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Lateropulsion After Stroke: Prevalence, Predictors And Impact On Recovery In Subacute Rehabilitation – A Prospective Observational Study

Pavithra Venugopal[1*], Narayanasamy Krishnasamy[2], Harihara Sudan Subramanian[3], Manoj Abraham Manoharlal[4]

[1*]Associate Professor, KG College of Physiotherapy (Affiliated to The Tamil Nadu Dr. M.G.R Medical University), Coimbatore,641035, Tamil Nadu, India.
[2] Vice Chancellor, The Tamil Nadu Dr. M.G.R Medical University, Chennai, 600032, Tamil Nadu, India.
[3] Professor, KG College of Physiotherapy (Affiliated to The Tamil Nadu Dr. M.G.R Medical University), Coimbatore,641035, Tamil Nadu, India.
[4] Professor/ Principal, KG College of Physiotherapy (Affiliated to The Tamil Nadu Dr. M.G.R Medical University), Coimbatore,641035, Tamil Nadu, India.

***Corresponding author:**
Mrs. Pavithra Venugopal, MPT (Neuro)., MBA.,
Associate Professor
E-mail: pavipvthr93@gmail.com
Phone no: +91 9600969884

ABSTRACT

Background: Lateropulsion, also known as contraversive pushing, is a common post-stroke disorder that disrupts vertical orientation and significantly interferes with functional recovery. Its prevalence in subacute rehabilitation settings varies widely, and the clinical factors predicting its occurrence and its influence on rehabilitation outcomes remain incompletely defined.

Objectives: To determine the prevalence of lateropulsion in patients undergoing subacute stroke rehabilitation, identify clinical predictors associated with its presence, and evaluate its impact on functional recovery.

Methods: A prospective observational study was conducted in an Institution and Rehabilitation centre from South India. Consecutive stroke patients meeting eligibility criteria were enrolled. Demographic data, stroke characteristics, and neurological assessments were recorded. Lateropulsion was evaluated using the Burke Lateropulsion Scale (BLS). Functional outcomes were assessed using standardized measures such as the Berg Balance Scale (BBS) and Functional Independence Measure (FIM). Prevalence was calculated, and predictors were analyzed using appropriate statistical models.

Results: A total of 176 subacute stroke rehabilitation patients were assessed to determine the prevalence and clinical impact of lateropulsion. The cohort was predominantly older adults, with most between 40 and 90 years, and females formed 53.41% of the sample. Ischemic stroke was the major subtype (76.70%), and left-sided involvement slightly predominated (56.25%). Lateropulsion was present in 34.09% of patients and was more frequent among those aged ≥70 years. Within the lateropulsion group, ischemic strokes (75%), left-sided lesions (58.33%), and severe NIHSS scores (68.33%) were common, and spatial neglect was highly prevalent (76.67%). Co-morbidities such as diabetes and heart disease were frequent. Although mean age and NIHSS values were comparable between groups, individuals with lateropulsion showed significantly poorer functional performance, reflected by lower BLS (10.56 ± 3.37), BBS (25.72 ± 9.27) and FIM (68.7 ± 14.2) scores compared to those without lateropulsion.

Conclusion: Overall, the findings indicate that lateropulsion affects one-third of the rehabilitation population and is strongly associated with older age, neglect, greater stroke severity, and reduced functional balance.

KEYWORDS: Lateropulsion; Stroke; Prevalence; Predictors; Functional Recovery; Prospective Observational Study

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INTRODUCTION

Stroke is a major global contributor to long-term disability, producing a wide spectrum of motor, sensory, and cognitive impairments. Beyond well-recognized deficits such as hemiparesis or aphasia, several post-stroke syndromes significantly hinder rehabilitation despite being less prominently discussed. (1) Lateropulsion is one such disorder, characterized by a disturbed perception of verticality in which patients actively push toward the paretic side and resist corrective efforts. (2) This maladaptive postural bias challenges clinicians, as patients persistently lean or "fall" toward the weaker side despite verbal and manual cues. The condition interferes with fundamental rehabilitation activities, including sitting balance, transfers, standing, and gait training, ultimately prolonging recovery and elevating fall risk. (3)

International research reports a highly variable prevalence of lateropulsion, ranging from 5% to 60%, influenced by differences in stroke type, lesion characteristics and assessment timing.[4] Despite its clinical relevance, evidence from India remains limited, though rehabilitation environments, patient demographics, and recovery trajectories differ substantially from Western populations. [5] A clearer understanding of its prevalence, associated clinical factors, and impact on functional recovery in the Indian subacute rehabilitation context is essential for optimizing therapeutic strategies and resource planning.

The aims of this study were to estimate the prevalence of lateropulsion among subacute stroke patients, identify associated clinical characteristics, and evaluate its impact on balance, functional performance, and overall functional independence.

MATERIAL AND METHODS

Study Design and Setting

This prospective observational study was conducted in the KG Physiotherapy and Rehabilitation Center, KGISL Campus, Department of Physiotherapy at KG Hospital and KG Pain Relief Centre (Community Centre) Coimbatore from October 2024 to May 2025. Consecutive sampling was employed; all eligible stroke patients admitted for in-patient rehabilitation during the study period were screened. The study received approval from the Institutional Ethics Committee, and written informed consent was obtained from all participants or their caregivers.

Participants

Adults aged ≥40 years with a confirmed diagnosis of ischemic or haemorrhagic stroke were included if they were in the subacute stage of stroke, after onset (2-6 months). Exclusion criteria were: (i) co-existing neurological or musculoskeletal disorders likely to influence posture or balance, (ii) severe cognitive or communication impairments that limited reliable assessment, and (iii) unstable medical conditions that could interfere with evaluation or rehabilitation.

Sample Size

Assuming an expected prevalence of lateropulsion in the subacute stroke population, the minimum required sample size was calculated as 176 participants.

Operational Definitions

• Lateropulsion: A postural control disorder characterized by active pushing toward the paretic side and resistance to correction.
• Burke Lateropulsion Scale (BLS): A standardized tool assessing lateropulsion across five functional tasks. Scores range from 0–17, with higher scores indicating greater severity.

Sampling Technique

A consecutive sampling method was used to minimize selection bias and ensure systematic inclusion of all eligible patients.

Assessment Tools and Procedure

The evaluation followed a standardized stepwise protocol:
1. Demographic and stroke details: Age, sex, stroke type, side of lesion, and stroke severity measured using the NIH Stroke Scale (NIHSS).
2. Associated deficits: Spatial neglect assessed using the Star Cancellation Test.
3. Lateropulsion assessment: Conducted using the Burke Lateropulsion Scale (BLS).
4. Balance and functional status: Evaluated using the Berg Balance Scale (BBS) and Functional Independence Measure (FIM).

Severity Classification of Lateropulsion

The severity of lateropulsion was categorized using the Burke Lateropulsion Scale (BLS), which quantifies pushing behavior across five functional tasks. Total scores range from 0 to 17, with higher scores indicating greater impairment. Severity was classified according to established cutoff values as follows: Mild lateropulsion: BLS score 1–3; Moderate lateropulsion: BLS score 4–8; Severe lateropulsion: BLS score ≥9. These categories were used to analyze clinical characteristics and compare functional outcomes across severity levels.

Bias and Quality Control

• Standardized instructions and scoring guidelines were followed to reduce measurement bias.
• When more than one therapist conducted assessments, inter-rater reliability was ensured through prior joint training sessions and periodic cross-checking of scoring.
• Consecutive sampling minimized selection bias.

Statistical Analysis

Data were analyzed using SPSS version 24. Descriptive statistics summarized demographic and clinical characteristics. Prevalence of lateropulsion was reported as percentages with 95% confidence intervals. Group comparisons and predictor analyses were performed using appropriate statistical tests. A p-value <0.05 was considered statistically significant.

RESULTS

A total of 176 patients undergoing subacute stroke rehabilitation were included to determine the prevalence of lateropulsion, identify clinical predictors associated with its presence, and assess its impact on functional recovery.

Age Distribution:
Participants ranged from 40 to 90 years. The largest proportion belonged to the 80–90-year age group (31.30%), followed by 70–79 years (24.23%) and 60–69 years (18.69%). Individuals aged 50–59 years comprised 18.37% of the sample, while those aged 40–49 years accounted for 7.42%. This distribution reflects a predominance of older adults in the rehabilitation cohort.

Table: 1 Distribution of Age in years

AGE	NUMBER OF PATIENTS (n)	PERCENTAGE (%)
40-49	19	7.42%
50-59	40	18.37%
60-69	34	18.69%
70-79	39	24.23%
80-90	44	31.30%
Total	176	100.00%

Gender Distribution:
Among the 176 participants, females constituted a slightly higher proportion of the sample, accounting for 53.41% (n=94), while males represented 46.59% (n=82). This indicates a modest female predominance in the subacute stroke rehabilitation population.

Table: 2 Distribution of Gender

GENDER	NUMBER OF PATIENTS (n)	PERCENTAGE (%)
Female	94	53.41%
Male	82	46.59%
Total	176	100.00%

Clinical Profile of the Study Population
The study included 176 patients with a predominance of ischemic stroke (76.70%), while hemorrhagic stroke accounted for 23.30%. Left-sided involvement was slightly more common (56.25%) than right-sided lesions (43.75%). Half of the cohort had mild stroke severity (50%), followed by moderate (28.98%) and severe strokes (21.02%). Co-morbidities were frequently present, with dyslipidemia (22.16%) and heart disease (21.59%) being the most common, along with hypertension (18.75%) and diabetes (16.48%); 21.02% had no co-morbid conditions. NIHSS scores varied widely, with the largest proportion falling within the 29–32 range (12.5%), reflecting a mix of mild to substantial neurological deficits. CT was the most frequently used imaging modality (48.86%), followed by MRI (35.23%), and 10.23% underwent both. Lateropulsion was identified in 34.09% of participants, indicating that over one-third of the rehabilitation population demonstrated this postural control disorder.

Table: 3 Clinical Profile of the Study Population

CLINICAL PROFILE		NUMBER OF PATIENTS (n)	PERCENTAGE (%)
STROKE TYPE	Hemorrhagic	41	23.30%
	Ischemic	135	76.70%
SIDE INVOLVED	Left	99	56.25%
	Right	77	43.75%
SEVERITY	Mild	88	50.00%
	Moderate	51	28.98%
	Severe	37	21.02%
CO-MORBIDITIES	Diabetes	29	16.48%
	Dyslipidemia	39	22.16%
	Heart Disease	38	21.59%
	Hypertension	33	18.75%
	None	37	21.02%
NIHSS	Mild	27	15.34%
	Moderate	34	19.32%
	Severe	115	65.34%
IMAGING	Both	18	10.23%

	CT	**86**	**48.86%**
	MRI	**62**	**35.23%**
	NA	**10**	**5.68%**
LATEROPULSION	**Absent**	**116**	**65.91 %**
	Present	**60**	**34.09%**

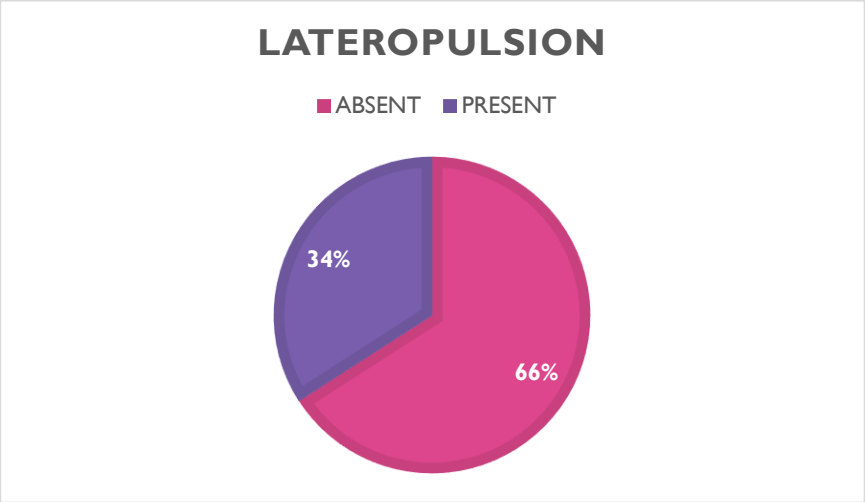

Figure 1 **Lateropulsion**

Interpretation of NIHSS Categories and Lateropulsion Patterns

Most patients in the cohort presented with severe neurological impairment, with 65.34% classified under the severe NIHSS category, while moderate and mild categories accounted for 18.33% and 13.34% respectively. This indicates that a significant proportion entered rehabilitation with substantial deficits. Among the 60 patients who exhibited lateropulsion, ischemic stroke was the predominant type, contributing 75%, whereas hemorrhagic stroke accounted for 25%. Among the 60 patients exhibiting lateropulsion, left-sided lesions were more common, accounting for 58.33% (n=35), while right-sided involvement was observed in 41.67% (n=25)

Table: 4 Interpretation of NIHSS Categories and Lateropulsion Patterns

CLINICAL PROFILE IN LATEROPULSION POPULATION		**NUMBER OF PATIENTS (n)**	**PERCENTAGE (%)**
AGE	**40-49**	**7**	**7.96%**
	50-59	**15**	**20.76%**
	60-69	**11**	**17.85%**
	70-80	**13**	**23.92%**
	>80	**14**	**29.51%**
STROKE TYPE	**Hemorrhagic**	**15**	**25.00%**
	Ischemic	**45**	**75.00%**
STROKE SIDE	**Left**	**35**	**58.33%**
	Right	**25**	**41.67%**
CO MORBIDITIES	**Diabetes**	**13**	**21.67%**
	Dyslipidemia	**12**	**20.00%**
	Heart Disease	**13**	**21.67%**
	Hypertension	**7**	**11.67%**
	None	**15**	**25.00%**
NEGLECT	**Absent**	**14**	**23.33%**
	Present	**46**	**76.67%**

NIHSS	**Mild**	**8**	**13.33%**
	Moderate	**11**	**18.33%**
	Severe	**41**	**68.33%**

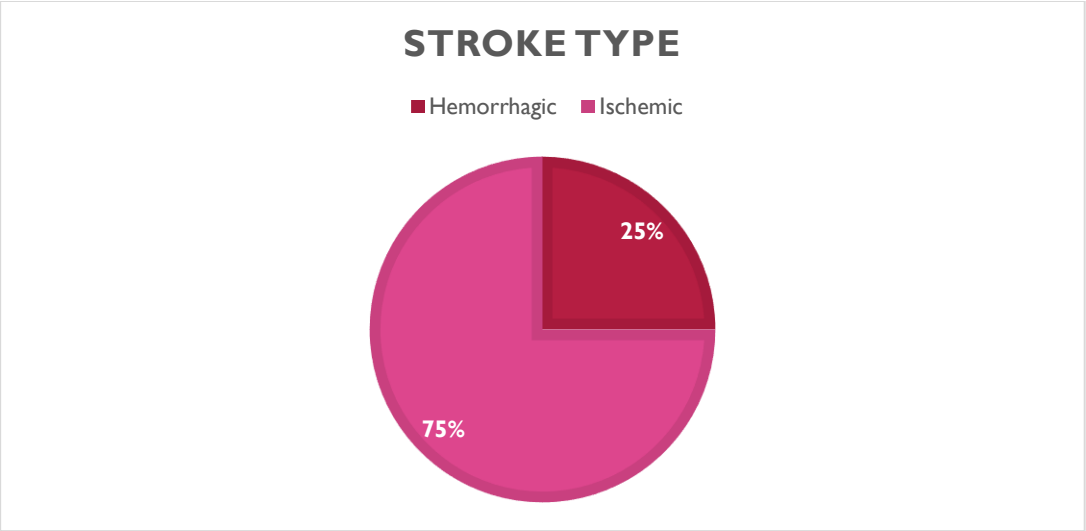

Figure 2 **Stroke Type**

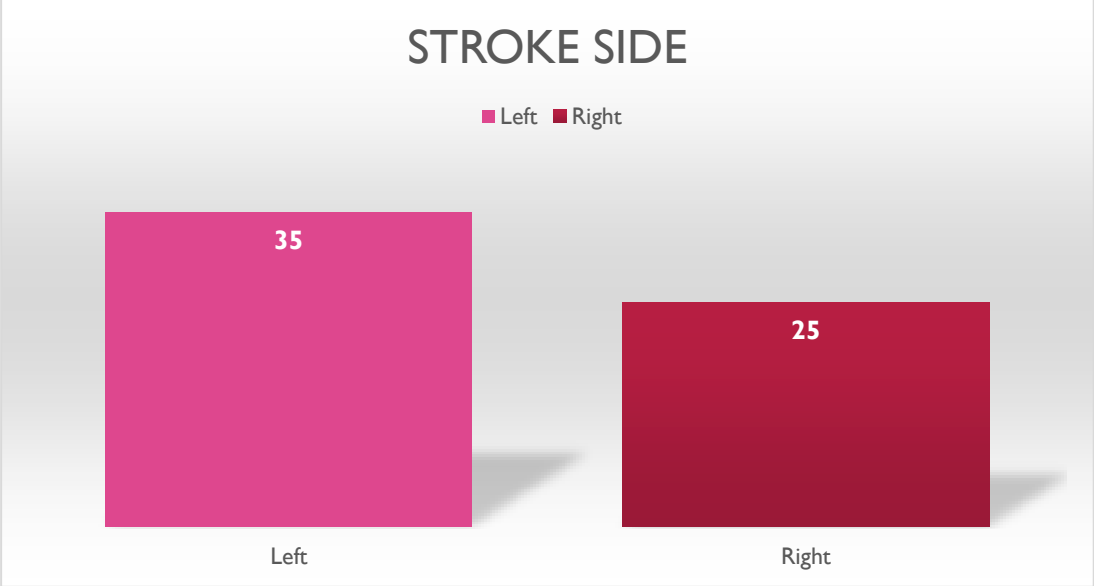

Figure 3 **Stroke Side**

Age Distribution Among Patients With Lateropulsion

In the lateropulsion subgroup, older adults formed the majority. Individuals above 80 years constituted the largest proportion at 29.51% (n=14), followed by those aged 70–80 years at 23.92% (n=13). The 50–59 and 60–69 age groups contributed 20.76% (n=15) and 17.85% (n=11) respectively, while the 40–49 group accounted for only 7.96% (n=7). This distribution indicates that lateropulsion was more prevalent among older stroke survivors, with a clear increase in frequency in those above 70 years.

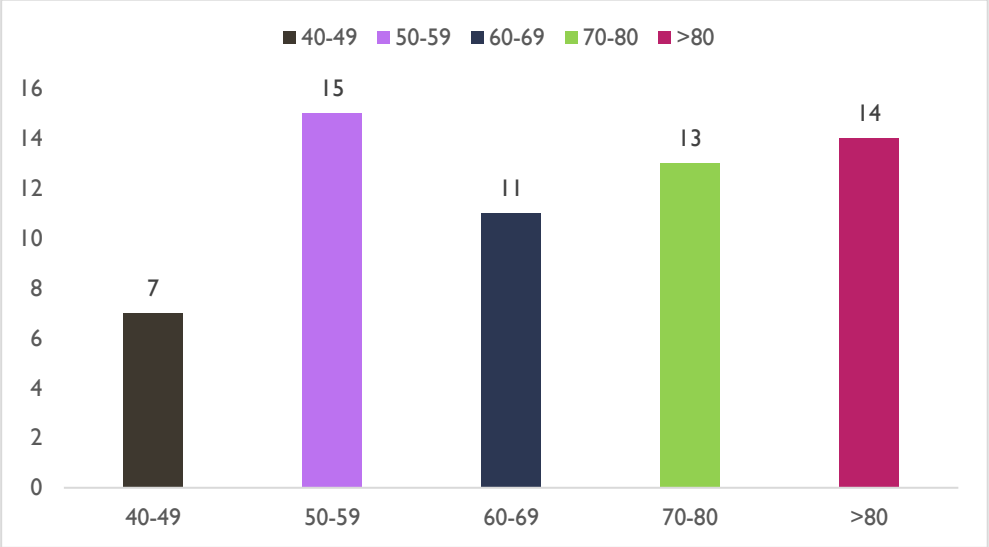

Figure 4 **Age**

Co-morbidities among Patients with Lateropulsion

Within the lateropulsion population, diabetes and heart disease were the most common co-morbidities, each present in 21.67% (n=13) of patients, followed closely by dyslipidemia at 20% (n=12). Hypertension accounted for 11.67% (n=7), while 25% (n=15) of individuals had no documented co-morbid conditions.

Neglect among Patients with Lateropulsion

In the lateropulsion subgroup, a high proportion of patients demonstrated neglect, with 76.67% (n=46) screening positive, while only 23.33% (n=14) showed no evidence of neglect. This indicates a strong association between lateropulsion and the presence of spatial neglect in the subacute stroke rehabilitation cohort.

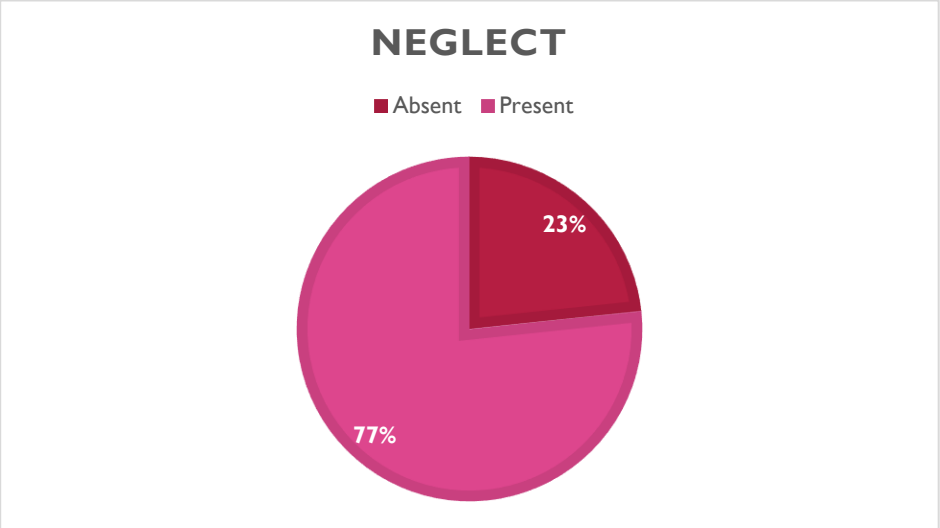

Figure 5 **Neglect**

NIHSS Severity Among Patients With Lateropulsion

Most patients with lateropulsion fell into the severe NIHSS category, accounting for 68.33% (n=41), while moderate severity was observed in 18.33% (n=11) and mild severity in 13.33% (n=8). This distribution shows that lateropulsion was predominantly associated with higher stroke severity levels in the rehabilitation population.

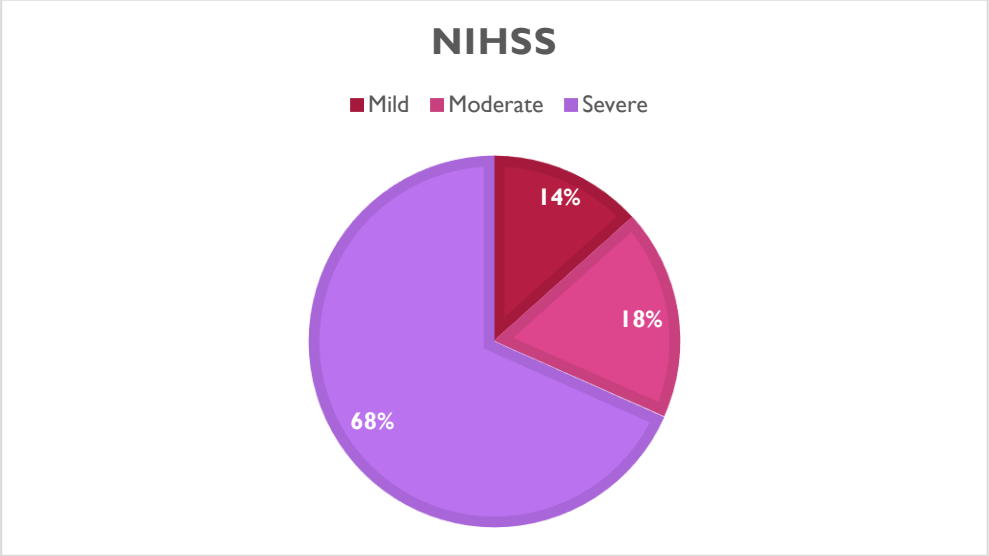

Figure 6 **NIHSS**

Comparative Analysis of Key Clinical Parameters

Across the study population, the mean age was comparable between groups, with the lateropulsion group showing a slightly lower mean age (67.03 ± 13.43 years) compared to those without lateropulsion (68.27 ± 13.40 years). Mean NIHSS scores were also similar between groups, indicating comparable overall stroke severity, with scores of 21.0 ± 10.69 in the lateropulsion group and 21.76 ± 12.33 in the non-lateropulsion group. However, clear functional differences were observed: patients with lateropulsion demonstrated significantly lower balance performance, with a mean BBS score of 25.72 ± 9.27 compared to 35.30 ± 9.99 in those without lateropulsion. Likewise, BLS scores were notably reduced in the lateropulsion subgroup (54.56 ± 17.37) versus the no-lateropulsion group (68.30 ± 19.09), highlighting the functional impact of lateropulsion on postural control and balance. For FIM scores were notable reduced in lateropulsion subgroup (68.7 ± 14.2) versus the no-lateropulsion group (76.3 ± 11.2), which showes the reduced functional independence level and thereby impact functional recovery.

Table: 5 Comparative Analysis of Key Clinical Parameters

PARAMETERS	MEAN ± SD		
	OVERALL POPULATION	NO LATEROPULSION	LATEROPULSION POPULATION
AGE	67.84 ± 13.38	68.27 ± 13.4	67.03 ± 13.43
NIHSS	21.5 ± 11.77	21.76 ± 12.33	21 ± 10.69
BLS	11.62 ± 1.63	8.34 ± 1.09	10.56 ± 3.37
BBS	32 ± 10.7	35.3 ± 9.99	25.72 ± 9.27
FIM	74.6 ± 12.7	76.3 ± 11.2	68.7 ± 14.2

DISCUSSION

The age pattern in this cohort shows that subacute stroke rehabilitation is largely utilized by older adults, with more than half of the participants aged 70 years and above and the highest concentration in the 80–90-year group, aligning with evidence that stroke incidence and rehabilitation needs rise steeply after 65 years and peak in the oldest age bands.[6, 7] Large registry-based studies consistently report median or mean rehabilitation ages in the early to mid-70s, supporting the representativeness of this distribution.[8] At the same time, the presence of younger patients below 60 years mirrors the established burden of "younger stroke," which constitutes up to 20% of cases and carries distinct vocational and social consequences despite forming a smaller rehabilitation subgroup.[6] Age remains a key contextual factor when interpreting lateropulsion, as older age is associated with greater comorbidity, slower functional recovery, and less efficient rehabilitation, although baseline functional status remains a stronger predictor of outcome.[10] The notable proportion of patients aged 80 years and above highlights the clinical importance of understanding lateropulsion within this vulnerable group, who are at heightened risk of prolonged disability and often require more intensive, individualized rehabilitation strategies.[11]

The gender distribution in this cohort, showing a slight female predominance with women comprising 53.41% of the sample, aligns with established evidence that women tend to experience strokes at older ages and with greater severity, resulting in a higher likelihood of requiring structured rehabilitation and exhibiting postural control impairments such as lateropulsion. Prior

studies consistently report that female stroke survivors present with a greater comorbidity burden, more profound functional deficits at admission, and slower recovery trajectories, which may partly explain their increased representation in rehabilitation settings addressing complex syndromes.[11] Evidence indicates that gender-related biological determinants contribute to differences in motor recovery, balance responses, and postural adaptation, with female patients often demonstrating poorer discharge outcomes and requiring extended or more individualized rehabilitation interventions.[15]

The clinical profile of the study population in this research is consistent with established stroke rehabilitation literature. The predominance of ischemic stroke (76.70%) aligns with global epidemiological data demonstrating that ischemic strokes account for approximately 80-85% of all strokes.[12] The slight predominance of left-sided involvement (56.25%) is similarly reported in several stroke registries, although lateralization patterns can vary depending on stroke etiology and population characteristics.[13] Stroke severity distribution showing 65% with Severe, 19% moderate, and 15% mild strokes reflects the typical heterogeneity encountered in subacute rehabilitation cohorts.[5] Comorbidities such as dyslipidemia, heart disease, hypertension, and diabetes were frequently observed, consistent with known vascular risk factor profiles influencing stroke occurrence and recovery trajectory.[14, 15] The variation in NIHSS scores from mild to substantial neurological deficits further highlights the diverse rehabilitation needs within this population.[16] The use of CT as the primary imaging modality, followed by MRI, mirrors standard clinical practice globally, balancing availability, diagnostic yield, and cost considerations.[17] Importantly, the identification of lateropulsion in over one-third of participants (34.09%) corroborates findings from other prospective studies indicating that lateropulsion affects approximately 10-40% of stroke survivors undergoing rehabilitation.[2, 11] Lateropulsion significantly impairs postural control, balance, and mobility, thus impacting functional recovery and lengthening rehabilitation duration.[3, 20] These clinical characteristics emphasize the necessity for early screening and tailored rehabilitation interventions targeting lateropulsion alongside general stroke recovery, supporting improved outcome prediction and resource allocation.

The distribution of NIHSS categories in this cohort indicates that the majority of patients (65.34%) entered subacute rehabilitation with severe neurological impairments, highlighting the complexity and challenges of managing this population. This substantial proportion with severe deficits aligns with prior studies demonstrating that severe strokes often result in extended rehabilitation needs and more complex functional recovery paths. [16, 20] Lateropulsion was observed in 34.09% of patients, predominately affecting those with ischemic stroke (75%), consistent with existing literature where ischemic strokes are commonly implicated in the development of lateropulsion.[13] The higher prevalence of lateropulsion in patients with left-sided lesions (58.33%) compared to right-sided strokes (41.67%) suggests a tendency for lateropulsion to be more associated with left hemisphere damage. This supports prior findings suggesting that left hemisphere strokes, which often impact spatial perception and postural control, may contribute to the manifestation of lateropulsion, though right-sided involvement also remains significant.[5] Overall, these findings emphasize that stroke severity, type, and lesion lateralization are critical factors influencing the occurrence of lateropulsion. Early recognition of these patterns in clinical assessments can facilitate targeted rehabilitation interventions, potentially improving postural control and functional outcomes in stroke survivors

The age distribution among patients with lateropulsion in this study shows a clear predominance of older adults, with nearly 30% of affected individuals aged over 80 and 24% over 70 years. This finding aligns with systematic reviews of post-stroke lateropulsion, which report a high prevalence in older populations, though meta-regression analyses reveal that age itself is not always a statistically significant predictor of lateropulsion prevalence across stroke cohorts.[18, 19] The higher frequency of lateropulsion in older stroke survivors may reflect the increased overall stroke incidence and severity in this age group, as well as age-related factors such as reduced neuroplasticity, comorbidities, and slower recovery patterns that can predispose to persistent postural control deficits.[5, 13] Rehabilitation strategies should therefore particularly focus on this vulnerable subgroup during the subacute phase to maximize functional gains.While age may not independently predict lateropulsion prevalence in some studies, the clinical burden in older adults underscores the importance of targeted assessment and individualized therapeutic approaches to address lateropulsion and improve balance and mobility outcomes.

In the subgroup of patients with lateropulsion, certain comorbidities were notably prevalent. Diabetes and heart disease each affected approximately 21.67% of these patients, reflecting the established link between metabolic and cardiovascular risk factors and stroke severity and complications. [14, 15] Dyslipidemia was also common, present in 20% of patients, further emphasizing the role of atherogenic risk factors in post-stroke motor and postural deficits. Interestingly, a quarter (25%) of patients with lateropulsion had no documented co-morbid conditions, highlighting that lateropulsion can occur even in the absence of significant systemic illnesses, possibly due to localized neuroanatomical damage affecting postural control centers.

The strong association between lateropulsion and spatial neglect observed in this cohort — with over three-quarters screening positive for neglect — underscores the likely shared neuroanatomical pathways involved in both disorders. Spatial neglect, particularly following right-hemisphere strokes, impairs awareness of space and body orientation, thus compounding motor deficits like lateropulsion and complicating rehabilitation efforts.[13, 18] The co-occurrence of neglect and lateropulsion warrants integrated neurocognitive and motor rehabilitation strategies.

Most patients with lateropulsion in this cohort exhibited severe stroke severity, with 68.33% classified in the severe NIHSS category. This is consistent with prior research demonstrating that lateropulsion is more common among stroke survivors with higher NIHSS scores, reflecting greater neurological impairment. Studies indicate that patients with severe strokes and higher NIHSS scores tend to experience more pronounced postural control deficits, including lateropulsion, which subsequently leads to slower functional recovery and longer inpatient rehabilitation stays. [19] The association of lateropulsion with severe NIHSS scores underscores the importance of early identification and targeted rehabilitation strategies for this high-risk group.

The comparative analysis of key clinical parameters in this study highlights important functional differences associated with lateropulsion after stroke. Although the mean age and NIHSS scores were statistically similar between patients with and without lateropulsion, the functional impairments were markedly worse in the lateropulsion group. Specifically, significantly lower scores in Burke Lateropulsion Scale (BLS), Berg Balance Scale (BBS) and Functional Independence Measure (FIM) among patients with lateropulsion underscore the profound impact of this postural disorder on postural control, balance and functional independence.[3] These findings are consistent with prior research demonstrating that lateropulsion is associated with larger lesion volumes, greater motor impairment, and lower functional independence scores despite comparable stroke severity on the NIHSS. The greater deficits in balance measures confirm that lateropulsion contributes to compromised postural stability, increasing fall risk and complicating functional recovery. [3] Notably, reduced FIM scores in this population reflect substantial difficulties in essential domains such as self-care, transfers, mobility, and communication, highlighting how postural asymmetry and impaired verticality perception translate into limitations in performing daily activities. Lower motor-FIM and total FIM outcomes also indicate slower rehabilitation progress and greater dependency on caregiver support, reinforcing the importance of early identification and targeted interventions to mitigate functional decline in individuals with lateropulsion.

CONCLUSION

In conclusion, the analysis of 176 subacute stroke rehabilitation patients revealed a significant prevalence of lateropulsion at 34.09%, mostly affecting individuals with 60-70 years of age, with ischaemic stroke constituting the majority of cases. Lateropulsion was closely linked to higher clinical complexity, including greater stroke severity, multiple comorbidities such as diabetes and cardiac disease, and a high rate of spatial neglect. Although overall NIHSS scores were comparable between groups, patients with lateropulsion demonstrated markedly poorer postural stability, evidenced by significantly reduced BBS and BLS scores. These results underscore the substantial functional burden associated with lateropulsion and reinforce the need for early recognition and individualized rehabilitation strategies to improve balance, mobility, and overall functional independence in affected stroke survivors.

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Author Contributions Statement:
All the authors have contributed equally completing this manuscript.

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