

# Prevalence of Scapular Dyskinesia Among Individuals with Stroke: A Cross-Sectional Study

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DOI: <https://doi.org/10.52403/ijshr.20250318>

## ABSTRACT

**Background:** Normal scapulo-humeral rhythm relies on coordinated scapular upward rotation, posterior tilt and external rotation to maintain optimal shoulder mechanics. Stroke-related weakness, spasticity and trunk posture changes can cause scapular dyskinesia and understanding its prevalence in stroke can guide targeted rehabilitation programs.

**Objective:** To determine the prevalence of scapular dyskinesia in individuals with stroke using the Scapular Balance Angle (SBA) and Lateral Scapular Slide Test (LSST).

**Methods:** A cross-sectional observational study was conducted on 88 individuals with subacute and chronic middle cerebral artery stroke which were selected via purposive sampling. SBA was measured using goniometer and values  $\geq 7^\circ$  were considered as dyskinesia. LSST was performed at  $0^\circ$ ,  $45^\circ$  and  $90^\circ$  of shoulder abduction and a side-to-side difference  $>1.5\text{cm}$  was considered as dyskinesia.

**Results:** The sample comprised of 69 males and 19 females with a mean age of  $57.74 \pm 5.37$  years. SBA  $\geq 7^\circ$  was observed in 42 participants (47.73%) with a mean SBA of  $8.93 \pm 1.09^\circ$ . LSST scores revealed increasing dyskinesia prevalence with shoulder elevation: 32.95% at  $0^\circ$ , 43.18% at  $45^\circ$  and 53.41% at  $90^\circ$  of shoulder

abduction. Participants at risk (1.0-1.5 cm difference) were most common at  $90^\circ$  (43.18%). Mean LSST values for dyskinesia group were highest at  $90^\circ$  ( $2.47 \pm 0.27\text{ cm}$ )

**Conclusion:** The findings of the present study revealed high prevalence of scapular dyskinesia in individuals with stroke, particularly at higher degrees of shoulder elevation reflecting underlying muscular weakness and altered neuromuscular control.

**Keywords:** Scapular Dyskinesia, Scapular Balance Angle, Lateral Scapular Slide Test, Stroke.

## INTRODUCTION

Normal scapulo-humeral rhythm refers to the synchronized movement between the scapula and humerus that enables effective shoulder motion. This coordination is essential for the proper functioning of the shoulder. When performing the majority of shoulder actions, the scapula and arm movement are closely linked. The scapula moves in three directions: upward and downward rotation, internal and external rotation, and anterior and posterior tilt.<sup>[1]</sup> The clavicle functions as a support structure for the shoulder complex, linking the scapula to the central part of the body. This helps in two types of movement: upward and downward translation and retraction and protraction.<sup>[2]</sup> The scapula has multiple roles

in shoulder function, and its ability to control both static position and dynamic movements and translations helps it fulfill these roles.<sup>[3]</sup> Along with upward rotation, the scapula must also undergo posterior tilting and external rotation to clear the acromion during flexion or abduction.<sup>[4]</sup> Furthermore, the scapula must simultaneously perform internal and external rotation along with posterior tilting to ensure that the glenoid remains a stable socket for the moving arm, thereby enhancing concavity compression and ball-and-socket motion. During movement, the scapula needs to be dynamically stabilized in a position of relative retraction to maximize the activation of all the muscles that originate from it.<sup>[5]</sup> Finally, the scapula functions as a key component in the kinetic chain of integrated segment movements, starting from the ground and ending at the hand.<sup>[6-7]</sup>

Scapular dyskinesia (dys- alteration of, kinesis- movement) is a collective term that refers to movement of the scapula that is dysfunctional. It has been identified by a group of experts as: (1) abnormal static scapular position and/or dynamic scapular motion characterised by medial border prominence; or (2) inferior angle prominence and/or early scapular elevation or shrugging on arm elevation; and/or (3) rapid downward rotation during arm lowering.<sup>[8]</sup> Scapular dyskinesia is a non-specific response to a painful condition in the shoulder joint instead of a specific response to certain glenohumeral pathology. It has many causative factors, both proximally (muscle weakness/imbalance, nerve injury) and distally (acromioclavicular joint injury, superior labral tears, rotator cuff injury) based. Consequently, Scapular dyskinesia results in improper function of the scapular component in the scapulo-humeral rhythm.<sup>[9]</sup>

When the blood supply to the cerebrum is interrupted either due to a hemorrhage or an infarction, it results in a neurovascular condition known as stroke.<sup>[10]</sup> A stroke results in an abrupt loss of neurological

function because the blood supply to the brain is interrupted.<sup>[11]</sup> The pathophysiological basis of stroke is characterized by damage to the central nervous system's motor neurons and pathways as a result of thrombus or bleeding that affects the brain's arterial supply and generally occurs suddenly.<sup>[12]</sup> Stroke is a global health issue; a WHO Collaborative Study carried in 12 countries found that its incidence ranges from 0.2 to 2.5 per thousand annually. It accounts for 20% of neurological admissions.<sup>[13]</sup>

In stroke patients, upper limb disability is regarded as a serious problem.<sup>[14]</sup> Following a stroke, there is a low-tone flaccid stage where there is no voluntary control, trailed by spastic stage. Serious shoulder joint subluxation and scapulothoracic joint asymmetry (dyskinesia) are caused by the spastic and flaccid stages.<sup>[15]</sup> In the first flabby flaccid stage, the glenoid fossa angle is changing because of the hypotonia of the trapezius, serratus anterior, and rhomboid muscles that reason scapular descending revolution, depression, and protraction, which may prompts, hence adding to subluxation<sup>[16]</sup>; Scapular withdrawal in retraction and shoulder depression with adduction are caused by the predominant flexor tone in the upper extremity (UE) during the spastic period.<sup>[17-18]</sup> During the spastic stage, the pectoralis major and minor, rhomboids, elevator scapulae and latissimus dorsi can become hypertonic, resulting in shoulder pain and glenohumeral subluxation by further rotating the scapula downward.<sup>[5,13]</sup> Apart from decreased glenohumeral motion, spasticity, subluxation and somatosensory impairments, poor scapulothoracic position and aberrant scapulo-humeral motion are also considered causes of pain and dysfunction after stroke.<sup>[19]</sup> Individuals with mild paresis and less hypertonicity can make well-fractionated movements, while those with more severe paresis and hypertonicity have less ability to do so.<sup>[20]</sup> Scapular dyskinesia, characterized by alterations in scapular positioning and

movement, can significantly impact shoulder mechanics and upper limb function, particularly in individuals recovering from stroke. Despite its critical role in the kinetic chain and upper extremity rehabilitation, scapular motion is often overlooked in clinical assessment and treatment planning. Given the high incidence of upper limb impairments post-stroke and the importance of scapular stability in functional recovery, there is a pressing need to assess the prevalence of scapular dyskinesia in this population. Understanding its occurrence and impact may enhance clinical awareness and inform targeted rehabilitation strategies aimed at improving functional outcomes.

## MATERIALS & METHODS

An observational study was conducted in Ahmedabad, India after obtaining approval from the institutional ethical committee. Participants were selected through purposive sampling method. A total of 88 individuals with subacute and chronic stroke enrolled in the study, all of whom met the inclusion and exclusion criteria and completed the assessment procedures. Participants included in the study were individuals diagnosed with Middle Cerebral Artery (MCA) Stroke. The study recruited both male and female participants between the age of 45 and 65 years. Participants who had mild to moderate spasticity in upper limb as indicated by Modified Ashworth Scale (MAS) grades ranging from 1 to 2 and who had partial voluntary control of the upper limb as indicated by Voluntary Control Grading (VCG) scores between 3 to 5. Participants were excluded if they had any difficulty in communication or comprehension that would impair their ability to follow instructions during testing. Additionally, individuals with other musculoskeletal or neurological conditions affecting the upper limb such as biceps tendinitis, frozen shoulder, rotator cuff tendinopathy, peripheral neuropathy, cervical myelopathy, etc were not included. Those with perceptual disorders including

conditions like neglect or apraxia, were also excluded from participation. The study was explained to the participants and written informed consent was taken.

The scapular position was determined through the measurement of Scapular Balance Angle (SBA). (Fig 1) The SBA measurement is obtained with the patient standing on both bare feet, with arms, pelvis, and heels together. Then the inferior angle of the scapula was marked bilaterally and the line connecting these marks and another vertical line between the C7 and T9-T10 spinous processes were drawn. And the angles formed by the line joining both inferior angles of the scapula with the vertical line running through the spine were measured with the goniometer. The SBA was defined as “the difference between the angles formed by the line joining the 2 inferior angles of the scapula with the vertical line passing through the spine. SBA greater than  $7^{\circ}$  would entail the diagnosis of scapular dyskinesia. Manual measurement of the SBA is reproducible at an intra-observer (ICC: 0.87) and inter-observer (ICC: 0.84) level.<sup>[21]</sup>



Figure 1: Scapula Balance Angle

The Lateral Scapular Slide test (LSST) was used to measure scapular position by taking the side-to-side differences between both sides in all 3 test positions. (Fig 2) On the same horizontal plane, the measurements were taken from the scapula's inferior angle to the thoracic vertebra's spinous process. The test was done in 3 positions of shoulder abduction (0, 45 and 90 degrees). (1) Arms relaxed at the sides, shoulders in a neutral stance. (2) The humerus is positioned in 45 degrees of abduction and medial rotation by placing the patient's hands around their

waist. (3) The humerus positioned at 90 degrees of abduction and maximum medial rotation. The test was positive when there was a difference of 1.5 cm when measurements are compared bilaterally. The LSST has demonstrated moderate to good intra-rater reliability, with ICC values

ranging from 0.52 to 0.80 and variable reliability ranging from 0.43 to 0.79 depending on the testing position and presence of shoulder impairment. A difference of >1.0 cm or >1.5 cm is commonly used as the threshold for identifying scapular dyskinesia.<sup>[22]</sup>

**Figure 2: Lateral Scapular Slide Test at 0°, 45° and 90° of Shoulder Abduction.**



### STATISTICAL ANALYSIS

Statistical analysis was performed using Microsoft Excel 2021. Data were collected from subacute and chronic stroke patients at rehabilitation centers. The prevalence of scapular dyskinesia was determined using descriptive statistics. Percentages were calculated to report the number of patients showing dyskinesia based on Scapular Balance Angle ( $SBA \geq 7^\circ$ ) and Lateral Scapular Slide Test ( $LSST \geq 1.5$  cm) across different arm positions ( $0^\circ$ ,  $45^\circ$ , and  $90^\circ$ ).

### RESULT

A total of 88 participants were included in the study, with a mean age of  $57.74 \pm 5.37$  years. The mean Body Mass Index (BMI) was  $26.05 \pm 2.97$  kg/m<sup>2</sup>. The sample comprised of 69 males (78.41%) and 19 females (21.59%). Most participants had experienced an ischemic stroke ( $n=70$ , 79.55%), while the remainder had a hemorrhagic stroke ( $n=18$ , 20.45%). (Table 1).

**Table 1: Demographic data of the participants.**

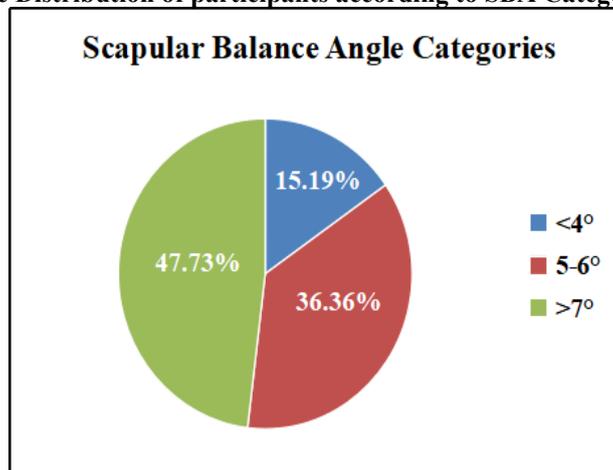
<b>Age (years)</b>	$57.74 \pm 5.37$
<b>BMI (kg/m<sup>2</sup>)</b>	$26.05 \pm 2.97$
<b>Gender</b>	
Male	69 (78.41%)
Female	19 (21.59%)
<b>Type of Stroke</b>	
Ischaemic	70 (79.55%)
Hemorrhagic	18 (20.45%)
<b>Affected Side</b>	
Right	23 (26.14%)
Left	65 (73.86%)
<b>Dominant Side</b>	
Right	77 (87.50%)
Left	11 (12.50%)

Based on the Scapular Balance Angle (SBA), scapular dyskinesia ( $\geq 7^\circ$ ) was identified in 42 out of 88 participants, corresponding to a prevalence rate of 47.73%. Participants with an SBA between  $5-6^\circ$  accounted for 36.36%, while those with  $\leq 4^\circ$  accounted for 15.19%. The mean SBA among participants with  $\geq 7^\circ$  was  $8.93 \pm 1.09$ , while those with  $5-6^\circ$  had a mean SBA of  $5.59 \pm 0.50$  and those with  $\leq 4^\circ$  had a mean SBA of  $3.79 \pm 0.41$  (Table 2).

**Table 2: Prevalence and Descriptive Analysis of Scapular Dyskinesia Based on SBA.**

SBA Status	No. of Cases	Percentage (%)	Mean ± SD
≤4°	14	15.19%	3.79 ± 0.41
5-6°	32	36.36%	5.59 ± 0.50
≥7°	42	47.73%	8.93 ± 1.09
Total	88	100.00%	6.90 ± 2.20

**Figure 3: Percentage Distribution of participants according to SBA Categories (≤4°, 5-6° & ≥7°)**



The prevalence of scapular dyskinesia varied across the three test positions of the Lateral Scapular Slide Test (LSST). At 0°, 31 participants (35.23%) had normal scapular positioning (≤1.0cm), 22 participants (25.00%) were at risk of dyskinesia (1.0-1.5cm) and 16 participants (18.18%) showed dyskinesia (>1.5cm). At 45°, 28 participants (31.82%) had normal scapular positioning (≤1.0cm), 28 participants (31.82%) were at risk (1.0-1.5cm) and 25 participants (28.41%) had dyskinesia (>1.5cm). At 90°, 29 participants

(32.95%) were in normal range (≤1.0cm), 38 participants (43.18%) were at risk (1.0-1.5cm) and 47 participants (53.41%) showed dyskinesia (>1.5cm). (Table 3) The mean LSST values for the dyskinesia group were highest at 90° (2.47 ± 0.27 cm), followed by 45° (2.38 ± 0.24 cm) and 0° (1.97 ± 0.17 cm), while the at risk group had mean values of 1.24 ± 0.14 cm at 90°, 1.17 ± 0.10 cm at 45° and 1.16 ± 0.12 cm at 0° and the normal group had mean values of 0.79 ± 0.12 cm at 90°, 0.81 ± 0.16 cm at 45° and 0.68 ± 0.19 cm at 0° (Table 4).

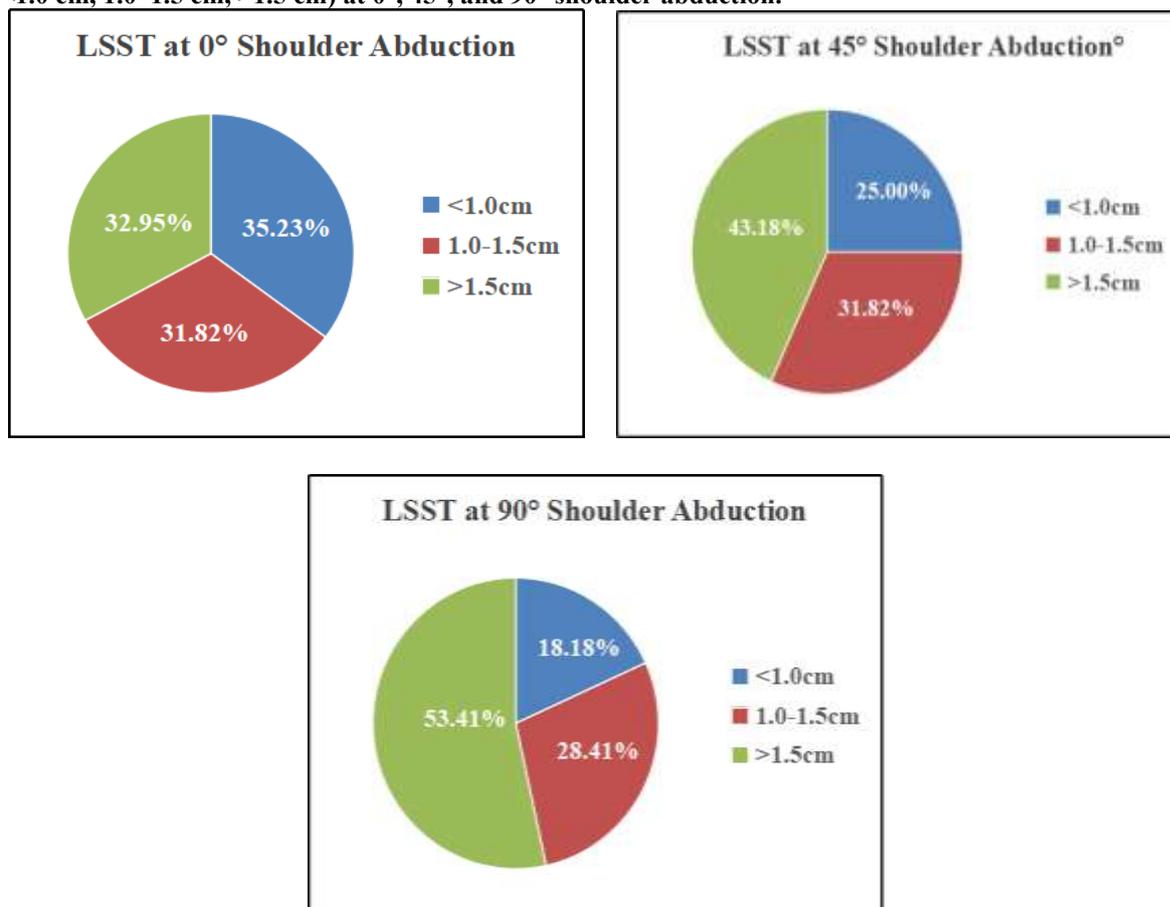
**Table 3: Percentage distribution of LSST categories at 0°, 45° & 90° of Shoulder Abduction.**

LSST Status	0°	Percentage	45°	Percentage	90°	Percentage
<1.0cm	31	35.23%	22	25.00%	16	18.18%
1.0-1.5cm	28	31.82%	28	31.82%	25	28.41%
>1.5cm	29	32.95%	38	43.18%	47	53.41%

**Table 4: Mean and SD values of LSST categories at 0°, 45° & 90° of Shoulder Abduction.**

LSST Status	<1.0cm	1.0-1.5cm	>1.5cm
0°	0.68 ± 0.19	1.16 ± 0.12	1.97 ± 0.17
45°	0.81 ± 0.16	1.17 ± 0.10	2.38 ± 0.24
90°	0.79 ± 0.12	1.24 ± 0.14	2.47 ± 0.27

**Figure 4: Percentage distribution of participants according to LSST side-to-side difference categories (<1.0 cm, 1.0–1.5 cm, >1.5 cm) at 0°, 45°, and 90° shoulder abduction.**



## DISCUSSION

The present study was conducted on subacute and chronic stroke to investigate the prevalence of scapular dyskinesia using Scapular Balance angle (SBA) and Lateral Scapular Slide Test (LSST). Based on the SBA scores of the study, dyskinesia was observed in 47.73% of the stroke patients and the LSST scores revealed that the prevalence rate of scapular dyskinesia was 32.95% at 0° abduction, 43.18% at 45° abduction and 53.41% at 90° of abduction of the shoulder. The progressive increase in the scapular dyskinesia prevalence with higher degrees of shoulder abduction supports the notion that scapular control decreases as shoulder elevation increases. This suggests that scapular control deficits become more evident when the kinetic and neuromuscular demands on the scapulothoracic complex are greater. Using the Scapular Dyskinesia Test (SDT), Dabholkar et al. reported that scapular

dyskinesia was found in 64% of stroke patients. SBA values revealed that 24% of the patients had  $\leq 4^\circ$ , 50% patients had 5 to  $7^\circ$  and 26% of the patients had values greater than  $7^\circ$ , indicative of scapular asymmetry. The stroke disability assessment scale revealed 19 patients had mild disability, 24 with moderate disability and 7 patients with severe disability. Both studies highlight that improper scapular mechanics are common in post-stroke patients and that static (SBA) and dynamic (LSST) measures can complement each other in assessing these impairments. Our study's slightly higher SBA scores could be explained by variations in the sample size, stroke chronicity, inclusion criteria, and most importantly our emphasis on patients with mild-moderate spasticity and partial voluntary controls.<sup>[13]</sup>

Mahmoud and Aly conducted a study to compare the post-stroke patients with and without scapular dyskinesia. The statistical

analysis of the study found that those with dyskinesia had significantly higher SBA values ( $9.43 \pm 1.86^\circ$ ) when compared to those without dyskinesia ( $4.03 \pm 1.37^\circ$ ). The dyskinesia group showed poorer motor and sensory scores on the Fugl-Meyer Upper Extremity scale compared to those without the dyskinesia. The LSST values reported in the study were also significantly higher in the dyskinesia group across all positions ( $1.81 \pm 0.2\text{cm}$  at  $0^\circ$ ,  $2.15 \pm 0.33\text{cm}$  at  $45^\circ$  and  $2.45 \pm 0.3\text{cm}$  at  $90^\circ$ ), when compared to those without dyskinesia ( $0.9 \pm 0.29\text{cm}$  at  $0^\circ$ ,  $1.0 \pm 0.3\text{cm}$  at  $45^\circ$  and  $1.21 \pm 0.21\text{cm}$  at  $90^\circ$ ) indicating that scapular malposition not only associated with altered biomechanics but also reduces sensorimotor function. These results support our finding that a higher prevalence of dyskinesia at  $90^\circ$  of abduction may be associated with compromised upward rotation, posterior tilt, and external rotation movements of the trapezius and serratus anterior, which are essential for functional arm elevation. [23]

Primary scapular stabilization and motion on the thorax involves coupling of the upper and lower fibres of the trapezius muscle with the serratus anterior and rhomboid muscles. [24] The serratus anterior and lower trapezius are activated and coupled with the upper trapezius and rhomboids to lift the scapula during arm elevation. During this motion, the lower trapezius helps maintain the instant centre of rotation of the scapula through its attachment to the medial scapular spine. [25] The lower trapezius has often been recognized as a scapular upward rotator because it maintains its long moment arm during the full range of upward rotation. But when the arm is brought down from an elevated position, it acts as a scapular stabilizer. [26] The serratus anterior also plays a role as a stabilizer of the scapula. In addition to anchoring the inferior angle and medial border, which inhibits scapular winging, the serratus anterior assists in scapular upward rotation, posterior tilt, and external rotation. [27]

A study conducted by Nascimento et al. reported a strong positive correlation

between isometric hand grip strength and isokinetic peak torque and work of glenohumeral and scapulothoracic muscles in chronic stroke individuals ( $r= 0.60-0.86$ ). The results demonstrated that a decrease in grip strength is indicative of a deficit in the proximal shoulder stabilizers, particularly the scapular muscles, which are essential for upper limb function and shoulder stability. Given the high prevalence of scapular dyskinesia observed in our study, this highlights the relationship that impaired scapular control contribute to overall upper limb weakness. [28] However, Grip strength was not assessed in the present study.

De Baets et al. investigated three-dimensional kinematics of scapula and trunk during active shoulder flexion in individuals with chronic stroke and reported that there were marked deviations from the normal movement patterns. The individuals with stroke demonstrated reduced scapular upward rotation and posterior tilting, along with increased internal rotation on the affected side, particularly in the mid to late phase of shoulder flexion. Also, these individuals showed greater trunk extension and lateral flexion towards the non-affected side, leading to compensatory strategies to achieve shoulder flexion when scapula mobility was compromised. These findings reveal impairments in scapulo-humeral rhythm and postural control post-stroke which indicates that scapular dyskinesia in this population not only arises due to local muscle weakness but also from altered motor strategies involving the trunk. [29]

In summary, this study highlights the high prevalence of scapular dyskinesia in subacute and chronic stroke individuals particularly at higher degrees of shoulder elevation. These findings suggest the need for early detection and targeted rehabilitation of scapula control for faster recovery and optimized upper limb function in post-stroke patients.

## CONCLUSION

In conclusion, the findings of the present study revealed high prevalence of scapular

dyskinesia in individuals with subacute and chronic stroke, particularly at higher degrees of shoulder elevation reflecting underlying muscular weakness and altered neuromuscular control. SBA and LSST provide complimentary perspectives for assessing scapular dyskinesia and implementing such assessments into routine post-stroke evaluations can help in tailoring appropriate rehabilitation protocols which are aimed at improving overall upper limb performance. Further research should be conducted to investigate targeted interventions and their impact on functional recovery of upper limb control in post-stroke patients.

#### **Declaration by Authors**

**Ethical Approval:** Approved by IEC of JG College of Physiotherapy, Ahmedabad

**Acknowledgement:** None

**Source of Funding:** None

**Conflict of Interest:** The authors declare no conflict of interest.

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How to cite this article: Sadhana Nimbhore, Megha S Sheth. Prevalence of scapular dyskinesia among individuals with stroke: a cross-sectional study. *International Journal of Science & Healthcare Research*. 2025; 10(3): 160-168. DOI: [10.52403/ijshr.20250318](https://doi.org/10.52403/ijshr.20250318)

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