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Research Article

Assessment of Stroke Patient Outcomes: Modified Rankin Scale-Based Evaluation of Functional and Patient-Centered Changes Pre and Post Antiplatelet and Statin Therapy

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Abstract

Background: Functional recovery after ischemic stroke varies considerably, and real-world Indian data evaluating longitudinal outcomes after secondary preventive therapy remain limited. Although antiplatelets and statins are routinely prescribed following ischemic stroke, their effect on functional recovery assessed using standardized disability scales requires further evaluation.

Methods: A prospective observational study was conducted in 106 patients with ischemic stroke. Functional outcomes were assessed using the Modified Rankin Scale (mRS), Barthel Index (BI), and Stroke-Specific Quality of Life (SS-QOL) scale at baseline and at 6, 12, and 18 weeks. Statistical analysis included the Friedman test, Wilcoxon signed-rank test, chi-square test, and Spearman correlation analysis.

Results: Most patients were male (55.66%) and older than 50 years (78.3%). Hypertension (78.3%) and diabetes mellitus (56.6%) were the predominant comorbidities. At baseline, 58.5% of patients had moderate-to-severe disability (mRS 3–5). Mean mRS score significantly decreased from 3.33 ± 1.62 at baseline to 2.03 ± 1.17 at week 18 ($p < 0.001$), and functional independence (mRS 0–1) was achieved in 43.4% of patients. The mean Barthel Index improved from 51.37 ± 20.93 to 80.25 ± 12.45 ($p < 0.001$). Moderate-to-good quality of life was reported in 83.96% of patients at 18 weeks. Stroke severity showed a significant association with SS-QOL ($p = 0.021$), with a weak but significant correlation between mRS and SS-QOL scores ($\rho = 0.128$, $p = 0.042$). Better lipid control was associated with improved recovery.

Conclusion: Antiplatelet and statin therapy was associated with significant improvement in disability, functional independence, and quality of life over 18 weeks. The Modified Rankin Scale provides a practical tool for monitoring recovery in routine clinical practice.

Keywords: Ischemic Stroke, Modified Rankin Scale, Barthel Index, Stroke-Specific Quality of Life,Antiplatelet Therapy, Statins.

INTRODUCTION

Stroke remains one of the most significant neurological disorders worldwide and is a leading cause of mortality and long-term disability. Despite advances in acute care and prevention strategies, the global burden of stroke continues to rise, particularly in low- and middle-income countries where healthcare resources and awareness remain limited. Recent epidemiological estimates suggest that millions of individuals live with stroke-related disability; making it a major contributor to disability-adjusted life years (DALYs) lost globally [1]. In developing nations such as India, stroke affects individuals at a relatively younger age compared with high-income countries, resulting in prolonged dependence, reduced productivity, and increased caregiver burden [2].

Ischemic stroke accounts for approximately 80–85% of all stroke cases and results from interruption of cerebral blood flow due to thrombotic or embolic occlusion of a cerebral artery [3]. The resulting deprivation of oxygen and glucose initiates a cascade of biochemical and cellular events including excitotoxicity, oxidative stress, inflammation, and neuronal apoptosis. The extent of neurological deficit depends on infarct size and the viability of the surrounding ischemic penumbra, a region of salvageable tissue that may recover if adequate perfusion is restored or further injury is prevented [4]. Because neuronal damage progresses over hours to days, early and sustained preventive therapy plays a critical role in determining long-term functional outcomes.

Stroke is strongly associated with modifiable vascular risk factors including hypertension, diabetes mellitus, dyslipidemia, smoking, alcohol consumption, obesity, and sedentary lifestyle [5]. Among these, hypertension is considered the most important contributor, followed by abnormal lipid levels and impaired glucose metabolism. The coexistence of multiple comorbidities accelerates atherosclerosis and increases the likelihood of recurrent ischemic events. Although mortality has declined due to improved emergency management, a substantial proportion of survivors continue to experience persistent disability, highlighting the need for effective secondary prevention strategies that also support neurological recovery [6].

Secondary prevention after ischemic stroke primarily focuses on preventing recurrent vascular occlusion and minimizing further neurological injury. Antiplatelet therapy is recommended for most patients with non-cardioembolic stroke because platelet activation plays a central role in thrombus formation over atherosclerotic plaques [7]. Aspirin inhibits cyclooxygenase-1 mediated thromboxane A2 production, thereby reducing platelet aggregation, while clopidogrel blocks ADP-mediated platelet activation through P2Y12 receptor inhibition. Large clinical trials and meta-analyses have demonstrated that antiplatelet therapy significantly reduces the risk of recurrent stroke, myocardial infarction, and vascular death [8].

Statins are also routinely prescribed following ischemic stroke due to their ability to reduce low-density lipoprotein cholesterol and stabilize atherosclerotic plaques. Beyond lipid lowering, statins exert pleiotropic effects including anti-inflammatory action, improved endothelial function, enhanced nitric oxide availability, and reduced oxidative stress [9]. These mechanisms improve vascular integrity and cerebral perfusion, thereby lowering the probability of recurrent ischemia. Intensive lipid-lowering therapy has been shown to reduce recurrent stroke risk and cardiovascular morbidity in secondary prevention settings [10].

While the benefits of antiplatelet and statin therapy in preventing recurrent vascular events are well established, their influence on functional recovery is less clearly defined. Functional recovery after stroke depends not only on reperfusion therapies but also on prevention of secondary neuronal injury, maintenance of cerebral perfusion, and facilitation of neuroplasticity [11]. Pharmacological strategies that prevent microvascular thrombosis, reduce inflammation, and improve endothelial function may therefore indirectly enhance neurological recovery. Understanding the real-world impact of these therapies on disability outcomes is clinically important because recovery of independence is often a more meaningful endpoint for patients than survival alone.

Evaluating recovery requires reliable and standardized outcome measures. The Modified Rankin Scale (mRS) is the most widely used global disability scale in stroke research and clinical practice. It grades functional status from 0 (no symptoms) to 6 (death) and reflects the degree of dependence in activities of daily living [12]. Compared with impairment-specific scales, the mRS provides a holistic measure of patient independence and is therefore commonly used as a primary endpoint in stroke trials and outcome studies. Scores of 0–2 generally indicate functional independence, whereas scores of 3–5 indicate moderate to severe disability requiring assistance [13].

Most evidence regarding stroke outcomes has been generated from randomized clinical trials conducted in controlled environments and well-resourced healthcare systems. However, recovery patterns may differ substantially in routine clinical practice, especially in developing countries. Factors such as delayed presentation, limited rehabilitation access, medication adherence, socioeconomic status, and comorbidity burden influence long-term outcomes [14]. Real-world observational studies are therefore essential to understand the practical effectiveness of guideline-recommended therapy in everyday clinical settings.

In India, data assessing longitudinal functional outcomes after initiation of secondary preventive therapy remain limited. Given the high prevalence of vascular risk factors and variability in follow-up care, evaluating recovery patterns in local populations is particularly important for optimizing patient management. Monitoring functional status using simple and reproducible tools such as the Modified Rankin Scale may help clinicians track recovery, predict rehabilitation needs, and improve long-term patient care [15].

Therefore, the present study was undertaken to prospectively evaluate functional recovery in ischemic stroke patients using the Modified Rankin Scale over an 18-week follow-up period after initiation of antiplatelet and statin therapy. Additionally, the study aimed to assess clinical characteristics associated with improvement in functional status in a real-world patient population [16].

METHODS

A prospective observational study was conducted over a period of six months in the General Medicine Department of a tertiary care teaching hospital in Telangana, India. The study aimed to evaluate functional outcomes in patients diagnosed with ischemic stroke receiving standard secondary prevention therapy.

A total of 106 patients with radiologically confirmed ischemic stroke were enrolled consecutively during the study period. Patients aged 18 years or older who were initiated on antiplatelet and statin therapy and were willing to participate in follow-up assessments were included. Patients diagnosed with haemorrhagic stroke, transient ischemic attack without infarction, severe cognitive impairment preventing assessment, terminal illness, or those lost to follow up after baseline evaluation were excluded from the study.

Data were collected using a structured case record form. Information documented included demographic characteristics such as age and gender, clinical presentation, comorbidities and risk factors including smoking and alcohol consumption. Laboratory parameters such as complete blood count and lipid profile were recorded along with radiological findings confirming cerebral infarction. All patients received standard treatment as prescribed by the treating physician, including antiplatelet agents and statins, and no therapeutic intervention was modified for study purposes.

Functional outcome was assessed using the Modified Rankin Scale (mRS). The Modified Rankin Scale grading system is provided in Annexure 1. Assessments were performed at baseline (hospital admission) and during follow-up at the 6th week, 12th week, and 18th week. Follow-up evaluations were conducted either through hospital visits or structured telephonic interviews. A favorable outcome was defined as an mRS score of 0–1, whereas scores of 3–5 were considered to represent moderate to severe disability.

Data analysis was performed using IBM SPSS software. Descriptive statistics were expressed as frequencies and percentages. Changes in functional status across follow-up visits were analyzed using non-parametric tests, including the Friedman test for repeated

measures and the Wilcoxon signed-rank test for pair wise comparisons. The relationship between lipid profile control and functional recovery was evaluated using appropriate statistical methods, and a p-value of less than 0.05 was considered statistically significant.

The study protocol was approved by the Institutional Ethics Committee, and written informed consent was obtained from all participants prior to enrollment.

Outcome Measures

Functional status was assessed using validated stroke outcome instruments. Disability was evaluated using the Modified Rankin Scale (mRS), a 7-point ordinal scale ranging from 0 (no symptoms) to 6 (death), where scores 0–1 indicate functional independence. Activities of daily living were measured using the Barthel Index (BI), which ranges from 0 to 100, with higher scores representing greater independence. Quality of life was assessed using the Stroke Specific Quality of Life (SS-QOL) scale, a multidimensional patient-reported measure evaluating physical, emotional, and social domains after stroke. All assessments were performed at baseline and during follow-up visits.

RESULTS

A total of 106 patients with radiologically confirmed ischemic stroke were included in the study.

Demographic Characteristics

Most patients were aged above 50 years, with the highest proportion in the 56–65 years (32.07%) and 66–75 years (31.13%) age groups. The mean age of the study population was 59.22 ± 10.95 years. Males constituted 55.66% of the participants (Table 1).

Baseline Risk Factors

Hypertension was the most common comorbidity (78.3%), followed by diabetes mellitus (56.6%) and hyperlipidaemia (41.5%). Alcohol consumption and smoking were reported in 51.9% and 31.1% of patients respectively. Nearly half of the patients had multiple metabolic risk factors (Table 2).

Neurological Symptom Changes

Significant improvement in neurological symptoms was observed during follow-up. Weakness decreased from 93.39% at baseline to 50.94% at week 18. Headache, dizziness, facial drooping, and loss of consciousness nearly resolved by the end of follow-up. Balance, swallowing, coordination, and speech also improved significantly ($p < 0.001$ for most comparisons) (Table 3).

Functional Recovery — Barthel Index

The mean Barthel Index score improved significantly from 51.37 ± 20.93 at baseline to 80.25 ± 12.45 at week 18 (Friedman test $\chi^2 = 220.74$, $p < 0.001$) (Table 4).

A progressive shift from dependency to independence was observed across follow-ups. At baseline, most patients were in severe dependency categories, whereas by week 18 the majority scored above 60, indicating improved performance of activities of daily living.

Functional Recovery — Modified Rankin Scale

The mean Modified Rankin Scale (mRS) score decreased from 3.33 ± 1.62 at baseline to 2.03 ± 1.17 at week 18 (Friedman test $\chi^2 = 97.41$, $p < 0.001$) (Table 5).

The proportion of patients with severe disability (mRS 4–5) declined markedly, while those with mild disability (mRS 0–2) increased progressively during follow-up. By week 18, 43.4% of patients achieved functional independence.

Pairwise comparison using the Wilcoxon signed-rank test demonstrated statistically significant improvement in Modified Rankin Scale scores across all follow-up intervals. Significant differences were observed between baseline and week 6 ($Z = 922.0$, $p < 0.001$), week 6 and week 12 ($Z = 855.5$, $p < 0.001$), week 12 and week 18 ($Z = 49.5$, $p < 0.001$), and baseline and week 18 ($Z = 328.0$, $p < 0.001$), indicating continuous functional recovery throughout the follow-up period (Table 5).

Quality of Life Outcomes

At 18 weeks, most patients reported moderate to very good quality of life (83.96%), while 16.04% reported poor or very poor status (Table 6).

Stroke severity showed significant association with quality of life ($\chi^2 = 23.74$, $p = 0.021$). A weak but statistically significant correlation was observed between mRS and SS-QOL scores ($\varrho = 0.128$, $p = 0.042$), indicating that

better functional recovery was associated with improved perceived quality of life.

Safety Outcomes

The treatment regimen was well tolerated. No adverse effects were reported in 84.91% of patients. Dyspepsia was the most common adverse event (7.55%), while fatigue and other minor events occurred in less than 3% of patients (Table 7).

Table 1: Demographic characteristics of study population (n = 106)

Variable	Category	Frequency	Percentage (%)
Age group (years)	30–45	13	12.26
	46–55	26	24.52
	56–65	34	32.07
	66–75	33	31.13
Gender	Male	59	55.66
	Female	47	44.34
Mean age	59.22 ± 10.95 years		

Table 2: Baseline risk factors and comorbidities

Risk factor	Frequency	Percentage (%)
Hypertension	83	78.3
Diabetes mellitus	60	56.6
Hyperlipidemia	44	41.5
Alcohol consumption	55	51.9
Smoking	33	31.1

Combination	Patients
HTN only	18
DM only	6
HTN + DM	25
HTN + Dyslipidaemia	15
DM + Dyslipidaemia	4
HTN + DM + Dyslipidaemia	25
None	13

Table 3: Neurological symptom profile (baseline vs 18 weeks)

Symptom	Baseline (%)	Week 18 (%)	p-value
Weakness	93.39	50.94	<0.001
Headache	41.51	0	<0.001
Dizziness	44.34	0	<0.001
Loss of balance	50.94	29.25	0.001
Vision problems	33.96	7.54	<0.001
Trouble swallowing	34.90	13.20	<0.001
Loss of coordination	72.64	46.23	<0.001
Altered mental state	30.18	0.94	<0.001
Loss of consciousness	32.07	0	<0.001
Facial drooping	37.73	0	<0.001
Speech difficulty	64.15	40.57	<0.001

Table 4: Functional recovery – Barthel Index

Time point	Mean ± SD
Baseline	51.37 ± 20.93
Week 18	80.25 ± 12.45

Barthel Index	Initial	Week 6	Week 12	Week 18
0–20	5	0	0	0
21–40	35	12	4	2
41–60	36	45	9	3
61–80	17	31	62	53
81–100	13	18	31	48

Statistical test	χ^2	p-value
Friedman test	220.74	<0.001

Table 5: Functional recovery – Modified Rankin Scale

Time point	Mean ± SD
Baseline	3.33 ± 1.62
Week 18	2.03 ± 1.17

mRS score	Baseline	Week 6	Week 12	Week 18
0	2	3	5	12
1	7	10	13	12
2	11	10	20	30
3	18	35	54	48
4	41	41	12	4
5	27	7	2	0

Comparison	Z value	p-value
Baseline vs Week 6	922.0	< 0.001
Week 6 vs Week 12	855.5	< 0.001
Week 12 vs Week 18	49.5	< 0.001
Baseline vs Week 18	328.0	< 0.001

Statistical test	χ^2	p-value
Friedman test	97.41	<0.001

Table 6: Quality of life outcomes (SS-QOL)

Category	Frequency	Percentage (%)
Very poor	5	4.72
Poor	12	11.32
Moderate	67	63.21
Very good	22	20.75

Association	Statistic	p-value
Stroke severity vs QoL	$\chi^2 = 23.74$	0.021
mRS vs SS-QOL	$\varrho = 0.128$	0.042

Table 7: Adverse events

Event	Frequency	Percentage (%)
None	90	84.91
Dyspepsia	8	7.55
Fatigue	3	2.83
Others	5	<1 each

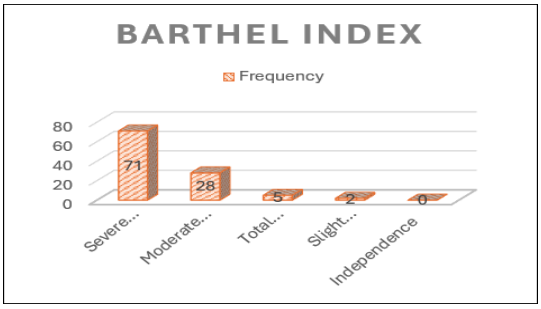

Fig 1: Baseline Functional Dependency According to Barthel Index:

At baseline, the majority of stroke patients were severely dependent, accounting for 71 patients (66.98%). Moderate dependence was observed in 28 patients (26.42%), while total dependence was present in 5 patients (4.72%). Only 2 patients (1.89%) showed slight dependence, and no patient was functionally independent at the time of admission. This indicates that most participants initially had substantial impairment in activities of daily living.

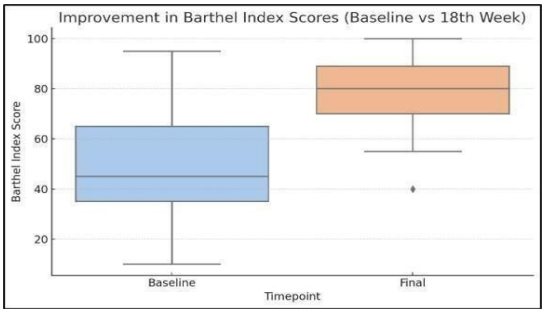

Fig 2: Improvement in Barthel Index Scores from Baseline to 18 Weeks

The boxplot demonstrates a marked increase in Barthel Index scores following treatment.At baseline, scores were widely distributed with a median around 45, indicating moderate dependency in daily activities.

By week 18, the median score increased to approximately 80, with a narrower spread, showing substantial improvement in functional independence. This confirms significant recovery in activities of daily living after therapy ($p < 0.001$).

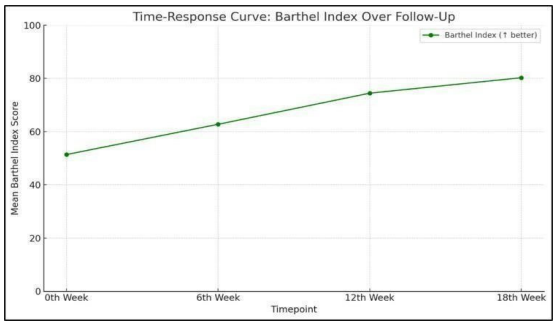

Fig 3: Time-Response Curve of Barthel Index During Follow-up

The line graph illustrates progressive improvement in mean Barthel Index scores across follow-up visits. The mean score increased from approximately 51 at baseline to 63 at week 6, 74 at week 12, and 80 at week 18. This steady upward trend indicates continuous recovery in activities of daily living over time, with the greatest improvement observed between weeks 6 and 12. The findings demonstrate sustained functional recovery following therapy ($p < 0.001$).

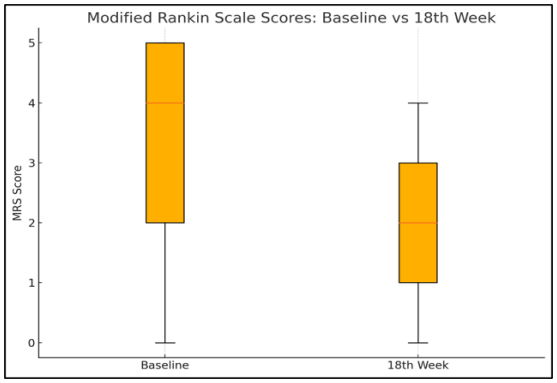

Fig4: Modified Rankin Scale Scores: Baseline vs 18th Week

The box plot demonstrates a significant reduction in disability levels over the follow-up period. At baseline, most patients had higher mRS scores indicating moderate-to-severe disability, whereas by the 18th week the distribution shifted toward lower scores representing improved functional independence. The median score decreased from approximately 3–4 at baseline to around 2 at follow-up, confirming meaningful neurological recovery following therapy.

The line graph shows a steady decline in mean mRS score across follow-up visits, decreasing from approximately 3.6 at baseline to 3.1 at 6 weeks, 2.6 at 12 weeks, and 2.2 at 18 weeks. This consistent downward trend

indicates progressive reduction in disability and continuous neurological recovery throughout the treatment period. The greatest improvement is observed between the 6th and 12th weeks, suggesting an active rehabilitation phase during mid-recovery.

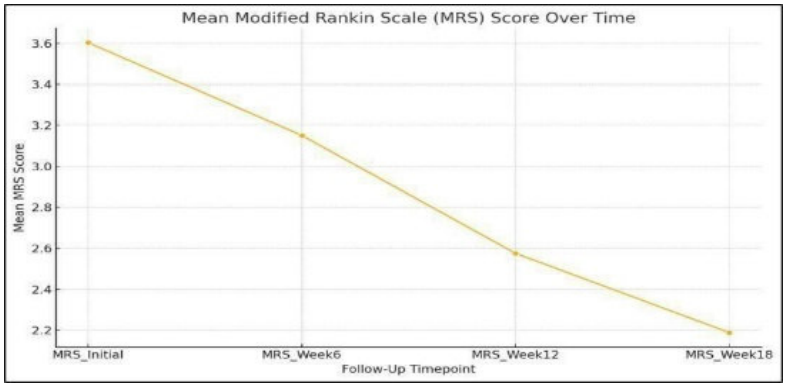

Fig 5: Mean Modified Rankin Scale (mRS) Score Over Follow-up

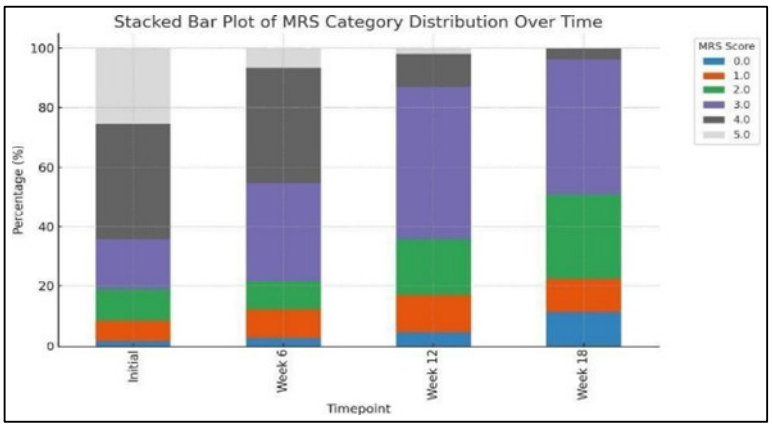

Fig 6: Distribution of Modified Rankin Scale Categories Across Follow-up Visits

The stacked bar chart demonstrates a progressive shift from higher disability categories to lower disability categories over time. At baseline, the majority of patients were concentrated in mRS grades 4–5 indicating moderate-to-severe disability. By week 6 and week 12, patients increasingly moved into mRS grades 2–3, and by the 18th week a larger proportion achieved mRS scores 0–2, representing functional independence or minimal disability. This trend confirms sustained functional recovery throughout the follow-up period.

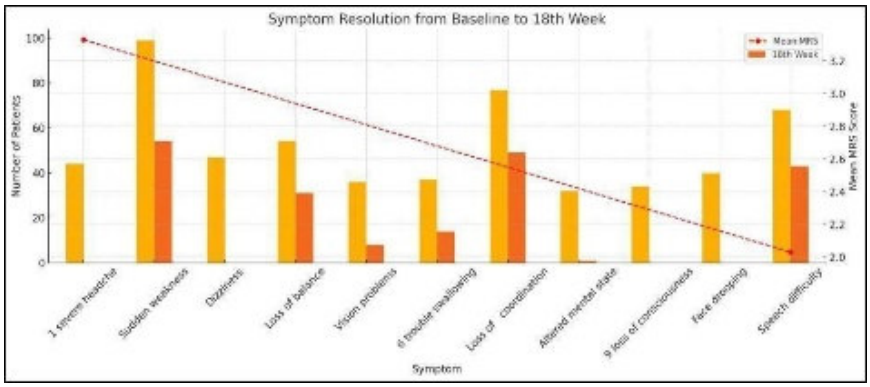

Fig 7: Symptom Resolution from Baseline to 18th Week

The bar chart illustrates a marked reduction in neurological symptoms over the follow-up period. Sudden weakness, headache, dizziness, facial drooping, altered mental status, and loss of consciousness showed major decline by the 18th week. Improvements were also observed in balance, coordination, swallowing, vision problems, and speech difficulty. The downward trend line alongside the bars indicates a parallel decrease in mean disability score, demonstrating overall clinical recovery during therapy.

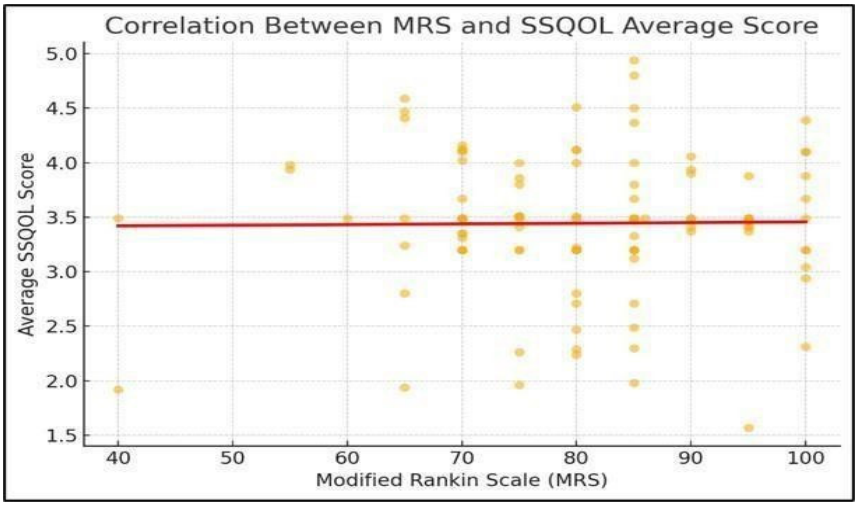

Fig 8: Correlation Between Modified Rankin Scale and SS-QOL Average Score

The scatter plot demonstrates the relationship between functional disability and quality of life at follow-up. A weak but statistically significant correlation is observed ($\rho = 0.128$, $p = 0.042$). Patients with lower mRS scores (less disability) generally reported better quality-of-life scores, whereas higher disability levels were associated with comparatively poorer perceived well-being. The wide dispersion of points indicates that quality of life is influenced not only by physical disability but also by psychological and social factors.

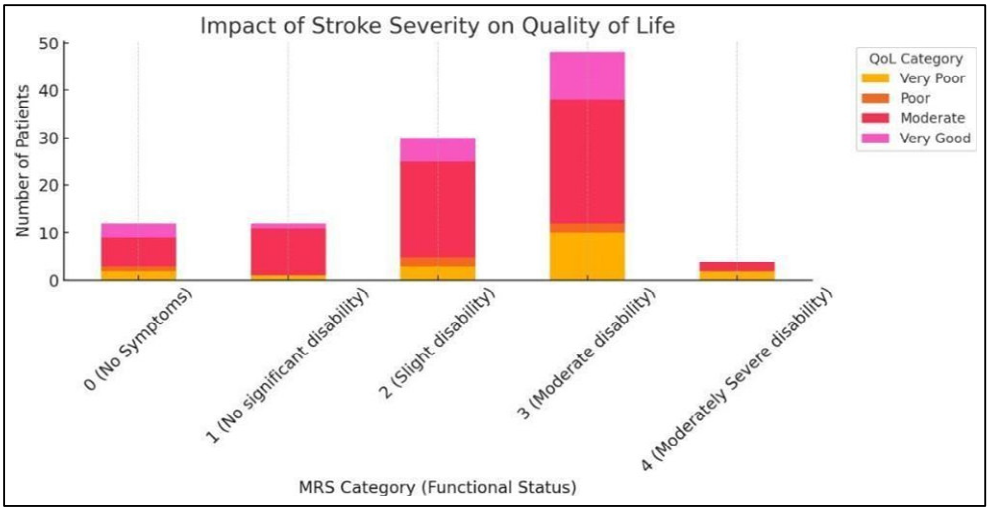

Fig 9: Impact of Stroke Severity on Quality of Life

The stacked bar chart shows the distribution of quality-of-life categories across different levels of functional disability. Patients with minimal disability (mRS 0–2) predominantly reported moderate to very good quality of life, whereas those with higher disability levels (mRS 3–4) showed a greater proportion of poor and very poor quality of life.

This demonstrates that increasing stroke severity is associated with worsening perceived well-being, confirming a significant relationship between functional status and quality of life (χ^2 = 23.74, p = 0.021).

DISCUSSION

This prospective observational study evaluated functional recovery in patients with ischemic stroke following initiation of antiplatelet and statin therapy over an 18-week follow-up period. The results demonstrated significant improvement in disability status, functional independence, neurological symptoms, and patient-reported quality of life, suggesting effective post-stroke recovery during secondary prevention therapy.

The demographic characteristics of the study population were consistent with the known epidemiology of stroke in low- and middle-income countries. The mean age of approximately 59 years and male predominance observed in the present study align with previous reports indicating earlier onset of stroke in developing populations compared to Western countries. The high prevalence of hypertension and diabetes mellitus among participants confirms their central role as major modifiable vascular risk factors in ischemic stroke. This emphasizes the importance of aggressive risk-factor control as part of long-term stroke management strategies.

A progressive decline in Modified Rankin Scale scores was observed across follow-up visits, indicating reduction in global disability. Nearly half of the patients achieved functional independence by the end of follow-up. The improvement likely reflects prevention of recurrent ischemic injury and stabilization of atherosclerotic plaques following antiplatelet therapy. In addition, statins may have contributed through pleiotropic effects such as improved endothelial function, anti-inflammatory activity, plaque stabilization, and enhanced cerebral perfusion, which are known to promote neurological recovery beyond lipid lowering alone.

Similarly, the Barthel Index demonstrated marked improvement in activities of daily living. The parallel improvement in both mRS and Barthel scores strengthens the validity of the findings because the two instruments measure complementary aspects of recovery, global disability and task-specific functional independence. Improvement in neurological symptoms further supports ongoing neuronal recovery and adaptive neuroplasticity during the rehabilitation phase.

Quality of life assessment revealed that most patients achieved moderate to good quality of life at 18 weeks. The significant association between stroke severity and quality of life indicates that functional recovery translates into meaningful patient-perceived benefit. However, the weak correlation between mRS and SS-QOL suggests that recovery after stroke is multidimensional. Psychosocial adaptation, emotional health, family support, and environmental factors likely influence perceived well-being in addition to physical disability.

The treatment regimen demonstrated a favorable safety profile, with only minor adverse events reported. This supports the routine use of combined antiplatelet and statin therapy in secondary stroke prevention and reinforces current guideline-based management approaches.

Overall, the findings indicate that early initiation of secondary prevention therapy combined with follow-up monitoring contributes not only to reduction of disability but also to improved functional independence and patient-centered outcomes.

STRENGTHS AND LIMITATIONS

Strengths

This study provides real-world clinical evidence on functional recovery following antiplatelet and statin therapy in patients with ischemic stroke. The prospective follow-up at multiple time points enabled evaluation of recovery trajectory rather than a single outcome measurement. The use of standardized and validated instruments — Modified Rankin Scale, Barthel Index, and Stroke-Specific Quality of Life scale — allowed comprehensive assessment of disability, functional independence, and patient-reported outcomes. Additionally, a combination of in-person and telephonic follow-up improved continuity of monitoring and minimized loss to follow-up.

Limitations

The study was conducted at a single center with a modest sample size, which may limit generalizability. The observational design

does not allow establishment of direct causality between therapy and recovery. Variations in rehabilitation intensity, medication adherence, and socioeconomic factors could not be fully controlled and may have influenced outcomes. Furthermore, longer follow-up was not available to evaluate long-term functional status or recurrence risk.

CONCLUSION

Antiplatelet and statin therapy was associated with significant improvement in disability, functional independence, and quality of life among ischemic stroke patients over an 18-week follow-up period. Progressive reduction in Modified Rankin Scale scores and corresponding improvement in Barthel Index scores indicate meaningful neurological recovery in routine clinical practice. The findings support the role of standardized functional assessment in monitoring recovery and guiding post-stroke management. Larger multicenter studies with longer follow-up are required to confirm long-term outcomes.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

FUNDING

This research received no external funding.

ANNEXURE

Annexure 1- Modified Rankin Scale (mRS) scoring criteria

Table A.1: Modified Rankin Scale (mRS) scoring criteria

Level	Description
0	No symptoms
1	No significant disability despite symptoms; able to perform all usual duties and activities
2	Slight disability; unable to perform all previous activities but able to look after own affairs without assistance
3	Moderate disability; requires some help but able to walk without assistance
4	Moderately severe disability; unable to walk without assistance and unable to attend to own bodily needs without assistance
5	Severe disability; bedridden, incontinent, and requires constant nursing care and attention
6	Death

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