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## Profiles Patients based on Risk Factors for Ischemic Stroke in the Neurology Inpatient Ward of Dr. Soetomo General Academic Hospital Surabaya during the Period of January to June 2022

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### ABSTRACT

**Introduction:** Stroke is a major cause of disability and death worldwide. Among the three types of strokes, the ischemic stroke is the most prevalent. Controlling risk factors is a key approach to preventing ischemic stroke. Due to the limited data availability in Indonesia, it is important to research patient profiles focusing on risk factors for ischemic stroke. **Objective:** To record the patient profiles based on the risk factors for ischemic stroke in the neurology inpatient ward of Dr. Soetomo General Academic Hospital Surabaya for the period of January–June 2022. **Methods:** This was a descriptive observational study with a retrospective design. This study examined secondary data from ischemic stroke patients' medical records at the Dr. Soetomo General Academic Hospital's neurology inpatient ward in Surabaya between January and June 2022. **Results:** Out of 176 patients, 108 were under the age of 65. Of these, 97 were male. There were 63 patients with a history of ischemic stroke, 58 with diabetes mellitus, 84 with stage 2 hypertension, 77 with dyslipidemia, 59 with impaired kidney function, 52 with diabetes mellitus by lab tests, and 23 who smoked. **Conclusion:** In this study, some risk factors exhibited discrepancies and contradicted existing theories. The two dominant variables in the patient population were a combination of risk factors that occur more frequently at a certain age and a combination of risk factors in patients with recurrent strokes.

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## INTRODUCTION

Stroke is a clinical manifestation of disruption or damage to the brain's blood circulation system, which can lead to significant morbidity and mortality. Strokes are classified into three types: ischemic, hemorrhagic, and subarachnoid.<sup>1</sup> The most common type of stroke is ischemic, caused by the formation of blood clots or other particles and fat accumulation on the vessel walls (plaques) that can block blood vessel flow to the brain, disrupting the brain's blood and oxygen supply.<sup>2</sup> In patients with hypertensive ischemic stroke, vessel remodeling and hypertrophy cause the vascular lumen to decrease while the vascular resistance increases. This makes blood flow to the brain harder during a stroke.<sup>3</sup>

Stroke is a leading cause of disability and death worldwide. It is defined as a neurological deficiency resulting from acute focal injury to the central nervous system caused by vascular disorders such as cerebral infarction, intracerebral hemorrhage, and subarachnoid hemorrhage.<sup>4</sup> According to the World Health Organization (WHO), 15 million people worldwide get strokes each year, posing a high risk of mortality. Of these 15 million, five million die, and another five million experience permanent disabilities.<sup>5</sup>

Nationally, based on Basic Health Research (Riskesdas) data, the prevalence of stroke in Indonesia in 2018, diagnosed by doctors in the population aged  $\geq 15$  years, was 1.09%, or an estimated 2,120,362 people. In East Java, it reached 1.24%.<sup>6</sup> In Surabaya, stroke prevalence increased from 0.7% in 2007 to 16.2% in 2013. A study conducted at Dr. Soetomo General Academic Hospital Surabaya from January to October 2018 showed 73 stroke cases, predominantly ischemic strokes (53 patients, or 72.6%).<sup>7</sup>

Ischemic stroke risk factors are classified into non-modifiable factors (age, gender, stroke history, and diabetes mellitus) and modifiable factors (hypertension, diabetes mellitus, smoking habits, dyslipidemia, and kidney function disorders).<sup>8</sup> Stroke remains a severe medical condition that can be life-threatening, with ischemic stroke being a commonly encountered type.<sup>9</sup> This underscores the importance of identifying high-risk factors for ischemic stroke as a preventive effort, especially in Surabaya, due to the limited information on this matter. Additionally, various studies have shown different results regarding the percentage of ischemic stroke risk factors, and this research can enhance knowledge and insight for colleagues, serving as a reference for similar studies in the future.

## OBJECTIVE

This study aimed to record the patient profiles

based on the risk factors for ischemic stroke in RSUD Dr. Soetomo Surabaya for the period of January–June 2022.

## METHODS

This was a descriptive observational study with a retrospective design conducted at the neurology ward at Dr. Soetomo General Academic Hospital during the period of January to June 2022. The study used medical record as secondary data and employed a total sampling technique. Ischemic stroke risk factors encompass both non-modifiable and modifiable factors. In this study, the non-modifiable risk factors consisted of age, sex, history of stroke, and history of diabetes mellitus. Meanwhile, the modifiable risk factors included diabetes, smoking habits, dyslipidemia, hypertension, and kidney function impairment.

## RESULTS

This study included 176 records of ischemic stroke patients from January to June 2022 in the neurology inpatient ward at Dr. Soetomo General Academic Hospital in Surabaya. The following non-modifiable risk factor group table includes a varying number of patients with different data points: 161 ischemic stroke patients had age data; 161 patients had gender data; 176 patients had stroke history data; 118 patients had diabetes mellitus history data. The modifiable risk factor group table includes a varying number of patients with different data points: 92 patients had diabetes mellitus data; 86 patients had dyslipidemia data; 157 patients had kidney function impairment data; 156 patients had hypertension data; and 140 patients had smoking habit data. The quantity of patient data entries in each variable table varies due to the fact that not all data sets contain all variables.

Table 1. Non-modifiable risk factors of ischemic stroke patients

Non-modifiable Risk Factors	n	Percentage (%)
<b>Age</b>		
< 65 years old	108	67
$\geq 65$ years old	53	33
<b>Gender</b>		
Male	97	60
Female	64	40
<b>History of stroke</b>		
Have a history of stroke	63	36
No history of stroke and no data	113	64

<b>History of stroke</b>		
Have a history of stroke	58	33
No history of stroke and no data	118	67

Table 2. Modifiable risk factors of ischemic stroke patients

<b>Non-modifiable Risk Factors</b>	<b>n</b>	<b>Percentage (%)</b>
<b>Diabetes Mellitus</b>		
Yes	52	56
No	40	44
<b>Dyslipidemia</b>		
Yes	77	89
No	9	11
<b>Kidney Function Impairment</b>		
Yes	59	38
No	98	62
<b>Hypertension</b>		
Stage 1 hypertension	26	17
Stage 2 hypertension	84	54
Hypertensive crisis	18	11
Not hypertensive	28	18
<b>Smoking Habit</b>		
Yes	23	64
No	13	36

Table 3. Frequency distribution of combined risk factors

<b>Combination of Risk Factors</b>	<b>Age</b>		<b>Stroke 2nd Attack (%)</b>
	<b>&lt; 65 years old (%)</b>	<b>≥ 65 years old (%)</b>	
DM + HT	23 (21%)	14 (26%)	17 (27%)
DM + Kidney function impairment	5 (5%)	6 (11%)	7 (11%)
DM + Dyslipidemia	21 (19%)	17 (32%)	14 (22%)
HT + Kidney function impairment	7 (6%)	9 (17%)	22 (35%)
HT + Dyslipidemia	36 (33%)	20 (38%)	22 (35%)
Dyslipidemia + Kidney function impairment	11 (10%)	9 (17%)	10 (16%)
HT + Kidney function impairment + Dyslipidemia	7 (6%)	8 (15%)	22 (35%)
DM + HT + Kidney function impairment	5 (5%)	5 (9%)	5 (8%)
DM + HT + Dyslipidemia	20 (19%)	14 (26%)	11 (17%)

DM + Kidney function impairment + Dyslipidemia	6 (6%)	6 (11%)	3 (5%)
DM + HT + Kidney function impairment + Dyslipidemia	5 (5%)	5 (9%)	2 (3%)

DM: Diabetes Mellitus  
HT: Hypertension

Table 4. Description of stroke history in patients with recurrent stroke

<b>Description of Stroke History</b>	<b>n</b>	<b>Percentage (%)</b>
Half right side	31	56
Half left side	24	44

Table 5. Laboratory examination results for diabetes mellitus, dyslipidemia, and kidney function impairment risk factors

<b>Laboratory Examination Results</b>	<b>n</b>	<b>Percentage (%)</b>
<b>Laboratory Examination Results for Diabetes Mellitus</b>		
Diabetes mellitus based on random plasma glucose	28	54
Diabetes mellitus based on HbA1c	51	98
<b>Laboratory Examination Results for Dyslipidemia</b>		
Dyslipidemia based on total cholesterol levels	37	43
Dyslipidemia based on LDL levels	64	74
Dyslipidemia based on HDL levels	42	49
Dyslipidemia based on triglyceride levels	14	16
<b>Laboratory Examination Results for Kidney Function Impairment</b>		
High blood urea nitrogen levels, normal serum creatinine	9	15
High serum creatinine levels, normal blood urea nitrogen	19	32
High blood urea nitrogen levels, high serum creatinine levels	31	53

Table 6. Random plasma glucose results classification

<b>Random Plasma Glucose Results</b>	<b>n</b>	<b>Percentage (%)</b>
Hypoglycemia	2	1
Normal	108	73
Hyperglycemia	38	26



Table 7. Combining the results of fasting plasma glucose and HbA1c levels

Random Plasma Glucose Levels	HbA1c Levels	
	Diabetes Mellitus	Pre-Diabetes and Normal
Hypoglycemia	0 (0%)	1 (1%)
Normal	24 (26%)	39 (42%)
Hyperglycemia	27 (29%)	1 (1%)

Table 8. Lipid profile and recurrent stroke events in patients with dyslipidemia and a history of recurrent stroke

Dyslipidemia	Stroke Second Attack
Total cholesterol	9 (32%)
LDL (Low-Density Lipoprotein)	23 (82%)
HDL (High-Density Lipoprotein)	18 (64%)
Triglycerides	5 (18%)

## DISCUSSION

### Non-Modifiable Risk Factor

#### Age

This study found that the majority of ischemic stroke patients were under the age of 65 (67%) (Table 1). Another study found that 66% of ischemic stroke patients are under 65 years old, which supports these findings.<sup>7</sup> In 2009, 34% of Americans hospitalized for stroke were under the age of 65.<sup>10</sup> Another study found that those under the age of 65 who live sedentary lifestyles tend to have a high body mass index (BMI), are more likely to smoke, and eat high-calorie snacks.<sup>11</sup> This result proved that ischemic stroke can occur at any age, including young people, and an unhealthy lifestyle could be one of the reasons. Furthermore, if hypertension, heart disease, or diabetes mellitus are present, the risk of ischemic stroke increases.<sup>12</sup>

Patients under 65 years old had a higher prevalence of a combination of risk factors for dyslipidemia and hypertension, as shown in Table 3. The prevalence was similar to the  $\geq 65$  age group, although the  $< 65$  age group has a higher number. Another study has indicated an increase in the occurrence of modifiable risk factors in young adults (20–44 years), specifically hypertension, dyslipidemia, obesity, and diabetes.<sup>13</sup> According to a study, obesity and low activity were more prevalent in the young age group, which are risk factors for hypertension.<sup>14</sup>

Dr. Soetomo General Academic Hospital is a Class A hospital. This hospital serves as a referral hospital for lower-class hospitals or community health centers. A study found that the mortality rate for

ischemic stroke patients in hospitals is relatively high, especially when affected by high serum creatinine levels, which resulted in a more than eightfold increase in hospital mortality.<sup>15</sup> The researcher assumed that patients aged 65 years and older may not be salvageable before being referred to Dr. Soetomo General Academic Hospital. This assumption might explain why more patients were in the age group under 65.

### Gender

The results of this study showed that the majority of ischemic stroke patients were male (60%) (Table 1). These findings are consistent with a study by Ramadhani *et al.*, which stated that males made up the majority (61%) of the ischemic stroke patients.<sup>16</sup>

According to one study, testosterone hormone can have physiological effects, such as reducing HDL levels and increasing LDL levels, leading to the development of atherosclerosis that culminates in ischemic stroke.<sup>17</sup> In contrast, women have the estrogen hormone, which plays a role in increasing HDL levels and decreasing LDL levels in the blood. When oral estrogen consumption is used to relieve menopausal symptoms and prevent postmenopausal osteoporosis, total blood cholesterol levels may decrease, protecting LDL from oxidation.<sup>18</sup> Regardless of hormonal differences, lifestyle and comorbidities (smoking, alcohol consumption, diabetes mellitus, hypertension, and heart disease) can also increase the risk of ischemic stroke.<sup>19</sup>

### History of Stroke

According to Table 1, only about 36% of ischemic stroke patients (176 in total) had a history of previous strokes. This contrasts with a study done by Fakhrurrazy *et al.*, which found that ischemic stroke patients were dominated by those who had a history of stroke (55%).<sup>20</sup> This difference may be due to the availability of healthcare facilities (hospitals, community health centers, clinics, etc.), as well as simple access to medication that can help prevent recurrent strokes. For example, in a large city such as Surabaya, the city government has implemented top-notch healthcare services, counseling, and health programs aimed at increasing public health awareness, improving access to healthcare services, and enhancing knowledge of disease prevention efforts.<sup>21</sup>

The recurrence of strokes can be caused by patients' poor adherence to the prescribed stroke treatment. Most stroke patients with a history of previous strokes didn't adhere to the prescribed treatment regimen and didn't appropriately control other stroke risk factors such as hypertension, diabetes mellitus, and dyslipidemia, which can lead to recurrent stroke incidents.<sup>22</sup> A study mentioned that 15%–30%

of ischemic stroke patients experienced recurrent strokes within the first two years. Epidemiologically, recurrent strokes can be caused by general stroke risk factors that emerge and are supported by poor lifestyle habits.<sup>23</sup>

According to stroke history data from patients with recurrent strokes (Table 4), the majority of patients had a half-right-side stroke (56%). Patients with weakness on the right side of the body indicate a blockage in the left-brain area's blood vessels. Left-brain strokes lead to a decline in speech and language comprehension skills, causing aphasia and communication difficulties. Reduced speech and language abilities, as well as weakness in the right upper extremity, can increase the risk of recurrent stroke due to the patient's limited communication with others around them. This can result in unspoken patient complaints, unexplained comorbidity symptoms, and challenges in involving the patient in the prevention of recurrent stroke risk factors as they struggle to comprehend others' instructions or words.<sup>24</sup>

In this study, the combined risk factors associated with recurrent stroke were dominated by hypertension accompanied by dyslipidemia, hypertension accompanied by kidney function impairment, and hypertension accompanied by kidney function impairment and dyslipidemia (Table 3). It has been shown that dyslipidemia is the main causes of recurrent stroke. Also, kidney function impairment can increase the risk of ischemic strokes because of stenosis, blood vessel plaques, and thickening of the intima-media layer of the arteries.<sup>25</sup> Therefore, doctors should consider controlling dyslipidemia, hypertension, kidney function impairment, and other risk factors, as well as educating patients about it.

## Modifiable Risk Factor

### Diabetes Mellitus

According to anamnesis data on the history of diabetes mellitus, 33% of inpatients at Dr. Soetomo General Academic Hospital's neurology ward from January to June 2022 had a history of diabetes mellitus. Meanwhile, based on laboratory results, patients ischemic stroke with diabetes mellitus were dominated (56%). This study aligns with the findings of Faruqi *et al.*, who found that ischemic stroke patients with type 2 diabetes mellitus accounted for 93.5%.<sup>26</sup> However, a similar study conducted by Ramadhani *et al.* showed different results, showing that ischemic stroke patients were dominated by those without diabetes mellitus, accounting for 64% of the patients, which proved that diabetes mellitus has increased in 2022.<sup>16</sup> Patients with diabetes mellitus were most frequently (98%) diagnosed through HbA1c examinations.

The dominance of ischemic stroke patients with diabetes mellitus in this study may be attributed to the post-pandemic conditions that have limited people's mobility in outdoor activities, leading to a sedentary and worsening lifestyle.<sup>27</sup> Sedentary lifestyles have been linked to obesity, muscle mass, blood sugar levels, and inflammation, all of which are critical factors in the development of type 2 diabetes mellitus.

There are several possible mechanisms for stroke occurrence in diabetic patients, such as endothelial dysfunction of blood vessels, increased arterial stiffness at an early age, thickening of capillary basement membranes, and systemic inflammation. In patients with type 2 diabetes, abnormalities in early diastolic filling in the left are common. Additionally, type 2 diabetes can cause metabolic disorders, interstitial fibrosis, autonomic dysfunction, and hypertension. Endothelial dysfunction can trigger a cascade of atherosclerosis. People with type 2 diabetes are more likely to have early damage to the common carotid artery's structural integrity. This is shown by increased intima-media thickness, which is an early sign of atherosclerosis. The inflammatory response that occurs in diabetic patients can increase atherosclerotic plaque development.<sup>28</sup>

The percentage of patients with a history of diabetes mellitus obtained from anamnesis (33%), as shown in Table 1, was higher than the laboratory examination results (30%). Based on this information, anamnesis for diabetes mellitus alone has proven to be sufficient to determine the patient's status and whether or not they have diabetes mellitus, although further laboratory examinations are still necessary.

Table 7 shows that 26% of patients with normal results in random plasma glucose tests had high HbA1c levels of  $\geq 6.5\%$ , indicating diabetes mellitus. This indicates that a HbA1c test is highly recommended because random plasma glucose levels cannot identify blood glucose levels over the previous three months. Patients may purposefully change their eating habits, consume excessive insulin, and engage in more intense physical activity before the examination, resulting in normal random plasma glucose levels. According to random plasma glucose tests, 29% of patients with hyperglycemia also have high HbA1c levels. This data suggests that these patients suffer from uncontrolled diabetes mellitus, as their blood sugar levels remained high for three months prior to the random plasma glucose test, indicating no improvement in their diabetes. Uncontrolled diabetes mellitus clearly increases the likelihood of ischemic stroke deterioration and approximately doubles the risk of recurrent stroke.<sup>29</sup>

### Dyslipidemia

The majority of ischemic stroke patients in this study had dyslipidemia (89%) (Table 2). According to

the data obtained in [Table 5](#), the majority of patients were diagnosed with dyslipidemia, as indicated by the results of the LDL level examination, which accounted for 74%. The research conducted by Ramadhani *et al.* aligned with these findings and revealed that ischemic stroke patients were dominated by those with dyslipidemia (58%).<sup>16</sup>

Excessive cholesterol levels in the body, caused by obesity, a lack of physical activity, and consumption of fatty foods, can lead to the narrowing and hardening of blood vessels through atherosclerosis, which can lead to ischemic stroke.<sup>30</sup> High LDL levels can also induce atherosclerosis, which starts with endothelial dysfunction caused by a high amount of cholesterol in the blood vessels. The formation of atherosclerosis can result in emboli and thrombi, which can cause blockages in the brain's blood vessels.<sup>31</sup> In contrast to cholesterol and LDL, the level of HDL in the blood is inversely related to the risk of ischemic stroke because HDL has the function of removing excess LDL from blood vessels and transporting LDL from body tissues or blood vessels to the liver for disposal, thus preventing the formation of atherosclerosis.<sup>32</sup> The higher the level of HDL in the blood, the more capacity there is to transfer cholesterol to the liver and prevent blockages from forming in the blood vessels. HDL also functions in vasodilation, reducing blood vessel damage through anti-inflammatory and antioxidant effects.<sup>33</sup> Triglycerides are formed from food calories that are not immediately used by the body, stored in fat cells, and released by hormones for energy during activity. If high-calorie foods are consumed too frequently without being balanced by high-calorie burning, hypertriglyceridemia can occur. A study stated that excessive triglycerides can have negative effects on arteries although they may not always increase the risk of atherosclerosis or coronary artery disease.<sup>34</sup>

LDL is referred to as "bad" cholesterol, while HDL is considered "good" cholesterol. In the results of this study, patients with dyslipidemia tended to have higher levels of bad cholesterol (LDL) and lower levels of good cholesterol (HDL). This indicated that LDL has a more detrimental effect on the body, leading to dyslipidemia.<sup>35</sup>

### Kidney Function Impairment

The results of this study indicated that the majority of patients did not have kidney function impairment (62%). Patients with kidney function impairment, as shown in [Table 5](#), are dominated by those with high blood urea nitrogen and high serum creatinine, which amount to 53%. This is followed by patients with high serum creatinine and normal blood urea nitrogen, totaling 32%, and patients with high blood urea nitrogen and normal serum creatinine, totaling 15%. Currently, there is no research that

replicates the findings of this study. However, a study conducted on patients with chronic kidney disease stage V undergoing hemodialysis revealed that out of 140 patients with chronic kidney failure stage V, 70 patients experienced a stroke, and 59 patients (85.7%) of them had ischemic strokes.<sup>36</sup> A study conducted at the Department of Neurology, Medical University Hospital in Bialystok, Poland, in 2016 showed an increase in serum creatinine in 106 ischemic stroke patients (18.6%) out of 570 patients.<sup>37</sup> In a study at the inpatient installation for stroke patients at Prof. Dr. R. D. Kandou Hospital in Manado, it was proven that, on average, out of 135 ischemic stroke patients, the average urea level was 37.64 mg/dL, and the average creatinine level was 1.27 mg/dL. The results of the glomerular filtration rate further confirm the average decline in kidney function among the patients, showing that only 22 patients (16%) had normal kidney function, 47 patients (35%) experienced mild kidney function decline, 51 patients (38%) experienced moderate kidney function decline, 12 patients (9%) experienced severe kidney function decline, and 3 patients (2%) had kidney failure.<sup>38</sup>

Impairment of kidney function can lead to inflammation, oxidative stress, neurohormonal imbalance, vascular calcification, and the formation of uremic toxins. These factors cause blood vessel inflammation, which in turn damages the endothelial cells that line the blood vessel surface. This endothelial cell damage causes atherosclerosis lesions and disrupts the blood vessel vasodilation process. Additionally, kidney function impairment can trigger risk factors for ischemic stroke, such as hypertension, atrial fibrillation, and diabetes.<sup>39</sup> Stenosis of the carotid artery can also occur due to kidney function impairment. Narrowing of the carotid blood vessels can lead to reduced blood flow, causing increased blood pressure/hypertension.<sup>40</sup>

Patients with chronic kidney failure who are on hemodialysis, accompanied by hypertension, heart disease, diabetes mellitus, and dyslipidemia, have cerebral hypoxia, which can occur through a neurodegenerative mechanism involving decreased blood flow to the brain. Additionally, diabetes mellitus and dyslipidemia can cause endothelial dysfunction, which can lead to atherosclerosis and blood vessel blockage in the brain, ultimately resulting in cerebral hypoxia as well.<sup>41</sup>

### Hypertension

This study was dominated by ischemic stroke patients with stage 2 hypertension ([Table 2](#)). In line with this study, Ramadhani *et al.* discovered that 72% of patients had hypertension, whereas 78% did not<sup>16</sup>. The study's results also prove that hypertensive crisis has a three times higher risk of experiencing ischemic stroke compared to patients with stage 2 hypertension

and below, and patients with stage 1 hypertension have a twice greater risk of blood vessel blockage in the brain than non-hypertensive patients.<sup>30</sup>

Hypertension can cause thinning of blood vessel walls and blood vessel damage, leading to the formation of platelet aggregation from detached endothelium and atherosclerotic plaques. These atherosclerotic plaques can block blood vessels in the brain, causing ischemic stroke.<sup>42</sup> Hypertension can also reduce blood vessel elasticity due to LDL entering the intima layer of blood vessel lumens. Poor lifestyle habits such as lack of exercise, excessive salt consumption, smoking, and obesity can contribute to hypertension.<sup>19</sup> Post-stroke disruption in cerebral blood flow occurs in hypertensive ischemic stroke patients, worsening the condition by the formation of atherosclerosis-thrombosis due to functional hyperemia, cerebrovascular, and endothelial dysregulation induced by persistently high blood pressure. Functional hyperemia refers to the cerebral vessels' regulation to dilate towards the activated region. Vascular remodeling and hypertrophy caused by hypertension lead to decreased vascular lumen and increased vascular resistance, contributing to insufficient cerebral blood flow during stroke. Moreover, elevated cerebral blood flow pressure leads to edema due to increased vascular permeability in hypertension.<sup>3</sup>

### Smoking

Overall, ischemic stroke patients in this study were predominantly those with a smoking habit (64%), as shown in [Table 2](#). This aligns with the findings of a study by Tumeleng, which showed that ischemic stroke patients were dominated by smokers, accounting for 57%.<sup>43</sup> However, in contrast, the study by Ramadhani *et al.* was dominated by patients without a smoking habit, totaling 60%.<sup>16</sup>

Smoking habits can increase the risk of ischemic stroke because cigarettes contain 7,000 toxic chemicals that can damage body cells, reduce blood flow to the brain, cause vasoconstriction, accelerate thrombus formation, decrease HDL levels in the blood, and damage endothelial cells.<sup>44</sup> Hypertension can also occur when carbon monoxide and nicotine react, causing a decrease in oxygen levels in the blood and causing the heart to beat faster (tachycardia). The consequences of hypertension include arterial blood vessel damage, vasoconstriction, and an increased risk of ischemic stroke. A study demonstrated that fibrinogen levels in smokers are higher than in non-smokers, leading to intravascular thrombosis and blood vessel occlusion.<sup>31</sup> Vasoconstriction caused by smoking can also lead to disturbances in endogenous fibrinolysis and reduced blood flow, which can result in lacunar stroke.<sup>45</sup>

This study revealed that smoking consumption compared has increased in comparison to the previous year's research at Dr. Soetomo General Academic Hospital. According to a scientific article, adolescents are aware of the health risks associated with smoking but simply ignore them. Providing education to them has also proven ineffective in increasing their awareness to avoid smoking habits.<sup>46</sup> This could be the cause of the dominance of patients with a smoking habit in this study.

### CONCLUSION

This study demonstrated that the risk factors for ischemic stroke were quite diverse. The evidence revealed that the majority of ischemic stroke patients were male, under the age of 65, had diabetes mellitus, dyslipidemia, stage 2 hypertension, and were smokers. Understanding the risk factors for ischemic stroke is crucial for avoiding an increase in the incidence of ischemic stroke and recurrent stroke. Subsequent researchers can use this study to do comparable research over a longer period of time and with a larger sample size in order to better reflect the population. An analysis of the relationship between risk factors can also be developed.

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### Conflict of Interest

The authors have no conflicts of interest.

### Ethic Consideration

This study had received ethical clearance from the Ethics Committee for Dr. Soetomo General Academic Hospital, Surabaya (No. 1067/LOE/301.4.2/X/2022) on 6th October 2022.

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### Author Contributions

Conceptualization: NDK, MSA, W; Methodology: NDK, MSA, W; Formal analysis and investigation: NDK; Writing – original draft preparation: NDK, MSA, W, SS; Writing – review and editing: NDK, MSA, W, SS; Funding acquisition: NDK; Resources: MSA, W, SS; Supervision: MSA, W, SS.

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