ORIGINAL ARTICLE

Stroke Risk Factors Based on The Framingham Stroke Risk Score Among Urban vs Rural Elderly Communities

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ABSTRACT

Introduction: Stroke causes the highest death in Indonesia based on 2019 World Health Organization Global Health Estimates. Framingham Stroke Risk Score can predict the 10-year stroke risk. There isn't much data related to the comparison in risk factors between urban and rural communities in Indonesia based on the Framingham Stroke Risk Score assessment, especially in elderly subject. This study aims to compare stroke risk factors based on the FSRS between the elderly in urban and rural communities. We also determine the relationship between environmental factors and stroke risk factors. **Materials and methods:** This study was a cross-sectional study using secondary data from Indonesia Basic Health Research data. Elderly (55-84 years old) in Surabaya and Kabupaten Malang without stroke history were included. There were 810 subjects that met the inclusion criteria in this study. The data was analysed using Microsoft Excel and SPSS programs. Independent sample t tests, chi-square, and binary logistic regression were used. **Results:** Comparison of risk factors in elderly based on the average probability of stroke within 10 years by Framingham Stroke Risk Score is higher in rural communities (9.05 ± 6.68 vs 7.77 ± 6.20). **Conclusion:** There is a higher probability of stroke in rural communities (9.05 ± 6.68 vs 7.77 ± 6.20). There is a relationship between environmental factors, namely economic status, education level, and living habits, with the measurement of stroke risk factors based on the Framingham Stroke Risk Score.
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Keywords: Elderly, Framingham stroke risk score, Rural, Stroke, Urban

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INTRODUCTION

Stroke is a focal or global disturbance of brain function, lasting more than 24 hours or causing death, with no apparent cause other than vascular origin (1,2). Stroke is the second highest cause of death in the world according to World Health Organization Global Health Estimates in 2019 (3). Stroke risk factors can be categorized into modifiable and non-modifiable factors (4,5). The non-modifiable stroke risk factors include age, gender, ethnicity, and family history. The modifiable stroke risk factors include hypertension, diabetes mellitus, hypercholesterolemia, heart disease, smoking, alcohol consumption, , obesity, and unhealthy lifestyle (6). Framingham stroke risk score (FSRS) is tool to estimate a person's risk of having a stroke in the next 10 years. Risk factors taken into account in this scoring system are age, history of diabetes, blood pressure or history of hypertension, smoking habit, history of atrial fibrillation, left ventricle hypertrophy, and cholesterol level or history of dyslipidaemia (7).

Compared to other countries in Asia, stroke in Indonesia is still major cause of death with highest mortality 193.3/100.000 and disability with disability-adjusted life years (DALYs) 3,382.2/100,000 (8). Indonesia has a high burden of stroke and number one cause of death with 21.2% of total deaths (9). In 2019, the incidence of stroke increased to 70%, prevalence increased to 85%, mortality increased to 43%, and disability increased to 32% (10). Between 1971 and 2020, the percentage of Indonesian elderly has doubled to 9.92%, 52.95% in urban areas and 47.05% in rural area (11). There are different stroke risk factor for both communities (12), but there isn't much data related to that matter. Therefore, this study compares FSRS in both communities and provides related data such as economic status, education level, and living habits. The research on risk factors of stroke using the framingham stroke risk score among urban and rural elderly communities has never been studied in Indonesia. The results and analysis of this study can be a source of information in efforts to prevent stroke in both communities.

MATERIALS AND METHODS

Study Participants

This study is a cross-sectional analytical study conducted in Surabaya and Kabupaten Malang from August 2021 to December 2022. Data in this study was obtained by total sampling from Indonesia Basic Health Research 2018 conducted by the Health Research and Development Agency.

Data Collection

The data collection methods used in Indonesia Basic Health Research 2018 are interviews, measurements, and laboratory examinations. Inclusion criteria in this study are age (55-84 years old) and living area (Surabaya or Kabupaten Malang). Surabaya is considered as urban area and Kabupaten Malang is considered as rural area. Data from respondents who had suffered a stroke, were suffering from a stroke, or had incomplete data were not included. The total data that met the inclusion and exclusion criteria was 810 data.

Data Analysis

The scoring tool used in this study is FSRS. FSRS incorporates risk factors for stroke including age, systolic blood pressure (SBP), use of antihypertensive drug, diabetes mellitus, smoking, history of cardiovascular disease, atrial fibrillation, and left ventricular hypertrophy (LVH) by electrocardiogram. There was no data related to atrial fibrillation, LVH, or EKG results, so the points for these risk factors were considered 0 in FSRS. Data analysis in this study was conducted descriptively and analytically. The obtained data will be grouped based on some variables such as living area, sex, age, occupation, income, education, and several stroke risk factors. It is then presented in the form of tables. The data was then processed using Microsoft Excel and SPSS programs. Independent sample t tests were carried out for numerical variables and chi-square for categorical variables with the aim of knowing the demographic characteristics of respondents. Multivariate analysis was also performed with binary logistic regression to determine the effect of each risk factor.

Ethical Consideration

This research includes human subjects, and ethical approval was granted by the National Ethics Committee for the 2018 Indonesian Basic Health Survey (LB.02.01/2/KE.267/2017). Respondents who are willing to take part in said series of surveys are required to sign informed consents. The survey removed the names of all respondents from the database. No ethics approval was required for the secondary analysis. The authors have received permission to use data for this analysis (IR.03.01/8/7668/2022).

RESULTS

The patients' demographic data in this study is presented on Table I. Most of the respondents in this study came from Surabaya (58.77%), are female (54.2% urban and 51.5% rural), and are 55-59 years old (36,76% urban and 30,24% rural). The majority of urban respondents are unemployed (50,42%). Most of the rural respondents work as farmers (57,78%). The majority of urban respondents have per capita expenditure in quintile 5 (63,24%). On the other hand, the majority of rural respondents have per capita expenditure in quantile 1 (41,62%). The majority of respondents both in urban and rural areas had low education (58,19% urban and 96,41% rural). In Table II, The average probability of stroke in 10 years was higher in rural areas (9,05 ± 6,68 vs 7,77 ± 6,20). It was found that high probability of stroke (22.3%–97.4%) was more prevalent in rural areas (5,69% vs 3,36%). Medium probability (13.3%–22.2%) also more prevalent in rural area (10,18% vs 7,77%). Meanwhile, low probability of stroke (3.7%–13.2%) was more prevalent in urban areas (88,87% vs 84,13%).

Table I: Sociodemographic Characteristics.

Variable	Total (%)	
	Urban	Rural
City		
Surabaya	476 (58.77)	
Malang	334 (41.23)	
Gender		
Men	218 (45.80)	162 (48.50)
Woman	258 (54.20)	172 (51.50)
Age		
55-59 years old	175 (36.76)	101 (30.24)
60-64 years old	133 (27.94)	85 (25.45)
65-69 years old	84 (17.65)	66 (19.76)
70-74 years old	44 (9.24)	32 (9.58)
75-79 years old	27 (5.67)	33 (9.88)
80-84 years old	13 (2.73)	17 (5.09)
Occupation		
Unemployed	240 (50.42)	72 (21.56)
Student	1 (0.21)	2 (0.60)
Civil servant/Military/Police/SOE employee	16 (3.36)	2 (0.60)
Private employee	48 (10.08)	6 (1.80)
Self-employed	118 (24.79)	19 (5.69)
Farmers/farm workers	3 (0.63)	193 (57.78)
Fisherman	4 (0.84)	0 (0.00)
Laborer/Driver/Household assistant	29 (6.09)	28 (8.38)
Other	17 (3.57)	12 (3.59)
Per Capita Expenditures Distribution		
Quantile 1	6 (1.26)	139 (41.62)
Quantile 2	16 (3.36)	64 (19.16)
Quantile 3	57 (11.97)	42 (12.57)
Quantile 4	96 (20.17)	52 (15.57)
Quantile 5	301 (63.24)	37 (11.08)

CONTINUE

Table I: Sociodemographic Characteristics. (CONT.)

Variable	Total (%)	
	Urban	Rural
Education		
Elementary Graduate	277 (58.19)	322 (96.41)
High School Graduate or Higher	199 (41.81)	12 (3.59)

Table II: Distribution of Stroke Probability in 10 Years.

Probability (%)	Urban (%)	Rural (%)
Mean ± SD	7.77 ± 6.20	9.05 ± 6.68
Low (3.7%–13.2%)	423 (88.87)	281 (84.13)
Medium (13.3%–22.2%)	37 (7.77)	34 (10.18)
High (22.3%–97.4%)	16 (3.36)	19 (5.69)

As we seen in Table III, The average age of rural respondents was significantly older than urban respondents (64.87 ± 7,49 vs 63.27 ± 6,80, p=0.0023). Rural respondents have significantly higher mean SBP than urban respondents (145,92 ± 2,61 vs 140,29 ± 22,03, p=0.0014). There were no significant differences in gender and hypertension incidents between urban and rural respondents.

Table III: Comparison of Stroke Risk Factors between Urban and Rural Areas.

Variable	Urban (n=476)	Rural (n=334)	T-test / Chi-Square	p-value
Age [Mean ± standard deviation]	63.27 ± 6.80	64.87 ± 7.49	3.06	0.0023
Gender (Male) [Number; Percentage]	218; 45.79%	162; 48.50%	0.47	0.49
Systolic Blood Pressure [Mean ± standard deviation]	140.29 ± 22.03	145.92 ± 2.61	3.21	0.0014
Diabetes (Yes) [Number; Percentage]	96; 20.16%	40; 11.97%	8.85	0.0029
Hypertension (Yes) [Number; Percentage]	175; 36.77%	103; 30.84%	2.8	0.094
Living Habits (Inactive) [Number; Percentage]	111; 23.32%	55; 16.47%	5.24	0.022
Smoking (Yes) [Number; Percentage]	92; 19.32%	107; 32.03%	16.4	0.000
Economic Status (Low) [Number; Percentage]	6; 1.2%	139; 41.61%	215	0.000
Education (Low) [Number; Percentage]	277; 58.19%	322; 96.41%	147	0.000

CONTINUE

Table III: Comparison of Stroke Risk Factors between Urban and Rural Areas. (CONT.)

Variable	Urban (n=476)	Rural (n=334)	T-test / Chi-Square	p-value
Alcohol Consumption (High) [Number; Percentage]	5; 1.05%	1; 0.29%	0.657	0.4200
Cardiovascular (No) (Number; Percentage)	22; 4.62%	12; 3.59%	0.293	0.59

Diabetes incidence, inactive living habits, smoking, low economic status, and low education has a significant difference (p<0,05) between urban and rural areas, while other variables do not. Urban respondents have more incidence of diabetes (20.16% vs 11.97%, p=0.0029) and have more inactive living habits (23.32% vs 16.47%, p=0.022). Rural respondents have greater number of smokers (32.03% vs 19.32%, p=0.000), have lower economic status (41.61% vs 1.2%, p=0.000), and have lower education (96.41% vs 58.19%, p=0.000).

The majority of risk factors for the elderly in urban areas are low education (58,19%), hypertension (36,76%), and low physical activity (23,32%). The majority of risk factors for the elderly in rural areas are low education (96,41%), very low income (41,62%), and smoking (32,04%) (Table IV). Rural respondents with high SBP tend to have stroke risk 1.0111 times higher than the urban areas (OR: 1.0111; 95% CI: 1.0005–1.0218; p=0.0391). Urban respondents who don't smoke tend to have stroke risk 0.4363 less than rural respondents (OR: 0.4363; 95% CI: 0.2459 – 0.7646; p=0.0040). Rural respondents with low education tend to have stroke risk 6.1028 times higher than those in urban areas (OR: 6.1028; 95% CI: 3.1033 – 13.0916; p<0.05) (Table V).

Table IV: Risk Factors for Urban and Rural Respondents

Risk Factors	Urban (%)	Rural (%)
Diabetes	96 (20.17)	40 (11.98)
Hypertension	175 (36.76)	103 (30.84)
Cardiovascular Disease	22 (4.62)	12 (3.59)
Smoking	92 (19.33)	107 (32.04)
Very Low Income (quantile 1)	6 (1.26)	139 (41.62)
Low Education	277 (58.19)	322 (96.41)
Low Physical Activity	111 (23.32)	55 (16.47)
Alcohol Consumption	5 (1.05)	1 (0.30)

Table V: Risk Factors Influencing Stroke Risk Score Calculation.

Variable	P	OR	CI
Gender (Male)	0.5574	1.1669	0.6992 – 1.9653

CONTINUE

Table V: Risk Factors Influencing Stroke Risk Score Calculation. (CONT.)

Variable	P	OR	CI
Age	0.0788	1.0270	0.9969 – 1.0583
Systolic Blood Pressure	0.0391	1.0111	1.0005 – 1.0218
Diabetes (No)	0.0581	1.7310	0.9909 – 3.0932
Smoking (No)	0.0040	0.4363	0.2459 – 0.7646
Hypertension (No)	0.0611	1.6743	0.9799 – 2.8881
Economic Status (Low)	0.0008	0.1778	0.0597 – 0.4706
Economic Status (Middle)	0.0000	0.0327	0.0116 – 0.0782
Economic Status (Upper Middle)	0.0000	0.0269	0.0098 – 0.0620
Economic Status (High)	0.0000	0.0102	0.0037 – 0.0236
Education (Primary)	0.0000	6.1028	3.1033 – 13.0916
Physical Activity (Moderately active)	0.0035	0.4662	0.2780 – 0.7780
Physical Activity (Inactive)	0.0018	0.3511	0.1800 – 0.6746
Alcohol (High)	0.1619	6.7476	0.6160 – 177. 0176
Cardiovascular Disease (No)	0.5182	0.7317	0.2874 – 1.9373

DISCUSSION

Our study found the average stroke probability in rural areas is higher than urban regions. This aligns with North China research showing a higher prevalence of ischemic stroke in rural areas (3.32% vs 2.43%) (13). Another study in China also showed the shifting of high stroke prevalence from urban to rural areas (14). Previous research found that 58% of stroke cases are in rural population and concluded that rural patients had a higher level of severity, thrombotic type, and mortality than urban patients (15). The elevated stroke mortality in rural areas is likely due to a greater burden of risk factors (16). A study by Kapral et al. found that rural areas experience higher rates of stroke and stroke mortality compared to urban areas. This disparity is due to more prevalent, yet less controlled, stroke risk factors in rural regions. Rural populations tend to have higher incidences of cardiovascular risk factors such as smoking, obesity, and atrial fibrillation, coupled with lower identification and management of these vascular risk factors (17).

The gender distribution in this study, with more female respondents in both urban and rural areas, aligns with findings from a study in Iran that reported similar trends (56.4% urban and 54.3% rural) (15). This contrasts with another study where a majority of urban patients were male (63.6%), and rural patients were predominantly female (51.5%) (18). Despite these variations in gender distribution, this study shows that gender had no significant effect on stroke risk. This suggests that while gender demographics vary across different regions, they do not appear to influence stroke risk in this particular population.

The average age of subjects in rural respondents is slightly higher than urban respondents. The finding differs from research in North China and Egypt, where the average age was higher for urban respondents compared to rural respondents (13,18). This difference can be attributed to the demographic pattern seen in many developing countries like Indonesia, where a significant portion of the elderly population resides in rural areas due to urbanization trends (19). This study did not show a significant effect of age on stroke risk, suggesting that within this population, age is not a determinant of stroke risk. However, The risk of stroke increases with age. An Indonesian study reported the average age of stroke is 63 years with an increasing rate of stroke following increasing age (9).

In this study, systolic blood pressure (SBP) emerges as a significant factor influencing stroke risk based on FSRS (OR: 1.0111; 95% CI: 1.0005–1.0218; p=0.0391). This finding aligns with a study from India focusing where SBP was identified as a critical determinant on stroke risk within 10 years in patients over 50 years of age with uncontrolled hypertension. The consistent association between SBP and stroke risk across studies underscores its relevance in clinical settings, particularly as SBP tends to rise with age (20). While hypertension shows a notable prevalence in urban areas, its significance in multivariate analysis was not statistically significant. Raising awareness about high blood pressure can reduce this risk factor in these communities (10).

The prevalence of diabetes in Indonesia is increasing and is expected to continue to increase until 2045 (21). Diabetes is linked to strokes through abnormalities in endothelial function, vascular smooth muscle cell function, and platelet function (22). There was more diabetes in urban areas in this study (20.17% vs 11.98%). The results obtained for the two areas were significantly different (p=0.0029). These results are in line with other studies where diabetes is more common in urban areas (13,20). Different results were found in a study in Iran with a higher percentage of diabetes in rural patients (37.7% vs 36.4%). The higher prevalence of diabetes in urban areas may be associated with a tendency to higher stress and greater consumption of fast food (15).

The number of smokers in Indonesia is still high and smoking increases the risk of all causes-mortality (23). According to the 2018 Basic Health Research, tobacco

prevalence was predominant among the rural areas. Cigarettes contain substances that have the potential to cause endothelial dysfunction, increase the risk of blood clots and narrowed arteries, and limit oxygen levels in the blood. These factors increase the risk of atherosclerosis (24,25). Bigger number of smokers were found in rural areas in this study (32.04% vs 19.33%). The results are in line with research in Egypt; 134 (11.7%) smokers in urban areas and 148 smokers in rural areas (44.6%) (18). Different results were found in another study where a greater percentage of smoker is in urban areas (26.80% vs 24.85%) (13). Various factors influence smoking habits in rural areas, such as gender, occupation, economic status, educational level, and household regulations on cigarette usage (26). There was more history of cardiovascular disease in urban respondents (4.62% vs 3.59%). Other studies in Cairo and Swahag found different result where rural areas had more history of cardiovascular disease (44.3% vs 10.6%) (18). Study in Kazakhstan also found that incidents and mortality rate of cardiovascular disease in rural areas are lower, but it can be due to the lack of healthcare facility and access so it requires more time to determine the diagnosis (27).

The majority of urban respondents in this study have per capita expenditure in quintile 5 (63,24%). On the other hand, the majority of rural respondents have per capita expenditure in quantile 1 (41,62%). In line with other studies, low income is more often found in rural patients (13). In Table 5, it is shown that economic status affects the results of stroke risk calculation. Urban respondents with low income (quantile 2) tend to have stroke risk 0.1778 times less than rural respondents (OR: 0.1778; (95% CI: 0.0597 – 0.4706, p=0.0008). Urban respondents with middle income (quantile 3) tend to have stroke risk 0.0327 times less than those in rural areas (OR: 0.0327; 95% CI): 0.0116 – 0.0782; p<0.05). Urban respondents with upper middle income (quantile 4) tend to have stroke risk 0.0269 times less than those in rural areas (OR: 0.0269; 95% CI: 0.0098 – 0.0620; p<0.05). Urban respondents with high income (quantile 5) tend to have a stroke risk 0.0102 times less than those in rural areas (OR: 0.0102; 95% CI: 0.0037 – 0.0236; p<0.05). People with low income from rural areas have many inequalities in health status and use of secondary facility services compared to urban areas. The long distance to health facilities so that there is a need to allocate more funds for transportation and specialists in urban areas are some of the reasons underlying this difference (28)

There are more people with low education in rural areas (96,41% vs 58,19%), in line with other studies stating that low education is more often found in rural patients (13). Table 5 shows that education level affects the results of calculating stroke risk (OR: 6.1028; 95% CI: 3.1033 – 13.0916; p<0.05). Respondents with low education in rural areas tend to have stroke risk 6.1028 times higher than those in urban areas. In China, women with lower education had a higher risk of stroke. This happens because women have fewer opportunities to develop themselves through education and employment (29).

In a systematic analysis of studies conducted in 188 countries, it was stated that 90.5% of the stroke burden (as measured in DAYLs) globally was caused by modifiable factors. As many as 74.2% of them were caused by lifestyle factors, one of which is low physical activity (30). Engaging in regular exercise decreases the likelihood of having a stroke. Based on The American Stroke Association (ASA), physical activity can reduce blood pressure, cholesterol levels and body weight. Various forms of physical activity ranging from light and moderate aerobic exercises to vigorous aerobic activities, recreational activities, muscle-strengthening activities were linked to decrease stroke risk (31). As many as 111 people (23.32%) from urban areas have low physical activity. In rural respondents, as many as 55 people (16.47%) have low physical activity. Contrary to other studies, low physical activity is more often found in rural patients (13). Table 5 shows that physical activity affects the results of measuring stroke risk. Respondents with moderate physical activity in urban areas tend to have stroke risk 0.4662 times less than those in rural areas (OR: 0.4662; 95% CI: 0.2780 – 0.7780; p=0.0035). Respondents with no physical activity in urban areas tend to have stroke risk 0.3511 times less than those in rural areas (OR: 0.3511; 95% CI: 0.1800 – 0.6746; p=0.0018).

A meta-analysis examining data from 7 studies found that alcohol consumption was associated with an increase in blood pressure. It was said that there was an increase in systolic blood pressure in people who consumed alcohol daily compared to those who did not (32). Alcohol consumption was found in 5 urban respondents (1.05%) and 1 rural respondent (0.29%). More urban residents who consume alcohol were also found in other studies (13). A different result was found in another study where people who consumed more alcohol were people in rural areas (12). Although it is found more in urban areas, alcohol consumption is not affecting stroke risk scores in this study (p>0.05). Alcoholism is also a common risk factor for stroke in urban areas based on multivariate analysis (17).

CONCLUSION

There is a higher probability of stroke in rural communities (9.05 ± 6.68 vs 7.77 ± 6.20). There is a relationship between environmental factors, economic status, education level, and living habits, with the measurement of stroke risk factors based on the FSRS. Rick factors for stroke are important for the public to know so that better prevention and treatment can be achieved. The government also needs to consider non-medical factors related to stroke such as citizen's

economic status, education level, and amount of physical activity.

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