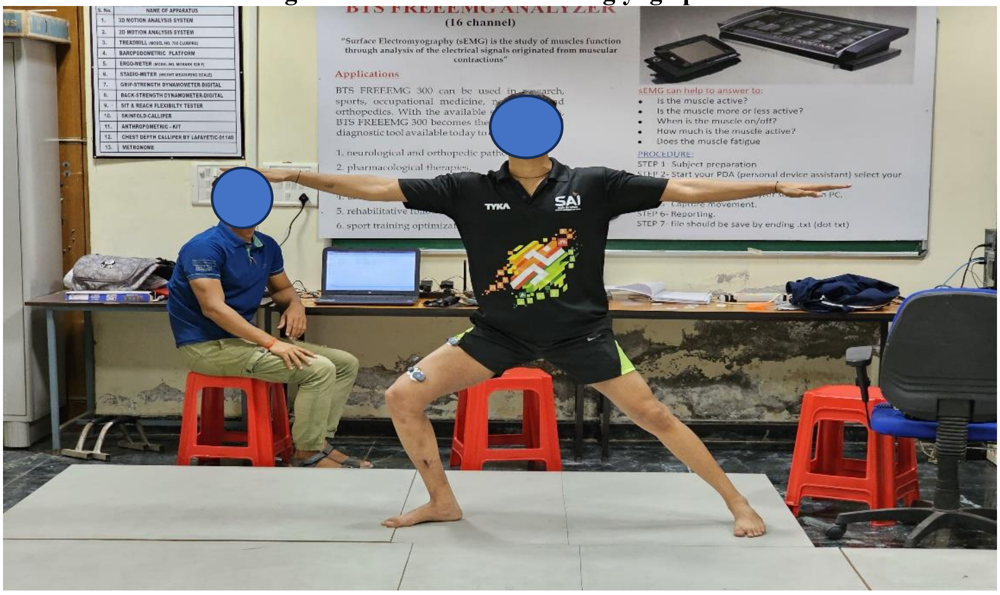
Equipment

The muscles' EMG was examined using the BTS FREEEMG instrument (Bioengineering, 2011). After conducting research to test the validity and reliability of the device, which consisted of the EMG-Analyzer software, a USB receiver, and up to 16 EMG probes, Jang et al. (2018) discovered that the device had acceptable validity and moderate to high reliability. Furthermore, it was determined by (Jang et al., 2018; S. Kumar et al., 2022) that the gadget is very customizable and beneficial for any type and intensity of exercise due to its excellent accessibility and portability. Three probes at a frequency of 1000 Hz were used to record the EMG of the three selected muscles for the warrior two yoga stance. After that, the signals were sent to a USB receiver for analysis, and an EMG-Analyzer program was used for transfer. A microvolt (µV) was employed as the unit of measurement.

Yoga Asanas

This study tested one popular standing yoga pose. The standing yoga positions are shown in Figure 1, and the asana instructions were as follows. Maintain the correct orientation of your front toes and your front heel in relation to the arch of your back foot. Straight over the ankle, bend the knee. Lean your head back to stretch your spine while lowering your hips toward the floor.

Figure 1. Warrior two standing yoga pose.



Procedure of data collection

The test process was explained to the participants and they were given enough time to become comfortable with it. The subjects were told to take off any clothing covering their lower bodies so that the EMG probes could be placed smoothly (Kothari et al., 2014; S. Kumar et al., 2022). Each participant's thigh electrode locations were cleansed with 70% alcohol. In order to gather surface EMG data, disposable bipolar electrodes were then implanted over the muscle bellies of the bicep femoris (BF), vastus medialis (VM), and vastus lateralis (VL). For each of the three examined muscles, the participants were given instructions on how to achieve their maximal voluntary contraction (MVC) by manual muscle testing.

Data analysis

The EMG Analyzer program showed the analysis reports on the laptop screen after removing the data from the USB receiver. The processed peak value, the root mean square, and the average rectified values were displayed alongside the raw EMG signals. For additional examination, just the processed RMS value (Figure 2) was taken into account. Using Microsoft Office Excel (Microsoft Office Professional Plus 2022), the RMS values from the three experiments were manually determined.

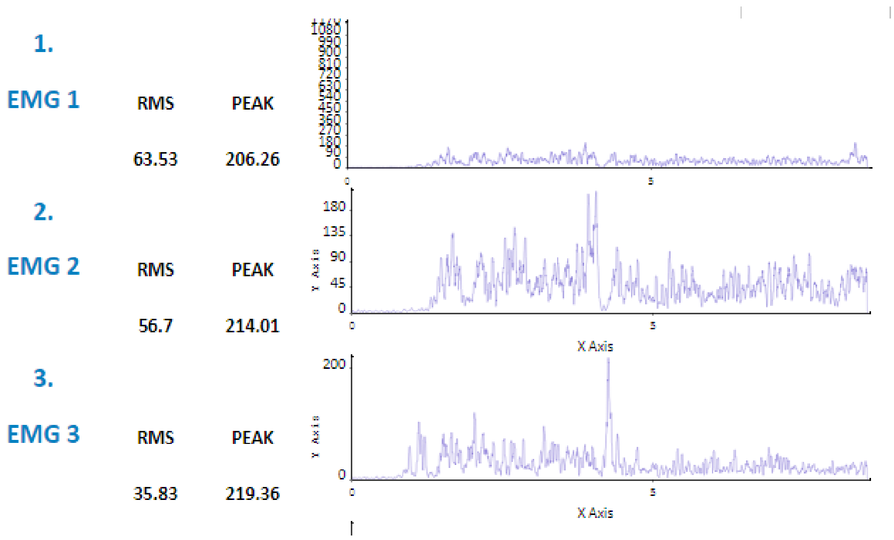


Fig. 2. Processed peak and root mean square values. Note that during Warrior 2 yoga pose, the Vastus lateralis (EMG 1), Vastus medialis (EMG 2) and Biceps femoris (EMG 3). experienced activation during yoga pose.

Statistical analysis

The computation of means and standard deviations was done. With the use of the Shapiro-Wilk test and Mauchly's sphericity test, the assumptions regarding data normality and sphericity were confirmed. A One-way ANOVA was performed with the Least Significant Difference (LSD) confidence interval adjustment method as a post-hoc analysis to assess the activation of the lower extremities' muscles (the right limb muscle, VL, VM, BF). IBM SPSS software for Windows (version 20) was used for all statistical analyses. A significance threshold of 0.05 was used to all computations.

III. Results

The mean and standard deviation of the EMG data for the chosen muscles used in the warrior two yoga stance are shown in Table 1.

Table 1. Mean and standard deviation of muscle activity during yogasana.

Muscle activation (RMS Value)	Mean ± SD		F	Sig. (p value)
	VL	126.8533 ±44.02298	3.696	0.04
	VM	249.5578 ± 124.68359		
	BF	157.4700 ± 110.95126		

Because the P value (=.04) in Table 1 is less than.05., the F-value is significant at the 5٪level. The null hypothesis, which states that there is no difference between the means of the three muscle groups, may therefore be rejected at the 5 level. Moreover, the null hypothesis may be rejected at the 1٪level as the P value is less than .01.

Table 2. Post hoc comparison of means using LSD test.

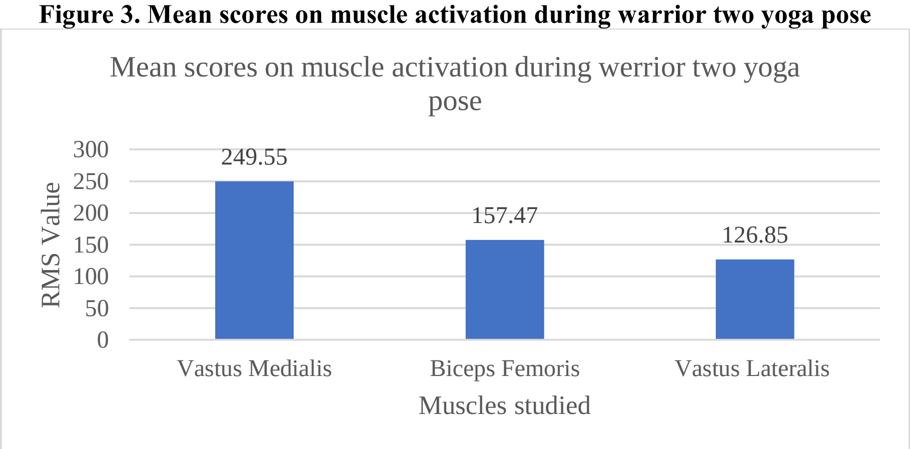
Muscle-activation (I)	Muscle-activation (J)	Mean difference (I-J)	Std. Error	Sig. (p-value)
VL	VM	-122.70444*	46.97849	.015
	BF	-30.61667	46.97849	.521
VM	VL	122.70444*	46.97849	.015
	BF	92.08778	46.97849	.062
BF	VL	30.61667	46.97849	.521
	VM	-92.08778	46.97849	.062

The post hoc test must be used to determine the significance of the mean difference between various pairs of groups because the F-value is significant. Table 2 offers this kind of comparison. This table shows that the p value for this mean difference is.015, which is less than.05. This indicates that the difference between the vastus lateralis muscle (VL) and vastus medialis muscle on the warrior two yoga position rating is significant at the 5٪ level.

Similar to this, the p value associated with this mean difference is.015, which is less than both.05 and.01, indicating that the difference between the vastus medialis muscle (VM) and vastus lateralis muscle (VL) on the warrior two yoga position is likewise significant at the 5٪ level.

The p value for this group is.521 more than.05. This indicates that there is no significant difference between the biceps femoris (BF) and vastus lateralis (VL) muscles in the warrior two yoga stance.

Figure 3. Mean scores on muscle activation during warrior two yoga pose



By examining the images in Figure 3, it is extremely easy to understand all of the previously described facts. This table shows that, when compared to the biceps femoris and vastus lateralis muscles, the vastus medialis muscle exhibits the highest mean muscular activation among executives during warrior two yoga stance. Thus, it may be inferred that during warrior two yogasana, the vastus medialis muscle exhibits greater activation of the executive than the biceps femoris and vastus lateralis muscles.

IV. Discussion

This study aimed to investigate the activation of the biceps femoris, vastus medialis, and vastus lateralis muscles during warrior two yoga poses using surface electromyography.

According to the current findings, the vastus medialis and biceps femoris muscles showed the highest levels of muscle activation during the warrior two yoga pose. The vastus lateralis muscle activates less when compressed than the other two muscles.

The results of this study demonstrated that during the warrior two yoga pose, the vastus medialis muscle of the front leg contributed the most. Comparisons based on muscle activity were not possible because the vastus medialis muscle of the front leg during warrior two yogasana has not been studied previously. This is already explained by some earlier research, which showed that during the Warrior 1 and Warrior 2 poses, there was increased EMG activity in the quadriceps muscles (RF, VM, and VL). When it came to the back limb of Warrior 1, VL muscle activation was highest, and when it came to the front limb of Warrior 2, VM muscle activation was highest (Liu et al., 2021). These studies reported that the vastus medialis muscle more activation during warrior two yoga pose. During a knee extension, the purpose of VM is to realign the patella. Achieving a muscular equilibrium between VM and VL is crucial. Achieving a successful recovery requires the restoration of sufficient VM strength and function (Liu et al., 2021). In a related study, the primary leg's quadriceps activations peaked during Chair, Goddess, and Warrior, while the secondary leg's activations peaked during Chair and Goddess. During Extended Lateral Angle and Warrior, there were greater activations of the vastus medialis and vastus lateralis in the primary leg compared to the secondary leg. For the primary leg, hamstring activations peaked during Triangle and Extended Lateral Angle, and for the secondary leg, during Triangle. A significant main effect of leg (F1, 29 = 13.188, p b 0.001) for the VL/VM CCIs revealed that, when collapsed across all postures, the primary leg had a higher CCI than the secondary leg. The VL/VM CCIs for both legs during two squats (Chair, Goddess) were higher than the VL/VM CCIs for both legs during the single leg and balance postures (Extended Lateral Angle, Tree, Triangle; p b 0.001), according to a significant main effect of posture (F4, 103 = 55.342, p b 0.001) (Longpré et al., 2015). Another study found no discernible differences between Warrior poses I, II, and IV, despite the fact that all of them involved the activation of the quadricep muscles. Although each warrior pose has a different purpose, the activation of the quadriceps muscles during each pose may indicate that the study's findings can be explained by the similarities between the poses. The vastus lateralis and vastus medialis did not significantly differ in mean muscle activity between the three warrior poses, according to the researcher's findings. However, there was quadricep muscle activation, which may point to a possible advantage of each pose. A larger sample size is required for future research, and the length of time that the pose is held could be altered (Ocampo, 2020). This study has a number of limitations. One is that there is a very small sample size, making it difficult to draw general conclusions from the data regarding all populations. Second, all of the test subjects were male; hence, more studies involving female subjects are required. Lastly, muscle activity was ascertained solely by surface EMG. It is impossible to tell whether the recorded activity in this instance actually came from the muscle that was supposed to be tested. Applying the findings to the broader population would require more research involving a wider range of genders, ages, and levels of expertise.

V. Conclusions

In summary, your research confirms the significance of the vastus medialis and the function of the biceps femoris in the Warrior Two yoga pose, but it contradicts some findings about the activation of the vastus lateralis. These variations highlight how subtle muscle activation is during yoga poses, implying that contextual and individual factors influence patterns of muscle activation. Our knowledge of the muscles used in yoga poses can be improved with more research in this field, which will benefit yoga practice and instruction. A yoga practitioner's preferred warrior pose can affect which of the three lower-body muscles are activated. However, during warrior two yoga pose, there appears to be very little variation in the rms EMG patterns of the VM, BF, and VL.