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Research Article
Proxy Model of Comorbidities with Stroke Incident in South Sulawesi

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Abstract

Background and Objective: Stroke is an acute brain disorder caused by an interruption in cerebral blood circulation, which suddenly (within seconds) or rapidly (within a few hours) arises and impairs circulation in focal areas of the brain. Stroke is a major health problem in the world and it is the third leading cause of death after heart disease and cancer and is the cause of major disabilities. This study aims to develop a risk factor model of stroke incidence in South Sulawesi. **Materials and Methods:** This research applied an analytic observational method with a control case that is an epidemiologic research design for the study of exposure level relationships with various disease conditions or other health problems. The study includes a stroke case sample and a non-stroke control patient samples. Analyses were performed using an odds ratio and logistic regression with a value of $p = 0.05$ considered significant. **Results:** The results showed there was a significant relationship between stroke and hypertension, with OR = 4.06, 95% CI: 3.25-5.07 and there was a relationship between diabetes mellitus and stroke incidence. There was a relationship between smoking and the incidence of stroke, with OR = 1.60, 95% CI: 1.23-2.07. There was a relationship between heart disease and the incidence of stroke, with OR = 1.81, 95% CI: 1.42-2.32. However, there was no relationship between stress and stroke incidence, with $p = 0.619$ ($p>0.05$) and OR = 1.9, 95% CI: 1.48-2.64. The value of OR = 1.10 with 95% CI: 0.75-1.63. **Conclusion:** Hypertension is the most significant risk factor for stroke incidence compared to other risk factors but all of these risk factors can be lowered by lifestyle modification.

INTRODUCTION

The world stroke rate is estimated at 200 per 100,000 population, each year. When viewed in terms of the age at which stroke occurs, there has been a change, where in stroke is not only occurring in the elderly but also in the young and those, who are still productive. Given the disability caused by permanent stroke, it is important for young people to be informed about stroke and its interactions so that they can implement a healthy lifestyle pattern and avoid stroke[1].

Stroke is the leading cause of death and disability worldwide. Each year, 5.7 million people die from stroke and it is the second most common cause of death worldwide (9.7% of all deaths), with deaths exceeding those from liver disease. Stroke survivors are likely to have disabilities that cause emotional and economic difficulties for themselves and their families. It also causes enormous costs to the health care system. More than 85% of strokes are reported from developing countries but the costs directed towards prevention in South Sulawesi are insufficient. Recent reports show that in the last 4 decades in developed countries, there has been a reduction in stroke of 42% and in developing countries there has been a 100% increase of stroke incidence. Stroke is regarded as a neurological disorder, often causing death or physical and mental disability and the World Health Organization (WHO) has determined that 15 million people suffer strokes worldwide, 5 million die and 5 million are permanently disabled[2,3].

The Basic Health Research (Riskesdas)[4], recorded cases of stroke in urban areas in 33 provinces and 440 districts and collected 258,366 samples of urban households and 987,205 household samples for the measurement of various public health variables. The results from an analysis of the incidence of stroke showed that stroke is a major cause of mortality among the urban population[4].

Based on the Riskesdas data[5], the prevalence of stroke in Indonesia increased from 8.3 per 1000 population in 2007 to 12.1 per 1000 population in 2013. South Sulawesi is the province with the highest stroke prevalence compared with other provinces in Indonesia and based on undiagnosed symptoms the highest incidence are 17.9% and the number has increased by 10.5% from 2007, which is equal to 7.4%[5]. The purpose of this research was to develop a risk factor model of stroke incidence using the proxy model on data from patients in South Sulawesi.

MATERIALS AND METHODS

Location and time of study: The research was conducted in South Sulawesi in the Public Hospital of Dr. Wahidin Sudirohusodo and in the Unhas Education Hospital as a research site for 6 months starting from June, 2016 to December, 2016.

Ethical approval: This study uses ethical clearance issued by the Ethics Committee of the Faculty of Medical, Hasanuddin University. Number: 925/H04.8.4.5.31/PP36-KOMETIK/2016.

Research design: This is an observational analytic study with a case control design that uses an epidemiological research design to study the relationship of stroke incidence with various states of disease or other health problems[6].

Population and sample: The population in this study was all stroke patients recorded in the medical records at the Hospital in 2016. The sample included the stroke patients recorded in the medical records in the Public Hospital of Dr. Wahidin Sudirohusodo and the Makassar Unhas Education Hospital, which have complete data on the research variables.

Data collection methods: The data collected was secondary data from medical records at the Public Hospital. Dr. Wahidin Sudirohusodo Makassar and Hospital of Education Unhas 2016 (Fig. 1). The data was acquired by filling the observation sheet in the form of a checklist, through observation of the patient's medical record and analyzing the research variables.

Statistical analysis: For general analysis, such as percentage and distribution of each research variable, a bivariate analysis and odds ratio test were used to evaluate the risk of the independent variable to the dependent variable and for multivariate analysis to evaluate the influence of one or more of the independent variables to the dependent variable.

RESULTS

Table 1 shows that the number of respondents includes more males [773,(51.5%)] and the age group of 40-49 years includes 479 people (31.9%) and includes 494 with an elementary school education (32.9%). Patients with a job as housewife include 467 people (31.1%) and those that are married include 1416 persons (94.4%).

Table 2 shows that the incidence of stroke is more prevalent in males (53.5%), in females: it is 46.5%, in the age group 50-59 years: it is 32.1%, in those with an elementary education: it is 32.0%, in those with a job as housewife: it is 31.2% and in those that have been married, it is 94.7%. Based on a chi square test analysis, the gender, age group, education and marital status of the respondent are homogeneous (p<0.05).
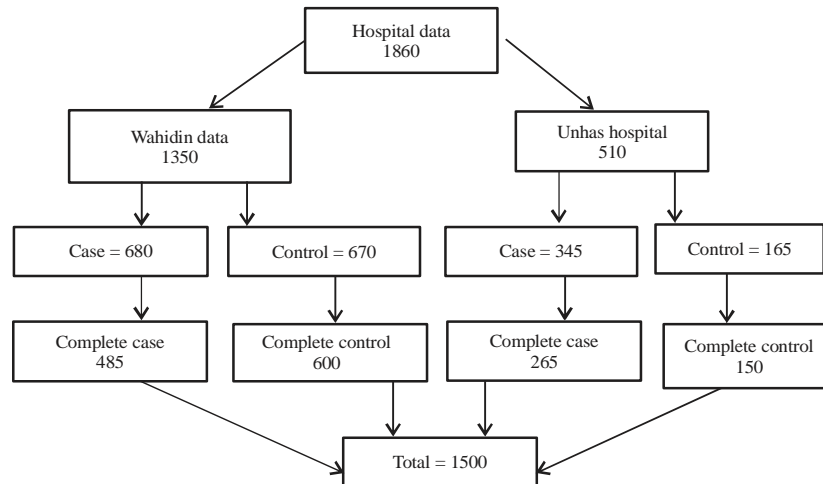
Fig. 1: Data selection

Table 1: Distribution of demographic characteristics of stroke risk samples in South Sulawesi in 2017

Respondents characteristics	Number	%
Sex		
Male	773	5.5
Female	727	48.5
Age		
10-19	2	0.1
20-29	43	2.9
30-39	61	4.1
40-49	185	12.3
50-59	479	31.9
60-69	436	29.1
70-79	230	15.3
$\geq$80	64	4.3
Education		
Uneducated	159	10.6
Elementary	494	32.9
Junior High School	164	10.9
Senior High school	483	32.2
Diploma	43	2.9
S1 (Bachelor's)	146	9.7
S2 (Master's)	11	0.7
Profession		
Housewife	467	31.1
Government employee	295	19.7
Private employee	222	14.8
Entrepreneur	66	4.4
Farmer	114	7.6
Unemployment	87	5.8
Retired	226	15.1
Student	23	1.5
Marital status		
Married	1416	94.4
Single	79	5.3
Widow	4	0.3
Widower	1	0.1

Primary data source: Table 3 shows that of the respondents, who were more likely to suffer from hypertension, [925(61.7%)], did not have diabetes mellitus (80.8%), were not smokers (77.4%), had no heart disease (84.6%) and had no stress (92.7%).

Table 4 shows that respondents, who suffer from hypertension suffered more stroke, [581 (77.5%)], than those, who did not suffer stroke, [344 (45,9%)], while respondents, who did not suffer from hypertension did not suffer more stroke, [406 (54.1%)] compared with those with stroke, [169 (22.5%)].

Statistical test with a chi square obtained a p-value = 0.000 (p<0.05), which means there is a correlation of hypertension with stroke incident. The values were OR = 4.06, 95% CI: 3.25-5.07, which indicates that hypertension is a risk factor for stroke events. An OR = 4.06 indicates that respondents, who suffer from hypertension will be at risk of stroke 4.06 times compared to non-hypertensive respondents.

Table 5 shows that respondents, who suffer from diabetes mellitus suffered more stroke, [171 (22.8%)] compared with those, who did not suffer stroke, [117 (15,6%)], while respondents, who did not suffer diabetes mellitus did not suffer a greater incidence of stroke, [633 (84.4%)] compared to those that suffered a stroke, [77 (2%)].

A statistical test with a chi square obtained a p-value = 0.000 (p<0.05) which means there is a relationship of diabetes mellitus with stroke incidence. The value of OR = 1.60, 95% CI: 1.23-2.07, means that diabetes mellitus patients have a risk factor for stroke events. The value of OR = 1.60 means that respondents, who suffer from diabetes mellitus will be at risk of stroke 1.6 times compared to respondents, who are not DM.

Table 6 shows that respondents, who smoked suffered more strokes, [208 respondents (27.7%)], than those, who did not smoke, [131 (17.5%)], while non-smokers, who did not

Table 2: Distribution of respondent characteristics based on stroke incidence in South Sulawesi in 2017

	Stroke						
	Case		Control		Total		
Respondent characteristics	Number	%	Number	%	Number	%	p-value
Sex							
Male	401	53.5	372	49.6	773	51.5	0.134
Female	349	46.5	378	50.4	727	48.5	
Age							
10-19	1	0.1	1	0.1	2	0.1	
20-29	16	2.1	27	3.6	43	2.9	
30-39	25	3.3	36	4.8	61	4.1	
40-49	94	12.5	91	12.1	185	12.3	0.606
50-59	241	32.1	238	31.7	479	31.9	
60-69	224	29.9	212	28.3	436	29.1	
70-79	115	15.3	115	15.3	230	15.3	
$\geq$80	34	4.5	30	4.0	64	4.3	
Education							
Uneducated	90	12.0	69	9.2	159	10.6	
Elementary	240	32.0	254	33.9	494	32.9	
Junior high school	84	11.2	80	10.7	164	10.9	
Senior High school	232	30.9	251	33.5	483	32.2	0.230
Diploma	18	2.4	25	3.3	43	2.9	
S1 (Bachelor's)	78	10.4	68	9.1	146	9.7	
S2 (Master's)	8	1.1	3	0.4	11	0.7	
Profession							
Housewife	234	31.2	233	31.1	467	31.1	
Government employee	128	17.1	167	22.3	295	19.7	
Private employee	99	13.2	123	16.4	222	14.8	
Entrepreneur	54	7.2	12	1.6	66	4.3	
Farmer	68	9.1	46	6.1	114	7.6	0.000
Unemployed	62	8.3	25	3.3	87	5.8	
Retired	95	12.7	131	17.5	226	15.1	
Student	10	1.3	13	1.7	23	1.5	
Marital status							
Married	710	94.7	706	94.1	1416	94.3	
Single	37	4.9	42	5.6	79	5.3	0.723
Widow	2	0.3	2	0.3	4	0.3	
Widower	1	0.1			1	0.1	

Table 3: Distribution of stroke risk variables in South Sulawesi in 2017

Research variable	Number	%
Hypertension		
Yes	925	61.7
Not	575	38.3
Diabetes mellitus		
Yes	288	19.2
Not	1212	80.8
Smoking		
Yes	339	22.6
Not	1161	77.4
Heart disease		
Yes	231	15.4
Not	1269	84.6
Stress		
Yes	109	7.3
Not	1391	92.7

suffer stroke, [619 (82, 5%)], compared to those that suffered a stroke, [542 (72.3%)].

A statistical test with a chi square obtained a p-value = 0.000 (p<0.05), which means there is relation between smoking and stroke incident. Values of OR = 1.81 with 95% CI: 1.42-2.32 indicate that smoking is a risk factor for stroke incidence. Values of OR = 1.81 means that smokers are at risk of stroke 1.81 times compared to non-smokers.

Table 7 shows that respondents, who suffer from heart disease suffer more stroke, [148 (19,7%)], than those, who do not suffer stroke, [83 respondent (11,1%)], whereas respondents, who do not suffer from heart disease do not suffer more stroke, [667 (88,9%)], compared to those, who suffer stroke, [602 (88,9%)].

A statistical test with a chi square obtained a p-value = 0.000 (p<0.05), which indicates there is a relation between heart disease and stroke incidence. An OR = 1.98, 95% CI: 1.48-2.64, means that heart disease is a risk factor for stroke.

Table 4: Risk of hypertension sufferers, who suffer stroke in South Sulawesi 2017

| | Stroke | | | | | | | |
| | Case | | Control | | Total | | | |
Hypertension	Number	%	Number	%	Number	%	p-value	OR
Yes	581	77.5	344	45.9	925	61.7	0.000	4.06
Not	169	22.5	406	54.1	575	38.3		
Total	750	100	750	100	1500	100.0		3.25-5.07

Table 5: Large risk of diabetes mellitus sufferers, who suffer stroke in South Sulawesi 2017

| | Stroke | | | | | | | |
| | Case | | Control | | Total | | | |
Diabetes mellitus	Number	%	Number	%	Number	%	p-value	OR
Yes	171	22.8	117	15.6	288	19.2	0.000	1.60
Not	579	77.2	633	84.4	1212	80.8		
Total	750	100	750	100	1500	100.0		1.23-2.07

Table 6: Risk for stroke in smokers in South Sulawesi 2017

| | Stroke | | | | | | | |
| | Case | | Control | | Total | | | |
Smoking	Number	%	Number	%	Number	%	p-value	OR
Yes	208	27.7	131	17.5	339	22.6	0.000	1.81
Not	542	72.3	619	82.5	1161	77.4		
Total	750	100	750	100	1500	100.0		1.42-2.32

Table 7: Risk of heart disease sufferers, who suffer from a stroke in South Sulawesi in 2017

| | Stroke | | | | | | | |
| | Case | | Control | | Total | | | |
Heart patients	Number	%	Number	%	Number	%	p-value	OR
Yes	148	19.7	83	11.1	231	15.4	0.000	1.98
Not	602	80.3	667	88.9	1269	84.6		
Total	750	100	750	100	1500	100.0		1.48-2.64

Table 8: Big Risk of stress sufferers, who suffer Stroke in South Sulawesi 2017

| | Stroke | | | | | | | |
| | Case | | Control | | Total | | | |
Heart patients	Number	%	Number	%	Number	%	p-value	OR
Yes	57	7.6	52	6.9	109	7.3	0.619	1.10
Not	693	92.4	698	93.1	1391	92.7		
Total	750	100	750	100	1500	100.0		0.75-1.63

The value of OR = 1.98 means that respondents, who suffer from heart disease will be at risk of stroke 1.98 times compared to respondents, who did not suffer from heart disease.

Table 8 shows that respondents, who suffer from stress suffer more stroke, [57 (7.6%)], than those, who do not suffer stroke, [52 (6.9%)], whereas respondents, who do not suffer more stress do not suffer stroke, [698 (93.1%)], compared with those, who do suffer stroke, [693 (92.4%)].

The results of a statistical test using a chi square obtained a p-value = 0.619 (p>0.05), which means there is no relationship between stress and the incidence of stroke. The value of OR = 1.10 with 95% CI: 0.75-1.63 means that stress is not a risk factor for stroke events. An OR = 1.10 means that stressful respondents will be at risk of stroke 1.6 times compared to non-stress responders.

The logistic regression test results show that the greatest risk factor for stroke is hypertension with an OR = 3.32 (Table 9).

Table 9: Greatest risk factors for stroke in South Sulawesi in 2017

Variables	B	Wald	p-value	OR	95% CI
Hypertension	1.200	100.564	0.000	3.32	2.63-4.20
Diabetes mellitus	0.303	5.406	0.036	1.35	1.02-1.80
Smoking	0.509	14.096	0.000	1.66	1.28-2.17
Heart disease	0.468	8.640	0.003	1.60	1.17-2.18
Constant	-5.591	89.109	0.000		

DISCUSSION

An established risk factor for stroke is elevated blood pressure with levels above 115/75 mm Hg and high blood pressure (BP) is the most important modifiable risk factor for stroke and is associated with 54% of stroke episodes worldwide. Socioeconomic deficiencies have proved to be a risk factor for both gastrointestinal immobilization (IGI) readmission and mortality. The literature has reported a link between socioeconomic deficiencies and the risk of re-enrollment after stroke[7].

Hypertension is the most important modifiable risk factor for stroke and according to the WHO Global Report, the 54% of high BP-caused the cerebrovascular incidents (SBP>115 mm Hg), half of them are associated with sustained hypertension (>140/90 mm Hg). Hypertension increases the risk for both ischemic and hemorrhagic strokes in subjects either without or with a history of previous coronary heart disease or stroke[8]. Diabetes mellitus is a common disease affecting approximately 1 in 30 adults. Suffering from this disease will double the likelihood of stroke because it causes a change in the cardiovascular system and encourages the development of atherosclerosis[9]. The Framingham heart study also found that smoking lowers HDL levels in the blood and HDL is a good cholesterol that helps to prevent atherosclerosis. According to Soeharto[10], the most important correlate was the number of cigarettes smoked/day.

Another study by Yatsuya *et al.* (2013), also estimated the risk of stroke with a point-based model for 10 years in Japan, the study showed that the estimated 10-year stroke risk would increase with age, as shown in previous studies and it also showed a simulation model which showed that hypertension is the most influential factor in predicting the incidence of stroke, with a score of 11-13 points, followed by diabetes mellitus with 7 points and smoking behavior in men with 4 points and in women with 8 points[11]. Although, programs that instigated control of diabetes mellitus and dyslipidemia and enrollment in quit smoking programs, particularly in combination with hypertensive treatment, also appear to have contributed to a decrease in stroke death rates[12,13].

High blood pressure is the single most important but treatable risk factor because high blood pressure treatment can reduce the chance of stroke by half. However, the incidence of stroke is reduced despite not having yet found an effective high blood pressure medication[14,15].

SIGNIFICANCE STATEMENTS

This study shows potential synergistic factors, such as hypertension and diabetes mellitus, that may lead to stroke occurrence. These data can be beneficial for patients with stroke susceptibility. This study help to uncover the critical areas of interaction between stroke and synergistic factors that many studies did not explore. Thus, a new theory on synergistic factor interactions with stroke occurrence is presented.

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