Galician medical journal 2024
Vol. 31, Issue 2, e-GMJ2024-A13
DOI: 10.21802/e-GMJ2024-A13

Research Article | Internal Medicine

Impact of Baseline Characteristics on Stroke Outcomes in Pakistan: A Longitudinal Study Using the Modified Rankin Scale

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Abstract

Introduction. Stroke is a leading cause of disability and mortality globally, with a significant impact on healthcare systems. Various factors, including age, gender, comorbidities, and the type of stroke, influence the burden of stroke and its outcomes.

The study was conducted with an **objective** to determine the impact of baseline characteristics on the long-term functional outcome of stroke patients.

Methods. This prospective observational study was conducted between April 6, 2022 - December 31, 2023, at a tertiary hospital. The study included patients with radiologically confirmed stroke, selected through convenience sampling. Stroke patients of any gender and all age groups, with any comorbidity, were included. The Modified Rankin Scale (mRS) assessed disability on admission and three months post-stroke.

Results. Of the 213 patients, 122 (57.3%) were males and the majority, 199 (93.4%) individuals, had acute ischemic stroke. The median age of the participants was 60 years (range: 13-97 years; IQR=18 years). The mRS score on admission was poor (5.0; IQR=1.0) for patients $\geq$ 60 years. In 74 (34.74%) participants, the left middle cerebral artery was a frequently involved site. Age of $\geq$ 60 years (mRS=4.0; IQR=4.0; p=0.001) and the presence of $\geq$ 3 comorbidities (mRS=5.0; IQR=1.0; p=0.001) were significantly associated with poor outcomes three months post-stroke. Ordinal logistic regression revealed that a mRS score of 4 (OR=14.20; 95% CI=1.70-145.25; p=0.02) and a mRS score of 5 (OR=78.84; 95% CI=9.35-820.25; p $<$ 0.001) on admission were associated with poor outcomes. In addition, the presence of $\geq$ 3 comorbidities (OR=4.59; 95% CI=14.65; p=0.01) and increasing age (OR=1.04; 95% CI=1.01-1.07; p=0.02) were predictors of poor outcomes three months post-stroke.

Conclusions. The study underscores the importance of early intervention and effective management of comorbidities to improve functional outcomes in stroke patients. It highlights the need for targeted stroke care and rehabilitation strategies.

Keywords

Stroke; Pakistan; Modified Rankin Scale; Comorbidities; Long-Term Outcomes; Healthcare; Rehabilitation

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Publication history:
Received: March 2, 2024
Revisions Requested: April 27, 2024
Revision Received: May 18, 2024
Accepted: May 23, 2024
Published Online: June 1, 2024

Introduction

Stroke is a critical neurological emergency that arises when the blood supply to the brain is interrupted, leading to neurological deficits or death [1]. Globally, strokes are a leading cause of death and disability, with 12 million new stroke events annually and 62 million survivors grappling with its long-term effects [2].

The Modified Rankin Scale (mRS) score is instrumental for healthcare providers in assessing disability levels, formulating rehabilitation plans, and evaluating intervention efficacy [3]. The long-term outcomes of stroke, as evaluated by the mRS score three months post-event, are influenced by many factors. These include stroke severity and type, comorbid conditions such as diabetes and hypertension, the patient's age and pre-stroke functional status, the timeliness and quality of medical interventions, and access to rehabilitation services [4–6]. Socioeconomic factors such as education level, social support, and healthcare resource availability also play a crucial role in shaping functional outcomes three months post-stroke [7–9]. Furthermore, complications during the acute phase, like recurrent strokes or other medical issues, significantly impact long-term outcomes as measured by the mRS score three months post-stroke [10].

In Pakistan and other developing countries in Asia, stroke outcomes are particularly concerning due to resource limitations and underdeveloped healthcare systems [11]. These challenges lead to delayed diagnoses, limited treatment options, and scarce specialised stroke units, potentially resulting in poorer outcomes compared to developed countries [12]. The study suggests a 4-20% fatality rate for stroke patients in Pakistan and recommends further investigation into patient outcomes. An effort is being made to determine the potential factors determining the outcome [13]. As a further attempt, this study **aims** to elucidate the impact of various factors on stroke outcomes using the mRS score three months post-stroke as the primary measure. It examines the relationship between the mRS score on admission, patient demographics (age and gender), comorbidities, and stroke type (ischemic or haemorrhagic), to understand their association with stroke functional outcomes.

Materials and Methods

Study Design

This is a prospective observational study employing non-randomized convenience sampling, conducted at Shifa Hospital, Pakistan, between April 6, 2022 - December 31, 2023. This approach was chosen due to resource constraints and the need for timely data collection.

Participants and Eligibility Criteria

The study included 213 patients, aged 13 to 97 years and of any gender, who were admitted with radiologically confirmed stroke. The initial identification was based on neurological deficits suggestive of stroke, followed by radiological confirmation through computerized tomography (CT), which showed hypodensity for cerebral infarction or hyperdensity for intracerebral bleeding, or through magnetic resonance imaging (MRI), which indicated diffusion restriction. The study inclusion criteria were both genders, all ages, and radiologically confirmed stroke with any comorbidity (hypertension, diabetes mellitus, ischemic heart disease, atrial fibrillation, previous stroke, or a combination of different comorbidities). Subjects were excluded if they experienced spontaneous recovery within 24 hours, had evidence of a space-occupying lesion, or were unwilling to participate in the study.

Outcome Measure Selection

The mRS [14] was employed to measure the degree of disability or dependence in daily activities post-stroke. The mRS scores range from 0 (no symptoms) to 6 (death). Disability was assessed both on admission and three months later during follow-up visits.

Assessment Measures

The data were collected by analysing patients' medical records. Information about the patient's age, diagnosis, and mRS scores at baseline and three months post-stroke was recorded on a standardised form. The change in mRS score over this period was used to evaluate the degree of improvement or deterioration in disability.

Statistical Analysis

To analyse the impact of different baseline characteristics on patient outcomes, SPSS version 21 Windows (SPSS, Inc., Chicago, IL, USA) was used. Categorical variables were presented as percentages and frequencies, while continuous variables were represented as median and interquartile range (IQR). The Chi-square and Mann-Whitney U tests were applied to assess the variation between baseline characteristics. Ordinal logistic regression was carried out to assess the association between baseline characteristics and mRS three months post-stroke. The Kruskal-Wallis H tests with post hoc (Bonferroni adjustment) were used to assess the impact of comorbidities on stroke outcome. A p-value of < 0.05 was considered significant.

Results

Baseline Characteristics of Study Population

The median age of the study population was 60 years [range: 13-97 years; IQR=18 years]. Of the total participants, 122 (57.3%) were males and the majority, 128 (60.1%) individuals, were $\geq$ 60 years. Acute ischemic stroke was diagnosed in 199 (93.4%) patients, with involvement of the left middle cerebral artery in 74 (34.74%) patients. The median mRS score on admission was 5.0 (IQR=1.0) for patients $\geq$ 60 years, indicating moderate to severe disability (Table 1).

Baseline Characteristics on Stroke Outcome

Among the various baseline characteristics, older age ($\geq$ 60 years) and the presence of $\geq$ 3 comorbidities were significantly associated with a poor mRS score three months post-stroke (Table 2, 3). Additionally, a poor mRS score on admission in patients $\geq$ 60 years old (Table 1) was associated with a poor outcome three months post-stroke (Table 2).

Higher age [OR=1.04 (1.01-1.07); p = 0.02], poor mRS score on admission, specifically a score of 4 [OR=14.20 (1.70-145.25); p = 0.01] and a score of 5 [OR=78.84 (9.35-820.25); $p < 0.001$], as well as having three or more comorbidities at presentation [OR=4.59 (1.45-14.65 p = 0.01), were strong predictors of higher disability three months after stroke (Table 4).

Table 1. Baseline characteristics of study participants (n=213).

Characteristics		Number (%)	p
Age (years)		Median (IQR) 60.0 (18.0)	-
Sex	Male	122 (57.3)	0.03*
	Female	91 (42.7)	
Age group (years)	<60	85 (39.9)	0.001*
	≥ 60	128 (60.1)	
Type of stroke	Acute ischemic stroke	199 (93.4)	0.001*
	Haemorrhagic	14 (6.6)	
Number of comorbidities	Nil	17 (7.98)	0.001*
	1	92 (43.19)	
	2	69 (32.39)	
	3	35 (16.43)	
Diagnosis	Left MCA	74 (34.74)	0.001*
	Right MCA	62 (29.11)	
	POCI	16 (7.51)	
	Left ACA	13 (6.10)	
	Right ACA	16 (7.51)	
	Multiple territory infarct	18 (8.45)	
	Left ICB	6 (2.82)	
	Right ICB	8 (3.76)	

Comparison of diagnoses between age groups

Diagnosis	<60 years (number)	≥ 60 years (number)	p
Left MCA	24	50	0.06*
Right MCA	25	37	
POCI	6	10	
Left ACA	8	5	
Right ACA	7	9	
Multiple territory infarct	5	13	
Left ICB	3	3	
Right ICB	7	1	
mRS (on admission)	Median (IQR) 4.0 (1.0)	Median (IQR) 5.0 (1.0)	p 0.03$

Notes: * – Chi-square test; $ – Mann-Whitney U test. IQR – interquartile range.
MCA – middle cerebral artery; POCI – posterior circulation infarction; ACA - anterior cerebral artery; ICB – intracerebral bleeding.

Table 2. Relationship between clinical variables and Modified Rankin Scale score three months post-stroke (n=213).

Variable	Number of patients	mRS (three months post-stroke) Median (IQR)	p*
Sex			
Male	122	3.0 (5.0)	0.79
Female	91	3 (4.0)	
Age group			
<60 years	85	2.0 (3.0)	0.001
≥60 years	128	4.0 (4.0)	
Type of stroke			
Acute ischemic	199	5.0 (1.0)	0.30
Haemorrhagic	14	4.5 (1.0)	
mRS (three months post-stroke)	<60 years (Median (IQR)) 2.0 (3.0)	≥60 years (Median (IQR)) 4.0 (4.0)	0.001

Notes: * – Mann-Whitney U test. IQR – interquartile range.

Table 3. Comparison of Modified Rankin Scale scores (three months post-stroke) based on the number of comorbidities (n=213).

Comorbidities	Number of patients	mRS (three months post-stroke) Median (IQR)	p*	p**		
				0	1	2
0	17	4.0 (2.0)	0.001	-		
1	92	4.0 (1.0)		1	-	
2	69	5.0 (1.0)		0.45	0.93	-
≥3	35	5.0 (1.0)		0.001	0.001	0.04

Notes: * – Kruskal-Wallis H test; ** – post hoc analysis. IQR – interquartile range.

Discussion

Stroke remains a critical health challenge in developing countries, significantly impacting morbidity and mortality rates [11]. This condition places a substantial burden on healthcare systems and profoundly affects the quality of life in both patients and their families [2]. Our study reflects these broader trends, highlighting the urgent need for improved stroke care and prevention strategies in these regions.

Consistent with global observations, our study in Pakistan has found that stroke is more prevalent in men than women [13]. However, women often face barriers to accessing appropriate medical care due to social and cultural factors [15, 16]. Notably, the mean age of stroke patients in our study was lower than that typically observed in Western countries, suggesting a higher incidence of stroke among younger populations in Pakistan [13]. This could be attributed to a combination of factors, including prevalent traditional risk factors such as diabetes and hypertension, limited healthcare access, and inadequate stroke awareness and prevention measures [15]. Our findings corroborate previous research indicating that higher age is a significant determinant of poor stroke outcomes in developing countries [17]. Our study strengthens the assumption highlighted in similar research that a higher mRS score on admission independently predicts poorer outcomes three months post-stroke [5]. This underscores the importance of early detection and intervention to improve stroke outcomes [18].

The presence of multiple comorbidities emerged as a key predictor of worse stroke outcomes in our study. This finding is consistent with previous studies, which have shown that comorbidities such as hyperlipidemia and large vessel occlusion are associated with worse functional outcomes [19]. Similarly, Downer *et al.* reported that multiple comorbidities were associated with higher stroke mortality [20]. Patients with multiple comorbidities had less improvement in mRS scores than those without comorbidities [21]. This finding aligns with other studies, such as

Table 4. Ordinal logistic regression of baseline predictors of Modified Rankin Scale scores three months post-stroke (n=213).

Characteristics	Estimates	95% CI		SE	Z	p	OR	95% CI	
		Lower	Upper					Lower	upper
Sex									
Reference [male]									
Female	-0.24	-0.78	0.29	0.27	-0.9	0.36	0.78	0.46	1.33
mRS on admission									
Reference [mRS score 1]									
2	-0.84	-3.18	1.61	1.19	-0.70	0.48	0.43	0.04	5.00
3	1.27	-0.98	3.69	1.16	1.09	0.27	3.56	0.37	40.21
4	2.65	0.53	4.98	1.1	2.41	0.02*	14.21	1.70	145.25
5	4.37	2.24	6.71	1.11	3.93	<0.001*	78.84	9.35	820.25
Number of comorbidities									
Reference [nil comorbidities]									
1	0.27	-0.76	1.29	0.52	0.51	0.60	1.31	0.47	3.64
2	0.17	-0.89	1.22	0.54	0.33	0.74	1.19	0.41	3.40
3	1.52	0.38	2.68	0.59	2.60	0.01*	4.59	1.46	14.65
Diagnosis									
Reference [left MCA]									
Right MCA	-0.2	-0.86	0.45	0.33	-0.61	0.54	0.82	0.42	1.57
POCI	-0.12	-1.15	0.89	0.52	-0.23	0.81	0.89	0.32	2.45
Left ACA	-0.15	-1.30	1.00	0.58	-0.26	0.79	0.86	0.27	2.72
Right ACA	0.60	-0.39	1.61	0.51	1.18	0.24	1.82	0.67	5.01
Multiple territory infarct	0.61	-0.39	1.64	0.51	1.18	0.23	1.83	0.68	5.16
Left ICB	-0.94	-2.49	0.57	0.76	-1.23	0.21	0.39	0.08	1.76
Right ICB	0.55	-0.75	1.86	0.66	0.83	0.40	1.73	0.47	6.42
Age	0.04	0.01	0.07	0.02	2.26	0.02*	1.04	1.01	1.07
Age group									
Reference [<60 years]									
≥60 years	0.35	-0.52	1.22	0.44	0.80	0.42	1.42	0.60	3.39

Notes: * – p<0.05. MCA – middle cerebral artery; POCI – posterior circulation infarction; ACA – anterior cerebral artery; ICB – intracerebral bleeding.

the one conducted by Nomani *et al.*, which highlighted the impact of comorbid conditions, including hypertension, cardiac disease, and diabetes, on stroke severity and outcomes [16]. Effective management of these comorbidities is crucial for improving patient outcomes as reported by Luqman *et al.* [22]. Our study found no significant differences in long-term outcomes based on the type of stroke (ischemic vs. hemorrhagic) or gender. This suggests that other factors, such as comorbidities and baseline functional status, may be more critical in determining outcomes.

Limitations

The insights from our study are constrained by its focus on a specific population in Pakistan, potentially limiting their generalizability to other settings. Additionally, the non-randomized sampling method and the potential underreporting of less severe strokes could have influenced the results. Future research should aim to incorporate a more diverse and representative sample, considering a broader range of factors such as socioeconomic status and access to rehabilitation services, to provide a more comprehensive understanding of stroke outcomes.

Conclusions

Based on the results of this study on stroke outcomes in Pakistan, using the mRS, we have revealed that older age and higher mRS scores on admission predict poorer recovery. Furthermore, comorbidities significantly worsen outcomes, while gender and stroke type (ischemic or hemorrhagic) show no substantial impact. These findings highlight the need for early intervention and comprehensive management of comorbid conditions to improve stroke care and rehabilitation, specifically for elderly patients in developing healthcare settings.

Ethical Statement

The study was performed according to the principles of the Declaration of Helsinki and in accordance with the local ethical standards (Institutional Review board and ethical committee number: IRB #0219-22).

Informed Consent

Informed consent was gained from the participants.

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflict of Interest

The authors declare that no conflicts exist.

Financial Disclosure

The authors declared no financial support.

References

[1] Zhang T, Yin X, Zhang Y, Chen H, Man J, Li Y, et al. Global trends in mortality and burden of stroke attributable to lead exposure from 1990 to 2019. Frontiers in Cardiovascular Medicine. 2022;9:870747. Available from: https://doi.org/10.3389/fcvm.2022.870747

[2] eClinicalMedicine. The rising global burden of stroke. eClinicalMedicine. 2023;59:102028. Available from: https://doi.org/10.1016/j.eclinm.2023.102028

[3] Pożarowszczyk N, Kurkowska-Jastrzebska I, Sarzyńska-Długosz I, Nowak M, Karliński M. Reliability of the modified Rankin Scale in clinical practice of stroke units and rehabilitation wards. Frontiers in Neurology. 2023;14:1064642. Available from: https://doi.org/10.3389/fneur.2023.1064642

[4] Banks JL, Marotta CA. Outcomes validity and reliability of the modified Rankin Scale: implications for stroke clinical trials. Stroke. 2007;38(3):1091–1096. Available from: https://doi.org/10.1161/01.STR.0000258355.23810.c6

[5] ElHabr AK, Katz JM, Wang J, Bastani M, Martinez G, Gribko M, et al. Predicting 90-day modified Rankin Scale score with discharge information in acute ischaemic stroke patients following treatment. BMJ Neurology Open. 2021;3(1):e000177. Available from: https://doi.org/10.1136/bmjno-2021-000177

[6] Zhou M, Liu X, Zha F, Liu F, Zhou J, Huang M, et al. Stroke outcome assessment: optimizing cutoff scores for the Longshi Scale, modified Rankin Scale and Barthel Index. PLOS ONE. 2021;16(5):e0251103. Available from: https://doi.org/10.1371/journal.pone.0251103

[7] Ambawatte SB, Weerathunga DN, Dissanayake A, Somaratne SC, Athukorala K, Wijewickrama PSA. Ischemic stroke subtypes: socio-demographic factors, risk factors, and outcomes in Southern Sri Lanka. Ethnicity & Disease. 2021;31(4):509–518. Available from: https://doi.org/10.18865/ed.31.4.509

[8] Elfassy T, Grasset L, Glymour MM, Swift S, Zhang L, Howard G, et al. Sociodemographic disparities in long-term mortality among stroke survivors in the United States. Stroke. 2019;50(4):805–812. Available from: https://doi.org/10.1161/STROKEAHA.118.023782

[9] Vincent-Onabajo G, Muhammad M, Ali U, Masta A. Influence of sociodemographic and stroke-related factors on availability of social support among Nigerian stroke survivors. Annals of Medical and Health Sciences Research. 2015;5(5):353. Available from: https://doi.org/10.4103/2141-9248.165258

[10] Merlino G, Corazza E, Lorenzut S, Gigli G, Cargnelutti D, Valente M. Efficacy and safety of intravenous thrombolysis in patients with acute ischemic stroke and pre–existing disability. Journal of Clinical Medicine. 2019;8(3):400. Available from: https://doi.org/10.3390/jcm8030400

[11] Bernhardt J, Urimubenshi G, Gandhi DBC, Eng JJ. Stroke rehabilitation in low-income and middle-income countries: a call to action. The Lancet. 2020;396(10260):1452–1462. Available from: https://doi.org/10.1016/S0140-6736(20)31313-1

[12] Pandian JD, Kalkonde Y, Sebastian IA, Felix C, Urimubenshi G, Bosch J. Stroke systems of care in low-income and middle-income countries: challenges and opportunities. The Lancet. 2020;396(10260):1443–1451. Available from: https://doi.org/10.1016/S0140-6736(20)31374-X

[13] Farooq MU, Majid A, Reeves MJ, Birbeck GL. The Epidemiology of stroke in Pakistan: past, present, and future. International Journal of Stroke. 2009;4(5):381–389. Available from: https://doi.org/10.1111/j.1747-4949.2009.00327.x

[14] Wilson JTL, Hareendran A, Grant M, Baird T, Schulz UGR, Muir KW, et al. Improving the assessment of outcomes in stroke. Stroke. 2002;33(9):2243–2246. Available from: https://doi.org/10.1161/01.STR.0000027437.22450.BD

[15] Farooq A, Venketasubramanian N, Wasay M. Stroke care in Pakistan. Cerebrovascular Diseases Extra. 2021;11(3):118–121. Available from: https://doi.org/10.1159/000519554

[16] Nomani AZ, Nabi S, Badshah M, Ahmed S. Review of acute ischaemic stroke in Pakistan: progress in management and future perspectives. Stroke and Vascular Neurology. 2017;2(1):30–39. Available from: https://doi.org/10.1136/svn-2016-000041

[17] Bender M, Jusufovic E, Railic V, Kelava S, Tinjak S, Dzevdetbegovic D, et al. High burden of stroke risk factors in developing country: the case study of Bosnia-Herzegovina. Materia Socio Medica. 2017;29(4):277. Available from: https://doi.org/10.5455/msm.2017.29.277-279

[18] Jauch EC, Saver JL, Adams HP, Bruno A, Connors JJ (Buddy), Demaerschalk BM, et al. Guidelines for the early management of patients with acute ischemic stroke. Stroke. 2013;44(3):870–947. Available from: https://doi.org/10.1161/STR.0b013e318284056a

[19] Ayub M, Ansari J, Sheikh M, Elsekaily O, Buchhanolla P, Neshatfar A, et al. Association of co-morbidities with functional outcomes in stroke patients with atrial fibrillation on long-term oral anticoagulation (P11-5.030). Neurology. 2023;100(17_supplement_2). Available from: https://doi.org/10.1212/WNL.0000000000204298

[20] Downer MB, Li L, Carter S, Beebe S, Rothwell PM. Associations of multimorbidity with stroke severity, subtype, premorbid disability, and early mortality. Neurology. 2023;101(6):e645–e652. Available from: https://doi.org/10.1212/WNL.0000000000207479

[21] Khan M, Ahmed B, Ahmed M, Najeeb M, Raza E, Khan F, et al. Functional, cognitive and psychological outcomes, and recurrent vascular events in Pakistani stroke survivors: a cross sectional study. BMC Research Notes. 2012;5(1):89. Available from: https://doi.org/10.1186/1756-0500-5-89

[22] Luqman S, Mumtaz A, Kulsoom S, Ahmed S, Malik A, Haider S. Predictors of mortality and poor functional outcome in patients with acute stroke admitted to a tertiary care hospital in Pakistan. Biological and Clinical Sciences Research Journal. 2023;2023(1):281. Available from: https://doi.org/10.54112/bcsrj.v2023i1.281