Muscle activation pattern of deltoid muscles during Adho Mukha Vrksasana

Patrón de activación muscular de los músculos deltoides durante Adho Mukha Vrksasana

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Abstract

Introduction: While performing Adho Mukha Vrksasana, deltoid muscles plays a great role. But there is no study has been done regarding among the three deltoid muscles which deltoid muscles is contributing more or less while performing Adho Mukha Vrksasana
Objective: This study compared the muscle activation pattern of the deltoid muscles while performing Adho Mukha Vrksasana.
Methodology: Thirty (N=30) male yoga practitioners were selected with mean age (21.4 ± 1.85), height (165.2 ± 2.3 cm), and weight (61.2 ± 4.6 kg), were selected for the study. A videography technique was employed, later processed using Kinovea 2D motion analysis software to calculate the angle of the neck (in degrees) and height (in cm) of the center of gravity (CG). cordless electromyography (EMG) was used, to compare muscle activity responses of all the selected deltoid muscles, ANOVA was used at a 0.05 level of significance.
Results: There was a significant difference among the selected deltoid muscles while performing the Adho Mukha Vrksasana, i.e., $F = 84.887$; $P \leq 0.05$. The medial deltoid muscles was most significantly better, followed by the posterior deltoid muscles, and the least was anterior deltoid muscles. The average height of the center of gravity was 95.86 cm, and the average angle of the neck was 103.66°.
Discussion: The previous study shows the significant contribution of lateral (medial) deltoid muscle while performing Adho Mukha Vrksasana
Conclusions: The mean angle of the neck was found to be 103.66°. The mean height of CG was reported to be 95.864 cm, and average muscle activation of each of the three deltoid muscles was not equal to the mean 41% of the medial deltoid, 32% of the posterior deltoid, and 27% of the anterior deltoid.

Keywords

Adho Mukha Vrksasana; deltoid muscles; kinematic variables; muscle activation pattern.

Resumen

Introducción: Al practicar Adho Mukha Vrksasana, los deltoides desempeñan un papel fundamental. Sin embargo, no se han realizado estudios que determinen cuál de los tres músculos deltoides contribuye en mayor o menor medida al realizar Adho Mukha Vrksasana.
Objetivo: Este estudio comparó el patrón de activación muscular de los deltoides al practicar Adho Mukha Vrksasana.
Metodología: Se seleccionaron treinta (N=30) practicantes de yoga masculinos con una edad media de 21,4 ± 1,85, estatura de 165,2 ± 2,3 cm y peso de 61,2 ± 4,6 kg. Se empleó una técnica de videografía, procesada posteriormente con el software de análisis de movimiento Kinovea 2D, para calcular el ángulo del cuello (en grados) y la altura del centro de gravedad (CG) (en cm). Se utilizó electromiografía (EMG) inalámbrica para comparar las respuestas de la actividad muscular de todos los músculos deltoides seleccionados. Se utilizó un ANOVA con un nivel de significancia de 0,05.
Resultados: Se observó una diferencia significativa entre los músculos deltoides seleccionados al realizar Adho Mukha Vrksasana ($F = 84{,}887$; $p \leq 0{,}05$). El deltoides medial mostró una mejoría significativa, seguido del deltoides posterior, y el deltoides anterior, la menor. La altura promedio del centro de gravedad fue de 95,86 cm y el ángulo promedio del cuello fue de 103,66°.
Discusión: El estudio previo muestra la contribución significativa del deltoides lateral (medial) al realizar Adho Mukha Vrksasana.
Conclusiones: El ángulo promedio del cuello fue de 103,66°. Se informó que la altura media del CG fue de 95,864 cm y la activación muscular promedio de cada uno de los tres músculos deltoides no fue igual a la media del 41 % del deltoides medial, el 32 % del deltoides posterior y el 27 % del deltoides anterior.

Palabras clave

Adho Mukha Vrksasana; músculos deltoides; variables cinemáticas; patrón de activación muscular.

Introduction

Yoga is an art, a science, and a philosophy. It touches the life of man at every level—physical, mental, and spiritual (Pramanik et al., 2023a; Vignesh et al., 2024). It is a practical method for making one's life purposeful, useful, and noble (Iyengar, 2003). The term ‘yoga is derived from the Sanskrit word ‘yuj,’ meaning ‘to unite,’ the union of the individual self with the supreme self. According to the classical definition by Patanjali, yoga means controlling the modifications of the mind. There are several styles of yoga, but the core idea of every style is controlling the mind (White, 2012). Yoga contains numerous truths, the scientific basis of which is yet only partially understood (Pramanik et al., 2023b). We are grateful for Swami Kuvalayananda's trailblazing efforts in igniting interest in yogic study (Joshi, 1965). The great sage Maharishi Patanjali did a magnificent job of arranging and codifying the prevalent Yogic practices, their meaning, and their connected information through Patanjali's Yoga Sutra while Yoga was being practiced in the pre-Vedic era (Kamakhya, 2008). Out of 195, Sage Patanjali only provided three yoga sutras pertaining to asanas (Kushwah et al., 2021). Asanas, or physical postures, were traditionally practiced to prepare the body for extended meditation sittings. Adho Mukha Vrksasana asana is one of the important asanas in yoga (Govindasamy et al., 2023; Taneja, 2014).

The act of holding the body in an inverted vertical stance while keeping the hands in touch with the supporting surface is commonly known as a ‘handstand (Wyatt et al., 2020). (Sanskrit refers to handstand as Adho Mukha Vrksasana, which translates to "Downward-Facing Tree Pose" in English.). It primarily affects the upper extremities of the body. Adha Mukha Vrksasana (handstand) requires greater effort to complete because it is done in opposition to the force of gravity; it is an inverted asana. Asanas performed inverted promote blood flow to the brain, which nourishes neurons and removes toxins. After building up in the lower limbs, pelvis, and belly, blood and lymph are evacuated back to the heart, where they are cleaned up and recirculated throughout the body (Satyānanda, 2009). There are many muscles involved. While performing Adho Mukha Vrksasana, such as the serratus anterior, which creates upward rotation and stabilization of the scapulae on the rib cage. The deltoids flex the shoulder; the infraspinatus and teres minor maintain external rotation in the glenohumeral joint. The triceps maintain extension of the elbows, and the pronators rotate the forearms to balance the rotation of the humerus; flexor carpi radialis and ulnaris protect the carpal tunnel. The intrinsic muscles of the hand work to maintain the hand’s arches (Kaminoff & Matthews, 2007). The study was conducted by Kochanowicz et al. (2018), where they studied the EMG activity of wrist flexor muscles, deltoid muscles, and triceps muscles. However, it is not clear which muscle among the three deltoid muscles is the dominant muscle in terms of peak muscle activation.

Electromyography (EMG) is a diagnostic procedure that assesses the health of muscles and the nerve cells controlling them (motor neurons). It measures the electrical activity produced by skeletal muscles to detect neuromuscular abnormalities (Kumar et al., 2022; Preston & Shapiro, 2013). The EMG technique was used to measure the muscle activation pattern while performing Adho Mukha Vrksasana (Kochanowicz et al., 2019a). The deltoid muscles played a great role while performing Adho Mukha Vrksasana (Long, 2009). The deltoid muscle is composed of three distinct muscle heads, i.e., the anterior deltoid muscle, middle deltoid muscle, and posterior deltoid muscle (Jarmey, 2018). The deltoid muscle activation pattern during Adho Mukha Vrksasana (handstand) is still not clear, despite the growing interest in yoga asana . The majority of the literature currently in publication concentrates on the general activation of the upper limbs or offers observations regarding shoulder engagement during handstands. The precise recruitment and coordination of the anterior, lateral, and posterior deltoid muscles while performing Adho Mukha Vrksasana much has not been thoroughly examined in many studies. The understanding of this differences in deltoid muscles is significant because the deltoid group is essential for maintaining upper limb stability throughout the pose as well as supporting body weight against gravity (kumar.L et al., 2024) . Similar study was conducted by Kochanowicz et al.,(2019a) which displays that handstand builds shoulder strength, especially in deltoid muscles. The majority of current knowledge is taken from gymnastic or rehabilitation studies, which do not accurately represent the yogic handstand's particular isometric demands, proprioceptive difficulties, or dynamic adjustments (Mizutori et al., 2021) because of this, yoga instructors and practitioners mostly relies on this information for arm and shoulder strengthening, possibly neglecting important muscle preparation techniques that would maximize performance and safety. Furthermore, there is a very little information is available about how different deltoid muscles are activated, how this varies depending on skill level or pose, and how technique or tiredness may change these patterns. To find out the unique activation pattern of deltoid engagement through the phases of Adho Mukha Vrksasana, proper study is therefore required. By studying in this area will significantly help to addressing a significant gap in yogic practices. Further, this kind of research would offer practical recommendations for risk minimization, pose progression, and rehabilitation techniques specific to yoga practice. By carefully understanding this gap could transform yoga handstand training methods and help practitioners, athletes, and clinicians achieve safer, more efficient, and enhancement in performance.

Participants

In this study, the random sampling technique was used for the collection of data. For the purpose of the study, thirty (N=30) male yoga practitioners of a various Yoga institute throughout Guwahati, Kamrup Metropolitan district, Assam, India, were selected. These institute have qualified yoga trainer to train the yogic practitioner throughout the year. To determine the minimum sample size required for detecting statistically significant of deltoid muscle groups differences using Analysis of Variance (ANOVA), G*Power software (Erdfelder et al., 1996) was used, in which effect size was kept as 0.60, α error probability as 0.05, power as 0.95, and number of groups as 3 was applied to ensure sufficient sensitivity and reduce the risk of Type I and Type II errors. The participants' ages ranged from 18 to 23, with a mean age of 21.4 ± 1.85, height of 165.2 ± 2.3 cm, and weight of 61.2 ± 4.6 kg, and those who performed the particular skill (Adho Mukha Vrksasana) in their practice routine properly were selected for the study. Inclusion criteria required that participants be full-time students enrolled in any academic program of the selected institute with a specialization in yoga or related studies. Additionally, each subject was required to have a minimum of one year of experience practicing yoga. Exclusion criteria stipulated that those individuals with musculoskeletal injuries or disorders, as well as those with orthopedic and/or neurological conditions, were not eligible to participate in the study.

Ethics and consent

All the subjects, after being informed well in advance about the objective, benefits, potential risks, and protocol of the study. They participated in this study with their own willingness and interest. Subjects were told that they could drop out of the study at any time without consequences. They were also asked to avoid doing intensive exercise 24 hours before the tests, and they were told to exert their maximal effort and perform the pose to the best of their abilities. They provided informed consent according to the principles of the Declaration of Helsinki and adhered to Consolidated Standards of Reporting Trials (CONSORT) guidelines.

Procedure

The Participants arrived at the laboratory of LNIPE,NERC, Guwahati, Assam, India. The assessments are conducted in controlled setting. The participants were also informed earlier that they don't have to engage in any physical activity one day prior to the collection of data. Where they warmed up using Surya Namaskar (Sun Salutation), as mentiParoned by Karasugi et al. (2023), at a self-determined pace. The subjects were advised to remove the cloth from their upper bodies so that EMG probes could be easily placed at the desired muscles without any hindrances. After that, the selected muscles were located by muscle palpation technique, as mentioned by Muscolino (2009). A study was conducted by Ataide-Silva et al. (2016) where they cleaned the location of selected muscles with an alcohol swab (non-woven cellulose alcohol swab, Medsmart Logistics Pvt Ltd, India), where EMG probes were used, because this process helps to enhance signal quality and accurate recording. Next, surface EMG electrodes (silver chloride, Gunjan Human Karigar Pvt. Ltd., Delhi, India) were placed on the skin over the muscles of interest. Adhesive medical tape (transparent polyester film, 3M India Ltd.) was used so that the EMG probes would not fall during the execution of Adho Mukha Vrksasana, as stated by Park et al. (2023). The EMG probes were linked with the USB receiver and EMG analyzer software, which is installed in the personal computer (PC). According to the user manual (BTS FREEEMG 300 User Manual, 2013), the EMG data were later calibrated. Following preparation and normalization, each subject performed Adho Mukha Vrksasana, maintaining the asana for 5-10 seconds. While performing the Adho Mukha Vrksasana, make sure that the EMG sensors are properly placed on the muscle of interest. Each pose was digitally recorded and evaluated. Surface electromyography (EMG) data was normalized across subjects using EMG results from three (03) maximal voluntary contractions (MVC) targeting each muscle.

All the related data was collected in the standard procedure as mentioned in the SENIAM (surface EMG for a non-invasive assessment of project, which aims at standardizing the use of surface electromyography (Hermens et al., 2000). To collect data on selected kinematic variables, videography technique was employed using a Canon M50 Mark II camera (Canon, 2020), and the procedure was followed as mentioned by Bartlett (1997). The researcher also conducted the inter-rater and intra-rater reliability tests for the Kinovea software used. The following results were found for inter-rater and intra-rater reliability by using statistical measure, i.e., Cohen's kappa (k): the value of k = 0.73, 95% CI (0.65, 0.81), and for intra-rater reliability, the value of k = 0.78, 95% CI (0.70, 0.86). The data that we got from the videography technique were later processed using Kinovea 2D motion analysis software (Fernández-González et al., 2020); with the help of this software angle of the neck was calculated. Height of the center of gravity was also measured with the help of the same software.

Instrument

To investigate the kinematic variables, the participate first capture, using a Canon M50 mirrorless camera (Canon, 2020) while performing the Adho Mukha Vrksasana. The camera video recording speed was kept at 4k and the video recording speed was kept at 24 frame per second. Furthermore, to record the muscle activation pattern of the selected muscles of the participants while performing the Adho Mukha Vrksasana, BTS FREEEMG (Bioengineering, 2011) device was used.

Data analysis

The raw electromyographic (EMG) signals collected using the BTS FREEEMG 300 system were first visually inspected to ensure signal quality and consistency. After that, full-wave rectification was applied to convert the EMG signals into absolute values, making it easier to interpret muscle activation levels. The average values were calculated manually by using Microsoft Office Excel (Microsoft Excel 2019, Microsoft Corporation, USA). For normalization, EMG amplitudes were expressed as a percentage of the participant's Maximum Voluntary Contraction (MVC). Key features that were extracted from the processed data included peak amplitude values, root mean square (RMS), and the average rectified values, which represent the intensity of muscle activation. However, only the processed peak amplitude value was considered for further analysis.

Statistical analysis

In the present study, IBM Statistical Package for Social Science (SPSS) software for Windows (version 26.0, Armonk, NY: IBM Corp.) was adopted for statistical analysis. All descriptive statistics like mean, standard deviation, minimum, and maximum were used in this study with graphs to analyze the kinematic and kinetic variables. All the assumptions regarding data sphericity, normality, and homogeneity of variance were verified through Mauchly's test of sphericity, Levene's test, and the Shapiro-Wilk test, respectively. To compare muscle activity responses of all the selected deltoid muscles, a one-way analysis of variance (ANOVA) test was executed to compare the muscle activation pattern of three selected deltoid muscles while performing Adho Mukha Vrksasana. The least significant difference (LSD) test was also applied as a post hoc test. All statistical tests were conducted using a significance level of 0.05.

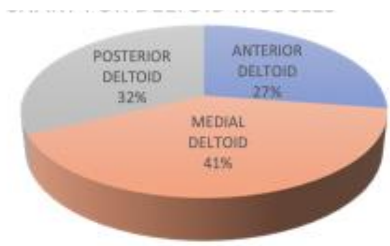
Results

The Table 1 represents the descriptive statistics, which comprises the mean value, standard deviation, and standard error of the mean, which clearly shows that the mean value of medial deltoid muscles is 270.65±10.57, which is more than the mean value of posterior deltoid muscles and anterior deltoid muscles. Further, the descriptive statistics of posterior deltoid muscles are 214.20±11.60, followed by anterior deltoid, which is 182.32±10.36. In a nutshell, by going through the above table, we can clearly understand that the mean value of medial deltoid muscles is highest, followed by posterior deltoid muscles and anterior deltoid muscles.

Table 1. Descriptive statistics of rectified EMG scores (N=30)

Muscles	Mean	Standard Deviation	Standard Error
Anterior Deltoid	182.32	10.36	4.63
Medial Deltoid	270.65	10.57	4.73
Posterior Deltoid	214.20	11.60	5.19

Figure 1. Pie chart of rectified EMG scores during Adho Mukha Vrksasana



The Figure 1 depicts that the mean value of medial deltoid muscles is 41%, which is more than the mean value of posterior deltoid muscles and anterior deltoid muscles. Further, from the above-mentioned pie chart, we can clearly assume that the mean value in percentage of medial deltoid muscles is highest, followed by posterior deltoid muscles, which is 32%, and the least is anterior deltoid muscles, which is 27%.

Table 2. Levene's test of homogeneity of selected group during Ando Mukha Vrksasana

Levene's Statistics	df1	df2	Significance
0.199	2	12	0.822

* Significant at 0.05 level of significance.

The Table 2 represents the Levene's Test to assess the assumption of homogeneity of variance, which is considered a very serious violation in the case of applying one-way ANOVA. The result of Levene's test in the above table was found insignificant, as the above table shows the p-value was more than the significance value ($p > 0.05$), so the sphericity assumption has not been broken [$F(2,12) = 0.199$, $p = 0.822$]. In that case, one-way ANOVA was proved as valid to apply for further analysis.

Table 3 ANOVA statistics of selected kinetic variables or Deltoid muscles

	Sum of Squares	df	Mean Square	F	Significance
Between Groups	20010.80	2	10005.40	84.89	.000*
Within Groups	1414.406	12	117.87		
Total	21425.207	14			

* Significant at 0.05 level of significance.

The Table 3. shows the application of the one-way ANOVA test to check whether the mean differences are significant. After examining the result, it was evidently demonstrated that there are significant differences among the selected deltoid muscles while performing the Adho Mukha Vrksasana ($F = 84.887$, $P \leq 0.05$). Therefore, it can be concluded that there are significant differences among the selected deltoid muscles while performing the Adho Mukha Vrksasana.

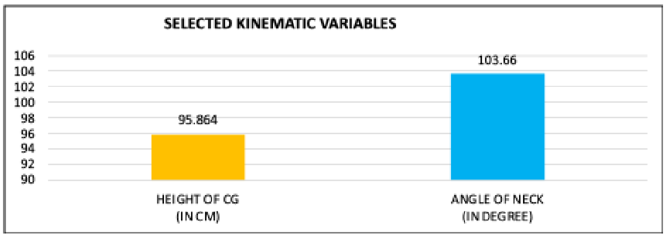
Table 4. Multiple comparisons of selected deltoid muscles in terms of rectified EMG scores

(I) Muscles Group	(J) Muscles Group	Mean Difference(I-J)	Std. Error	Sig.
Anterior Deltoid	Medial Deltoid	88.33	6.87	.000*
	Posterior Deltoid	31.88	6.87	.001*
Medial Deltoid	Anterior Deltoid	88.33	6.87	.000*
	Posterior Deltoid	56.45	6.87	.000*
Posterior Deltoid	Anterior Deltoid	31.88	6.87	.001*
	Medial Deltoid	56.46	6.87	.000*

*The mean difference is significant at the 0.05 level.

The Table 4 shows that there is a significant difference in all the pairwise comparisons because all the significant differences among various deltoid muscles are (P≤0.05) less than the 0.05 level of significance. The medial deltoid muscle's mean value is 270.65, and its contributing mean percentage is 41% while performing Adho Mukha Vrksasana, whereas the posterior deltoid muscle's mean value is 214.20, and its contributing percentage is 32%, and lastly anterior deltoid muscle's mean value is 182.32, and its contributing mean percentage is 27%. Therefore, the medial deltoid muscle is significantly better, followed by the posterior deltoid muscle, and the least dominating muscle is the anterior deltoid muscle while performing the Adho Mukha Vrksasana.

Figure 2. Bar Diagram of the selected Kinematic Variables



The Figure 2 indicates that the average height of the center of gravity while performing Adho Mukha Vrksasana was 95.864 cm, and the average angle of the neck while performing this asana was 103.66°.

Discussion

The researcher had conducted the study which incorporates the surface EMG to understand the muscle activation pattern and variation of deltoid muscles while performing Adho Mukha Vrksasana. The researcher has made an attempt to present the discussion of his findings after testing the collected data with the analysis of appropriate statistical technique to examine the EMG score of selected deltoid muscles. The result of EMG score distinctly discloses that there was a significant difference in all the selected deltoid muscles. Furthermore, the results of the present study also indicate that the medial deltoid muscles mean percentage is 41%, whereas posterior deltoid muscles mean percentage is 32% and lastly anterior deltoid muscles mean percentage is 27%. Therefore, the current study shows that the medial deltoid muscle is the most dominating muscles, followed by posterior deltoid and anterior deltoid muscles are the least dominating muscles among there selected deltoid muscles while performing Adho Mukha Vrksasana. Further, the statistical analysis of the data revealed that the ideal height of the centre of gravity should be 95.86 centimetre and the ideal angle of the neck should be 103.66 degree.

The study was conducted by Latash (2018) reported while performing handstand muscle coactivation is controlled by centre nervous system (CNS)especially by centre cortex, spinal circuits and muscle spindle and Golgi tendon organ feedback, which help in maintain balance between excitation and inhabitation in muscle fibres, ensuring precise force regulation and joint positioning. Malir et al. (2024) explain that shoulder's dynamic stability comes from muscle coactivation around the joint. The shoulder stability depends on neuromuscular control, Reflexive muscle activation and Central nervous system integration for balance and postural adjustments. A study was conducted by Kochanowicz et al. (2018) where he found that Skilled gymnasts exhibit more efficient muscle activation patterns during handstands compared to less-skilled individuals. Nagahi et al. (2020) demonstrate anthropometric characteristics, such as height, weight, and limb dimensions, can influence muscle activation during handstands. For instance, shorter individuals may use excessive muscle power compared to taller individuals to perform tasks, potentially leading to increased muscle fatigue. Conversely, heavier individuals often have greater muscle strength, which can affect muscle activation levels during tasks.

Comparison with Previous Studies

The previous study also shows the significant contribution of lateral (medial) deltoid muscle while performing Adho Mukha Vrksasana (Kumar et al., 2024). A study was conducted where it is found while performing Adho Mukha Vrksasana on still rings, which are less stable as compared with performing in floor or parallel bars, led to more activation level of deltoid muscle. The results of the study shows that deltoid muscles plays a crucial role in maintaining balance and stability (Kochanowicz et al., 2019b). The study was conducted by Kinoshita et al. in 2022 which support the idea of my paper, shows that the progressive handstand training increase the muscle activation pattern of anterior and medial deltoid muscles, and it also shows that there was a significant difference deltoid muscles while performing Adho Mukha Vrksasana (Kinoshita et al., 2022). A similar study was conducted between more experienced and less experienced gymnast, where it is found that experienced gymnast reduced anterior-posterior and medial-lateral sway as compared to less experienced gymnast and deltoid muscles plays a pivotal role as shoulder stabilizer (Sobera et al., 2019). A systematic review is conducted which provide the insight that while performing Adho Mukha Vrksasana deltoid muscles plays a pivotal role as a shoulder stabilizer (Malíř et al., 2023). According to the study by Raizada & Bagchi (2017), the medial deltoids activate more during the Arnold Dumbbell Press as the resistance moves straight over the head (Raizada & Bagchi, 2017). Similarly, while holding the Adho Mukha Vrksasana, the medial deltoids are engaged more readily. During a handstand, the control of balance is performed mainly by the wrist and the shoulder strategy, requiring a higher stabilization of the elbow (Yeadon & Trewartha, 2003).

Research Contribution

The finding of present study revealed the contributing factors to the performance of Adho Mukha Vrksasana in yoga. The study educated the coaches regarding the role played by different biomechanical variables in achieving the economic technique of Adho Mukha Vrksasana. The study was helpful to identify the pattern of muscles responses while performing Adho Mukha Vrksasana. Further, finding of the study helped the yoga instructors/ coaches as well as the yoga practitioners to prepare the appropriate training schedule for performing Adho Mukha Vrksasana with good techniques according to its dominating muscles. The results of this study were helpful in preparation of technical procedure for yoga practitioners as well as other scholars in muscles activation pattern and EMG operation more confidently.

Limitations of the study

One of the primary limitations of this study is the relatively small sample size. A limited number of participants reduces the statistical power of the analysis and may affect the generalizability of the findings to a larger population. Additionally, individual variability within a small group may disproportionately influence the results. Another key limitation of this study is the use of unilateral data only, which restricts the ability to generalize the findings to bilateral or symmetrical functions. Since we only looked at the deltoid muscle on one side, we weren't able to consider any differences or imbalances that might exist between a person's dominant and non-dominant arms. This may limit the comprehensive understanding of the phenomenon, particularly in tasks or conditions where bilateral coordination or balance is essential.

Future Research Directions

The same study should be conducted with a larger sample size in order to find the greater depth of the idea, and it will provide deeper insights and broader applicability. The similar research can be done by targeting more yoga practitioners in order to find more insight on this topic. Future studies on this topic can include different age groups; it will provide a more comprehensive understanding of the topic by capturing a wide range of perspectives, experiences, and needs. As this paper is considering only the muscle of the right arm, the future researcher can include both arms or other muscles of the body; it will enhance the comprehensiveness of the findings and provide a more complete understanding of muscle function and symmetry. Further, this study emphasizes only the position of the neck and the height of the center of gravity. The future researcher can include the position of other parts of the body; it will give a more precise in-depth understanding of the topic.

Conclusions

The findings of the study Clearly shows that there was a significant difference among all selected deltoid muscle activity responses while performing Adho Mukha Vrksasana. The result of the EMG score distinctly indicates that the medial deltoid muscle is the most dominant muscle, followed by the posterior deltoid, and the anterior deltoid muscle is the least dominant muscle among the selected deltoid muscles while performing Adho Mukha Vrksasana. Further, the statistical analysis of the data revealed that the ideal height of the center of gravity should be 95.86 centimeters and the ideal angle of the neck should be 103.66 degrees while performing Adho Mukha Vrksasana.

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