

The Knowledge Level of Hypertension Stage 2 Patients at *Harapan Keluarga* Hospital Regarding Complications in the form of Aortic Aneurysm

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Article History

Received : April 02th, 2025

Revised : May 05th, 2025

Accepted : May 06th, 2025

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Abstract: Hypertension is a major contributor to cardiovascular complications, including aortic aneurysms, which can be fatal if left untreated. This study aims to examine the relationship between the level of hypertension, particularly stage 2, and the incidence of aortic aneurysm. A retrospective cohort analysis was conducted using medical records of 24 patients diagnosed with varying degrees of hypertension and aortic aneurysm at Harapan Keluarga Hospital in December 2024. Statistical analysis using the chi-square test revealed a significant association between hypertension severity and the incidence of aortic aneurysm ($p = 0.000$), with an odds ratio of 2.001 (95% CI: 2.010–2.229). These findings emphasize the need for enhanced patient education and preventive strategies, particularly among those with hypertension stage 2, to mitigate the risk of aneurysm-related complications.

Keywords: Aortic aneurysm, hypertension stage, knowledge level.

Introduction

Hypertension is one of the most common chronic diseases in the world and is a major risk factor for cardiovascular complications. When blood pressure continues to increase to systolic pressure ≥ 140 mmHg or diastolic pressure ≥ 90 mmHg, this condition is categorized as hypertension stage 2, which carries a higher risk of various cardiovascular complications, including aortic (Guirguis-Blake et al., 2021; Oparil et al., 2018; Rooprai et al., 2022; Wang et al., 2025).

Aortic aneurysms were estimated to have caused 149,012 deaths globally in 2019, highlighting the major impact this condition has on cardiovascular health worldwide. Aortic aneurysm is an extremely dangerous pathological condition and contributes significantly to the overall burden of cardiovascular disease, with a survival rate of less than 20% after rupture. Therefore, there is a need for better preventive measures and more efficient disease management, which is emphasized by epidemiological trends showing an increase in age-standardized death rates and disability-

adjusted life years due to aortic aneurysms between 1990 and 2021

(Golledge et al., 2023; Wang et al., 2025).

Aortic aneurysm is a pathological condition characterized by abnormal widening or swelling of the aortic wall, which occurs due to excessive mechanical stress caused by increased blood pressure in the arterial system. This weakness in the aortic wall structure reduces its elasticity and integrity, which increases the risk of rupture which can be fatal if not treated immediately. Hypertension, also known as high blood pressure, refers to a chronic medical condition in which the pressure of blood flowing in the blood vessels remains higher than normal physiological levels. Over time, this increased pressure exerts ongoing stress on the blood vessels, particularly the aorta, leading to progressive damage and structural changes that predispose individuals to aneurysm formation (DeGuire et al., 2019; Syed et al., 2019; World Health Organization, 2023).

In general, aortic aneurysms can occur in various aortic segments, such as the thoracic and abdominal aorta. This abnormal enlargement of the aortic wall is caused by weakness in the structure of the blood vessels. Aortic aneurysms

often have no symptoms until they reach a certain size that can cause aneurysm rupture, potentially causing severe internal bleeding and sudden death if not treated immediately (Commodore-Mensah *et al.*, 2021; Hellawell *et al.*, 2021; Lu & Daugherty, 2017; Shen *et al.*, 2020).

Hypertension places sustained mechanical stress on the aortic wall, which, over time, compromises the structural integrity of the vasculature by causing injury to the endothelial lining and triggering chronic inflammation. This pathological process triggers the recruitment of immune cells that secrete tissue-damaging enzymes, especially matrix metalloproteinases (MMPs), which break down extracellular matrix (ECM) components such as collagen and elastin. These proteins are very important for maintaining the tensile strength and elasticity of the aortic wall. Simultaneously, the oxidative stress caused by hypertension plays an important role by generating reactive oxygen species (ROS), which not only damage vascular smooth muscle cells (VSMCs) — an important element for maintaining the stability of the aortic wall — but also initiate pathways of apoptosis and necrosis that further weaken the vascular structure.

According to (Yang *et al.*, 2024), activation of the renin–angiotensin system (RAS), especially the ACE/Angiotensin II/AT1R axis, contributes significantly to the pathogenesis of aneurysms by promoting vasoconstriction, inflammation, and oxidative damage. Angiotensin II was shown to increase ROS production and stimulate the expression of proinflammatory cytokines, while also activating MMPs that break down the ECM and facilitate arterial wall expansion. Histological evidence demonstrated endothelial cell damage, VSMC apoptosis, and disordered collagen arrangement in the aneurysm wall, which was exacerbated by Angiotensin II signaling. As the aortic wall continues to lose its structural resilience, it becomes susceptible to abnormal dilatation, ultimately forming an aneurysm that, if not treated promptly, can rupture with fatal consequences.

These findings highlight the complex interplay between mechanical, inflammatory, and molecular mechanisms in the formation of aortic aneurysms caused by hypertension, indicating the importance of early intervention and therapies targeting the RAS to reduce disease

progression (Hou *et al.*, 2022; Márquez-Sánchez & Koltsova, 2022a; Quintana & Taylor, 2019). In addition to hypertension stage 2, which serves as a central factor in the development of aortic aneurysm, a variety of other clinical, demographic, and behavioral risk factors have been identified as significantly contributing to both the initiation and progression of this life-threatening vascular condition. Age is widely recognized as one of the most influential non-modifiable factors, as the aging process naturally leads to structural degradation of the aortic wall, particularly involving the loss of elastin and collagen fibers, which are essential for maintaining vascular elasticity and strength.

According to (Keisler & Carter, 2015), the prevalence of aortic aneurysm increases notably in individuals aged 65 years and older, highlighting how aging-related changes in connective tissue and vascular integrity predispose older adults to aneurysmal formation and complications. In addition, male sex is consistently associated with a higher risk of developing aortic aneurysm compared to females, a disparity believed to arise from hormonal differences, variations in vascular wall thickness, and differences in inflammatory and hemodynamic responses. Tobacco use is also a well-established and highly modifiable risk factor, with long-term smoking shown to promote endothelial dysfunction, elevate oxidative stress, and accelerate the degradation of extracellular matrix components, ultimately weakening the aortic wall and promoting its pathological dilation.

The toxic chemicals found in tobacco not only contribute to the formation of aneurysms but also increase their expansion rate and the likelihood of rupture, making smoking history a key consideration in screening recommendations. Furthermore, obesity, as measured by body mass index or abdominal girth, imposes additional hemodynamic load on the aorta while simultaneously contributing to systemic inflammation and metabolic dysregulation, both of which negatively impact vascular stability and remodeling.

Cardiovascular comorbidities such as coronary artery disease, a history of myocardial infarction, and peripheral arterial disease also show strong associations with aortic aneurysm, suggesting the involvement of overlapping pathological mechanisms including atherosclerosis, chronic inflammation, and extracellular matrix remodeling. Interestingly,

although diabetes mellitus is typically viewed as a major cardiovascular risk factor, some studies suggest it may have a protective effect against aneurysm formation, possibly due to glycation-induced stiffening of the arterial wall that reduces its tendency to dilate.

A positive family history of aortic aneurysm further increases individual susceptibility, implying a genetic predisposition that affects the composition and resilience of connective tissue, as well as the regulation of inflammatory and enzymatic processes within the vessel wall. Collectively, these factors demonstrate that aortic aneurysm is a complex, multifactorial condition influenced by a combination of intrinsic and extrinsic factors, emphasizing the importance of comprehensive clinical assessment, personalized risk stratification, and integrative prevention strategies in high-risk populations. (Hunter et al., 2021; Márquez-Sánchez & Koltsova, 2022b; Musto et al., 2024; J. Zhou et al., 2022).

This study was designed to evaluate the knowledge level of patients diagnosed with hypertension stage 2 at Harapan Keluarga Hospital, specifically regarding the potential complications of aortic aneurysm. Aortic aneurysm is a severe vascular disorder that can develop slowly as a result of long-term uncontrolled high blood pressure, and is often associated with high rates of morbidity and mortality due to the risk of sudden rupture. Given the asymptomatic nature of aortic aneurysms in the early stages, patient awareness and understanding of the condition is a critical component in promoting early detection, adherence to treatment, and implementation of appropriate lifestyle modifications. Therefore, assessing the level of patient knowledge is important not only to identify current educational gaps, but also to guide the design and implementation of effective and targeted health education programs.

The results of this study are expected to contribute to the improvement of patient-centered prevention strategies by providing empirical insights into how much patients understand about hypertension-related complications, specifically aneurysms. Through this, healthcare providers can develop more responsive and customized educational interventions that address specific knowledge deficiencies among at-risk populations. Such interventions may ultimately help reduce the

incidence of severe vascular complications, improve clinical outcomes, and support long-term disease management in hypertensive patients. In this context, this study emphasizes the importance of integrating patient education into routine hypertension care as a key component of comprehensive cardiovascular risk reduction.

Materials and Methods

This research is a retrospective cohort study conducted at Harapan Keluarga Hospital in December 2024. The population of this study were patients diagnosed with hypertension with different levels of hypertension, namely pre-hypertension, stage 1 hypertension, and stage 2 hypertension with aortic aneurysm. The research sample consisted of 80 patients who met the inclusion criteria, namely patients who had complete data regarding blood pressure and the results of supporting examinations that confirmed the diagnosis of aortic aneurysm. The sampling technique used random sampling taken from outpatients at the heart, internal medicine and urology surgery clinics. The dependent variable in this study was the knowledge of stage 2 hypertension patients regarding aortic aneurysms, while the independent variable was the patient's stage 2 hypertension status. Data was collected through a questionnaire that measured patient knowledge about aortic aneurysms. The materials used in this research include questionnaires as data collection instruments and tools for measuring patient knowledge.

The research procedure began with collecting medical record data from patients who met the inclusion criteria, which was then followed by distributing questionnaires to patients to measure their knowledge about aortic aneurysms. Each step of data collection is carried out by referring to standard procedures that ensure data validity. After the data was collected, statistical analysis was carried out using statistical software for the chi-square test, to assess the significant relationship between the level of hypertension and the incidence of aortic aneurysm. It is hoped that the results of this analysis will provide further insight into the factors that influence patient knowledge regarding aortic aneurysm complications associated with stage 2 hypertension.

Results and Discussion

This study aims to determine the relationship between the level of hypertension and the incidence of aortic aneurysm. The data used were taken from patient medical records at Harapan Keluarga Hospital in December 2024, with a total of 24 respondents.

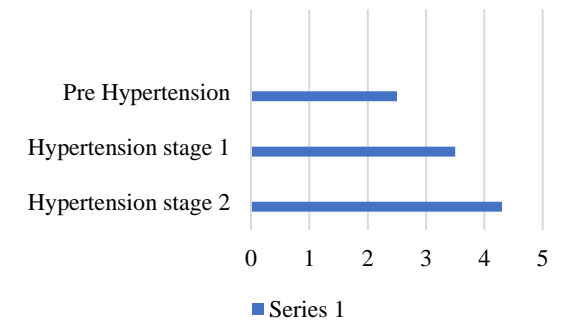


Figure 1. Relationship between Hypertension and Aortic Aneurysm

Table 3. Analysis of the Relationship Between Hypertension stage 2 and Aortic Aneurysm

Variable	OR (95% CI)	P value
Hypertension stage 2		0,000
Hypertension stage 1	2,001 (2,010-2,229)	

Table 2 shows the distribution data of the number of patients who experienced aortic aneurysms adjusted for the hypertension category experienced by the patients, namely pre-hypertension, hypertension stage 1, and hypertension stage 2. From a total of 24 patients, it is known that the highest number of aneurysm events was found in the group of patients with hypertension stage 2, followed by patients with stage 1 hypertension, and the least occurred in pre-hypertensive patients.

The Relationship Between Aortic Aneurysm and Hypertension stage 2

This distribution illustrates a clear and consistent upward trend in the incidence of aortic aneurysms as the severity of hypertension increases, suggesting a dose-response relationship between blood pressure levels and aneurysmal risk. This finding aligns with the research presented by (Zhou *et al.*, 2022), which emphasizes that hypertension is not merely

correlated with, but indeed has a direct causal effect on the development of aortic aneurysms through mechanisms such as sustained mechanical stress, vascular inflammation, and structural weakening of the aortic wall. These results further strengthen the understanding that hypertension should not be regarded solely as a comorbid condition, but rather as a primary pathological driver in the progression of aneurysmal disease. In particular, hypertension stage 2 is considered a significantly high-risk condition due to the persistently elevated systolic and diastolic pressures that accelerate endothelial dysfunction, trigger matrix degradation, and promote chronic changes within the vascular structure, all of which contribute directly to aneurysm formation and potential rupture. (Gallo & Savoia, 2024; Rossi *et al.*, 2020). In addition, long-term hypertension is strongly associated with both structural and functional alterations in the aortic wall, including fragmentation of elastic fibers, smooth muscle cell apoptosis, and remodeling of the extracellular matrix, all of which contribute to the progressive weakening of the vessel and increased susceptibility to aneurysm formation.

These pathological changes do not occur in isolation but also affect other target organs such as the heart, kidneys, and brain, thereby compounding the systemic burden of uncontrolled hypertension. In the context of this study, statistical analysis further reinforced these findings by demonstrating a significant relationship between the level of hypertension and the incidence of aortic aneurysm, as indicated by a p-value of 0.000, which reflects a high level of statistical significance and rules out the possibility of random association. Moreover, the calculated odds ratio of 2.001, with a 95% confidence interval ranging from 2.010 to 2.229, suggests that individuals with hypertension are approximately twice as likely to develop an aortic aneurysm compared to those without hypertension. This strong association provides compelling evidence that elevated blood pressure is not only a risk factor but may play a pivotal role in the pathogenesis of aneurysms, particularly when sustained over a prolonged period without effective clinical management..

The Mechanism and Therapy of Aortic Aneurysms

Until now, there are no pharmacological therapies that have proven effective in halting or reversing the progression of aortic aneurysms, so

the primary treatment still relies on surgical measures such as open repair and endovascular aortic repair (EVAR), which are only recommended when the aneurysm diameter has crossed a critical threshold or shows a high risk of rupture. However, these invasive approaches are not free from complications and cannot be widely applied, especially in patients with comorbid conditions such as advanced hypertension that exacerbate procedural risks. Therefore, in recent years, the focus has shifted to developing molecular-based therapies by targeting key pathophysiological pathways involved in aneurysm formation. According to (Gao *et al.*, 2023), processes such as vascular smooth muscle cell (VSMC) death, oxidative stress, extracellular matrix (ECM) degradation, and chronic inflammatory response play a major role in weakening the aortic wall structure and accelerating aneurysm enlargement.

Furthermore, immunologic and genetic-based therapeutic approaches are beginning to be explored, including the use of gene therapy, microRNA (miRNA) modulation, and suppression of inflammatory pathways such as the NLRP3 inflammasome as well as proinflammatory cytokines IL-6 and IL-1 β . Efforts to inhibit non-apoptotic forms of programmed cell death such as ferroptosis and pyroptosis have also shown potential in preventing massive VSMC cell loss. Although most of these strategies are still at the preclinical stage, these findings open up opportunities for the development of more targeted and sustainable non-surgical therapies. In the context of patients with hypertension, especially stage 2 hypertension, knowledge of these mechanisms may help in the development of more effective preventive interventions, either through strict blood pressure control or the integration of molecular therapies in the future. Thus, understanding the mechanisms and treatment strategies of aneurysms is important not only in the curative aspect, but also in encouraging preventive approaches based on individual patient risk.

Implications for Patient Knowledge

Although the analyzed tables in this study did not provide direct data on patient knowledge levels, the overall findings strongly emphasize the importance of enhancing patient education, particularly among individuals diagnosed with hypertension stage 2 who face a significantly

elevated risk of aortic aneurysm. Patients with advanced hypertension often remain unaware of the severe vascular complications that may arise from uncontrolled blood pressure, such as aneurysmal weakening and eventual rupture of the aortic wall, a condition associated with a high rate of mortality. The meta-analysis by (Kobeissi *et al.*, 2019) confirms that hypertension increases the risk of developing aortic aneurysms by approximately 66%, with diastolic blood pressure (DBP) showing an even more pronounced dose-dependent relationship, which highlights the clinical urgency of improving patient literacy in this area. Without adequate knowledge, patients are less likely to adhere to long-term treatment regimens, make appropriate lifestyle adjustments, or recognize the importance of regular monitoring, all of which are essential in preventing the silent progression of aneurysmal disease.

Educating patients about the mechanisms by which persistent hypertension damages the arterial wall, including through inflammatory processes, oxidative stress, and extracellular matrix degradation can foster a deeper understanding of the stakes involved and motivate sustained engagement with their care plans. Moreover, when patients understand that aneurysms often remain asymptomatic until they reach a critical size, they may be more likely to comply with screening recommendations, especially if they are already classified as high risk based on their blood pressure profiles. Kobeissi *et al.* further point out that the association between hypertension and aortic aneurysm risk is particularly strong among women, a group that often receives less attention in cardiovascular screening programs, which reinforces the importance of inclusive and accessible educational initiatives tailored to patient demographics.

Comprehensive and structured patient education programs that incorporate information about vascular complications, risk modification, and the significance of blood pressure control are not only valuable for improving individual outcomes but are also essential tools in public health efforts to reduce morbidity and mortality related to aneurysmal disease. Therefore, improving the knowledge level of hypertension stage 2 patients regarding aortic aneurysm risk should be regarded as a key component of both individual patient management and broader preventive strategies within cardiovascular care systems. (Leeuwen *et al.*, 2024).

Conclusion

This is a retrospective cohort study conducted at Harapan Keluarga Hospital. Data were obtained from the medical records of patients diagnosed with hypertension at various levels, namely pre-hypertension, stage 1 hypertension, and hypertension stage 2 with aortic aneurysm. Data collection was carried out in December 2024, with a total of 24 patients who met the inclusion criteria, namely having complete blood pressure data and the results of supporting examinations showing the presence of aortic aneurysm. The main objective of this study is to determine whether there is a relationship between the level of hypertension, especially hypertension stage 2, and the incidence of aortic aneurysm as a clinical complication. The data collected included the results of blood pressure examination and confirmation of the diagnosis of aortic aneurysm based on the patient's medical records. Statistical analysis was performed using the chi-square test to assess the significance of the relationship between the level of hypertension and the incidence of aortic aneurysm.

Acknowledgment

We would like to express our sincere gratitude to dr. Maz Isa Ansyori Arsatt, Sp.BTKV, as the Head of Degenerative and Primary Cardiac Research, for overseeing this study. Our appreciation also goes to dr. Basuki Rahmat, Sp.JP, as well as Dr. dr. Anak Agung Ayu Niti Wedayani, M.Sc, for their invaluable support. Furthermore, we extend our deepest gratitude to all parties who have provided assistance throughout the process of completing this journal.

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