



Association between Gastritis and Duodenitis with the Incidence of Hypertension in Semarang City

Yhoaninda Nurul Ilmi[✉], Mahalul Azam, Dina Nur Anggraini Ningrum

Department of Public Health, Faculty of Medicine, Universitas Negeri Semarang, Indonesia

Article Info	Abstract
Article History: Submitted 22 January 2025 Revised 05 January 2026 Accepted 31 March 2026 Keywords: Hypertension, Gastritis, Duodenitis, Comorbidities DOI: https://doi.org/10.15294/phpi.v10i1.20478	The prevalence rate in Semarang City has not yet reached the global SDG 2025 target of a 25% reduction (WHO, 2023). Hypertension is often referred to as a “silent killer” because its early symptoms are rarely noticeable, leading many individuals to be unaware of their condition until complications such as gastritis and duodenitis occur. This study aims to analyze the epidemiological patterns of hypertension and gastritis and duodenitis, as well as the association between these conditions and hypertension incidence. This quantitative research uses a nested case-control design with SIMPUS data from Semarang City from 2020–2022, involving 220,093 patients, consisting of 21,639 cases and 198,032 controls. The dependent variable was hypertension, while gastritis and duodenitis served as independent variables. Univariate and bivariate (chi-square) analyses were performed. The results show that hypertension was more common in women (27,709 patients) and highest in the 50–59 age group, while gastritis and duodenitis were also more frequent in women (25,042 patients), peaking in the 20–29 age group. Bivariate analysis revealed a significant association between gastritis and duodenitis and hypertension. Among males, the highest risk occurred in the 70–79 age group, with an OR of 2.76 (95% CI: 2.62–2.89), while among females, the highest risk was observed in the 80–89 age group, with an OR of 3.32 (95% CI: 3.08–3.57). The Semarang City Health Office is recommended to strengthen hypertension prevention by prioritizing early screening for gastritis and duodenitis in high-risk older adults.

[✉]Correspondence Address:
Kampus UNNES Jl Kelud Utara III, Semarang, 50237, Indonesia
E-mail: yhoaninda28@students.unnes.ac.id

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INTRODUCTION

Hypertension is included in non-communicable diseases that are currently a priority in the world of health globally. Hypertension is a condition in which blood vessels have high blood pressure (systolic blood pressure ≥ 140 mmHg or diastolic blood pressure ≥ 90 mmHg) (Unger et al., 2020). The term "silent killer" is often used to describe hypertension because its symptoms are rarely seen in the early stages, so many individuals do not realize they are suffering from this condition until serious complications occur. Gastritis and duodenitis are inflammatory conditions that affect the digestive tract, especially the stomach and duodenum.

Gastritis is characterized by inflammation of the gastric mucosa, which can arise due to a variety of factors including infection, irritation, and autoimmune responses (Silwal et al., 2021; Waseem et al., 2021). Hypertension is often found in patients with gastrointestinal disorders, including gastritis and duodenitis. *Helicobacter pylori* is etiologically related to gastritis, peptic ulcer disease and gastric cancer. Long-lasting *Helicobacter pylori* infection is an independent risk factor for hypertension (Dore et al., 2022). Hypertensive patients are often accompanied by comorbidities such as gastritis and duodenitis (Osmanov et al., 2022).

The global SDG's target for hypertension prevalence is 25% by 2025. According to the World Health Organization (WHO), the prevalence of hypertension in the world in 2019 was 33%, and decreased to 29.2% in 2021 (WHO, 2023). However, the prevalence rate still does not reach the global SDG's target of 2025 of 25% (WHO, 2023). The prevalence of hypertension is higher in men (34%) compared to women (32%) (Zhou et al., 2021). The prevalence of hypertension in Central Java Province in 2022 by 29.3% increased to 38.2% in 2023 (Dinkes Jawa Tengah, 2023). The highest hypertension case in Central Java Province is Semarang City (Dinkes Provinsi Jawa Tengah, 2022).

The prevalence of hypertension in Semarang City increased in 2013 by 27.1% to 37.02% in 2018 (Ministry of Health of the Republic of Indonesia, 2018). This prevalence rate has not reached the target of the Semarang

City SDG's related to the hypertension prevalence rate, which is 25%. The highest case of NCD in Semarang City is hypertension of 50.48% suffered by residents aged 45-65 years (Dinkes Jawa Tengah, 2023). Emerging evidence suggests a possible link between gastrointestinal inflammation especially infection by *Helicobacter pylori*, a major cause of gastritis/duodenitis and elevated blood pressure: a meta-analysis of 17 studies (6,376 hypertension cases and 10,850 controls) reported an overall odds ratio (OR) of 2.07 (95% CI: 1.46–2.94; $p < 0.05$) for hypertension among those infected with *H. pylori* (Huang et al., 2021). A large cohort study found that *H. pylori* infection was associated with a higher prevalence of hypertension (57.5% and 55.1%) and independently increased the risk of hypertension (OR=1.117; 95% CI: 1.029–1.213; $p = 0.008$). (Xiong et al., 2020)

SIMPUS (Puskesmas Management Information System) Semarang City has been developed since 2003 until now. SIMPUS has been implemented by all health centers totaling 38 health centers in Semarang City. SIMPUS is a system created to help manage and provide health services at health centers. SIMPUS makes it easier to record patient data as well as process and present data into information quickly and accurately, which helps the decision-making process in the management of the Health Center to achieve its activity targets (Ministry of Health of the Republic of Indonesia, 2019). The total population of Semarang City is 1.6 million people and the average population per year who use Puskesmas services throughout Semarang City (38 Puskesmas) is 110,046 people. This shows that 6.65% of the population in Semarang city is recorded as patients at SIMPUS every year.

This study was conducted using electronic medical record data from SIMPUS et al. Semarang regarding the association between gastritis and duodenitis with the incidence of hypertension based on sex and age group (Phenome-Wide Association Studies). Based on this background, research was carried out to determine the epidemiological pattern of hypertension and the association between gastritis and duodenitis with the incidence of hypertension in Semarang City in the 2020-2022

Semarang City SIMPUS data so that it can be used as material for efforts to prevent hypertension complications, especially in gastritis and duodenitis.

METHOD

This study is a quantitative research with a nested case-control study design. The research was conducted in Semarang City in 2024. This study examined hypertension (code I10) as the dependent variable and gastritis and duodenitis (code K29) as the independent variables. The variables analyzed included hypertension (code I10) as well as gastritis and duodenitis (code K29) in patients aged ≥ 20 years. The sampling method used is total sampling. The population in this study consisted of all Puskesmas patients in Semarang City recorded in the SIMPUS database from 2020–2022, totaling 220,093 individuals. Cases were defined as patients diagnosed with hypertension, amounting to 21,639 individuals, while controls were patients without a hypertension diagnosis, totaling 198,032 individuals. The case-to-control ratio in this study was approximately 1:9.

The data used is secondary data in the form of SIMPUS data for 2020–2022. SIMPUS data in Semarang City is a series of data sorted by time, with a temporal relationship between hypertension and other diseases. The instrument used is the documentation table of the Puskesmas patient recorded in the RME data of SIMPUS Semarang City such as Patient ID, diagnosis of hypertension (I10) and gastritis and duodenitis (K29), date of birth, gender, and date of examination. The inclusion criteria in the case group in this study are patient data in 2020–2022, complete data and hypertension I10 code. The inclusion criteria in the control group are patient data in 2020–2022, complete data and code K29 (gastritis and duodenitis). The exclusion criteria in the case and control groups in this study are incomplete and unreasonable data.

The data analysis in this study is univariate and bivariate analysis. Using the Phenome-Wide Association Studies (PheWAS) method, the univariate analysis will display the distribution of hypertension frequency by gender and age group in hypertensive patients in Puskesmas throughout

Semarang City in 2020–2022. Meanwhile, the bivariate analysis with the PheWAS method will be displayed in an association pattern, with p-value parameters using the Chi Square test if qualified and an alternative test using the Fisher test, and OR (Odds Ratio) calculation. Research bias occurs when data is entered incorrectly, resulting in inaccurate research results. Data that is not included can be excluded from the study to maintain the accuracy of the results. This study uses ethical clearance with Number: 332/KEPK/FK/KLE/2024.

RESULTS AND DISCUSSIONS

Tabel 1. Hypertension Frequency (I10) By Gender and Age Group (Year)

Age Group (Year)	Male		Female		Total
	n	%	n	%	
20-29	1390	6.5	1125	4.1	2515
30-39	2284	10.7	3199	11.5	5483
40-49	4150	19.5	6243	22.6	10393
50-59	5361	25.1	7147	25.8	12508
60-69	5039	23.7	6125	22.1	11164
70-79	2428	11.4	3024	10.9	5452
80-89	584	2.8	786	2.8	1370
>90	59	0.3	60	0.2	119
Total	21295	100	27709	100	

Source: SIMPUS data of Semarang City in 2020–2022

Table 1 shows the frequency of hypertension patients by gender and age group, it can be seen that hypertension patients are higher in women (27709 patients) than men (21295 patients). In men, the 50–59 age group contributed the largest proportion, namely 25.1% (5,361 patients), while in women this group was also the highest with 25.8% (7,147 patients). The fewest cases of hypertension were found in the age group >90 years, both in men (0.3%) and women (0.2%), which is reasonable considering that the population in the very old age group is relatively small.

The results of this study are in line with the research of Akl et al., 2017 which shows that women are more likely to be affected by hypertension compared to men (Akl et al., 2017). The National Health and Nutrition Examination

Survey (NHANES) conducted in the US in 2015–2016 found that the prevalence of hypertension was more common in women (25042) compared to men (14241) (Fryar et al., 2015).

The impact of menopause on cardiovascular health is significant. When women go through menopause, the protective effect of estrogen decreases which leads to an increase in cardiovascular risk factors including hypertension. The prevalence of high total cholesterol and LDL increases significantly in women after the age of 50, which is a known risk factor for hypertension and cardiovascular disease (Gu et al., 2018). These hormonal changes not only increase blood pressure but also alter lipid profiles, which contributes to a higher incidence of cardiovascular events in postmenopausal women compared to men.

The results of this study are in line with a study conducted by Katibeh (2020) a study conducted in Taiwan reported that the prevalence of hypertension reached 60.4% among individuals aged 50 years and older (Katibeh et al., 2020). Physiological changes associated with aging contribute to an increase in the prevalence of hypertension. As we age, arterial walls tend to stiffen due to structural changes including increased collagen deposition and reduced elastin which can lead to an increase in blood pressure (Mohammad & Bansod, 2024). In addition, the aging process is often accompanied by an increase in comorbid conditions such as obesity and diabetes that are known to worsen hypertension (Shi et al., 2022).

Table 2 shows the frequency of gastritis and duodenitis patients by gender and age group, it can be seen that the number of patients with gastritis and duodenitis is higher in women (25042 patients) than men (14241 patients). The highest proportion of cases appears in the 20–29-year age group, accounting for 27.6% among men and 28.1% among women. The second and third largest age groups are 30–39 years and 40–49 years, with similar proportions across genders. These findings indicate that gastritis and duodenitis are most common in early to middle adulthood. The proportion of cases gradually decreases with increasing age. Among individuals aged 70 years and above, the prevalence becomes much lower, representing

less than 6% in men and less than 5% in women. The lowest proportion is found in the >90-year group, which contributes only 0.1% of cases in both genders.

Table 2. Frequency of Gastritis and Duodenitis (K29) Based on Gender and Age Group (Years) in SIMPUS Semarang City

Age Group (Year)	Male		Female		Total
	n	%	n	%	
20-29	3914	27.6	7051	28.1	10965
30-39	2428	17.0	4425	17.7	6853
40-49	2448	17.2	4614	18.4	7062
50-59	2405	16.9	4442	17.7	6847
60-69	2066	14.5	3154	12.6	5220
70-79	767	5.4	1089	4.4	1856
80-89	192	1.3	241	1.0	433
>90	21	0.1	26	0.1	47
Total	14241	100	25042	100	

Source: SIMPUS data of Semarang City in 2020–2022

The results of this study are in line with a study conducted by Manappallil & Alexaet (2017) in South India reporting a prevalence of duodenitis of 17.5%, with most of the affected population being women (Manappallil & Alexander, 2017). A meta-analysis by Zhang et al. (2022) reported that the rate of *H. pylori* infection in the 20–29 age group ranged from 30–50%, contributing significantly to the development of gastritis and duodenitis (Zhang et al., 2017).

The results of research conducted by Suwindri et al. (2021) also show that women are more likely to suffer from gastritis than men because the incidence of stress in women tends to be higher than in men, according to Suwindri et al. (2021), gastritis is more suffered by women, because women are more concerned and concerned about weight and appearance. So that women try to lose weight by regulating their diet, the amount and type of food consumed as much as possible so as not to become obese (Suwindri et al., 2021).

Table 3 shows that gastritis and duodenitis were significantly associated with hypertension across all gender and age groups ($p < 0.0001$). In men, the highest risk was found in the 70–79 age groups, with an OR of 2.76 (95% CI: 2.62–2.89). In women, the highest risk occurred in the 80–89 age group, with an OR of 3.32 (95% CI: 3.08–

3.57). Men in the 70-79 year old age group who experience gastritis and duodenitis have a 2.76 times greater risk of experiencing hypertension compared to people who do not experience gastritis and duodenitis in the Community Health Center area throughout Semarang City. Women in the 80-89 year old age group who experience gastritis and duodenitis have a 3.32 times greater risk of experiencing hypertension compared to people who do not experience gastritis and duodenitis in the Community Health Center area throughout Semarang City.

The findings of this study are consistent with the research conducted by Mohamed et al. (2022), which reported that hypertension frequently occurs in patients with diabetes mellitus and is often accompanied by gastrointestinal complications, including gastritis

and duodenitis (Mohamed et al., 2022). This relationship underscores the complex interplay between systemic metabolic disorders and gastrointestinal health, suggesting that comorbid conditions such as diabetes and hypertension can exacerbate the severity and progression of gastrointestinal disorders. The presence of dyspeptic symptoms in kidney transplant recipients has also been linked to various factors, including hypertension, highlighting the potential impact of elevated blood pressure on gastrointestinal function and overall digestive health (Nazeer et al., 2017). These findings point to a bidirectional relationship, where systemic conditions can worsen gastrointestinal outcomes, and conversely, gastrointestinal inflammation may influence vascular function and blood pressure regulation.

Table 3. Association of Gastritis and Duodenitis with Hypertension Incidents Based on Gender and Age Group in SIMPUS Data of Semarang City 2020-2022

Gender	Age Group	OR	95% CI		p-value
			Lower	Upper	
Male	20-29	2.08	1.91	2.26	<0.0001
	30-39	3.03	2.90	3.16	<0.0001
	40-49	2.25	2.15	2.34	<0.0001
	50-59	2.47	2.40	2.55	<0.0001
	60-69	2.64	2.56	2.71	<0.0001
	70-79	2.76	2.62	2.89	<0.0001
	80-89	2.75	2.49	3.04	<0.0001
	90-99	2.73	1.85	3.61	<0.0001
Female	20-29	3.08	2.93	3.23	<0.0001
	30-39	2.85	2.76	2.93	<0.0001
	40-49	2.31	2.26	2.36	<0.0001
	50-59	2.49	2.44	2.53	<0.0001
	60-69	2.85	2.79	2.91	<0.0001
	70-79	3.06	2.94	3.18	<0.0001
	80-89	3.32	3.08	3.57	<0.0001

Source: Primary Data

Several pathophysiological mechanisms may explain the relationship between gastrointestinal disorders and hypertension. Chronic inflammation resulting from gastritis and duodenitis can trigger systemic inflammatory responses, leading to endothelial dysfunction, impaired nitric oxide bioavailability, and increased arterial stiffness. This vascular impairment can contribute to elevated blood pressure and enhance the risk of cardiovascular complications. Gastrointestinal inflammation

may also result in increased levels of circulating pro-inflammatory markers such as C-reactive protein (CRP), interleukin-6 (IL-6), and tumor necrosis factor-alpha (TNF- α), which have been positively correlated with systolic blood pressure in hypertensive individuals (Yang et al., 2022). These inflammatory mediators not only affect vascular tone but also increase vascular permeability and promote atherogenesis, thereby linking gastrointestinal inflammation to systemic cardiovascular risk.

Complications of gastritis and duodenitis, including upper gastrointestinal bleeding, ulceration, and mucosal erosion, further exacerbate systemic stress and can lead to anemia, malnutrition, and impaired overall health (Singh et al., 2023; Zein et al., 2019). The presence of hypertension in individuals with such gastrointestinal disorders may amplify the severity of these complications, as elevated blood pressure increases the risk of vascular injury and bleeding tendencies. Moreover, multimorbidity the coexistence of hypertension and gastrointestinal disorders poses significant clinical challenges, including difficulties in pharmacological management, increased risk of adverse drug interactions, and prolonged recovery periods.

The interaction between gastrointestinal disorders and hypertension may also involve the gut-vascular axis, where alterations in the gut microbiome due to chronic inflammation or infection can influence systemic vascular function. Dysbiosis has been linked to increased production of endotoxins, oxidative stress, and low-grade chronic inflammation, all of which can exacerbate hypertension and impair endothelial function. In addition, lifestyle factors common among patients with metabolic or cardiovascular comorbidities, such as poor diet, sedentary behavior, and medication non-adherence, may further worsen gastrointestinal inflammation and blood pressure control.

Increased levels of C-reactive protein (CRP), a marker of systemic inflammation, are positively correlated with systolic blood pressure (SBP) in hypertensive individuals, suggesting that inflammation may play an important role in the pathophysiology of hypertension and its comorbidities (Yang et al., 2022). This systemic inflammation can lead to increased permeability of the gastric mucosa and contribute to the development of gastritis and duodenitis. The existence of multimorbidity, hypertension along with gastrointestinal disorders has been proven to make it difficult to treat this condition.

Research conducted by Palo et al. found that hypertension often appears in conjunction with peptic ulcer disease, which indicates a pattern of multimorbidity that includes gastrointestinal problems (Palo et al., 2023).

These findings are supported by the work of Nguyen, who reported that patients living with multiple chronic conditions, including hypertension, have a substantially higher likelihood of experiencing uncontrolled blood pressure. Uncontrolled hypertension can exacerbate physiological stress, impair vascular integrity, and diminish perfusion to the gastrointestinal tract. Reduced blood flow may compromise mucosal protection, increase susceptibility to inflammation, and worsen existing gastrointestinal conditions. These processes may, in turn, exacerbate existing gastrointestinal disorders and intensify symptoms such as those seen in gastritis and duodenitis.

Nguyen's findings therefore reinforce the evidence that hypertension and gastrointestinal conditions can interact bidirectionally, where poor hypertension control not only affects cardiovascular health but also worsens digestive system abnormalities (Nguyen et al., 2023). Lifestyle factors such as diet and stress, which are often associated with hypertension and gastrointestinal disorders, can contribute to the comorbidities of gastritis and duodenitis in hypertensive patients. Poor dietary habits among individuals with hypertension may exacerbate gastric disorders, as excessive sodium intake, high-fat foods, and irregular meal patterns can stimulate increased gastric acid secretion and aggravate existing gastritis.

In women, especially those in the 50-59 age group, the prevalence of this condition can be exacerbated by hormonal changes associated with menopause, which can affect gastrointestinal motility and increase susceptibility to inflammation (Puri et al., 2022). The use of certain medications for hypertension such as angiotensin II receptor inhibitors is associated with the development of gastritis and duodenitis which suggests the presence of direct pharmacological interactions that can worsen gastrointestinal inflammation (Shenbagaraj & Swift, 2018). Lifestyle factors including dietary patterns, physical activity levels, stress management, and adherence to prescribed medications play a critical role in influencing both hypertension and gastrointestinal health.

Poor nutritional choices, such as high-sodium or high-fat diets, can elevate blood

pressure while simultaneously increasing gastric acid production, thereby worsening gastritis symptoms. Inadequate medication adherence may lead to uncontrolled hypertension, which can exacerbate systemic inflammation and negatively impact gastrointestinal function. Conversely, consistent adherence to antihypertensive therapy and the adoption of healthy dietary and lifestyle behaviors can help improve blood pressure control and reduce the risk of gastrointestinal complications. Consumption of nonsteroidal anti-inflammatory drugs (NSAIDs) used to manage pain and inflammation can lead to gastritis and duodenitis, complicating the clinical picture for hypertensive patients (Park et al., 2023). The interaction between diet, medication, and gastrointestinal health underscores the importance of a holistic approach to managing patients with hypertension and gastrointestinal disorders.

The results of this study are in line with research conducted by (Osmanov et al., 2022) showing that there is a relationship between gastritis and duodenitis and hypertension. This study is in line with the research of Dore et al., (2022) showing that long-lasting *Helicobacter pylori* infection is an independent risk factor for hypertension. *Helicobacter pylori* is etiologically related to gastritis, peptic ulcer disease and gastric cancer. *Helicobacter pylori* infection has been reported to be positively associated with hypertension, with several studies suggesting that chronic infection may contribute to systemic inflammation, endothelial dysfunction, and metabolic disturbances that elevate blood pressure. The persistent inflammatory response triggered by *H. pylori* can interfere with normal vascular regulation and may exacerbate underlying cardiovascular risk factors. This association indicates that gastrointestinal infections may play a more significant role in the development and progression of hypertension than previously understood (Dore et al., 2022).

Research conducted by Tali et al. (2022) shows that cardiac dysfunction associated with *helicobacter pylori* shows that individuals infected with *helicobacter pylori* are more likely to experience hypertension (Tali et al., 2022). Infection with *H. pylori* bacteria in the stomach can cause problems in the digestion process and

absorption of nutrients such as vitamin B6, vitamin B12, and folic acid resulting in a deficiency of coenzyme important for methionine metabolism and increased homocysteine levels. Homocysteine has been shown to promote platelet aggregation and vasoconstriction, primarily by inhibiting the secretion of nitric oxide (NO) in endothelial cells.

The reduction in NO production impairs vasodilation, leading to narrower blood vessels and elevated blood pressure. Additionally, homocysteine facilitates the binding of lipoproteins to fibrinogen, contributing to the formation of atherosclerotic plaques within the vessel walls. The combination of pro-platelet effects, vasoconstriction, and lipoprotein accumulation creates a predisposition to atherosclerosis and hypertension, thereby significantly increasing the risk of cardiovascular disease (Tali et al., 2022). Research conducted (Kountouras et al., 2021) shows *H. pylori* infection can impair immune regulation and trigger chronic low-grade inflammation, which may contribute to the development of hypertension. The persistent inflammatory response caused by *H. pylori* affects vascular function, increases oxidative stress, and disrupts endothelial homeostasis, all of which can elevate blood pressure over time. (Kountouras et al., 2021).

A limitation of this study is that the data were derived solely from electronic medical records at the health center. As a result, the findings may not fully represent the overall health status of the broader population, since factors outside the recorded clinical encounters such as undiagnosed conditions, lifestyle behaviors, or health services accessed elsewhere were not captured. This limitation should be considered when interpreting the results, as it may affect the generalizability and completeness of the study's conclusions.

CONCLUSION

The conclusion of this study is that gastritis and duodenitis are significantly associated with the incidence of hypertension across all gender and age groups, with the highest risks observed in men aged 70–79 years and women aged 80–89

years in the health center area of Semarang City. It is recommended that policymakers in the Non-Communicable Disease Prevention and Control Division of the Semarang City Health Office strengthen efforts to prevent hypertension complications by implementing early screening for gastritis and duodenitis, with priority given to females aged 80–89 years and males aged 70–79 years who show the highest risk.

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