Int. j. adv. multidisc. res. stud. 2024; 4(3):1313-1317

Received: 28-04-2024
Accepted: 08-06-2024

International Journal of Advanced Multidisciplinary Research and Studies

ISSN: 2583-049X

The Relationship between Hemodynamic Status and Stroke Risk in Hypertensive Patients at the General Hospital of South Aceh Regency

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DOI: https://doi.org/10.62225/2583049X.2024.4.3.2939
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Abstract

Hypertension is a major health issue causing global mortality and disability. This condition can lead to severe damage to the heart and blood vessels, potentially resulting in stroke. This study aims to determine the relationship between hemodynamic status and stroke risk in hypertensive patients. This study used a quantitative cross-sectional design. The population consisted of hypertensive patients at the outpatient clinic of General Hospital of South Aceh Regency, with 248 respondents. A sample of 151 respondents was selected using convenience sampling. Data were collected through face-to-face interviews and self-reporting using a manual sphygmomanometer and stethoscope to measure blood pressure, Mean Arterial Pressure (MAP) and heart rate and the Stroke Recognition Questionnaire (SRQ) to measure stroke risk variables. Data collection took place from January to March, 2024. Statistical analysis was performed using chi-square and multiple logistic regression. The study showed a significant relationship between stroke risk and blood pressure ($p = 0.000$), mean arterial pressure (MAP) ($p = 0.000$), and heart rate ($p = 0.009$). Logistic regression analysis indicated that the most significant predictors of stroke risk were blood pressure ($p = 0.000$; OR: 3.187), mean arterial pressure (MAP) ($p = 0.024$; OR = 2.766), and heart rate was not a predictor of stroke. Better monitoring and management of hemodynamics can help reduce the risk of stroke in hypertensive patient populations. It is crucial for healthcare practitioners to routinely monitor MAP and intervene as necessary to lower stroke risk.

Keywords: Hypertension, Hemodynamics, Mean Arterial Pressure, Stroke

Introduction

Hypertension remains a major public health issue, causing 104 million deaths and 218 million disabilities globally [1]. According to the World Health Organization (2023), an estimated 1.28 billion adults aged 30-79 years worldwide have hypertension, with the majority (two-thirds) living in low- and middle-income countries. About 46% of adults with hypertension are unaware they have the condition [2].

Hypertension is defined as abnormally high blood pressure [3]. An increase in systolic blood pressure of at least 140 mmHg or diastolic pressure of at least 90 mmHg is considered hypertension [4]. Symptoms such as migraine headaches are often found as clinical signs of hypertension [5]. Hypertension can cause severe damage to the heart with excessive pressure that can rupture or block arteries, reducing blood flow and oxygen to the brain, leading to stroke [6, 2].

Stroke is the second leading cause of death and the third leading cause of disability globally. In 2021, there were over 12.2 million new stroke cases worldwide each year. In Indonesia, stroke-related deaths reached 252,473 cases or 14.83% [7]. Data from RISKESDAS 2019 showed that the national prevalence of stroke in Indonesia was 713,783 cases (10.9%) for individuals aged >15 years. East Kalimantan Province had the highest prevalence (14.7%), while Aceh Province ranked 28th with 13,389 cases (7.8%). The highest prevalence of stroke was found in the age group 75 years and older (50.2%) [4].

Stroke is a serious medical condition that occurs when blood flow to the brain is disrupted, either due to a blood vessel blockage (ischemic stroke) or a blood vessel rupture (hemorrhagic stroke) [8]. Several risk factors can increase the likelihood of a person experiencing a stroke, including hypertension, smoking, diet, and physical activity [9]. Consumption of high-fat foods

and smoking habits significantly influence the incidence of ischemic stroke in individuals under 45 years old, controlled for hypertension, heart disease, and diabetes mellitus [10].

Hemodynamic monitoring, including the examination of physical aspects of blood circulation, heart function, and peripheral vascular physiological characteristics, aims to detect and identify physiological abnormalities early [11]. According to Yusuf *et al*. (2021), parameters often used to assess a patient's hemodynamic status include Mean Arterial Pressure (MAP), which is an assessment of hemodynamic status based on blood pressure and Heart Rate through manual measurement on the radial artery within one minute [12].

Previous studies have shown the correlation between hemodynamic status and stroke risk in hypertensive patients. Research by Smith (2021) indicated that increased MAP is significantly associated with an increased risk of stroke in hypertensive patients [13]. Another study by Johnson (2022) found that blood pressure variability is also an independent predictor of stroke incidence in hypertensive patients [14].

Changes in hemodynamics, such as blood flow through the vessels, can affect stroke risk. The total blood volume in the body can influence blood pressure; if blood volume increases, the pressure in the circulatory system can also increase. An unhealthy diet, such as consuming high levels of saturated fats, salt, and sugar, and low fiber intake, can increase stroke risk factors.

This study explores the direct relationship between hemodynamic status and stroke risk in hypertensive patients in the southern coastal area. Understanding the relationship between hemodynamic status and stroke risk can provide preventive and management efforts for stroke in hypertensive patients. More appropriate interventions can be undertaken to reduce this risk. This study is expected to provide useful information for healthcare practitioners in monitoring and managing hypertensive patients to reduce future stroke incidents.

Methods and Materials

This is a quantitative cross-sectional study aiming to determine the relationship between hemodynamic status and stroke risk in hypertensive patients. The study population included all hypertensive patients undergoing outpatient care at the clinic of General Hospital of South Aceh Regency, totaling 248 respondents. The sample consisted of 151 respondents selected using convenience sampling.

Data collection was conducted in the clinic room from January 30 to March 15, 2024. Data were collected through face-to-face interviews and self-reporting using a manual sphygmomanometer and stethoscope to measure blood pressure, Mean Arterial Pressure (MAP) and heart rate, while stroke risk was assessed using the Stroke Recognition Questionnaire (SRQ) developed by Ennen and Zerwic (2010). The SRQ instrument was validated with a content validity index (CVI) on stroke symptoms and non-symptoms after being reviewed by eight doctors and nurses specializing in stroke patient research. The SRQ reliability test showed a Cronbach's Alpha value of 0.819 for stroke symptoms, 0.755 for non-stroke symptoms, 0.719 for stroke risk factors, and 0.649 for non-stroke risk factors [15].

MAP measurement was performed using the formula (Systolic blood pressure + 2xDiastolic blood pressure/3). The final MAP result was categorized into six categories: Normal (70-90 mmHg), high (100-105 mmHg), stage 1 (106-119 mmHg), stage 2 (120-132 mmHg), stage 3 (133-149 mmHg), and stage 4 (>150 mmHg) (National Heart Lung and Blood Institute, 2000). Stroke risk was determined using the SRQ, where a score above the average (>60%) indicated a high stroke risk, while a score ≤60% indicated no risk.

All research procedures adhered to applicable research ethics principles and received approval from the Ethics Committee of Nursing Research, Faculty of Nursing Universitas Syiah Kuala Banda Aceh (Number: 111003181223). All respondents provided written informed consent before participating in the study. Data analysis was performed using chi-square and multiple logistic regression to determine the relationship between hemodynamic status and stroke risk.

Results

This study aimed to determine the relationship between hemodynamic status and stroke risk in hypertensive patients. The study results are presented in the following tables and graphs.

Distribution of Respondent Characteristics

Table 1 shows that the majority of respondents were in the pre-elderly age category (46-59 years) with 79 respondents (52.3%) and most were male, totaling 85 respondents (56.3%). The majority of respondents had a secondary school education, totaling 78 respondents (51.7%). Of the respondents, 68 (45.0%) had smoking behavior and most had a family history of stroke, totaling 97 respondents (64.2%). The majority of respondents had hypertension for 1-5 years, totaling 97 respondents (64.2%). The most commonly consumed pharmacological therapy was Amlodipine 5 mg by 44 respondents (29.1%).

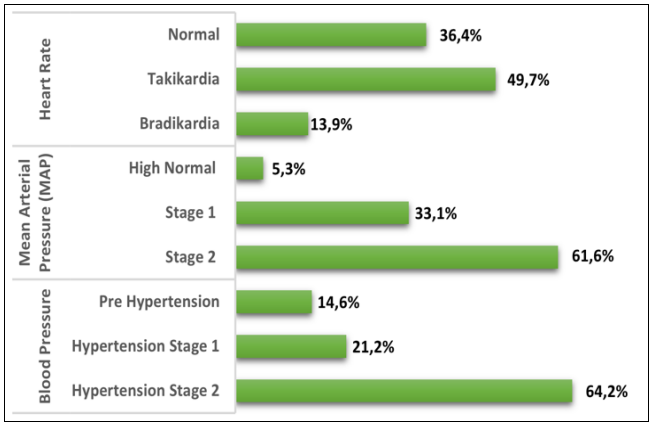
Table 1: Frequency Distribution of Respondent Characteristics (n=151)

Characteristic	Frequency	Percentage
Age		
Adult (18-45 years)	7	4,6
Pre-elderly (46-59 years)	79	52,3
Elderly (>60 years)	65	43,0
Gender		
Male	85	56,3
Female	66	43,7
Last Education		
Higher education	8	5,3
Secondary education	78	51,7
Primary education	63	41,1
No Schooling	3	2,0
Smoking Behavior		
Yes	68	45,0
No	83	55,0
Family History of Stroke		
Yes	97	64,2
No	54	35,8
Duration of Hypertension		
<1 year	22	14,6
1-5 years	97	64,2
>5 years	32	21,2
Pharmacological Therapy		
Amlodipin 10 mg	30	19,9
Amlodipin 10 mg + Candesartan 16 mg	15	9,9
Amlodipin 10 mg + Candesartan 8 mg	6	4,0
Amlodipin 5 mg	44	29,11
Amlodipin 5 mg + Candesartan 16 mg	8	5,3

Amlodipin 5 mg + Candesartan 8 mg	23	15,2
Candesartan 16 mg	15	9,9
Candesartan 8 mg	10	6,6

Hemodynamic Status of Hypertensive Patients

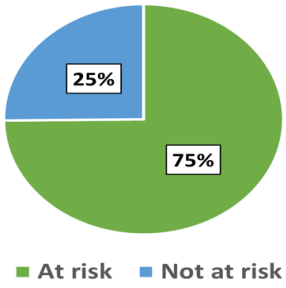
The research results in Graph 1 show that out of 151 respondents, 64.2% of respondents had a blood pressure of ≥160 mmHg, classified as Hypertension Stage 2. The Mean Arterial Pressure (MAP) examination results showed that most respondents had a blood pressure of 120/132 mmHg, categorized as Stage 2, at 61.6%. Heart Rate examination results showed that most respondents experienced tachycardia (>100 beats/minute) at 49.7%.



Graph 1: Percentage of Hemodynamic Status of Hypertensive Patients

Stroke Risk in Hypertensive Patients

The study results in the Graph 2 above indicate that of the 151 respondents, 75% of hypertensive patients at the Internal Medicine Clinic of General Hospital of South Aceh Regency are at risk of stroke in the future.



Graph 2: Percentage of Stroke Risk in Hypertensive Patients

Correlation Analysis of Hemodynamic Status and Stroke Risk

The study results Table 2 show that the mean blood pressure of hypertensive patients is 156 mmHg. Mean Arterial Pressure (MAP) measurements show a mean value of 117 mmHg and a mean heart rate of 96 beats/minute. Based on chi-square test analysis, there is a significant relationship between blood pressure (p-value = 0.000), Mean Arterial Pressure (p-value = 0.000), and Heart Rate (p-value = 0.009) with the risk of stroke in hypertensive patients at the Internal Medicine Clinic of General Hospital of South Aceh Regency.

Table 2: Correlation Analysis of Hemodynamic Status and Stroke Risk in Hypertensive Patients

Hemodynamic Status	Mean	SD	p-value
Blood Pressure	156.05	10.012	0,000
Mean Arterial Pressure (MAP)	117.356	5.7010	0,000
Heart Rate	96.74	17.292	0,009

Stroke Risk Predictors

Regression analysis at step 3 shows that the significant predictors related to stroke risk in hypertensive patients at the Internal Medicine Clinic of General Hospital of South Aceh Regency are blood pressure (Sig. = 0.000) with a B value of 1.159 and mean arterial pressure (Sig. = 0.024) with a B value of 1.017. The Heart Rate variable was eliminated at step 2 with a value (Sig. = 0.986 > α=0.05) and is not a stroke risk predictor. The results indicate that blood pressure in the hypertension stage 2 category can increase stroke risk in hypertensive patients by three times compared to the hypertension stage 1 category (OR = 3.187). The higher the blood pressure of hypertensive patients, the higher the stroke risk.

Table 3: Stroke Risk Predictors in Hypertensive Patients

Hemodynamic Status	B	OR	Sig.	95% CI	
				Lower	Upper
Blood Pressure	1,159	3,187	0,000	1,669	6,085
Mean Arterial Pressure (MAP)	1,017	2,766	0,024	1,146	6,674

Discussion

Patients with a history of hypertension tend to exhibit more significant clinical symptoms of stroke compared to those without comorbid diseases [16]. Hypertension can damage the walls of blood vessels, leading to blockages or even ruptures [17]. High systolic and diastolic blood pressure causes the formation of hyaline in the intima layer of cerebral blood vessels. This results in the vessel diameter becoming static, losing its ability to dilate or contract according to systemic blood pressure. Elevated blood pressure affects the pressure on capillary walls, causing hyperemia, cerebral edema, and brain hemorrhage [18].

The research results in Graph 1 show that the hemodynamic status of hypertensive patients at the Internal Medicine Clinic of General Hospital of South Aceh Regency, based on blood pressure measurements, found 64.2% of respondents had Hypertension Stage 2 (≥160 mmHg) with a mean value of 156.05. Most respondents had Mean Arterial Pressure in Stage 2 at 61.6%, and 49.7% showed a heart rate >100 beats/minute in the tachycardia category. Chi-square test analysis showed that there is a relationship between hemodynamic status and stroke risk, with both blood pressure and Mean Arterial Pressure having p-value = 0.000, and heart rate having p-value = 0.009.

Individuals with normal blood pressure also have normal Mean Arterial Pressure (MAP) and heart rate. Conversely, high blood pressure increases stroke risk. Effective blood pressure management strategies are crucial for hypertensive patients. When patients can effectively manage their blood pressure, they are less likely to face stroke risks. The primary stroke prevention program for hypertensive patients involves maintaining systolic blood pressure below 140

mmHg and diastolic pressure under 90 mmHg, along with adopting a healthy lifestyle to prevent other risk factors such as elevated blood sugar and cholesterol levels [19].

Logistic regression analysis shows that blood pressure is the most related aspect to stroke risk in hypertensive patients at General Hospital of South Aceh Regency (OR = 3.187). This indicates that high blood pressure triples the risk of stroke. Therefore, the higher the blood pressure, the greater the risk of stroke.

The Theory of Symptom Management consists of symptom experience, symptom management strategies, and outcomes. Managing blood pressure falls under symptom management strategies, whereby controlling blood pressure can minimize stroke risk. Conversely, poor symptom management increases stroke risk. This aligns with research by Chandra (2015) at RSUD Dr. Moewardi Surakarta, which found a significant relationship between MAP and stroke risk in hypertensive patients (p = 0.000). High MAP can increase mortality in stroke patients [20].

High Mean Arterial Pressure (MAP) reduces vascular elasticity, making MAP crucial in preventing increased intracranial pressure, blood flow disturbances, or vessel rupture, which can damage brain cells [21]. Cumulative MAP increases are an independent risk factor for ischemic stroke in hypertensive patients. Special attention should also be given to men over 60 years old [22].

Logistic regression analysis indicates that Mean Arterial Pressure (MAP) has an OR of 2.766, meaning it increases stroke risk by 2.7 times. Thus, the higher the MAP, the greater the stroke risk. Managing blood pressure along with MAP can reduce stroke risk. Hidayati (2021) found that high heart rates can trigger heart disease (p = 0.035), which can lead to strokes [23]. Fauzi (2022) reported an average pulse rate of 92.04 beats/minute in stroke patients at the Emergency Room (IGD), with a minimum of 76 and a maximum of 128 beats/minute [24].

Long-term hemodynamic changes can cause blood clots in the heart, which, if released into systemic circulation, can cause blockages. Blockages in brain vessels lead to ischemic stroke. Consuming high-salt and high-fat or cholesterol foods 1-3 times daily for 10 years can cause fat buildup in vessels, hindering blood flow to the brain [25].

This study concludes that high blood pressure can trigger stroke risk, especially in hypertensive patients, as high blood pressure can cause ischemic stroke. Uncontrolled high blood pressure can lead to vessel rupture, causing hemorrhagic stroke.

Hypertension, a modifiable factor, can increase stroke incidence by six times compared to other conditions if not managed. High blood pressure negatively impacts patients, including increased cardiovascular disease risk. Systolic blood pressure increases over 20 mmHg and diastolic increases over 10 mmHg can trigger ischemic heart disease and stroke [26]. Hypertensive patients should ensure their blood pressure remains within normal limits or below 200 mmHg.

Understanding the relationship between hemodynamic status and stroke risk can enhance prevention and management efforts. Appropriate interventions such as blood pressure control and healthy lifestyle education can reduce stroke risk in hypertensive patients. This research provides critical information for healthcare practitioners to monitor and manage hypertensive patients and reduce future stroke occurrences.

This study has several limitations. First, due to its observational nature and data collection being limited to a single site, causal conclusions cannot be drawn from the findings. Second, the data collection technique used was self-report, which has inherent limitations related to the respondents' ability to comprehend the statements and accurately disclose their personal conditions. Additionally, self-reporting may introduce bias, as respondents might provide answers that do not accurately reflect their true situations.

Conclusion

This study reveals a significant relationship between hemodynamic status, measured through blood pressure, Mean Arterial Pressure (MAP), and Heart Rate, and stroke risk in hypertensive patients. The majority of hypertensive patients at General Hospital of South Aceh Regency fall into the high stroke risk category. These findings underscore the importance of better blood pressure monitoring and management, as well as lifestyle interventions, to lower stroke risk. Effective prevention strategies can help reduce the stroke burden among hypertensive patients. Further research is needed to explore other factors that may influence stroke risk and develop more comprehensive interventions.

Recommendations

“Strengthen hypertension management programs”: Implementing and reinforcing hypertension management programs at healthcare facilities is crucial. Regular monitoring and controlling of blood pressure in hypertensive patients can significantly reduce stroke risk. “Educational campaigns”: Conduct educational campaigns to raise awareness about the importance of maintaining normal blood pressure levels and the potential risks of hypertension. Patients should be educated on the benefits of a healthy diet, regular physical activity, and avoiding smoking and excessive alcohol consumption. “Comprehensive lifestyle interventions”: Develop and promote comprehensive lifestyle interventions that include dietary modifications, physical activity, stress management, and weight control. These interventions should be tailored to individual needs and circumstances. And “Further research”: Conduct further research to identify additional factors that may influence stroke risk in hypertensive patients. Studies focusing on genetic predispositions, environmental factors, and the impact of long-term medication use can provide deeper insights into stroke prevention.

Acknowledgement

We extend our gratitude to the Human Resources Development and Empowerment Agency of the Ministry of Health, Republic of Indonesia, for funding this research, and to the Human Resources Development Agency of South Aceh Regency, and the Director of General Hospital of South Aceh Regency, for facilitating this research, as well as all respondents who shared their time, experiences, and participation in this study.

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