

3 ORIGINAL ARTICLE

4 HbA1c levels and risk factor burden among 5 stroke patients: a retrospective study in 6 Saudi Arabia

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9 ABSTRACT

10 **Background:** Stroke is a leading cause of mortality and disability, and poor glycemic control may affect recur-
11 rence and clinical outcomes. This study compared glycated hemoglobin (HbA1c) across ischemic stroke, hem-
12 orrhagic stroke, and transient ischemic attack (TIA) and examined associations with risk factor burden and
13 in-hospital survival.

14 **Methods:** This retrospective study included 903 patients with ischemic stroke, hemorrhagic stroke, or TIA
15 treated at King Fahad Specialist Hospital, Qassim, Saudi Arabia, from 2018 to 2025. Demographic and clinical
16 data were extracted from electronic medical records and analyzed using SPSS version 27.

17 **Results:** Of 903 patients, 715 (79.2%) had ischemic stroke, 80 (8.9%) had hemorrhagic stroke, and 108 (12.0%)
18 had TIA; 503 (55.7%) had HbA1c $\geq 6.5\%$. Mean HbA1c was $7.59\% \pm 2.32\%$ in ischemic stroke, $7.25\% \pm 1.86\%$ in
19 hemorrhagic stroke, and $7.12\% \pm 1.89\%$ in TIA ($p = 0.068$). HbA1c correlated with risk factor burden ($r = 0.313$,
20 $p < 0.001$). Uncontrolled glycemia was more common with previous stroke (62.3% vs. 53.3%, $p = 0.015$). Each
21 1-percentage-point increase in HbA1c was associated with higher adjusted odds of ischemic stroke versus TIA
22 (adjusted odds ratio = 1.160, 95% confidence interval: 1.035-1.301; $p = 0.011$). Older age and hemorrhagic
23 stroke were associated with lower in-hospital survival.

24 **Conclusion:** Higher HbA1c was associated with greater cardiovascular risk-factor burden and higher odds of
25 ischemic stroke relative to TIA, while uncontrolled glycemia was more frequent among patients with previous
26 stroke. These findings support glycemic and cardiovascular risk-factor optimization in stroke prevention.

27 **Keywords:** Glycated hemoglobin, stroke, cardiovascular risk factors, risk factor burden, glycemic control,
28 Saudi Arabia.

29 Introduction

30 Stroke is an acute neurological disorder resulting from
31 either interruption of cerebral blood flow or rupture of a
32 cerebral blood vessel [1]. It remains one of the leading
33 causes of mortality and long-term disability worldwide
34 [2]. According to the American Heart Association's 2026
35 report, approximately 795,000 people in the United States
36 experience a new or recurrent stroke each year, including
37 around 610,000 first-ever strokes and 185,000 recurrent
38 strokes [3]. Epidemiological data on stroke in Saudi
39 Arabia remain limited. However, a systematic review
40 and meta-analysis published in 2020 estimated an annual
41 stroke incidence of ~ 29 cases per 100,000 population
42 [4]. Stroke has also been identified as the second leading
43 cause of mortality in Saudi Arabia [5].

Stroke is broadly classified into ischemic and hemorrhagic 44
subtypes. Ischemic stroke, caused by obstruction of a cerebral 45
blood vessel, accounts for $\sim 87\%$ of all strokes in the United 46
States, whereas hemorrhagic stroke results from rupture 47
of a cerebral blood vessel and accounts for the remaining 48

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cases [3]. Stroke risk factors are commonly categorized as non-modifiable or modifiable. Non-modifiable risk factors include age, sex, race or ethnicity, family history, and genetic predisposition. Major modifiable risk factors include hypertension, diabetes mellitus, dyslipidemia, smoking, physical inactivity, obesity, and atrial fibrillation. In addition, a history of transient ischemic attack (TIA) is an important clinical marker associated with an increased risk of future stroke [6].

Glycated hemoglobin (HbA1c) reflects average blood glucose concentrations over the preceding 2-3 months and is widely used as a marker of long-term glycemic control [7]. Increasing evidence indicates that elevated HbA1c levels are associated with a higher risk of stroke and poorer clinical outcomes. A systematic review and meta-analysis demonstrated that higher HbA1c levels were associated with an increased risk of first-ever stroke [8]. Likewise, a Chinese cohort study reported that elevated HbA1c independently predicted stroke recurrence within one year following a first-ever non-cardioembolic ischemic stroke [9].

In Saudi Arabia, a recent study reported elevated mean HbA1c levels among patients with ischemic stroke, hemorrhagic stroke, and TIA, with significantly higher levels observed in those with ischemic stroke [10]. Another local study found a positive association between HbA1c levels and stroke severity in patients with acute ischemic stroke, with higher HbA1c levels corresponding to greater neurological impairment [11]. Despite these findings, evidence regarding the relationships between HbA1c, stroke subtype, cumulative cardiovascular risk factor burden, and clinical outcomes remains limited in the Saudi population.

Therefore, this study aimed to compare HbA1c levels among patients with ischemic stroke, hemorrhagic stroke, and TIA and to evaluate their associations with risk factor burden and in-hospital outcomes in a Saudi Arabian cohort.

Methods

Study design and data collection

This retrospective study was conducted at King Fahad Specialist Hospital, Qassim, Saudi Arabia. The study was approved by the Qassim Institutional Review Board, Ministry of Health, Kingdom of Saudi Arabia (approval no. 607-47-10646; February 2, 2026). As the study involved retrospective analysis of existing medical records, the requirement for informed consent was waived. To ensure patient confidentiality, all personal identifiers were removed and replaced with unique study codes before data analysis.

The study included 903 patients with ischemic stroke, hemorrhagic stroke, or TIA between January 2018 and December 2025 and an available HbA1c measurement. Duplicate records, patients admitted for conditions other than stroke or TIA, records with an unclear stroke subtype, and records with incomplete clinical information were excluded.

Data were extracted retrospectively from electronic medical records using a standardized data collection form. Demographic variables included age, sex, nationality, smoking status, and body mass index (BMI). Clinical variables included stroke subtype, HbA1c level, history of previous stroke, comorbidities, medication use, and in-hospital survival status.

HbA1c was analyzed as both a continuous and a categorical variable. HbA1c levels $<6.5\%$ were classified as controlled glycemia, whereas levels $\geq 6.5\%$ were classified as uncontrolled glycemia [12].

A risk factor burden score was calculated using five modifiable cardiovascular and metabolic risk factors: hypertension, diabetes mellitus, dyslipidemia, smoking, and obesity. Each documented risk factor was assigned one point, while the absence of a risk factor was assigned zero points, resulting in a total score ranging from 0 to 5. Higher scores indicated a greater burden of documented cardiovascular and metabolic risk factors.

Statistical analysis

Data management and statistical analyses were performed using IBM SPSS Statistics for Windows, version 27.0 (IBM Corp). Categorical variables were summarized as frequencies and percentages, whereas continuous variables were presented as means and SDs. Of the 903 patients included in the study, valid percentages were calculated using the number of patients with available data for each variable. Patients with missing data were excluded only from analyses involving the corresponding variable. Smoking status was available for 893 patients (10 missing), BMI for 843 patients (60 missing), and statin use for 902 patients (one missing).

The chi-square test was used to examine associations between glycemic control and stroke subtype, previous stroke, in-hospital survival, smoking status, and BMI category. One-way analysis of variance (ANOVA) was used to compare mean HbA1c levels among patients with ischemic stroke, hemorrhagic stroke, and TIA. Pearson's correlation analysis was performed to evaluate the relationship between HbA1c level and the risk factor burden score. Analysis of covariance (ANCOVA) was used to compare HbA1c levels across stroke subtypes after adjustment for age and BMI. Multinomial logistic regression analysis was performed to identify factors associated with stroke subtype, using TIA as the reference outcome category and female sex as the reference category. Binary logistic regression analysis was used to identify predictors of in-hospital survival. All statistical tests were two-sided, and a p value <0.05 was considered statistically significant. Odds ratios (ORs) are presented with 95% confidence intervals (CIs).

Results

A total of 903 patients were included in the analysis. Of these, 715 (79.2%) had ischemic stroke, 80 (8.9%) had hemorrhagic stroke, and 108 (12.0%) had TIA (Figure 1).

The mean age of the study population was 64.35 ± 13.82 years, with 461 (51.1%) patients aged ≥ 65 years. Most participants were male (582, 64.5%) and Saudi nationals

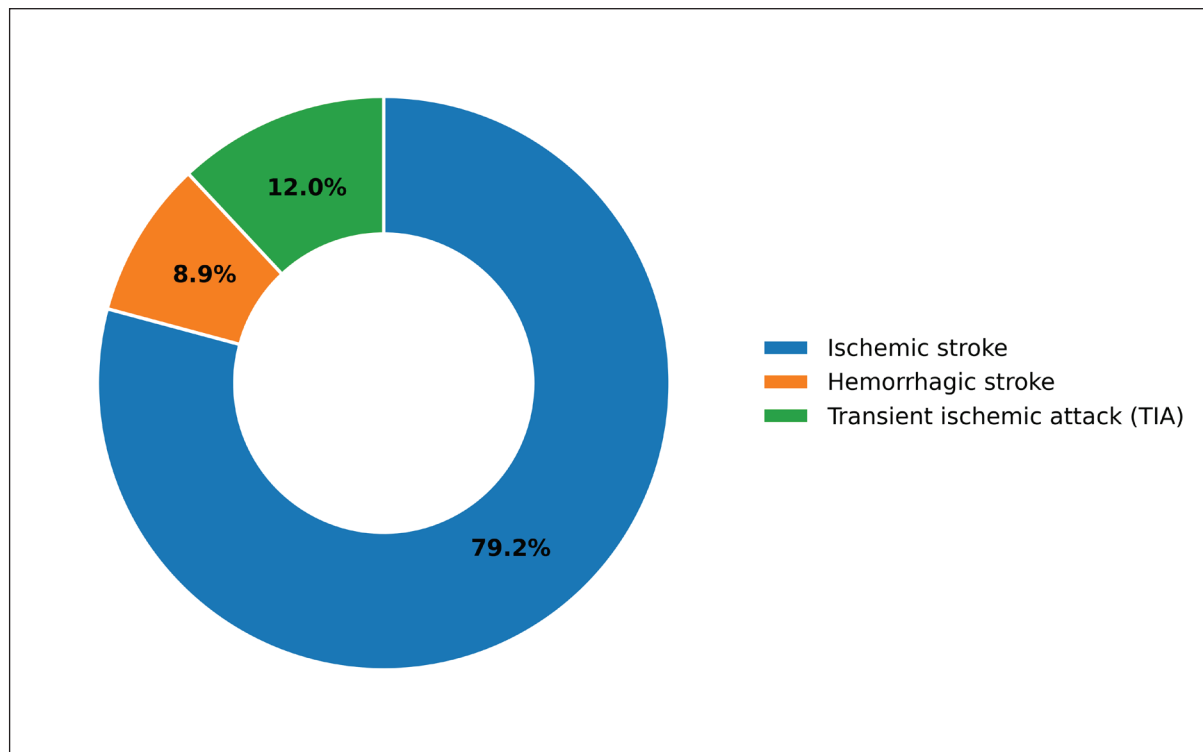


Figure 1. Distribution of stroke subtypes in the study cohort.

(799, 88.5%). Among those with available data, 108 (12.1%) were smokers, 334 (39.6%) were overweight, and 179 (21.2%) were obese. The mean HbA1c level was $7.51\% \pm 2.24\%$, and 503 (55.7%) patients had uncontrolled glycemia ($\text{HbA1c} \geq 6.5\%$). A history of previous stroke was documented in 244 (27.0%) patients, while 48 (5.3%) died during hospitalization. Hypertension (641, 71.0%) and diabetes mellitus (566, 62.7%) were the most prevalent comorbidities. The mean risk factor burden score was 1.79 ± 1.02 . Antiplatelet agents, statins, and anticoagulants were prescribed to 206 (22.8%), 201 (22.3%), and 90 (10.0%) patients, respectively (Table 1).

Mean HbA1c levels were elevated across all three stroke subtypes. The highest mean HbA1c level was observed among patients with ischemic stroke ($7.59\% \pm 2.32\%$), followed by hemorrhagic stroke ($7.25\% \pm 1.86\%$) and TIA ($7.12\% \pm 1.89\%$). However, the differences among the three groups were not statistically significant ($p = 0.068$) (Table 2).

Among the 843 patients with complete data, HbA1c level showed a statistically significant positive correlation with the risk factor burden score ($r = 0.313$, $p < 0.001$). This finding indicates that higher HbA1c levels were associated with a greater burden of cardiovascular and metabolic risk factors.

Uncontrolled glycemia was significantly more common among patients with a history of previous stroke than among those without a previous stroke (62.3% vs. 53.3%, $p = 0.015$). No significant associations were observed between glycemic control and stroke subtype, in-hospital survival, smoking status, or BMI category (Table 3).

After adjustment for potential confounding variables, the ANCOVA model (Table 4) showed that differences in mean HbA1c levels across stroke subtypes were not statistically significant [$F(2, 838) = 2.043$, $p = 0.130$, partial $\eta^2 = 0.005$]. However, age was a significant independent covariate in the model [$F(1, 838) = 7.473$, $p = 0.006$, partial $\eta^2 = 0.009$].

Multivariable regression analyses were performed to identify factors associated with stroke subtype and prognosis. As shown in Table 5, multinomial logistic regression analysis demonstrated that each 1-percentage-point increase in HbA1c was associated with 16% higher odds of ischemic stroke relative to TIA [adjusted OR (aOR) = 1.160, 95% CI: 1.035-1.301; $p = 0.011$]. In addition, male sex was independently associated with approximately twofold higher odds of hemorrhagic stroke relative to TIA (aOR = 1.997, 95% CI: 1.049-3.801; $p = 0.035$).

The binary logistic regression results presented in Table 6 indicated that the model demonstrated a good fit for predicting in-hospital survival (Omnibus test, $p < 0.001$; Hosmer–Lemeshow test, $p = 0.428$). Older age (aOR = 0.954, 95% CI: 0.931-0.978; $p < 0.001$) and hemorrhagic stroke, compared with TIA (aOR = 0.102, 95% CI: 0.012-0.871; $p = 0.037$), were independently associated with lower odds of in-hospital survival. In contrast, glycemic status was not significantly associated with in-hospital survival following stroke ($p = 0.773$).

Discussion

In this retrospective study, more than half of the patients had HbA1c levels $\geq 6.5\%$, indicating a high prevalence of

Table 1. Baseline demographics and clinical characteristics of the study cohort (N = 903).

Variable	Frequency (n)	Percentage (%)
Age		
<65 years	442	48.9%
≥65 years	461	51.1%
Mean age (SD), years	64.35 (13.82)	
Sex		
Male	582	64.5%
Female	321	35.5%
Nationality		
Saudi	799	88.5%
Non-Saudi	104	11.5%
Smoking status ^a		
No	785	87.9%
Yes	108	12.1%
BMI category ^b		
Normal (<25.0)	330	39.1%
Overweight (25.0-29.9)	334	39.6%
Obese (≥30.0)	179	21.2%
Glycemic control category		
Controlled (HbA1c < 6.5%)	400	44.3%
Uncontrolled (HbA1c ≥ 6.5%)	503	55.7%
Mean HbA1c (SD), %	7.51 (2.24)	
History of previous stroke		
No	659	73.0%
Yes	244	27.0%
Survival status		
Alive	855	94.7%
Deceased	48	5.3%
Comorbidities		
Hypertension	641	71.0%
Diabetes mellitus	566	62.7%
Coronary artery disease	139	15.4%
Dyslipidemia	107	11.8%
Atrial fibrillation/flutter	88	9.7%
Chronic kidney disease	87	9.6%
Thyroid diseases	60	6.6%
Respiratory diseases (asthma/COPD)	32	3.5%
Heart failure	17	1.9%
Autoimmune diseases	14	1.6%
Risk factor burden score (0-5), mean (SD)	1.79 (1.02)	
Medication use		
Antiplatelets	206	22.8%
Statins ^c	201	22.3%
Anticoagulants	90	10.0%

Percentages are valid percentages and account for minor missing data. COPD, chronic obstructive pulmonary disease.

^aMissing n = 10.

^bMissing n = 60.

^cMissing n = 1.

Table 2. Comparison of mean HbA1c levels across primary stroke subtypes (N = 903).

Stroke subtype	Mean HbA1c (%)	SD	Lower 95% CI	Upper 95% CI	p value
Ischemic stroke	7.59	2.32	7.42	7.76	0.068
Hemorrhagic stroke	7.25	1.86	6.83	7.66	
TIA	7.12	1.89	6.76	7.48	
Total	7.51	2.24	7.36	7.65	

p value from one-way ANOVA across the three stroke subtypes.

HbA1c levels were positively correlated with the cumulative burden of cardiovascular and metabolic risk factors. After adjustment for potential confounders, each 1-percentage-point increase in HbA1c was associated with 16% higher odds of ischemic stroke relative to TIA. Male sex was independently associated with higher odds of hemorrhagic stroke, whereas older age and hemorrhagic stroke were associated with lower in-hospital survival.

Ischemic stroke was the predominant cerebrovascular diagnosis, accounting for 715 patients (79.2%), followed by TIA in 108 (12.0%) and hemorrhagic stroke in 80 (8.9%). Hypertension and diabetes mellitus were the most prevalent comorbidities, affecting 641 (71.0%) and 566 (62.7%) patients, respectively. These findings are consistent with previous evidence highlighting the major contribution of modifiable cardiovascular risk factors to stroke occurrence. A large case-control study involving 26,919 participants from 32 countries reported that ten potentially modifiable risk factors accounted for ~90% of the population-attributable risk of stroke, with hypertension identified as the most influential factor [13]. Similarly, Al Rukn et al. [14] reported that hypertension (66%) and diabetes mellitus (38%) were the most prevalent risk factors among patients with stroke in the Middle East and North Africa. A previous Saudi study also identified ischemic stroke as the predominant cerebrovascular subtype and reported a high prevalence of hypertension and diabetes mellitus among patients with stroke [10].

Elevated HbA1c levels have consistently been associated with an increased risk of stroke and adverse clinical outcomes. A study involving 44,451 patients with atrial fibrillation and diabetes mellitus demonstrated that stroke risk was higher among individuals with HbA1c ≥ 7% than among those with HbA1c < 7%, while HbA1c levels > 9% were associated with significantly increased mortality [15]. Likewise, a meta-analysis found that increasing HbA1c levels were associated with a higher risk of first-ever ischemic stroke among individuals with and without diabetes [8]. A tertiary care study conducted in Saudi Arabia similarly reported elevated HbA1c levels across ischemic stroke, hemorrhagic stroke, and TIA, with significantly higher HbA1c levels among patients with ischemic stroke [10]. Although our study observed the

uncontrolled glycemia among patients with stroke. Mean HbA1c levels were elevated across all stroke subtypes and were highest among patients with ischemic stroke, although the differences were not statistically significant. Uncontrolled glycemia was significantly more common among patients with a history of previous stroke, and

Table 3. Association of glycemic control with clinical characteristics and outcomes (N = 903).

Characteristic	Controlled HbA1c <6.5% (n = 400)	Uncontrolled HbA1c ≥6.5% (n = 503)	χ^2 (df)	p value
Stroke subtype			5.270 (2)	0.072
Ischemic stroke	303 (42.4%)	412 (57.6%)		
Hemorrhagic stroke	40 (50.0%)	40 (50.0%)		
TIA	57 (52.8%)	51 (47.2%)		
History of previous stroke			5.888 (1)	0.015*
No	308 (46.7%)	351 (53.3%)		
Yes	92 (37.7%)	152 (62.3%)		
Survival status			0.142 (1)	0.706
Deceased	20 (41.7%)	28 (58.3%)		
Alive	380 (44.4%)	475 (55.6%)		
Smoking status			0.042 (1)	0.839
No	348 (44.3%)	437 (55.7%)		
Yes	49 (45.4%)	59 (54.6%)		
BMI category			0.730 (2)	0.694
Normal	153 (46.4%)	177 (53.6%)		
Overweight	144 (43.1%)	190 (56.9%)		
Obese	79 (44.1%)	100 (55.9%)		

Patients with missing smoking status ($n = 10$) or BMI ($n = 60$) were excluded from the corresponding analyses. χ^2 , chi-square statistic; df, degrees of freedom.

*Statistically significant at $p < 0.05$.

Table 4. ANCOVA comparing mean HbA1c levels across stroke subtypes after adjustment for age and BMI (N = 843).

Source	Type III sum of squares	df	Mean square	F statistic	p value	Partial η^2
Corrected model	63.036	4	15.759	3.263	0.011	0.015
Intercept	621.911	1	621.911	128.757	<0.001	0.133
Stroke subtype	19.735	2	9.868	2.043	0.130	0.005
Age (covariate)	36.098	1	36.098	7.473	0.006*	0.009
BMI (covariate)	1.858	1	1.858	0.385	0.535	0.000
Error	4047.638	838	4.830			
Total	51381.190	843				
Corrected total	4110.674	842				

$R^2 = 0.015$ (adjusted $R^2 = 0.011$). df, degrees of freedom.

*Statistically significant at $p < 0.01$.

highest mean HbA1c level among patients with ischemic stroke, the difference between stroke subtypes was not statistically significant after adjustment for potential confounders.

After adjustment for potential confounders, each 1-percentage-point increase in HbA1c was associated with a 16% higher adjusted odds of ischemic stroke relative to TIA. In addition, uncontrolled glycemia was significantly more common among patients with a history of previous

stroke. These findings are consistent with previous evidence suggesting that poor long-term glycemic control contributes to stroke recurrence and adverse outcomes. A previous study found that elevated HbA1c independently predicted stroke recurrence within one year after a first-ever non-cardioembolic ischemic stroke [9]. In Saudi Arabia, higher HbA1c levels have also been associated with greater neurological severity among patients with acute ischemic stroke [11]. Furthermore, several studies have demonstrated that elevated glucose levels

Table 5. Multinomial logistic regression predicting stroke subtype (reference outcome: TIA) (N = 843).

Outcome comparison	Predictor	aOR (95% CI)	p value
Ischemic stroke versus TIA	HbA1c level	1.160 (1.035-1.301)	0.011*
	Age	1.011 (0.996-1.027)	0.149
	Risk factor burden	0.713 (0.576-0.884)	0.002*
	Male vs. female	1.228 (0.802-1.879)	0.345
Hemorrhagic stroke versus TIA	HbA1c level	1.075 (0.918-1.259)	0.369
	Age	0.997 (0.976-1.019)	0.817
	Risk factor burden	0.777 (0.574-1.052)	0.103
	Male vs. female	1.997 (1.049-3.801)	0.035*

Reference outcome: TIA. Reference sex: female. Model sample size: N = 843. Cox and Snell pseudo- R^2 = 0.026; Nagelkerke pseudo- R^2 = 0.036. .

*Statistically significant at $p < 0.05$.

Table 6. Binary logistic regression predicting in-hospital survival (outcome: alive) (N = 843).

Predictor	Comparison	aOR (95% CI)	p value
Glycemic control			
Uncontrolled HbA1c	Reference	1.00	—
Controlled HbA1c	Controlled versus uncontrolled	0.908 (0.470-1.753)	0.773
Stroke subtype			0.107 ^a
TIA	Reference	1.00	—
Ischemic stroke	Ischemic stroke versus TIA	0.169 (0.023-1.250)	0.082
Hemorrhagic stroke	Hemorrhagic stroke versus TIA	0.102 (0.012-0.871)	0.037*
Age	Per 1-year increase	0.954 (0.931-0.978)	<0.001**
Risk factor burden score	Per 1-point increase	0.912 (0.652-1.276)	0.592

Uncontrolled glycemia and TIA were the reference categories. Model diagnostics: omnibus test, $p < 0.001$; Nagelkerke R^2 = 0.080; Hosmer–Lemeshow test, p = 0.428. .

^aOverall p value for stroke subtype.

*Statistically significant at $p < 0.05$.

**Statistically significant at $p < 0.001$.

are associated with poorer neurological and functional outcomes, longer hospital stays, and an increased risk of stroke recurrence [16]. Collectively, these findings suggest that poor long-term glycemic control may contribute to a greater burden of vascular risk factors and may increase susceptibility to ischemic stroke.

Our study also demonstrated a significant positive correlation between HbA1c levels and the risk factor burden score, indicating that poorer glycemic control coexisted with a greater accumulation of cardiovascular and metabolic risk factors. Similar composite risk-factor approaches have been used in previous stroke research to assess the cumulative impact of modifiable risk factors. One study evaluated seven modifiable risk factors requiring better control and reported that approximately half of patients with ischemic stroke had four or more inadequately controlled risk factors [17]. Libruder et al. [18] evaluated five modifiable risk factors comparable to those included in our risk factor burden score—hypertension, diabetes mellitus, smoking, obesity, and hyperlipidemia—and estimated that their combined population-attributable risk accounted for ~80% of acute ischemic stroke incidence. In Saudi Arabia, hypertension, diabetes mellitus, obesity, and hypercholesterolemia

have also been identified as independent risk factors for first-ever stroke [19]. Together, these findings support the importance of comprehensive risk-factor assessment and optimization in stroke prevention.

Sex-related differences were also observed in our analysis. Male sex was associated with approximately twofold higher odds of hemorrhagic stroke relative to TIA. Previous studies have likewise reported a higher incidence of stroke among men, although the magnitude of the difference varies according to age, population, and stroke subtype [20]. Peters et al. [21] reported that the incidence of hemorrhagic stroke was higher among men than women. Similarly, a previous Saudi study found that hemorrhagic stroke occurred more frequently in males than females [10].

Regarding prognosis, the overall in-hospital mortality rate in our study was 5.3%. Older age and hemorrhagic stroke were independently associated with lower in-hospital survival. Deljavan et al. [22] reported an in-hospital case-fatality rate of 12.5% and found that age ≥ 65 years and hemorrhagic stroke were each associated with a 55% higher hazard of in-hospital death. Another study identified older age, neurological severity, white blood cell count,

345	and systolic blood pressure as independent predictors of	OR	odds ratio	405
346	in-hospital mortality among patients with ischemic stroke	TIA	transient ischemic attack	406
347	[23]. In addition, Baptista et al. [24] reported substantially			
348	higher in-hospital mortality following intracerebral	Conflict of interest		407
349	hemorrhage than cerebral infarction (14.4% vs. 3.7%).	None.		408
350	These findings reinforce that hemorrhagic stroke, although			
351	less common than ischemic stroke, is associated with a	Funding		409
352	substantially poorer short-term prognosis.	None.		410
353	This study has several limitations. Patients with missing	Consent to publication		411
354	BMI or smoking data were excluded only from analyses	The requirement for informed consent was waived because		412
355	involving these variables, reducing the sample size for	this study involved retrospective analysis of existing medical		413
356	complete-case analyses. One patient also had missing	records.		414
357	information on statin use. As a retrospective study, the			
358	analysis depended on the accuracy and completeness of	Ethics approval		415
359	routinely recorded medical records. Important clinical	The study was approved by the Qassim Institutional Review		416
360	variables, including stroke severity, functional status,	Board, Ministry of Health, Kingdom of Saudi Arabia (approval		417
361	duration of diabetes, and long-term outcomes, were	no. 607-47-10646; February 2, 2026).		418
362	unavailable. Information regarding medication adherence			
363	and the duration of treatment with antiplatelet agents,	AI-use disclosure		419
364	anticoagulants, and statins was also not available. In	Generative AI (OpenAI ChatGPT) was used for language and		420
365	addition, the risk factor burden score assigned equal weight	formatting assistance during revision. All scientific content,		421
366	to hypertension, diabetes mellitus, dyslipidemia, smoking,	interpretations, and final decisions were reviewed and		422
367	and obesity without accounting for differences in disease	approved by the authors.		423
368	duration, severity, treatment, or level of control. Finally,			
369	because this was a single-center study conducted at a tertiary	Author details		424
370	care hospital, the findings may not be generalizable to the	Mariam Alharbi ¹ , Abdulaziz Alluhayb ² , Saud Alamri ² , Omar		425
371	broader Saudi population or to other healthcare settings.	Aldhuwayhi ² , Almathna Alharbi ² , Rana Alamri ³ , Abdullah		426
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		Arabia		433
372	Conclusion	<i>Supplementary content (If any) is available online.</i>		434
373	HbA1c levels were elevated across all stroke subtypes	References		435
374	and were highest among patients with ischemic stroke.	1. Jameson JL, Fauci AS, Kasper DL, Hauser SL, Longo DL,		436
375	Higher HbA1c levels were associated with a greater	Loscalzo J, editors. Harrison's manual of medicine. 20th		437
376	burden of cardiovascular and metabolic risk factors	ed. New York: McGraw-Hill; 2020.		438
377	and increased odds of ischemic stroke relative to TIA.	2. Katan M, Luft A. Global burden of stroke.		439
378	Uncontrolled glycemia was also more common among	Semin Neurol. 2018;38(2):208–11. https://doi.org/10.1055/s-0038-1649503		440
379	patients with a history of previous stroke. In addition, male			441
380	sex was independently associated with higher odds of	3. Palaniappan LP, Allen NB, Almarzooq ZI, Anderson CA,		442
381	hemorrhagic stroke, whereas older age and hemorrhagic	Arora P, Avery CL, et al.; American Heart Association		443
382	stroke were associated with lower in-hospital survival.	Council on Epidemiology and Prevention Statistics		444
383	These findings highlight the importance of optimizing	Committee and Stroke Statistics Committee. 2026 Heart		445
384	long-term glycemic control alongside comprehensive	disease and stroke statistics: a report of US and global		446
385	management of modifiable cardiovascular risk factors	data from the American Heart Association. Circulation.		447
386	to reduce the burden of stroke. Further prospective	2026;153(9):e275–906.		448
387	multicenter studies are warranted to investigate the	4. Alqahtani BA, Alenazi AM, Hoover JC, Alshehri MM,		449
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392	disease, and evidence-based preventive interventions	5. Basri R, Issrani R, Hua Gan S, Prabhu N, Khursheed Alam		454
393	should be strengthened.	M. Burden of stroke in the Kingdom of Saudi Arabia: a		455
394	List of Abbreviations	soaring epidemic. Saudi Pharm J. 2021;29(3):264–8.		456
395	AF atrial fibrillation/flutter	https://doi.org/10.1016/j.jsps.2021.02.002		457
396	ANCOVA analysis of covariance	6. Bushnell C, Kernan WN, Sharrief AZ, Chaturvedi S, Cole		458
397	aOR adjusted odds ratio	JW, Cornwell WK 3rd, et al. 2024 guideline for the primary		459
398	BMI body mass index	prevention of stroke: a guideline from the American		460
399	CAD coronary artery disease	Heart Association/American Stroke Association. Stroke.		461
400	CI confidence interval			
401	CKD chronic kidney disease			
402	COPD chronic obstructive pulmonary disease			
403	DM diabetes mellitus			
404	HbA1c glycated hemoglobin			

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