



Metabolic Risk Factors with Stroke Among Indonesians

Eldha An Nissa^{1✉}, Indah Purnama Sari²

¹Program Studi Ilmu Kesehatan Masyarakat Fakultas Kesehatan Masyarakat Universitas Sriwijaya

²Program Studi Gizi Fakultas Kesehatan Masyarakat Universitas Sriwijaya

Article Info

Article History:

Submitted December 2020

Accepted December 2021

Published January 2022

Keywords:

Stroke, Hypertension, Diabetes Mellitus, Obesity, Metabolic

DOI

<https://doi.org/10.15294/kemas.v17i3.28087>

Abstract

Stroke is one of the leading causes of death. It is not only in the world but also in Indonesia. Various factors that trigger the incidence of stroke are known as metabolic risk factors. This study aims to determine the risk of stroke caused by one or more metabolic risk factors. This study used a retrospective cohort design from secondary data from the 2007 and 2014 Indonesia Family Life Survey (IFLS). The population was the population aged 15 years and over. The sample was the population who did not experience a stroke in 2007 as many as 7,707 people. The sampling technique used was multistage random sampling. The results showed that as much as 1.8% of Indonesia's population aged at least 15 years had a stroke. People with three metabolic risk factors had a 39.9 times higher risk of having a stroke than people without metabolic risk factors (95% CI: 29.3-54.4) after controlling for age, sex, and physical activity. Hypertension was a metabolic risk factor with the greatest risk for having a stroke. Therefore, preventive practices such as controlling and monitoring blood pressure, blood glucose levels and body weight can be carried out through regulating food consumption and engaging in regular physical activity.

Introduction

Stroke is the second leading cause of death worldwide (6.7 million) after a heart attack or ischemic heart disease (7.4 million). Furthermore, it is also the fourth primary cause of death in the UK, with over 100,000 sufferers each year. It is also known to kill an individual every 3 minutes 45 seconds, and a rate of 133,000 people annually in the United States, which makes it rank fifth. In Indonesia, it has become the leading cause of death, at 21.1% followed by ischemic heart disease (12.9%), diabetes mellitus (6.7%), tuberculosis (5.7%), hypertension and its complications (5.3%), transportation accidents (2.6%), pneumonia (2.1%) and diarrhea (1.9%). Meanwhile, the disorder of obesity makes it difficult to prevent hypertension and diabetes mellitus, subsequently increasing the prevalence of stroke (Ministry of Health Republic of Indonesia, 2017). These three conditions are collectively known as metabolic risk factors,

due to the relationship with the metabolic system of humans, which is modifiable.

Obesity is a risk factor for stroke. It is characterized by the accumulation of fat that exceeds the normal blood limit for a long time, as well as for coronary heart disease, hypertension, and diabetes mellitus. The prevalence of obesity has almost doubled throughout the world since 1980. Moreover, hypertension has also been attributed to the narrowing or thickening of artery walls (atherosclerosis) and the rupture of blood vessels in the brain, subsequently leading to ischemic and hemorrhagic strokes. Therefore, a higher value for blood pressure increases the chances of a stroke, where 51% of deaths are due to hypertension. It is also possibly caused by diabetes mellitus, resulting in brain atherosclerosis, being a chronic hyperglycemia condition characterized by a deficiency in secretion or a decline in the effectiveness of insulin. This further increases blood viscosity, leading to the manifestation of high blood

✉ Correspondence Address:

Program Studi Gizi Fakultas Kesehatan Masyarakat Universitas Sriwijaya, Indonesia.

Email : indah_purnamasari@fkm.unsri.ac.id

pressure (hypertension), and subsequently causing a stroke (Ramadany, Pujarini & Candrasari, 2013; Kabi, Tumewah & Kembuan, 2015). Furthermore, diabetes mellitus affects 15-20% of the adult population and is also one of the major causes of ischemic stroke (Kabi, Tumewah & Kembuan, 2015; Ghani, Mihardja & Delima, 2016).

Several previous studies affiliated the metabolic factors of obesity, hypertension, and diabetes mellitus with the risk of stroke (Chen, Ovbiagele & Feng, 2016; Ghani, Mihardja & Delima, 2016; Gan et al., 2017; Tun et al., 2017; Zhang et al., 2017; Habibi-koolae et al., 2018; Owolabi et al., 2018; Soliman et al., 2018; Alharbi et al., 2019; Sofiana & Rahmawati, 2019). In addition, others include the non-modifiable age (Ghani, Mihardja & Delima, 2016), gender (Wang et al., 2019) and modifiable factors, including deficiency in the consumption of vegetables and fruits (fiber) (Mo et al., 2019), physical activity (Reinholdsson, Palstam & Sunnerhagen, 2018), smoking status (Pan et al., 2019) and exposure to stressful conditions (Booth et al., 2015). This study is, therefore, aimed to identify the influence of metabolic factors (obesity, hypertension, and diabetes mellitus) as risk factors for stroke as a whole, and also in conjunction with others. Furthermore, a retrospective cohort design was used to observe the incidence of stroke for seven-year, hence the purpose of this study was to analyze the influence of risk factors affiliated with body metabolism, as well as other factors in people aged 15 years and older in Indonesia.

Method

This study used a retrospective cohort design, which was conducted through an analytical survey approach, using the Indonesian Family Life Survey (IFLS) 4 and 5 data. Also, all residents in Indonesia encompass the possible target population, using the successfully interviewed residents in 13 provinces in 2007 and 2014 as the study population. The sample comprises of individuals aged 15 years old and above, known to be free from a stroke in 2007, using the results collected for each complete record (inclusion criteria). Meanwhile, candidates missing from the observation (died or moved) and pregnant women were excluded,

leading to a sample size of 7,707 people.

Stroke is assessed based on the diagnosis of health workers (doctors, paramedics, nurses, or midwives) and categorized into two, including yes (ever diagnosed) and no (never diagnosed). In addition, the metabolic risk factors encompass hypertension (based on three measurements with an average value of 140/90 mmHg or more), obesity (based on Body Mass Index (BMI) values of 27 or more), and diabetes mellitus (based on diagnosis result by health professionals). The practice of a physical activity is grouped into two categories, including less (at a score less than 35), and sufficient (for scores over 35), while less fiber consumption is evaluated based on the frequency of ingesting green vegetables and fruits within the past week. It is categorized as yes (on instances where the score obtained is less than 11) and no (for scores over 11). Moreover, the smoking status of an individual is assessed with the question based on the presence of the habit as of the data collection time or the practice of its termination. Hence the subjects were categorized into three, encompassing smokers (have smoked up to the time of data collection), ex-smokers (smoked but had stopped), and non-smokers (never smoke). In addition, stress conditions were attained from several statements related to psychological health, including the feeling of being disturbed by non-existing things, depression, having difficulty concentrating, the demand for a lot of effort, fear, possessing good hopes about the future, being alienated, having sleep trouble, and the inability to start anything. The declaration of positive statements is provided with a score of 1 (frequently: 5-7 days), 2 (sometimes: 3-4 days), 3 (a few: 1-2 days) and 4 (rarely: <1 day), while negative statements are given 4 (often: 5-7 days), 3 (sometimes: 3-4 days), 2 (few: 1-2 days) and 1 (rarely: <1 day). These parameters are collectively categorized as yes (with a total score of 5 or more) and no (the total of less than 5). However, the non-modifiable risk factors include age (using a ratio scale) and gender, which were grouped into males and females.

Weighting, province (cluster), and enumeration area (strata) are needed in complex sample analysis to obtain a similar selection probability for each item (Equal Probability of

Selection Method/ EPSEM). Modifiable (body metabolism, physical activity, smoking status, and stress condition) and non-modifiable (age and gender) risk factors are described using univariate analysis. Meanwhile, the bivariate evaluation was performed using the Chi-Square Test, to determine the effect of various risk factors on the incidence of stroke in crude association, with a significance level of 5% and confidence interval of 95%. Furthermore, a multivariate analysis was conducted using multiple logistic regression tests to obtain the adjusted association, and the results are presented in the form of cross-tabulation and narrated explanations.

Result and Discussion

The result of the univariate analysis

showed the occurrence of stroke in 1 to 2 out of every 100 Indonesians, while 30 out of every 1000 people suffer from a combination of three metabolic diseases at once (obesity, hypertension, and diabetes mellitus). Furthermore, 8 to 9 out of every 100 individuals suffer from obesity and hypertension, 30 to 31 out of every 100 experiences hypertension alone, while 51 to 52 out of 100 suffer from no metabolic syndrome. The male respondents were 3.6% less than female, and 49 to 50 out of every 100 people participate in proper physical activity, while the number of smokers was 36.8% more than non-smokers. In addition, 5 to 6 out of every 100 people consume less fiber, while 52 to 53 experience stress, with the average age of respondents being 52.17 years old (Table 1).

Table 1. Distribution of Respondent Characteristics (n=7,707)

Characteristics	Frequency (n=7,707)	Percent (%)
Stroke		
Yes	140	1,8%
No	7567	98,2%
Metabolic Risk Factors		
Hypertension, obesity and diabetes mellitus	23	0,3%
Diabetes mellitus and obesity	19	0,2%
Diabetes mellitus and hypertension	54	0,7%
Obesity and hypertension	667	8,6%
Diabetes mellitus	52	0,7%
Obesity	571	7,4%
Hypertension	2345	30,4%
Nothing	3976	51,6%
Gender		
Male	3713	48,2%
Female	3994	51,8%
Physical Activity		
Less	3921	50,9%
Sufficient	3786	49,1%
Smoking Status		
Smokers	2314	30,0%
Ex-smokers	244	3,2%
Non-smokers	5149	66,8%
Fiber Consumption		
Less	4207	54,6%
Sufficient	3500	45,4%
Stress		
Yes	4060	52,7%
No	3647	47,3%
Age (year)		
Mean and 95% CI	52,17 (95% CI: 52,04-52,30)	

Source: Secondary Data from IFLS 2007 and 2014 (Processed Data 2019)

The results of the bivariate analysis showed a higher risk for stroke with the increase of metabolic diseases, including obesity (RR: 2.4; 95% CI: 1.6-3.6), diabetes mellitus (RR: 6.5; 95% CI: 3.6-11.9), and hypertension (RR: 7.5; 95% CI: 5.9-9.6). However, respondents with a combination of two, comprising of obesity and hypertension, experienced the lowest risk with RR: 10.3 (95% CI: 7.6-14.0), followed by diabetes mellitus and hypertension (RR: 27.2; 95% CI: 20.5-36.1) and finally the mixture of diabetes mellitus and obesity (RR: 28.9; 95% CI:

8.5-98.6). The respondents with three metabolic diseases, at the same time, had the highest risk of stroke, with RR: 37.4 (95% CI: 27.1-51.7). Conversely, the unmodifiable risk factors (age and sex) influence the incidence of stroke, which is also observed with the modifiable forms (smoking status and physical activity), although a deficiency in the consumption of vegetables and fruits (fiber), as well as the exposure to stressful conditions, have not proven to be influential (p-value > 0.05) (Table 2).

Table 2. Risk Factors of Stroke among Indonesians

Risk Factors	Stroke				p-value	RR (95% CI)
	Yes		No			
	n	%	n	%		
Metabolic Risk Factors						
Hypertension, obesity and diabetes mellitus	3	14.1	20	85.9	< 0.001*	37.4 (27.1-51.7)
Diabetes mellitus and obesity	2	11.3	17	88.7	< 0.001*	28.9 (8.5-98.6)
Diabetes mellitus and hypertension	6	10.7	48	89.3	< 0.001*	27.2 (20.5-36.1)
Obesity and hypertension	29	4.3	638	95.7	< 0.001*	10.3 (7.6-14.0)
Diabetes mellitus	2	2.8	50	97.2	< 0.001*	6.5 (3.6-11.9)
Obesity	6	1	565	99	< 0.001*	2.4 (1.6-3.6)
Hypertension	75	3.2	2270	96.8	< 0.001*	7.5 (5.9-9.6)
Nothing	17	0.4	3959	99.6	-	Reference
Gender						
Male	77	2.1	3636	97.9	< 0.001*	1.3 (1.2-1.5)
Female	63	1.6	3931	98.4	-	Reference
Physical Activity						
Less	86	2.2	3835	97.8	< 0.001*	1.6 (1.4-1.8)
Sufficient	54	1.4	3732	98.6	-	Reference
Smoking Status						
Smokers	35	1.5	2279	98.5	0.005	0.8 (0.7-0.9)
Ex-smokers	5	2.2	239	98.1	0.498	1.1 (0.8-1.6)
Non-smokers	99	1.9	5050	98.1	-	Reference
Fiber Consumption						
Less	76	1.8	4131	98.2	0.915	1.0 (0.9-1.1)
Sufficient	64	1.8	3436	98.2	-	Reference
Stress						
Yes	74	1.8	3986	98.2	0.804	1.0 (0.9-1.2)
No	65	1.8	3582	98.2	-	Reference
Age (year)						
Mean		56.87	52.09		< 0.001*	1.047 (1.041-1.053)

Source: Secondary Data from IFLS 2007 and 2014 (Processed Data 2019)

This study also uses multivariate analysis to obtain adjusted risk values for stroke incidence, which remains higher in respondents with three metabolic diseases than for individuals possessing only one or two. In

addition, the risk factors of physical activity, age, and gender also control the manifestation of stroke (RR: 39.9; 95% CI: 29.3- 54.4; p < 0.001) (Table 3).

Table 3. Risk Factors of Stroke among Indonesians using Multiple Logistic Regression

Variables	First Model		Last Model	
	p-value	RR _{crude} (95% CI)	p-value	RR _{adjusted} (95% CI)
Metabolic Risk Factors				
Hypertension, obesity and diabetes mellitus	< 0.001	37.8 (27.5-51.9)	< 0.001	39.9 (29.3-54.4)
Diabetes mellitus and obesity	< 0.001	37.9 (10.7-134.8)	< 0.001	38.1 (10.6-136.6)
Diabetes mellitus and hypertension	< 0.001	21.4 (16.1-28.4)	< 0.001	21.9 (16.7-28.9)
Obesity and hypertension	< 0.001	11.4 (8.3-15.7)	< 0.001	11.6 (8.5-15.9)
Diabetes mellitus	< 0.001	5.2 (2.8-9.5)	< 0.001	5.1 (2.8-9.3)
Obesity	< 0.001	3.0 (1.9- 4.6)	< 0.001	3.1 (2.0-4.6)
Hypertension	< 0.001	6.4 (5.0-8.1)	< 0.001	6.5 (5.1-8.2)
Age	< 0.001	1.037 (1.031-1.043)	< 0.001	1.037 (1.031-1.043)
Gender	< 0.001	2.1 (1.8-2.4)	< 0.001	1.7 (1.5-1.9)
Physical Activity	0.003	1.2 (1.1-1.4)	0.003	1.3 (1.1-1.5)
Smoking Status				
Smokers	< 0.001	0.7 (0.6-0.8)	-	-
Ex-smokers	0.015	0.6 (0.5-0.9)	-	-
Fiber Consumption	0.564	1.04 (0.91-1.2)	-	-
Stress	0.931	0.9 (0.8-1.1)	-	-

Source: Secondary Data from IFLS 2007 and 2014 (Processed Data 2019)

Stroke is an acute, diffuse, or focal brain dysfunction originating from vessels and lasting for a period longer than 24 hours. Types of stroke are intracerebral hemorrhages, subarachnoid hemorrhages, ischemic, and cerebral venous sinus thrombosis. Stroke has been considered the third most common cause of death besides cardiovascular diseases and malignant tumors (Alrabghi et al., 2018). The results obtained showed the occurrence of stroke in one to two out of 100 residents aged 15 years and older, between 2007 and 2014. Additional information was obtained from the diagnosis of doctors, nurses, paramedics, or midwives, and the study outcomes were supported by previous researches, which demonstrated an increase in prevalence from 7‰ to 10.9‰ within the period of 5 years (2013 to 2018; Ministry of Health Republic of Indonesia, 2019).

Metabolic risk factors are important in predicting the incidence of stroke, including (1) the waist circumference measurement of over 40 inches for males or 35 inches for females, (2) fasting blood sugar of more than 100 mg/dl, (3) triglyceride levels above 150 mg/dl, (4) blood pressure > 130/85 mmHg and (5) fasting HDL of less than 40 mg/dl in male or 50 mg/dl in female (Khafagy et al., 2019). These conditions possibly affect and disrupt

body metabolic processes, subsequently increasing the risk for stroke. Based on Imanda et al., Sofiana & Rahmawati and Riyadina & Rahajeng studies have shown that hypertension has a significant influence on stroke (Riyadina & Rahajeng, 2013; Imanda, Martini & Artanti, 2019; Sofiana & Rahmawati, 2019). However, this is higher in respondents suffering from three metabolic diseases at a time, compared to those experiencing one or two, as supported by previous studies (Renjen, Beg & Ahmad, 2015; Hörnsten et al., 2016; Boehme, Esenwa & Elkind, 2017; Hong, 2017; Furlan et al., 2018). Hypertension is one of the cognitive impairment risk factors after Ischemic Stroke. The process of cognitive impairment in patients with hypertension begins with the occurrence of pathological changes in the blood vessels of the brain causing abnormalities in the brain vessels. Abnormalities and damage to brain vessels will cause an increased risk of cognitive impairment (Nurani, Martini & Marzela, 2019). Meanwhile, Endarti and Handito's previous study showed that people who have a history of at least one type of NCDs run the risk six times more likely to experience the poor health-related quality of life (POR: 5.581; 95% CI: 3.883 to 8.020) (Endarti & Handito, 2016).

Physical activity (PA) is another mo-

difficult risk factor, as respondents that rarely participate (less physical activity) were comparably at more risk than those with sufficient physical activity (OR: 3.5; 95% CI: 1.2-10.2). It is in line with a study that identified a 7.4% less incidence of stroke in physically active residents aged ten years and above (Ministry of Health Republic of Indonesia, 2019). The practice of a sedentary lifestyle leads to a build-up of fat, cholesterol, and calcium, which tend to interfere with the flow of blood to the brain and heart, subsequently leading to stroke or death. The previous study concludes that physical activity was not only a predictor for body mass index, but also a determinant of type 2 diabetes mellitus (Botabara-Yap, Estrada & Balila, 2019; Kandou et al., 2019; Simbolon, Siregar & Talib, 2020). Stroke guidelines from the American Stroke Association recommend at least 40 min/day of moderate to vigorous-intensity aerobic PA 3 to 4 days/week. Moderate-intensity exercise was defined as sufficient to break a sweat or noticeably raise heart rate (eg: walking briskly, using an exercise bicycle). The World Health Organization also recommends 150 min/week of moderate-intensity exercise or 75 min/week of vigorous-intensity exercise includes activities such as jogging (Jeong et al., 2017; Prior & Suskin, 2018).

These risks were elevated with age, as seen in 1.9%, 2.7%, and 3.2% of respondents at 40, 50, and 65 years or more, respectively. Furthermore, amongst the individuals experiencing a combination of three metabolic diseases, 14 to 15 of those aged 15-40 years were suffering from strokes, as this age group had a proportion of less physical activity (0.633%) that was slightly higher than sufficient physical activity (0.628%). Also, the obese proportion was more significant amongst respondents living a sedentary lifestyle, compared to the more active persons (13.1% and 7.7%), which was lesser in females (53.1%) than males (38.7%). It is an indication of higher risk in females at this age group, although individuals that were 15-50, and 15-64 years exhibited higher values in males than females. However, there was a higher prevalence of stroke in 15-64 years old participants lacking physical activity, consuming fewer vegetables and fruits (fiber), and experiencing stress. The results are

supported by the outcome of previous research like Anderson & Durstine, 2019; Everson-Rose et al., 2014; Hankey, 2017; Kotłęga et al., 2016; Li et al., 2017, meanwhile the Total Diet Study in 2014 and some others identified similarity with the consumption of excessive sugar, sodium and the presence of hypertension, which is experienced more by males (Thaha, A & A, 2016; Ministry of Health Republic of Indonesia, 2017).

The results identified the importance of conducting physical activity as a preventative measure for the occurrence of metabolic diseases, known to impact the increased incidence of stroke. The Ministry of Health launched an effort to prevent and control non-communicable diseases through the conduction of "Gerakan Masyarakat Hidup Sehat". It involves carrying out preventive behaviors, including periodic health check-ups (measuring blood pressure, blood sugar levels, cholesterol levels, stomach circumference, pulse, body weight, and height), avoiding and slowly quitting the habit of smoking, conducting physical activity (exercise at least half an hour per day for three to five days a week), consuming nutritious and balanced food, acquiring enough rest and stress management. This conduct is also termed "CERDIK" behavior, alongside the practice of preventive efforts and raising awareness for stroke sufferers, as a control measure to always "PATUH". Furthermore, the approach involves routine participation in health checks according to doctor's advice, obtaining proper and regular treatment, consuming nutritious and balanced food, engaging in physical activities, which is adjusted to the ability of each patient, and also the avoidance of alcohol, cigarettes, and other harmful substances (Ministry of Health Republic of Indonesia, 2014).

Conclusion

A total of one to two out of 100 residents aged 15 years and above had a stroke (1.8%), based on the observation conducted for seven years. This value was simultaneously influenced by the risk factors of metabolic, physical activity, gender, and age, as a higher incidence was affiliated with an increase in the experience of metabolic diseases. However, it is possible for individuals that have not suffered a stroke

to make preventive efforts by implementing a healthy lifestyle and engaging in physical activities. It includes the practice of regular exercise, monitoring and controlling blood pressure, cholesterol, blood sugar, and body weight, as well as recognizing the symptoms of stroke, encompassing the presence of asymmetrical smile, weak/ paralyzed hand and foot movements, speaking unclearly, numbness throughout the body and around the mouth, double vision/sudden loss of vision in one eye, impaired balance, decreased consciousness/unconscious, vomiting, and headache. However, individuals experiencing the three diseases related to metabolism are recommended to maintain physical activities adapted to the ability, including walking activities for a quarter of an hour in the morning and routinely participating in stretching exercises. This practice possibly enhances limb training (muscles and joints), blood circulation, and O₂ supply in the body, which consequently optimizes metabolism. In addition, it is also necessary to conduct routine checks on blood pressure, sugar levels, and body weight, limiting the use of table salt and high sodium food ingredients, restricting the intake of fried food or high coconut milk diet, and also avoiding corned beef, sausages, sardines, organ meats, being sources of high saturated fat from animals.

Acknowledgments

The researchers would like to thank the RAND, the Center for Population and Policy Studies (CPPS) of the University of Gadjah Mada and Survey METRE for providing data. We also express our appreciation to all respondents who participate in this survey.

References

- Alharbi, A.S., Alhayan, M.S., Alnami, S.K., Traad, R.S., Aldawsari, M.A., Alharbi, S.A., Sharif, A.O.A., Alboqami, S.T., Alshammari, S.A., Alzeer, M.K.S., & Alshammari, M.A., 2019. Epidemiology and Risk Factors of Stroke. *Archives of Pharmacy Practice*, 10(4), pp. 60–66.
- Alrabghi, L., Alnemari, R., Aloteebi, R., Alshammari, H., Ayyad, M., Ibrahim, M.A., Alotayfi, M., Bugshan, T., Alfaiifi, A., & Aljuwayd, H., 2018. Stroke Types and Management. *International Journal of Community Medicine And Public Health*, 5(9), pp.1–5.
- Anderson, E., & Durstine, J., 2019. Physical Activity, Exercise, and Chronic Diseases: A Brief Review. *Sports Medicine and Health Science*, 1, pp.3–10.
- Boehme, A.K., Esenwa, C., & Elkind, M.S.V., 2017. Stroke Risk Factors, Genetics, and Prevention. *Circulation Research*, 120(3), pp.472–495.
- Booth, J., Connelly, L., Lawrence, M., Chalmers, C., Joice, S., Becker, C., & Dougall, N., 2015. Evidence of Perceived Psychosocial Stress as a Risk Factor for Stroke in Adults: A Meta-Analysis. *BMC Neurology*, 15, p.233.
- Botabara-Yap, M.J., Estrada, M.R., & Balila, E., 2019. Lifestyle Predictors of Overweight among Malaysians. *Malaysian Journal of Public Health Medicine*, 19(1), pp.167–171.
- Chen, R., Ovbiagele, B., & Feng, W., 2016. Diabetes and Stroke: Epidemiology, Pathophysiology, Pharmaceuticals and Outcomes. *The American Journal of the Medical Sciences*, 351(4), pp.380–386.
- Endarti, A.T., & Handito, A., 2016. The Relationship between Non-Communicable Diseases History and Health-Related Quality of Life. *KEMAS Jurnal Kesehatan Masyarakat*, 12(1), pp.120–130.
- Everson-Rose, S.A., Roetker, N.S., Lutsey, P.L., Kershaw, K.N., Longstreth-Jr, W.T., Sacco, R.L., Roux, A.V.D., & Alonso, A., 2014. Chronic Stress, Depressive Symptoms, Anger, Hostility, and Risk of Stroke and Transient Ischemic Attack in the Multi-Ethnic Study of Atherosclerosis. *Stroke*, 45(8), pp.2318–2323.
- Furlan, N.E., Bazan, S.G.Z., Braga, G.P., Castro, M.C.N.E., Franco, R.J.d-S., Gut, A.L., Bazan, R., Martin, L.C., 2018. Association between Blood Pressure and Acute Phase Stroke Case Fatality Rate: A Prospective Cohort Study. *Arquivos de Neuro-Psiquiatria*, 76(7), pp.436–443.
- Gan, Y., Wu, J., Zhang, S., Li, L., Yin, X., Gong, Y., Herath, C., Mkandawire, N., Zhou, Y., Song, X., Zeng, X., Li, W., Liu, Q., Shu, C., Wang, Z., & Lu, Z., 2017. Prevalence and Risk Factors Associated with Stroke in Middle-Aged and Older Chinese: A Community-Based Cross-Sectional Study. *Scientific Reports*, 7(1), p.9501.
- Ghani, L., Mihardja, L., & Delima, D., 2016. Dominant Risk Factors of Stroke in Indonesia. *Bulletin of Health Research*, 44(1), pp.49–58.
- Habibi-koolaee, M., Shahmoradi, L., Kalhori,

- S.R.N., Ghannadan, H., & Younesi, E., 2018. Prevalence of Stroke Risk Factors and Their Distribution Based on Stroke Subtypes in Gorgan: A Retrospective Hospital-Based Study—2015-2016. *Neurology Research International*, 4, pp.1-7.
- Hankey, G.J., 2017. The Role of Nutrition in the Risk and Burden of Stroke: An Update of the Evidence. *Stroke*, 48, pp.3168-3174.
- Hong, K.-S., 2017. Blood Pressure Management for Stroke Prevention and in Acute Stroke. *Journal of Stroke*, 19(2), pp.152-165.
- Hörnsten, C., Weidung, B., Littbrand, H., Carlberg, B., Nordström, P., Lövheim, H., & Gustafson, Y., 2016. High Blood Pressure as a Risk Factor for Incident Stroke among Very Old People: A Population-Based Cohort Study. *Journal of Hypertension*, 34(10), pp.2059-2065.
- Imanda, A., Martini, S., & Artanti, K.D., 2019. Post Hypertension and Stroke: A Case Control Study. *Kemas: National Public Health Journal*, 13(4), pp.164-168.
- Jeong, H.-G., Kim, D.Y., Kang, D.-W., Kim, B.J., Kim, C.K., Kim, Y., Yang, W., Park, E.-S., & Lee, S.-H., 2017. Physical Activity Frequency and the Risk of Stroke: A Nationwide Cohort Study in Korea. *Journal of the American Heart Association*, 6, p.e005671.
- Kabi, G.Y.C., Tumewah, R., & Kembuan, M.A.H., 2015. Description of Risk Factors in Ischemic Stroke Patients Taken Care of Neurology Hospital Prof. Dr. R. D. Kandou Manado July 2012-June 2013. *Jurnal e-Clinis (eCl)*, 3(1), pp.457-462.
- Kandou, G.D., Ratag, B.T., Kalesaran, A.F.C., Kandou, P.C., 2019. Obesity and Lifestyle Factors as Determinants of Type 2 Diabetes Mellitus in Manado City, Indonesia. *Malaysian Journal of Public Health Medicine*, 19(2), pp.54-60.
- Khafagy, A.T., Hamdy, N.A., Hassan, E.M., Yehia, M.A., Ismail, M.M., Abdelkader, M.M., & Shawky, N.M., 2019. Association between Metabolic Syndrome and Atherothrombotic Stroke: A Clinical Study in Tertiary Care Hospital, Minia, Egypt. *The Egyptian Journal of Neurology, Psychiatry and Neurosurgery*, 55, p.51.
- Kotłęga, D., Gołąb-Janowska, M., Masztalewicz, M., Cieciewicz, S., & Nowacki, P., 2016. The Emotional Stress and Risk of Ischemic Stroke. *Neurologia i Neurochirurgia Polska*, 50, pp.265-270.
- Li, M., Cui, F., Yang, F., & Huang, X., 2017. Association between Fiber Intake and Ischemic Stroke Risk: A Meta-Analysis of Prospective Studies. *International Journal of Clinical and Experimental Medicine*, 10(3), pp.4659-4668.
- Ministry of Health Republic of Indonesia., 2014. *Stroke Prevention and Control Policies and Strategies in Indonesia*. Jakarta: Ministry of Health Republic of Indonesia.
- Ministry of Health Republic of Indonesia., 2017. *National Action Plan for Prevention and Control of Non-communicable Diseases 2015-2019*. Jakarta: Ministry of Health Republic of Indonesia.
- Ministry of Health Republic of Indonesia., 2019. *Report of Basic Health Research 2018*. Jakarta: Board of Health Research and Development Ministry of Health Republic of Indonesia.
- Mo, X., Gai, R.T., Sawada, K., Takahashi, Y., Cox, S.E., Nakayama, T., & Mori, R., 2019. Coronary Heart Disease and Stroke Disease Burden Attributable to Fruit and Vegetable Intake in Japan: Projected DALYS to 2060. *BMC Public Health*, 19, p.707.
- Nurani, R.R.S., Martini, S., & Marzela, F., 2019. Risk Factors of Cognitive Impairment Post Ischemic Stroke. *KEMAS Jurnal Kesehatan Masyarakat*, 15(2), pp.295-302.
- Owolabi, M.O., Sarfo, F., Akinyemi, R., Gebregziabher, M., Akpa, O., Akpalu, A., Wahab, K., Obiako, R., Owolabi, L., & Ovbiagele, B., 2018. Dominant Modifiable Risk Factors for Stroke in Ghana and Nigeria (SIREN): A Case-Control Study. *The Lancet Global Health*, 6(4), pp.e436-e446.
- Pan, B., Jin, X., Jun, L., Qiu, S., Zheng, Q., & Pan, M., 2019. The Relationship between Smoking and Stroke: A Meta-Analysis. *Medicine*, 98(12), p.e14872.
- Prior, P.L., & Suskin, N., 2018. Exercise for Stroke Prevention. *Stroke and Vascular Neurology*, 3(e000155), pp.59-68.
- Ramadany, A.F., Pujarini, L.A., & Candrasari, A., 2013. The Relationship of Diabetes Mellitus with the Event of Ischemic Stroke in RSUD Dr. Moewardi Surakarta in 2010. *Biomedika*, 5(2), pp.11-16.
- Reinholdsson, M., Palstam, A., & Sunnerhagen, K., 2018. Prestroke Physical Activity Could Influence Acute Stroke Severity (Part of PAPSIGOT). *Neurology*, pp.e1-e7.
- Renjen, P.N., Beg, M.A., & Ahmad, K., 2015. Epidemiological Study of Incidence and Risk Factors of Ischemic Stroke Subtypes According to Trial of ORG 10172 in Acute Stroke Treatment Criteria: A 3 Years, Hospital-Based Study. *International Journal of Medicine and Public Health*, 5(1), pp.50-

- 54.
- Riyadina, W., & Rahajeng, E., 2013. Determinan Penyakit Stroke. *Kesmas: Jurnal Kesehatan Masyarakat Nasional*, 7(7), pp.325–330.
- Simbolon, D., Siregar, A., & Talib, R.A., 2020. Physiological Factors and Physical Activity Contribute to the Incidence of Type 2 Diabetes Mellitus in Indonesia. *Kesmas: National Public Health Journal*, 15(3), pp.120–127.
- Sofiana, L., & Rahmawati, D.D., 2019. Hypertension and Diabetes Mellitus Increase the Risk of Stroke. *KEMAS Jurnal Kesehatan Masyarakat*, 15(2), pp.147–152.
- Soliman, R.H., Oraby, M.I., Fathy, M., & Essam, A.M., 2018. Risk Factors of Acute Ischemic Stroke in Patients Presented to Beni-Suef University Hospital: Prevalence and Relation to Stroke Severity at Presentation. *The Egyptian Journal of Neurology, Psychiatry and Neurosurgery*, 54, p.8.
- Thaha, I.L.M., A, A.W., & A, D.S., 2016. Hypertension Cases in Segeri Community Health Center, Pangkep District. *The Indonesian Journal of Public Health*, 12(2), pp.104–110.
- Tun, N.N., Arunagirinathan, G., Munshi, S.K., & Pappachan, J.M., 2017. Diabetes Mellitus and Stroke: A Clinical Update. *World Journal of Diabetes*, v8(6), pp.235–248.
- Wang, Y., Dai, Y., Zheng, J., Xie, Y., Guo, R., Guo, X., Sun, G., Sun, Z., Sun, Y., & Zheng, L., 2019. Sex Difference in the Incidence of Stroke and Its Corresponding Influence Factors: Results from a Follow-up 8.4 Years of Rural China Hypertensive Prospective Cohort Study. *Lipids in Health and Disease*, 18, p.72.
- Zhang, F.-L., Guo, Z., Wu, Y., Liu, H., Luo, Y., Sun, M., Xing, Y., Yang, Y., 2017. *Prevalence of Stroke and Associated Risk Factors: A Population Based Cross Sectional Study from Northeast China*. *BMJ Open*, 7(9), pp.1–11.