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ANALYSIS OF FACTORS ASSOCIATED WITH THE LENGTH OF HOSPITAL STAY AMONG STROKE PATIENTS: A SCOPING REVIEW

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ABSTRACT
Length of Stay (LOS) is a key determinant influencing inpatient care costs and serves as an important indicator of hospital service quality. The duration of hospitalization is affected by multiple factors. This study aims to identify the factors associated with the length of stay among patients with stroke. This research employed a scoping review approach using the databases Elsevier Scopus, Google Scholar, and Academia.edu. The review process consisted of the following stages: (1) identifying the research question, (2) identifying relevant articles, (3) screening articles, (4) data charting, (5) summarizing the findings, and (6) consultation. A total of 640 articles were initially selected based on title, abstract, content, and relevance to the inclusion criteria and objectives of this study. Following the screening process, next step was to analyze the 12 selected journals using the JBI Critical Appraisal tool. The inclusion criteria were full-text articles focusing on factors associated with the length of hospital stay in stroke patients, involving populations and samples of stroke patients aged over 18 years and/or their family members. This scoping review identified several factors associated with the length of hospital stay among stroke patients, including patient characteristics, comorbidities, stroke type, management strategies, complications, stroke symptoms, and smoking history, all of which may contribute to shorter hospitalization duration. The length of hospital stay among stroke patients may vary depending on multiple influencing factors. Further comprehensive studies are recommended to explore in greater depth the impact of these factors on hospitalization duration among stroke patients.

Keywords: length of stay; LOS; stroke; stroke patients

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INTRODUCTION

Stroke is a disease caused by the occlusion or rupture of blood vessels in the brain, resulting in an inadequate supply of blood and oxygen to brain tissue, which leads to the death of brain cells (Nathania et al, 2022). Stroke is the second leading cause of death and the third leading cause of disability worldwide (Johnson et al, 2016). According to the American Heart Association (AHA, 2017), the global prevalence of stroke in 2013 reached 25.7 million people, with 6.5 million deaths worldwide. This number places stroke as the second leading cause of death after ischemic heart disease (Go et al, 2014). Projections indicate that by 2030, approximately 3.4 million people will experience stroke, representing a 20.5% increase from 2012 (Ovbiagele et al, 2013). The annual incidence of stroke is 15 million cases worldwide; one-third of these patients will die, and another one-third will suffer permanent disability (Johnston et al). More than 85% of stroke-related deaths occur among individuals living in low- and middle-income countries (WHO, 2006). The main type of stroke is ischemic stroke, which varies in cause, clinical presentation, risk factors, and outcomes — all of which are critical for early stroke management (Sacco et al, 1998). Post-stroke outcomes differ among countries, and recent studies have sought to explain these variations (Barinin et al, 2000).

Several stroke registries from different countries and continents have provided valuable knowledge and data on the epidemiology, risk factors, mechanisms, subtypes, and outcomes of stroke (Lee et al, 2005). Some studies have found associations between in-hospital mortality rates and factors such as sex, older age, previous stroke history, and other risk factors (Gargano et al, 2008). Length of

Stay (LOS) is an important factor influencing hospitalization costs and serves as an indicator of hospital service quality. LOS represents the total number of days a patient spends in the hospital, from admission to discharge. A higher LOS is generally interpreted as an indicator of lower service efficiency, whereas a shorter LOS reflects better quality and efficiency of healthcare services (Nirmalasari et al, 2020).

Several factors influence the length of hospital stay among stroke patients, including stroke type, sex, age, number of comorbid diagnoses, lesion location, Glasgow Coma Scale (GCS) score, and complications during hospitalization (Saxena et al, 2016). Age and sex are significant sociodemographic determinants strongly associated with LOS among stroke patients (Arboix, 2015). Meanwhile, comorbidities, medical complications, residual symptoms, and stroke type affect the rate of clinical recovery (Dina & Purhadi, 2013). Other influencing factors include age, sex, marital status, blood pressure (hypertension), heart disease, diabetes mellitus, cholesterol level, medical complications, stroke type, infarction or hemorrhage location, and hemorrhage volume (Putu et al, 2018). Understanding the determinants of LOS in stroke patients is essential to reducing the economic burden on patients and families and can serve as a basis for clinical decision-making in stroke management within hospitals (Delbari et al, 2010).

According to several international studies, various factors are associated with the length of hospital stay among stroke patients. Female patients tend to have a significantly longer LOS compared to males, and patients with heart disease also experience prolonged hospitalization (Huang et al, 2013). Other predictive factors significantly associated with LOS include diabetes mellitus, atrial fibrillation, cost of care, smoking, and secondary prevention treatment (Kim et al, 2013).

In Indonesia, studies analyzing factors associated with the length of hospital stay among stroke patients have been conducted in Jakarta and Yogyakarta. However, there remains a lack of comprehensive literature reviews that specifically analyze these factors. Therefore, this study aims to analyze the factors associated with the length of hospital stay among stroke patients. Identifying these influencing factors is expected to support targeted interventions that can help reduce hospitalization duration in stroke patients.

METHOD

This literature study employed a scoping review method using secondary data obtained from both national and international journals published between 2010 and 2025. The search was conducted using the following keywords: *stroke AND length of stay*, *LOS AND factors*, and *factors AND determinants*. The databases used in this study were Elsevier Scopus, Google Scholar, and Academia.edu. A total of 19 articles were included in this literature review, selected through the PRISMA flow diagram stages of scientific article identification and screening.

Tabel 1.
Article Search Results

Database used	Number of articles found	Articles selected for further screening
Elsivier scopus	120 articles	13 articles
Google scholar	365 articles	3 articles
Academia.edu	155 articles	3 articles
Total	640 articles	19 articles

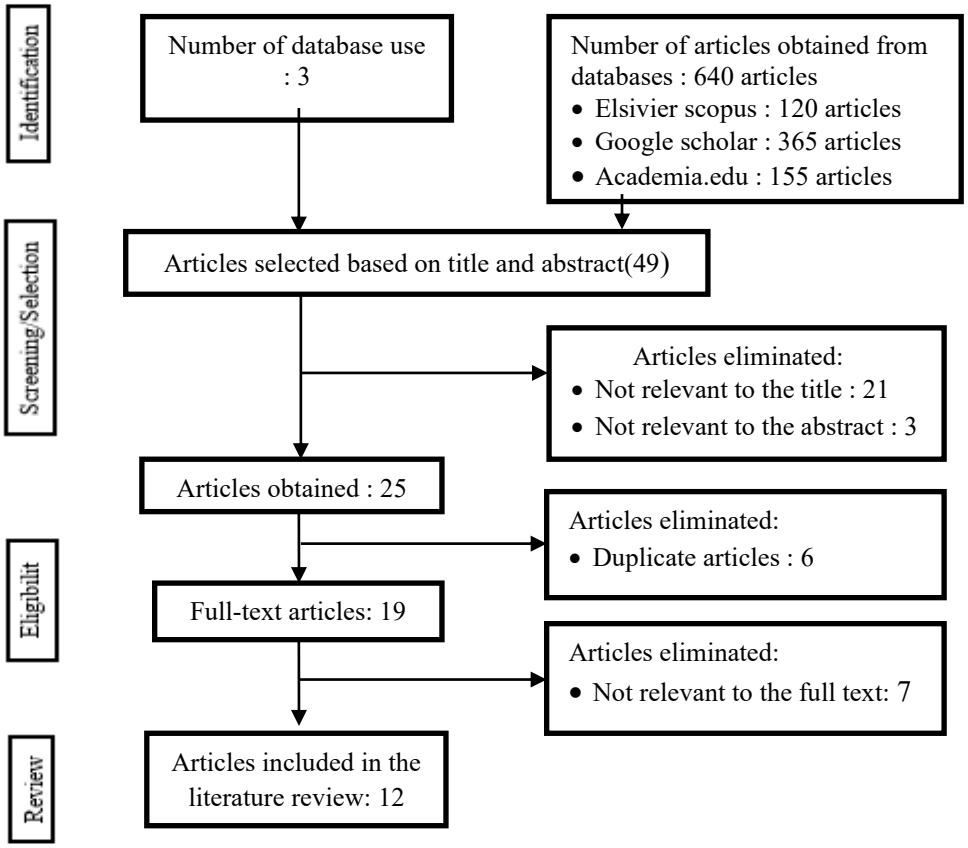

Figure 1. PRISMA Flow Diagram (Results of the Literature Review Process)

RESULT

After completing the scoping review process, a total of 19 articles were obtained, which were then further screened to 12 articles that met the inclusion criteria. The next stage involved analyzing these 12 articles using the JBI Critical Appraisal tool. From these articles, several factors were identified and categorized into four main factors associated with the length of hospital stay among stroke patients.

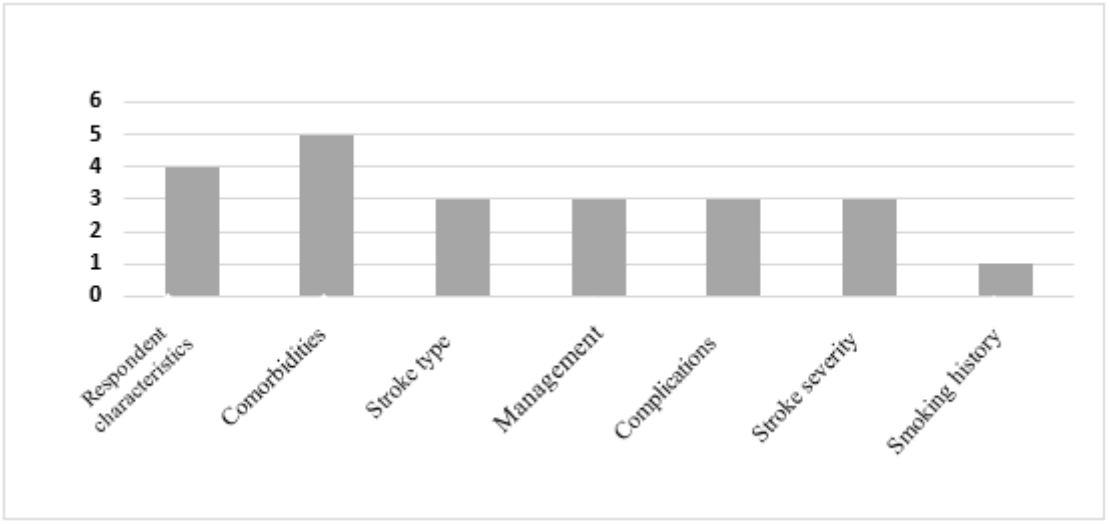

Figure 2. Graph of Frequently Identified Factors in the Scoping Review

Tabel 2.
Results of the Literature Review

No	Author (Year)	Article Title	Associated Factors	Findings
1.	Sang Mi Kim, Sung Wan Hwangb, Eun-Hwan Ohc, Jung-Kyu Kang (2013) (Kim et al, 2013)	Determinants of the Length of Stay in Stroke Patients	Respondent characteristics	Older age ($p < 0.05$) was associated with longer hospital stays due to the need for surgical intervention
			Comorbidities	Hypertension and diabetes were significant factors associated with reduced LOS ($p < 0.05$).
			Management (Surgical/ Operative)	Patients who underwent surgery had longer hospital stays
2.	Ahmad Delbari, MD,Reza Salman Roghani, Sayed Shahaboddin Tabatabaei, and Johan Lo¨kk, (2010) (Delbari et al, 2010)	A Stroke Study of an Urban Area of Iran: Risk Factors, Length of Stay, Case Fatality, and Discharge Destination.	Respondent characteristics	Female patients had significantly longer LOS than males (8.4 vs. 7 days, $p = 0.0075$).
			Comorbidities	Patients with coronary heart disease had significantly longer LOS (8.9 days, 95% CI: 8–10, $p = 0.004$).
			Stroke type	The mean LOS for ischemic stroke inpatients was 7.7 days (95% CI: 7.2–8.2).
3.	Ying-Chih Huang, Chaur-Jong Hu, Tsong-Hai Lee, Jen-Tsung Yang, Hsu-Huei Weng, Leng Chieh Lin, and Shiao-Lin Lai (2013) (Huang et al, 2013)	The Impact Factors on the Cost and Length of Stay among Acute Ischemic Stroke	Respondent characteristics	Age ≥65 years ($p = 0.005$) was significantly associated with longer LOS
			Comorbidities	Diabetes mellitus showed a significant association with longer LOS ($p = 0.001$).
			Stroke type	Ischemic stroke type was associated with longer LOS ($p = 0.033$), including TACI ($p = 0.001$) and POCI ($p = 0.016$).
4.	Filomena Gomes, Peter W. Emery, and C. Elizabeth Weekes (2016) (Gomes et al, 2016)	Risk of Malnutrition Is an Independent Predictor of Mortality, Length of Hospital Stay, and Hospitalization Costs in Stroke Patients	Complications	Length of stay increased progressively with higher malnutrition risk ($p < 0.001$), ranging from an average of 14 to 48 days.
5.	Bharti Manwani, Subhendu Rath, MBBS,Nora S. Lee, Ilene Staff, Christoph Stretz, Janhavi Modak, MBBS, and Pasquale F. Finelli (2019) (Manwani et al, 2019)	Early Magnetic Resonance Imaging Decreases Hospital Length of Stay in Patients with Ischemic Stroke. Journal of Stroke and Cerebrovascular Diseases,	Management	Statistically significant difference in LOS between patients who underwent MRI within 12 hours ($p < 0.001$).
6.	Zhong Yu, Jingjing Xing, Bing Wang, Hua Hang , Sheng Ye (2025) (Yu et al, 2025)	Development of a predictive model for prolonged length of stay in conservatively treated patients with spontaneous intracerebral hemorrhage A retrospective study	Comorbidities	Pulmonary infection was associated with prolonged LOS ($p = 0.006$). Systolic blood pressure was also a risk factor related to longer LOS ($p = 0.045$).
			Stroke severity (NIHSS scale)	NIHSS score was significantly associated with LOS ($p = 0.018$).
7.	Ramesh Grandhi, Vijay M. Ravindra, John P. Ney, OsamaZaidat, Philipp Taussky, and Adam de Havenon (2021)	Investigating the “Weekend Effect” on Outcomes of Patients Undergoing Endovascular Mechanical	Management	Average LOS ranged from 7.8–9.1 days. No significant differences were found between weekend and weekday admissions regarding in-hospital mortality (11.0% vs. 11.9%, $p = 0.327$), favorable

No	Author (Year)	Article Title	Associated Factors	Findings
	(Grandhi et al, 2021)	Thrombectomy for Ischemic Stroke		discharge (20.1% vs. 21.0%, p = 0.467), or LOS >10 days (21.0% vs. 20.5%, p = 0.620)
8.	Alejandro García-Rudolph, Mark Andrew Wright, Emilien Amar Devilleneuve, MSc , Eloy Opisso, Elena Hernandez-Pena (2024) (Garcia-Rudolph et al, 2024)	Falls characteristics experienced by working-age adults during inpatient post-stroke rehabilitation and their impact on length of stay, discharge functional status, ambulation and destination	Complications	Patients who experienced falls had an average LOS that was 8 days longer ($p < 0.001$).
9.	Olasheni Abdul-Afeez Somotun, Kayode Omoniyi Osungbade, Oluwaseun Oladapo Akinyemi,&, Taiwo Akinyode Obembe, Folashayo Ikenna Adeniji (2017) (Somotun et al, 2024)	What factors influence the average length of stay among stroke patients in a Nigerian tertiary hospital?	Comorbidities	Patients with alcohol consumption, diabetes, and hypertension had a greater likelihood of LOS >7 days, though the difference was not statistically significant ($0.310 < p < 0.883$).
10.	Aniza Ismail, Muhammad Alimin Mat Reffien, Norlinah Mohamed Ibrahim, Hanani Nabilah Mohd Sobri, Noor Dalila Inche Zainal Abidin, Sharifah Ain Shameera Syed Rusli, Ellyana Mohd Selamat (2020) (Ismail et al, 2020)	Factors Associated With Length of Stay for Patients With Stroke in Malaysia	Stroke severity	Disease severity was significantly associated with prolonged LOS ($p < 0.001$).
11.	Iswari Septiana Nindi Wulandari, Wahyu Ratri Sukmaningsih, Sri Wulandari (2024) (Wulandari et al, 2024)	Analysis of Factors Affecting the Length of Hospital Stay of Stroke Patients at Dr. Soediran Mangun Sumarso Regional General Hospital, Wonogiri	Stroke type Complications	Stroke type was significantly associated with LOS ($p = 0.004$). Complications were also associated with LOS ($p = 0.025$).
12.	Ku-Chou Chang, Mei-Chiun Tseng, Hsu-Huei Weng, Yin-Hui Lin, RN; Chia-Wei Liou, Teng-Yeow Tan (2016) (Chang et al, 2016)	Prediction of Length of Stay of First-Ever Ischemic Stroke	Respondent characteristics Stroke severity (NIHSS scale) Smoking	Male sex was associated with an average increase of 1.2 days in LOS ($p = 0.004$). NIHSS score was significantly correlated with LOS ($p = 0.001$). Smoking reduced LOS by approximately 1.2 days ($p = 0.043$).

DISCUSSION

Based on 12 collected articles, there are seven main themes related to the length of hospital stay (LOS) among stroke patients, which include: respondent characteristics, comorbidities, type of stroke, management, complications, stroke symptoms, and smoking history, to analyze the factors associated with the LOS of stroke patients.

Respondent Characteristics

From the literature review, it was found that respondent characteristics such as age, sex, and race are influential factors affecting the length of hospital stay among stroke patients. One study reported that among patients who underwent surgery, age was a factor influencing LOS (Kim et al, 2013). Age above 65 years significantly affected hospital costs and LOS, excluding recurrent stroke cases (Huang et al, 2013). Besides age, the scoping review revealed that sex also influenced LOS. The study found that sex may affect LOS among patients with ischemic stroke, with female patients staying longer than male patients. (Delbari et al, 2010). Another study showed that male sex was associated with an increase in LOS by approximately 1.2 days (Chang et al, 2016). The incidence of stroke increases with advancing age in both men and women from 1.76 per 1,000 individuals per year in the 55–64 age range to 16.47 per 1,000 among those aged 85 and older (Dina & Purhadi, 2013). The difference in disease incidence by sex may be attributed to differences in anatomy, physiology, and hormonal systems. Additionally, sex characteristics are linked to variations in exposure and vulnerability to certain diseases (Arulprakash & Umaiorubahan, 2018). Among the 12 reviewed articles, four discussed respondent characteristics associated with LOS, identifying age and sex as key influencing factors.

Comorbidities

Common comorbidities among stroke patients include hypertension, diabetes mellitus, and hypercholesterolemia/hyperlipidemia. Studies investigating the relationship between hypertension and LOS among stroke patients have shown varying results. After examining differences in LOS based on hypertension and diabetes classified as “no risk factors,” “hypertension,” “diabetes,” or “hypertension and diabetes” it was found that having both hypertension and diabetes was a significant factor associated with reduced LOS across all groups (Kim et al, 2013). Diabetes mellitus (DM) was identified as the second most common risk factor among patients in one study (Somotun et al, 2017). Other comorbidities influencing LOS included heart disease, where patients with cardiac conditions had significantly longer stays (9 days; 95% CI 7.8–10; P = 0.004) (Delbari et al, 2010). Predictive factors for LOS included diabetes mellitus, atrial fibrillation, recurrent stroke, and stroke subtype (TACI total anterior circulation infarction and POCI posterior circulation infarction) (Huang et al, 2013). A nomogram was developed from multivariate logistic regression analysis to predict prolonged LOS in patients with spontaneous intracerebral hemorrhage, incorporating systolic blood pressure at admission, ADL score, NIHSS score, and hospital-acquired pulmonary infection (Yu et al, 2025).

Type of Stroke

Stroke type is often considered one of the most influential factors affecting LOS. Pathologically, stroke is classified into ischemic stroke and hemorrhagic stroke (Putu et al, 2018). In the scoping review, the average LOS for ischemic stroke was 7.7 days (95% CI 7.2–8.2) among ischemic stroke patients in Iran (Delbari et al, 2010). The type of stroke showed a significant relationship with LOS (P = 0.033), particularly for TACI (P = 0.001) and POCI (P = 0.016) subtypes (Huang et al, 2013). In another study reviewed, ischemic stroke cases predominated (196 patients, 65.3%) with comorbidities present in 186 patients (62%) data drawn from Dr. Soediran Mangun Sumarso Regional General Hospital, Wonogiri. Ischemic stroke patients were hospitalized between 1–17 days (mean 7 days), while hemorrhagic stroke patients stayed 1–41 days (mean 8 days) (Wulandari et al, 2024). Among the 12 articles, three reported that ischemic stroke type was significantly associated with LOS in stroke patients.

Stroke Symptoms

Another factor influencing LOS is the severity of symptoms, which reflects the urgency of medical attention required. The National Institutes of Health Stroke Scale (NIHSS) is a tool used to assess the neurological deficit severity and can indicate symptom intensity based on the score obtained.

Higher NIHSS scores, indicating more severe symptoms, are associated with earlier hospital arrival (Arulprakash & Umaiorubahan, 2018). In one study, patients in the prolonged LOS group (n = 26,

16.1%) had significantly higher NIHSS scores, systolic blood pressure, pulmonary infection rates, and white blood cell counts; NIHSS was significantly related to LOS among patients with spontaneous intracerebral hemorrhage (P = 0.018) (Yu et al, 2025). Similarly, another study found that disease severity was significantly associated with longer LOS (p < 0.001) (Ismail et al, 2020). Specifically, each 1-point increase in total NIHSS score was linked to an increase of about 1 day in LOS for mild-to-moderate neurological impairment (score 0–15), whereas in severe cases (score >15), LOS decreased by about 1 day (Chang et al, 2016). These findings suggest that public perception of stroke symptom severity may predict delays in treatment. Therefore, improving stroke awareness including recognition of early signs and appropriate responses such as contacting hospitals or emergency numbers (Indonesia: 119) can reduce prehospital delay and consequently shorten LOS.

Management

Because the therapeutic window in acute stroke management is extremely short, rapid, systematic, and accurate evaluation and diagnosis are essential. Supporting diagnostic tests should be promptly performed in emergency departments for all acute stroke patients. The literature review found a statistically significant difference in LOS between patients who underwent MRI within 12 hours (P < 0.001) (Manwani et al, 2019). When patients were categorized based on whether they underwent surgery, LOS differed by 2.4 times for subarachnoid hemorrhage, 2.0 times for cerebral infarction, and 1.4 times for intracerebral hemorrhage. Patients who underwent surgery stayed 16.7 days longer (2.1 times, 32.6 days) than those who did not (15.9 days) (Kim et al, 2013). Among ischemic stroke patients treated with endovascular mechanical thrombectomy, there was no significant difference in LOS between weekend and weekday admissions (10 days; 21.0% vs. 20.5%, p = 0.620) (Grandhi et al, 2021).

Complications

Stroke patients are generally prone to medical complications during hospitalization, which affect their clinical condition. Common complications include pneumonia, urinary tract infection, constipation, and pressure ulcers, often resulting from stroke-related symptoms and the hospital care process (Feigin et al, 2019). The scoping review found that complications were significantly associated with LOS (P = 0.025). Stroke-related complications may arise due to brain injury, and prolonged hospitalization increases the risk of infection (Wulandari et al, 2024) (Shah & Cole, 2010). LOS also increased with higher malnutrition risk (P < 0.001), ranging from 14 to 48 days on average (Gomes et al, 2016). Another study found that patients who experienced falls had an average LOS 8 days longer (P < 0.001) (Garcia-Rudolph, 2024).

Smoking

Smoking increases the risk of thrombus formation in narrowed arteries and contributes to atherosclerotic plaque buildup. It also increases blood viscosity, fibrinogen levels, platelet aggregation, and decreases high-density lipoprotein (HDL) cholesterol, leading to endothelial damage and elevated blood pressure. Passive smoking also heightens the risk of stroke. Cigarette smoke damages blood vessels, potentially causing blockages and leading to stroke (Feigin et al, 2021). According to the scoping review, smoking was found to reduce LOS by approximately 1.2 days (P = 0.043), as it was one of the main factors influencing LOS among first-time ischemic stroke patients (Chang et al, 2016). However, this finding contradicts other studies indicating that while smoking is widely recognized as a stroke risk factor, evidence supporting a strong dose response relationship between smoking and stroke risk remains insufficient (Shah & Cole, 2010).

CONCLUSION

Based on the review of the collected journals, seven factors were identified to be associated with the length of hospital stay among stroke patients. These factors are: (1) Respondent characteristics, which include variables such as age and gender; (2) Comorbidities, encompassing medical histories of hypertension, diabetes mellitus, coronary heart disease, and pulmonary disease; (3) Type of stroke, with ischemic stroke showing a more dominant influence; (4) Management, referring to in-

hospital interventions such as MRI examinations, surgical procedures, and endovascular mechanical thrombectomy; (5) Complications, including conditions such as malnutrition or falls occurring during hospitalization; (6) Stroke symptoms, assessed using the NIHSS (National Institutes of Health Stroke Scale) to determine the severity level of the disease and its impact on the length of stay; and (7) Smoking history, referring to the patient's smoking behavior prior to having a stroke. Further research is still needed to comprehensively examine the influence of these factors on the length of hospital stay among stroke patients.

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