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Factors Affecting the Severity of Non-Hemorrhagic Stroke

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ABSTRACT

Background: Stroke severity is influenced by multiple factors, including sociodemographic characteristics, health access, and time of treatment. Timely recognition of stroke onset and early hospital arrival are critical to reduce neurological damage. However, evidence on these factors in local Indonesian settings remains limited. This study aimed to analyze factors affecting the severity of non-hemorrhagic stroke among patients at Darmayu Ponorogo Public Hospital.

Subjects and Method: This cross-sectional study was conducted at Darmayu Ponorogo Public Hospital from July to September 2025. A total of 200 patients aged ≥18 years, diagnosed with non-hemorrhagic stroke, were selected using an accidental sampling method. The dependent variable was stroke severity, measured using the National Institutes of Health Stroke Scale (NIHSS). Independent variables included age, gender, education, occupation, income, health insurance, distance from home to hospital, and prehospital delay. Data were collected using structured questionnaires and medical records. Analysis was performed using simple logistic regression for bivariate analysis and multiple logistic regression for multivariate analysis.

Results: Bivariate analysis showed that prehospital delay was most powerfully significant factor, where patients arriving within ≤4.5 hours had lower odds of severe stroke compared to those with delays >4.5 hours (OR = 0.20; p = 0.020). Multivariate analysis confirmed prehospital delay as an independent predictor (OR = 0.09; 95% CI = 0.01 to 0.62; p = 0.015).

Conclusion: Prehospital delay is the most significant determinant of non-hemorrhagic stroke severity. Early hospital arrival (≤4.5 hours) substantially reduces the risk of severe stroke.

Keywords: non-hemorrhagic stroke, prehospital delay, risk factors, severity

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BACKGROUND

Stroke remains a leading cause of morbidity and mortality worldwide, with ischemic or non-hemorrhagic stroke accounting for the majority of cases (Feigin et al., 2021). In 2021, stroke accounted for 1 in 6 deaths from cardiovascular disease, with a stroke occurring in an individual every 40 seconds and a stroke-related death every 3 minutes and 14 seconds (Tsao et al., 2023). Nearly

one-quarter of strokes (about 185,000 cases) occur in individuals with a history of prior stroke. Ischemic strokes, which block blood flow to the brain, make up approximately 87% of all strokes. According to data from the 2023 Indonesian Health Survey, the prevalence of stroke in Indonesia reached 8.3 per 1,000 people. The prevalence of stroke in East Java in 2021 was 12.4% (Ministry of Health of Indonesia, 2023; Putri, 2023).

The severity of non-hemorrhagic stroke is influenced by a combination of demographic, clinical, and health-system related factors, which ultimately affect patient outcomes, disability, and quality of life (Lu et al., 2025). Age and gender are recognized predictors of stroke severity. Older age is strongly associated with more severe neurological deficits, while sex differences have been reported, with women often experiencing worse functional outcomes compared to men (Bushnell et al., 2018). Timely access to health services is another critical determinant. Prehospital delay, defined as the time from symptom onset to hospital arrival, is consistently linked to stroke severity and poor outcomes, as delayed treatment reduces the effectiveness of reperfusion therapies (Su et al., 2025; Terecoasă et al., 2022). Insurance coverage and health system capacity further influence access to acute interventions, particularly in low- and middle-income countries (Akinyemi et al., 2021).

Clinical characteristics such as comorbidities, including hypertension, diabetes, and atrial fibrillation, play significant roles in determining stroke severity and progression (Li et al., 2015). Similarly, signs and symptoms at presentation, such as motor weakness, speech impairment, and decreased consciousness, often reflect the underlying extent of ischemic injury and correlate with clinical severity (Powers et al., 2019). According to Xiuyun et al. (2020), higher education level is associated with a decreased rate of total stroke and ischemic stroke incident, but not hemorrhagic stroke incident. In addition, low socioeconomic status is associated with a higher risk of stroke mortality, with income and occupation being the most significant factors (Wang et al., 2020).

Evidence also highlights the importance of distance from home to hospital, as longer travel times are associated with delayed care and worse neurological outcomes (Wanichanon et al., 2024). Studies in different populations demonstrate that structural inequalities, geographic access, and prehospital systems of care strongly shape the severity of stroke at admission (Reddin et al., 2024).

This research is necessary to identify modifiable determinants and inform targeted interventions to reduce preventable stroke severity and improve patient outcomes. Given the multifactorial nature of stroke, it is essential to examine both individual and systemic determinants of severity in non-hemorrhagic stroke. A better understanding of these factors can guide targeted interventions, reduce prehospital delay, and improve stroke outcomes. Therefore, the purpose of this study was to analyze factors affecting the severity of non-hemorrhagic stroke among patients at Darmayu Ponorogo Public Hospital, East Java, Indonesia.

SUBJECTS AND METHOD

1. Study Design

This was a cross-sectional study to examine the factors affecting the severity of non-hemorrhagic stroke. The study was conducted at Darmayu Ponorogo Public Hospital. The study period was from July to September 2025.

2. Population and Sample

The population consisted of residentsmaged ≥18 years in Darmayu Ponorogo Public Hospital, East Java, Indonesia. The sample size was 200 respondents selected using an accidental Sampling method. The subjects were male and female non-hemorrhagic stroke patients aged ≥18 years. Inclusion criteria were those who visited the Darmayu Ponorogo Public Hospital and were either diagnosed with non-hemorrhagic stroke by a doctor. Exclusion criteria were patients who has another complication of disease or who has been in coma or decreased in condition.

3. Study Variables

The dependent variable was the severity of non-hemorrhagic stroke. The independent Variables were age, gender, education, occupation, income, health insurance, distance from home to hospital, hypertension, and prehospital delay.

4. Operational Definition of Variables

Stroke severity was defined as the level of neurological impairment caused by non-hemorrhagic stroke, measured using the National Institutes of Health Stroke Scale (NIHSS). It was categorized as mild–moderate (NIHSS score ≤15) and severe–very severe (NIHSS score >15).

Age was defined as the age of the patient at the time of stroke, obtained from medical records. It was categorized into ≤25 years and >25 years.

Gender was defined as the biological sex of the patient, obtained from medical records, and categorized as male and female.

E**ducation** was defined as the highest level of formal education attained, collected through questionnaire, and categorized as <bachelor's degree and ≥bachelor's degree.

Occupation was defined as the main work status of the patient, obtained through questionnaire, and categorized as working and not working.

Income was defined as the average monthly household income, collected through questionnaire, and categorized as ≤1,000,000 IDR and >1,000,000 IDR.

Health insurance was defined as the type of health coverage owned by the patient, obtained through questionnaire, and categorized as national health insurance (BPJS) and private insurance.

Distance from home to hospital was defined as the distance between the patient's residence and the hospital, obtained through questionnaire or estimation using address, and categorized as ≤20 km and >20 km.

Hypertension was defined as a history of high blood pressure based on medical diagnosis or medical records (≥130/80 mmHg), categorized as yes and no.

Prehospital delay was defined as the time interval between onset of stroke symptoms and arrival at the hospital, obtained from patient or family report and medical records, and categorized as ≤4.5 hours and >4.5 hours. hospital.

5. Study Instruments

Research instruments included the National Institutes of Health Stroke Scale (NIHSS) score, a questionnaires, and excel-based forms for collecting data on variables.

6. Data analysis

Data analysis was performed in three stages. Univariate analysis to describe respondent characteristics using frequency distribution tables.Bivariate analysis to explore associations between each independent variable and the dependent variable, using simple logistic regression. Multivariate analysis using multiple logistic regression to identify the most significant predictors of the severity of non-hemorrhagic stroke.

7. Research Ethics

Research ethical issues including informed consent, anonymity, and confidentiality,

were addressed carefully during the study process. The research ethical clearance approval letter was obtained from the Ethics Committee of Darmayu General Hospital, Ponorogo, No. 160.1/RSDmy/Ket/B-ADM/-II/2025, on February 22, 2025.

RESULTS

The majority of respondents were in the >25 years old age group (86%). Most were female (62%). In terms of education, the largest proportion had less than bachelor degree (70%). Regarding occupation status, most participants were working (80%). The majority reported an income of more than 1,000,000 Rupiah (52%), and most had national health insurance (BPJS) (70%). The farthest group was dominant in terms of distance, with ≤20 km from home to hospital (86%). Finally, the majority experienced a prehospital delay of less than 4.5 hours (72%). (see Table 1).

Table 1. Sample characteristics

Characteristics	Category	Frequency	Percentage
Age	≤ 25 years old	28	14.0%
	>25 years old	172	86.0%
Gender	Male	76	38.0%
	Female	124	62.0%
Education	<Bachelor	140	70.0%
	Bachelor	60	30.0%
Occupation	Not working	40	20.0%
	Working	160	80.0%
Income	≤IDR 1.000.000	96	48.0%
	>IDR 1.000.000	104	52.0%
Health insurance	National (BPJS)	140	70.0%
	Private	60	30.0%
Distance from home to hospital	≤20 km	172	86.0%
	>20 km	28	14.0%
Hypertension	No	107	53.50%
	Yes	93	46.50%
Prehospital delay	≤4,5 hours	144	72.0%
	>4,5 hours	56	28.0%

1. Bivariate Analysis

Age was not associated with stroke severity (≤25 years old vs. >25 years old: OR = 0.94; p = 0.895). Similarly, gender showed no significant association (male vs. female: OR= 0.88; p = 0.673). Education level indicated a higher risk of severe stroke among participants with less than a bachelor's degree compared to those with a bachelor's degree (OR = 2.91; p = 0.002), and it was statisticaly significant. Likewise, occupation showed a trend, where non-working individuals had increased odds of severe stroke compared to those who were working (OR = 3.88; p= 0.001). Regarding income, no significant relationship was observed (≤IDR 1,000,000 vs. >IDR 1,000,000((OR= 1.60; p = 0.101). Health insurance type showed a significant trend, with national (BPJS) holders having higher odds of severe stroke compared to private insurance holders (OR= 2.91; p = 0.002). Distance from home to hospital (>20 km vs. ≤20 km) was not significantly associated with severity (OR = 2.17; p= 0.081). Patients arriving within ≤4.5 hours had substantially lower odds of severe stroke compared to those arriving later (OR = 0.20; p = 0.0001).

Table 2. Determinants of the severity of non-hemorrhagic stroke

Variables	The severity of non-hemorrhagic stroke				OR	p
	Mild-Moderate		Severe-Very Severe			
	N	%	N	%		
Age						
≤25 years old	12	6.0	16	8.0	0.94	0.895
>25 years old	76	38.0	96	48.0		
Gender						
Male	32	16.0	44	22.0	0.88	0.673
Female	56	28.0	68	34.0		
Education						
< Bachelor	72	36.0	68	34.0	2.91	0.002
Bachelor	16	8.0	44	22.0		
Occupation						
Not working	28	14.0	12	6.0	3.88	0.0001
Working	60	30.0	100	50.0		
Income						
≤1.000.000 Rupiah	48	24.0	48	24.0	1.60	0.101
>1.000.000 Rupiah	40	20.0	64	32.0		
Health Insurance						
National (BPJS)	72	36.0	68	34.0	2.91	0.002
Private	16	8.0	44	22.0		
Distance from home to hospital						
≤20 km	80	40.0	92	46.0		
>20 km	8	4.0	20	10.0	2.17	0.081
Hypertension						
No	48	24.0	96	48.0	1.92	0.024
Yes	40	20.0	16	16.0		
Prehospital delay						
≤4,5 hours	48	24.0	96	48.0	0.20	0.0001
>4,5 hours	40	20.0	16	8.0		

2. Multivariate analysis

Age was not significantly associated with stroke severity (OR = 0.57; 95% CI= 0.19–1.68; p = 0.312). Similarly, gender (OR = 1.07; 95% CI= 0.49–2.33; p= 0.852), occupation (OR= 3.40; 95% CI= 0.85–13.60; p = 0.307), and hypertension (OR = 0.65; 95% CI = 0.25–1.68; p = 0.377).

In contrast, education (OR = 3.14; 95% CI = 1.22–8.05; p = 0.017), distance from home to hospital (OR = 6.11; 95% CI = 0.62–50.02; p = 0.001), health insurance showed a higher odds ratio (OR= 6.11; 95% CI= 2.00–18.69; p= 0.001), and prehospital delay (OR = 0.09; 95% CI= 0.03–0.24; p = 0.0001) was significantly associated with stroke severity. Patients who arrived at the hospital within ≤4.5 hours had markedly lower odds of severe stroke compared to those with longer delays.

Table 3. The result of multiple logistic regression analysis

Independent Variables	OR	95% CI		p
		Lower Limit	Upper Limit	
Age	0.57	0.19	1.68	0.312
Gender	1.07	0.49	2.33	0.852
Education	3.14	1.22	8.05	0.017
Occupation	3.40	0.85	13.60	0.307
Income	0.82	0.30	2.18	0.695
Health Insurance	6.71	2.06	21.75	0.002
Distance from home to hospital	6.11	2.00	18.69	0.001
Hypertension	0.65	0.25	1.68	0.377
Prehospital delay	0.09	0.03	0.24	0.0001

DISCUSSION

The results of this study found that education, distance from home to hospital, health insurance, and prehospital delays significantly associated with the severity of non-hemorrhagic stroke. This result aligns with findings from several previous studies. First, a multicenter Korean study reported that early arrival (within 3 hours of onset) was significantly associated with higher severity on the NIH Stroke Scale, and more importantly, with better outcomes, compared to delayed arrivals. Patients and bystanders' awareness of stroke symptoms and use of ambulance services substantially increased the odds of early presentation, thereby reducing the risk of severe stroke (Kim et al., 2011). Second, a large regional stroke registry analysis demonstrated that among acute ischemic stroke patients, arrival within 4 hours of symptom onset was associated with more favorable modified Rankin Scale (mRS) outcomes (score 0-2), even after adjusting for stroke severity and thrombolytic therapy use. Early presenters were less likely to have severe disability and more likely to recover to a lesser degree of functional impairment (Nagao et al., 2020). Third, a study in India examining prehospital factors in acute ischemic stroke (Thrissur, Kerala) found that patients who arrived within the 4.5-hour window had significantly lower severity compared to those who came later. The study also identified modifiable delays (e.g., lack of awareness, difficulty accessing transport) as major contributors to later arrival (Edakkattil et al., 2024). The results of current study was also similar with study by Xiuyun et al. (2020b)which stated that Higher education levels are linked to a lower risk and reduced severity of ischemic (non-hemorrhagic) stroke. Both epidemiological and genetic (Mendelian randomization) studies suggest a protective, potentially causal effect of education on ischemic stroke risk and outcomes. In terms of health insurance, the current study also supported by Pinapaka et al. (2025) which explained that insurance status significantly affects stroke outcomes. Patients with Medicaid or Medicare are less likely to be discharged home (a marker of better recovery and less severe stroke), while those who self-pay are more likely to be discharged home, compared to those with private insurance. In addition, the factor distance from home was probably also associated with prehospital delays of treatment to non-hemorrhagic stroke patients. Currently, there is no found study which investigate the association between those two factors. However, two studies did mention that longer driving time from home to hospital is linked to lower odds of receiving tissue plasminogen activator, a critical treatment for ischemic stroke, and longer onset-to-arrival time (Acharya et al., 2011; Ader et al., 2019).

Meanwhile, the analysis demonstrated that several sociodemographic and contextual factors, including gender, occupation, income, and, hypertension were not significant predictors in the studied model. Specifically, gender showed only a slight association with the outcome, indicating that male and female respondents did not differ substantially in terms of risk. Occupation showed a similar trend, yet remained statistically nonsignificant. Household income appeared to have little influence on the studied outcome, reflecting that financial status alone may not determine health-related behaviors or access in this context. However, the lack of statistical significance and wide interval imply that further evidence is needed before drawing firm conclusions. Interestingly, in the multivariate analysis we found no association between hypertension and stroke, this could be due to a lack of statistical power (small sample size), the low-risk group, or the presence of other influential risk factors or protective factors that may have masked the effect of hypertension. This finding supported by several studies stated hypertension, gender, and other comorbidities did not significantly predict stroke severity when controlling for more direct clinical measures (Fernandez-Lozano et al., 2021; Rost et al., 2016). Others study stated that inflammatory markers and specific clinical scores have shown stronger associations with stroke severity than traditional demographic or socioeconomic factors (Cheng et al., 2021; Ren et al., 2017).

This study has several limitations that should be acknowledged when interpreting the findings. First, the research employed a cross-sectional design, which inherently restricts the ability to infer causal relationships between the identified factors and the severity of non-hemorrhagic stroke. While associations can be observed, temporal dynamics cannot be established, limiting conclusions about directionality. Second, the relatively small sample size of 200 respondents reduces the statistical power of the study. As a result, several potential predictors showed wide confidence intervals and failed to reach statistical significance, which may reflect insufficient sample representation rather than a true absence of effect. Third, the use of accidental sampling may introduce selection bias, as patients included in the study might not represent the broader population of non-hemorrhagic stroke patients in different hospitals or regions. This limitation may reduce the generalizability of the findings. Fourth, the study was conducted in a single hospital setting, thereby limiting the external validity. Stroke outcomes and contributing factors may differ across regions due to variations in healthcare infrastructure, patient awareness, socioeconomic factors, and cultural practices. Lastly, unmeasured confounding variables, such as lifestyle factors, other comorbidities, and social support, were not included in the analysis but may significantly influence both prehospital delay and stroke severity.

Despite these limitations, the findings of the study provide important insights. The results demonstrated that among the variables examined, most powerfully significant prehospital delay with stroke severity. Patients who arrived at the hospital within 4.5 hours of symptom onset had substantially lower odds of experiencing severe non-hemorrhagic stroke compared to those who presented later. This emphasizes the crucial role of time-to-hospital as a modifiable factor in determining stroke outcomes.

Based on these findings, several recommendations can be proposed. At the public health level, efforts should focus on increasing community awareness of stroke symptoms and the urgency of immediate

hospital presentation. Educational campaigns emphasizing the importance of the "golden period" within 4.5 hours could help reduce delays in seeking care. Health systems should strengthen prehospital emergency services, particularly ambulance accessibility, to ensure rapid transport of suspected stroke patients. At the policy level, integrating stroke awareness into broader non-communicable disease prevention programs may prove beneficial, particularly in rural or underserved areas where delays are more common. For clinicians, reinforcing patient and family education about recognizing stroke signs during hospital visits may help improve readiness for timely action in future events. For future research, larger multicenter studies with probability-based sampling are recommended to validate the observed findings and enhance generalizability. Incorporating additional variables such as comorbid conditions, stroke awareness, transportation availability, and prehospital care utilization could provide a more comprehensive understanding of determinants of stroke severity. Longitudinal or cohort designs would also help clarify causal relationships. Ultimately, strengthening early recognition and response to stroke symptoms remains a key strategy to reduce severity and improve patient outcomes.

AUTHOR CONTRIBUTION

All authors contributed to the study conception and design. Nurul Sri Wahyuni developed the research idea, conducted data collection, and performed data analysis. Eky Okviana Armyati supervised the research process and contributed to the study design and interpretation of the results. Aisyah Miftakhur Rohmah assisted in data analysis and manuscript drafting. All authors reviewed, revised, and approved the final version of the manuscript.

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CONFLICT OF INTEREST

There are no conflicts of interest.

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