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Factors Associated with Recurrent Stroke Among Inpatients at Adam Malik General Hospital: A Case-Control Study

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ABSTRACT

Background: Recurrent stroke is a major public health concern because it is associated with increased mortality, disability, hospitalization, and healthcare burden. This study aimed to identify factors associated with recurrent stroke among inpatients at H. Adam Malik General Hospital from 2023 to 2025.
Method: This retrospective case-control study included 222 stroke inpatients, consisting of 111 patients with recurrent stroke and 111 patients with first-ever stroke. Cases were selected using total sampling, while controls were selected using quota sampling with a 1:1 ratio. Data were obtained from medical records. The independent variables were age, sex, hypertension, type 2 diabetes mellitus, coronary heart disease, and obesity. Data were analyzed using Chi-square tests and multiple logistic regression.
Result: Bivariate analysis showed that age ≥55 years (OR=2.057; 95% CI: 1.107–3.821; p=0.021), male sex (OR=1.927; 95% CI: 1.130–3.286; p=0.016), type 2 diabetes mellitus (OR=2.088; 95% CI: 1.219–3.576; p=0.007), and coronary heart disease (OR=3.200; 95% CI: 1.634–6.267; p=0.001) were significantly associated with recurrent stroke. In the multivariate model, age ≥55 years (aOR=2.381; 95% CI: 1.208–4.696; p=0.012), male sex (aOR=1.852; 95% CI: 1.092–3.141; p=0.024), type 2 diabetes mellitus (aOR=2.124; 95% CI: 1.203–3.751; p=0.010), and coronary heart disease (aOR=3.200; 95% CI: 1.634–6.267; p=0.004) remained significantly associated with recurrent stroke. Coronary heart disease showed the strongest association.
Conclusion: Recurrent stroke was associated with age ≥55 years, male sex, type 2 diabetes mellitus, and coronary heart disease. Coronary heart disease was the dominant associated factor after adjustment for other variables. Comprehensive secondary prevention targeting cardiovascular and metabolic comorbidities is essential to reduce recurrent stroke risk.

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INTRODUCTION

Stroke is one of the most significant non-communicable diseases globally and remains a major contributor to mortality, disability, and healthcare burden. According to the World Health Organization, stroke is currently the third leading cause of death and disability worldwide after ischemic heart disease and COVID-19-related complications. In 2021, approximately 93.8 million people worldwide were living with stroke, with an estimated 11.9 million new stroke cases occurring annually (WHO, 2025). Stroke contributes substantially to disability-adjusted life years (DALYs), reduced quality of life, long-term dependency, and socioeconomic burden, especially in low- and middle-income countries where access to preventive and rehabilitative services remains limited. More than 70% of global stroke cases and deaths occur in developing countries, indicating significant disparities in prevention and treatment outcomes (Feigin et al., 2022).

Stroke recurrence has become an increasingly important public health concern because recurrent stroke is associated with poorer prognosis than first-ever stroke. Patients with recurrent stroke generally experience more severe neurological deficits, higher mortality rates, prolonged hospitalization, increased treatment costs, and greater functional dependence (Katan & Luft, 2018). Evidence suggests that approximately 20–30% of stroke survivors experience recurrent stroke within five years after the first attack, while the risk is highest during the first year after the initial event (Kleindorfer et al., 2021). Recurrent stroke not only worsens clinical outcomes but also places a significant burden on healthcare systems due to repeated hospitalization, rehabilitation needs, and long-term care dependency. Therefore, identifying modifiable and non-modifiable risk factors associated with recurrent stroke is essential for improving secondary prevention strategies.

In Indonesia, stroke remains a critical health problem and is consistently ranked among the leading causes of death. Data from the Ministry of Health of the Republic of Indonesia reported that stroke contributes to more than 18.5% of all deaths nationally and accounts for approximately 11.2% of total disability burden (Kemenkes RI, 2024). The increasing prevalence of hypertension, diabetes mellitus, obesity, and cardiovascular disease in Indonesia has contributed substantially to the rising incidence of stroke and stroke recurrence. According to the 2023 Indonesian Health Survey, the national prevalence of stroke was 8.3 per 1,000 population, while North Sumatra Province reported a prevalence of 6.6%, placing it among the provinces with the highest stroke burden in Indonesia (Kemenkes RI, 2023).

The burden of stroke in urban areas such as Medan City is also substantial. Data from the Medan City Health Office documented 839 hospitalized stroke cases and 79 stroke-related deaths in 2024, with a Case Fatality Rate (CFR) of 9.42% (Dinas Kesehatan Kota Medan, 2025). These findings indicate that stroke remains a major clinical and public health challenge in North Sumatra Province. Furthermore, increasing urbanization, sedentary lifestyles, unhealthy dietary habits, and aging populations are expected to further increase stroke incidence and recurrence rates in the coming years.

The occurrence of recurrent stroke is influenced by complex interactions between demographic, metabolic, and cardiovascular factors. Advanced age is widely recognized as the strongest non-modifiable risk factor for stroke recurrence because vascular degeneration, endothelial dysfunction, and atherosclerotic changes increase with aging (Ovbiagele et al., 2013). Older individuals also tend to have multiple comorbidities that increase cerebrovascular risk. Several studies have demonstrated that patients aged ≥55 years have a significantly higher probability of experiencing recurrent stroke compared with younger patients (Rizkidawati et al., 2024).

Sex differences have also been reported in recurrent stroke risk. Male patients generally have a higher prevalence of smoking, alcohol consumption, uncontrolled hypertension, and

cardiovascular disease, which may contribute to increased recurrence risk (Appelros et al., 2009). However, some studies found that women experience worse long-term outcomes and disability after stroke, indicating inconsistency in findings regarding the role of sex in recurrent stroke events. These inconsistencies suggest that demographic characteristics may interact differently across populations and healthcare settings.

Hypertension is considered one of the most important modifiable risk factors for both primary and recurrent stroke. Persistent elevation of blood pressure can accelerate vascular damage, promote atherosclerosis, and increase the likelihood of cerebral hemorrhage or ischemia (Whelton et al., 2018). Several studies have shown that uncontrolled hypertension significantly increases recurrent stroke risk. Nevertheless, other studies reported non-significant associations after adjustment for other cardiovascular comorbidities, indicating that the contribution of hypertension may depend on patient characteristics and treatment adherence.

Type 2 diabetes mellitus (T2DM) is another major contributor to recurrent stroke because chronic hyperglycemia promotes endothelial dysfunction, inflammation, and accelerated atherosclerosis. Patients with diabetes are also more likely to experience poor vascular recovery after the first stroke episode (American Diabetes Association, 2024). Previous studies demonstrated that T2DM significantly increases recurrent stroke risk, particularly among older adults with multiple cardiovascular comorbidities. However, the magnitude of this association varies across studies and populations.

Several demographic and clinical factors have been associated with recurrent stroke; however, findings from previous studies remain inconsistent. Advanced age is widely recognized as a strong non-modifiable risk factor due to progressive vascular degeneration and atherosclerotic changes that occur with aging (Ovbiagele et al., 2013). Nevertheless, several studies reported that age lost statistical significance after adjustment for comorbid cardiovascular conditions, suggesting possible interactions between age and other metabolic risk factors. Similarly, sex differences in recurrent stroke remain inconclusive. Male patients are often reported to have higher recurrence risk because of greater exposure to smoking, alcohol consumption, and uncontrolled hypertension (Appelros et al., 2009), whereas other studies found poorer long-term outcomes among women due to older age at stroke onset and greater post-stroke disability. These inconsistencies indicate that demographic characteristics may influence recurrent stroke differently across populations and healthcare settings.

Clinical comorbidities such as hypertension, type 2 diabetes mellitus, coronary heart disease, and obesity are also frequently associated with recurrent stroke, although their contributions vary among studies. Hypertension is considered the most important modifiable risk factor because persistent elevated blood pressure accelerates vascular damage and cerebral ischemic events (Whelton et al., 2018). However, some multivariate studies reported non-significant associations after controlling for medication adherence and other cardiovascular diseases. Likewise, type 2 diabetes mellitus has been linked to endothelial dysfunction and accelerated atherosclerosis, but the strength of association differs across age groups and patient populations. Coronary heart disease shares common atherosclerotic mechanisms with stroke recurrence, yet several studies found its predictive role diminished after adjustment for hypertension and diabetes mellitus. Evidence regarding obesity is even more controversial due to the reported "obesity paradox," where overweight patients appeared to have better survival outcomes following stroke (Doehner et al., 2013). These inconsistent findings highlight the need for further investigation, particularly among hospitalized stroke patients with multiple comorbidities.

The selection of age, sex, hypertension, type 2 diabetes mellitus, coronary heart disease, and obesity in this study was based on their strong biological plausibility and consistent inclusion in international stroke recurrence models. These variables represent major demographic, metabolic, and cardiovascular determinants that contribute to vascular dysfunction, endothelial

injury, and recurrent cerebrovascular events. Furthermore, these factors are highly prevalent among Indonesian stroke patients and are clinically important because several of them are modifiable through secondary prevention strategies. Identifying the dominant predictors among these variables may therefore support risk stratification and improve evidence-based prevention programs for recurrent stroke patients.

At the hospital level, H. Adam Malik General Hospital is an important setting for recurrent stroke research because it functions as a tertiary referral hospital in North Sumatra and receives patients with more severe clinical conditions, multiple comorbidities, and recurrent cerebrovascular complications from various districts and cities. Compared with primary and secondary healthcare facilities, tertiary referral hospitals manage more complex stroke populations that better reflect the burden of advanced disease and recurrent events. Hospital records documented 2,099 hospitalized stroke patients between 2023 and 2025, with recurrent stroke cases increasing from 20 cases in 2023 to 60 cases in 2025. This upward trend indicates that recurrent stroke remains a substantial clinical challenge requiring stronger secondary prevention approaches.

Although many previous studies in Indonesia have examined stroke risk factors, most primarily focused on behavioral and lifestyle determinants such as smoking, physical inactivity, dietary habits, and medication adherence. In addition, several Indonesian studies only assessed single risk factors independently without simultaneously analyzing demographic and major cardiovascular comorbidities using multivariate approaches. Research specifically investigating recurrent stroke among hospitalized patients in tertiary referral hospitals also remains limited. Therefore, the novelty of this study lies in its simultaneous analysis of demographic and major clinical comorbid factors among recurrent stroke inpatients in a tertiary referral hospital population using multivariate analysis to identify dominant independent predictors of recurrent stroke.

METHOD

Research Design

This study employed an observational analytical design using a retrospective case-control approach to examine the association between demographic and clinical risk factors with recurrent stroke among hospitalized patients. The retrospective case-control design was selected because it allows comparison between recurrent stroke patients (case group) and first-ever stroke patients (control group) based on previous exposure histories recorded in medical records. This design is appropriate for identifying factors associated with recurrent stroke occurrence and estimating the magnitude of risk through odds ratio analysis. The study was conducted in April 2026 at H. Adam Malik General Hospital, a tertiary referral hospital in North Sumatra, Indonesia. The study population consisted of 2,099 stroke inpatients treated between 2023 and 2025.

Sample Selection

The study population included all stroke inpatients recorded at H. Adam Malik General Hospital during the 2023–2025 period. Samples were selected using a combination of total sampling and quota sampling techniques. All eligible recurrent stroke patients who met the inclusion criteria were included as the case group using total sampling. Meanwhile, the control group consisted of first-ever stroke patients selected using quota sampling with a 1:1 ratio between cases and controls. A total of 222 participants were included in the study, comprising 111 recurrent stroke patients and 111 first-ever stroke patients. This sampling approach ensured balanced group comparison and improved the analytical power of the study.

Data Collection Procedures

Data were collected retrospectively using secondary data obtained from patients' medical records. An observation sheet was used to record relevant demographic and clinical variables. The dependent variable in this study was recurrent stroke occurrence, while the independent variables included age, sex, hypertension, type 2 diabetes mellitus, coronary heart disease, and obesity. Medical records were reviewed systematically to ensure data completeness and consistency before analysis. The use of hospital-based medical record data enabled the identification of clinical comorbidities and demographic characteristics among stroke inpatients in a tertiary referral setting.

Data Analysis

Data analysis was performed using Statistical Package for the Social Sciences (SPSS). Univariate analysis was conducted to describe the characteristics of respondents and study variables. Bivariate analysis using the Chi-Square test was applied to examine the association between independent variables and recurrent stroke occurrence, while Odds Ratios (OR) with 95% Confidence Intervals (CI) were calculated to estimate risk magnitude. Variables with significant associations in bivariate analysis were further analyzed using multiple logistic regression to identify the dominant independent predictors of recurrent stroke. The reporting of this observational study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines to ensure methodological transparency and reporting quality.

Ethical Considerations

This study received ethical approval from the Health Research Ethics Committee under approval number 007.D/KEP-MLP/II/2026. The research used retrospective medical record data while maintaining patient confidentiality and anonymity throughout the study process. All collected data were used solely for research purposes in accordance with ethical principles for health research.

RESULTS AND DISCUSSION

Results

Table 1. Demographic Characteristics of Inpatients at H. Adam Malik General Hospital in 2023-2025

No.	Characteristics	f	%
1.	**Stroke**		
	a. Recurrent Stroke	111	50.0
	b. First Stroke	111	50.0
2.	**Age Group**		
	a. ≥ 55	165	74.3
	b. < 55	57	25.7
3.	**Gender**		
	a. Man	116	52.3
	b. Woman	106	47.7

Based on Table 1, the study included 222 respondents, consisting of 111 recurrent stroke patients and 111 first-ever stroke patients, each representing 50.0% of the total sample. Most respondents were aged ≥55 years (74.3%), while 25.7% were aged <55 years. Regarding sex distribution, male patients accounted for 52.3% of the sample, slightly higher than female patients (47.7%).

Table 2. Factors Associated with Recurrent Stroke in Inpatients at H. Adam Malik General Hospital in 2023-2025

Variables	Case n (%)	Control n (%)	p-value	OR (95% CI)
Age				
≥55 years	90 (81.1)	75 (67.6)	0.021	2.057 (1.107–3.821)
<55 years	21 (18.9)	36 (32.4)		
Sex				
Male	67 (60.4)	49 (44.1)	0.016	1.927 (1.130–3.286)
Female	44 (39.6)	62 (55.9)		
Hypertension				
Yes	92 (82.9)	84 (75.7)	0.185	1.556 (0.807–3.003)
No	19 (17.1)	27 (24.3)		
Type 2 Diabetes Mellitus				
Yes	60 (54.1)	40 (36.0)	0.007	2.088 (1.219–3.576)
No	51 (45.9)	71 (64.0)		
Coronary Heart Disease				
Yes	37 (33.3)	15 (13.5)	0.001	3.200 (1.634–6.267)
No	74 (66.7)	96 (86.5)		
Obesity				
Yes	53 (47.7)	46 (41.4)	0.107	1.546 (0.910–2.628)
No	58 (52.3)	65 (58.6)		

Based on the bivariate analysis, age, sex, type 2 diabetes mellitus, and coronary heart disease were significantly associated with recurrent stroke ($p<0.05$). Hypertension and obesity were not significantly associated with recurrent stroke among inpatients at H. Adam Malik General Hospital during 2023–2025.

Table 3. Results of Logistic Regression Analysis of Risk Factors for Recurrent Stroke in Inpatients at H. Adam Malik General Hospital in 2023-2025

Variables	Adjusted OR	95% CI	p-value
Age (≥55 years)	2.381	1.208–4.696	0.012
Sex (Male)	1.852	1.092–3.141	0.024
Hypertension	0.935	0.449–1.947	0.858
Type 2 Diabetes Mellitus	2.124	1.203–3.751	0.010
Coronary Heart Disease	3.200	1.634–6.267	0.004
Obesity	1.733	0.968–3.101	0.064

Based on multivariate logistic regression analysis, age, sex, type 2 diabetes mellitus, and coronary heart disease were significantly associated with recurrent stroke ($p<0.05$). Coronary heart disease showed the strongest association with recurrent stroke (AOR=3.200; 95% CI: 1.634–6.267). Meanwhile, hypertension and obesity were not significantly associated with recurrent stroke in the final model.

Discussion

Based This study demonstrated that age, sex, type 2 diabetes mellitus, and coronary heart disease were significantly associated with recurrent stroke among hospitalized patients, while hypertension and obesity were not significantly associated after adjustment in the multivariate model. These findings indicate that recurrent stroke is influenced by complex interactions between demographic characteristics and cardiovascular comorbidities in tertiary hospital populations.

Advanced age remained an important predictor of recurrent stroke in this study. Aging is associated with progressive vascular remodeling, endothelial dysfunction, arterial stiffness, and impaired cerebral autoregulation, all of which increase susceptibility to recurrent cerebrovascular ischemia (Ovbiagele et al., 2013). Older patients also tend to have multiple comorbidities and prolonged exposure to vascular risk factors, which may amplify recurrence risk. Although previous studies consistently identified older age as a major risk factor for recurrent stroke, several reports found weakened associations after adjustment for cardiovascular comorbidities (Yuan et al., 2022). In the present study, age remained significant even after multivariate adjustment, suggesting that aging itself may independently contribute to recurrent vascular injury beyond accompanying metabolic disorders.

Male sex was also significantly associated with recurrent stroke. This finding may reflect both biological and behavioral mechanisms. Men generally have higher exposure to smoking, alcohol consumption, dyslipidemia, and other cardiovascular risk factors that accelerate atherosclerotic progression (Park et al., 2024). In addition, sex-related hormonal differences may contribute to vascular protection among women, particularly through the effects of estrogen on endothelial function and vascular elasticity (Xiang et al., 2021). However, findings regarding sex differences in recurrent stroke remain inconsistent across studies. Some previous studies reported higher recurrence risk among men, while others found poorer long-term disability and mortality among women (Chung et al., 2023). These inconsistencies may be explained by differences in population characteristics, age distribution, healthcare access, and prevalence of vascular comorbidities across study settings.

Type 2 diabetes mellitus was significantly associated with recurrent stroke in both bivariate and multivariate analyses. Chronic hyperglycemia contributes to endothelial injury, oxidative stress, inflammation, platelet activation, and accelerated atherosclerosis, thereby increasing the risk of recurrent cerebrovascular events (Tuttolomondo et al., 2022). Poor glycemic control may further impair vascular repair mechanisms following an initial stroke episode. The present findings support previous evidence identifying diabetes mellitus as an important determinant of recurrent stroke (Huang et al., 2022). Nevertheless, some studies reported varying effect sizes depending on age, duration of diabetes, and glycemic control status. This suggests that the relationship between diabetes mellitus and recurrent stroke is multifactorial and may be influenced by additional metabolic and cardiovascular conditions (Zamzam et al., 2023).

Coronary heart disease emerged as the strongest factor associated with recurrent stroke in this study. This finding is biologically plausible because stroke and coronary heart disease share common atherosclerotic mechanisms, including endothelial dysfunction, vascular inflammation, and thromboembolic processes (Kato et al., 2024). Patients with coronary heart disease are also more likely to experience cardiac arrhythmias, impaired cardiac output, and embolic events that increase cerebrovascular risk. The stronger association observed in this study compared with several previous reports may reflect the characteristics of the tertiary referral hospital population, where patients commonly present with more severe cardiovascular comorbidities and advanced disease conditions. Similar findings were reported in a meta-analysis by Chiangkhong et al. (2023), which identified heart disease as one of the strongest predictors of recurrent stroke.

In contrast, hypertension was not significantly associated with recurrent stroke in the multivariate model. Although hypertension is widely recognized as one of the most important

modifiable stroke risk factors, its effect may have been attenuated by the high prevalence of hypertension in both study groups. In addition, hypertension may interact with other cardiovascular comorbidities such as diabetes mellitus and coronary heart disease, thereby reducing its independent statistical contribution after adjustment. Another possible explanation is the lack of data regarding blood pressure control, treatment adherence, and duration of hypertension, which are important determinants of recurrent stroke risk (Wang et al., 2025). Therefore, the absence of statistical significance in this study should not be interpreted as evidence that hypertension is clinically unimportant.

Obesity was also not significantly associated with recurrent stroke after adjustment for other variables. This finding suggests that obesity may contribute indirectly through intermediary metabolic disorders such as hypertension, diabetes mellitus, and dyslipidemia rather than acting as an independent predictor. Previous studies examining obesity and recurrent stroke have shown inconsistent findings, including the so-called "obesity paradox," in which overweight patients appeared to have better post-stroke outcomes (Doehner et al., 2013). Differences in obesity measurement, ethnic characteristics, metabolic profiles, and study populations may explain these inconsistencies.

This study also identified potential issues related to confounding and collinearity among cardiovascular risk factors. Hypertension, diabetes mellitus, obesity, and coronary heart disease are biologically interconnected and frequently coexist in stroke patients. Such overlap may reduce the apparent independent effect of certain variables in multivariate analysis. For example, the non-significant association of hypertension may partly reflect its interaction with diabetes mellitus and coronary heart disease. Similarly, obesity may exert its effect indirectly through metabolic and vascular complications rather than directly increasing recurrent stroke risk. These interactions highlight the importance of interpreting regression findings cautiously and considering the multifactorial nature of recurrent stroke (Chiangkhong et al., 2023).

The findings of this study should be interpreted within several limitations. The retrospective case-control design relied on secondary medical record data, limiting the availability of information regarding smoking, medication adherence, duration of disease, lipid profiles, physical activity, and blood pressure or glycemic control. Residual confounding may therefore remain present despite multivariate adjustment. In addition, the study was conducted in a tertiary referral hospital, where patients generally have more severe disease and multiple comorbidities, potentially limiting generalizability to broader community populations. However, this setting also provides important clinical insight into recurrent stroke among high-risk hospitalized patients in Indonesia.

Implications:

The findings suggest that secondary prevention programs for recurrent stroke should prioritize older patients, particularly those with cardiovascular concomitant conditions include type 2 diabetes and coronary heart disease. Clinicians should adopt a comprehensive risk stratification approach during follow-up care.

Research Contribution:

This study provides evidence-based data on the profile of recurrent stroke risk factors in a tertiary referral hospital in North Sumatra, contributing to the limited literature on inpatient populations in Indonesia.

Limitations:

The retrospective nature of this research and its dependence on medical records, which can include missing data inputs, were its main limitations. The findings may have been impacted by the study's failure to evaluate blood pressure control levels in hypertension individuals or lifestyle variables like physical activity and smoking.

Suggestions:

Future studies should include longitudinal designs with longer follow-up periods, broader variable coverage including lifestyle and pharmacological compliance factors, and multi-center settings to improve generalizability

CONCLUSION

This study demonstrated that recurrent stroke among inpatients at H. Adam Malik General Hospital was significantly associated with age ≥55 years, male sex, type 2 diabetes mellitus, and coronary heart disease, while hypertension and obesity were not significantly associated after multivariate adjustment. Coronary heart disease emerged as the strongest factor associated with recurrent stroke, indicating the important role of cardiovascular comorbidities in recurrent cerebrovascular events. These findings suggest that recurrent stroke is a multifactorial condition influenced by complex interactions between demographic, metabolic, and vascular factors. The non-significant findings for hypertension and obesity may be influenced by confounding effects, collinearity with other cardiovascular variables, and the absence of data regarding blood pressure control, treatment adherence, and metabolic status. Therefore, comprehensive secondary prevention strategies focusing on older patients and individuals with cardiovascular and metabolic comorbidities are essential to reduce recurrent stroke risk

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AUTHOR CONTRIBUTION STATEMENT

STJ contributed to the study conceptualization, data collection, data analysis, and manuscript drafting. NS provided methodological supervision and critically reviewed the study design. HES contributed to data interpretation and statistical analysis. YKA participated in manuscript review and editing. LRS facilitated clinical coordination and access to medical record data. All authors read, reviewed, and approved the final version of the manuscript

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