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Association of Central Obesity and Hypertension in an Urban Area

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Abstract

Hypertension is one of the non-communicable diseases in Indonesia that is closely related to obesity. Therefore, this study aimed to determine the association between central obesity and hypertension in a cohort study group in Bogor City, West Java from 2011 to 2021. A retrospective cohort study design was employed, with multivariate Cox regression analysis performed using secondary data from the Risk Factors for Non-Communicable Diseases (FRPTM) Cohort Study. Among 3,586 samples, 879 incident cases of hypertension were observed by the end of follow-up, accounting for 24.5% of the at-risk population. The incidence rate of hypertension was 28 cases per 1000 people per year, with a cumulative incidence rate of 25%. Multivariate analysis found that people with central obesity (RR: 1.415; 1.181-1.694) had a higher risk of developing hypertension. Other covariates were present, including age (p = 0.000), obesity (p = 0.000), light smoking (p = 0.000), moderate smoking (p = 0.011), and heavy smoking (p = 0.035). The control of central obesity through routine waist circumference screening in primary health care can serve as an important opportunity to prevent hypertension.

Keywords: Bogor City, Bogor retrospective, central obesity, hypertension

Abstrak

Hubungan Antara Obesitas Sentral dan Hipertensi di Daerah Perkotaan. *Hipertensi merupakan salah satu penyakit tidak menular di Indonesia yang erat kaitannya dengan kegemukan. Penelitian ini bertujuan untuk mengetahui hubungan antara obesitas sentral dengan hipertensi pada kelompok studi kohort di Kota Bogor, Jawa Barat dari tahun 2011 hingga 2021. Penelitian menggunakan desain studi kohort retrospektif, analisis multivariat regresi Cox dikembangkan dengan data sekunder dari Studi Kohor Faktor Risiko Penyakit Tidak Menular (FRPTM). Diantara 3.586 sampel, kejadian hipertensi pada akhir pemantauan adalah 879 orang, atau 24,5% dari populasi berisiko. Angka kejadian hipertensi adalah 28 kasus per 1000 orang per tahun dengan angka kejadian kumulatif sebesar 25%. Analisis multivariat menemukan bahwa orang dengan obesitas sentral (RR: 1,415; 1,181–1,694) memiliki risiko lebih tinggi terkena hipertensi. Terdapat kovariat lain, termasuk usia (p = 0,000), obesitas (p = 0,000), perokok ringan (p = 0,000), perokok sedang (p = 0,011), dan perokok berat (p = 0,035). Pengendalian obesitas sentral melalui skrining lingkar perut rutin di layanan kesehatan primer dapat menjadi peluang penting untuk mencegah hipertensi.*

Kata Kunci: *hipertensi, kohor retrospektif, Kota Bogor, obesitas sentral*

Introduction

Hypertension is a non-communicable disease defined as a condition in which blood pressure persistently reaches 140/90 mmHg or higher (World Health Organization [WHO], 2023). Hypertension is a global health problem that results in increased morbidity and mortality rates. Hypertension is the leading cause of cardiovascular disease and premature death worldwide and known as a silent killer. A study of global and regional trends in hypertensive heart disease-related mortality from WHO Database included 117 countries across 6 regions found that There was a significant increase in global mortality associated with hypertensive disorder. Crude mortality rate increased from 10.60 to 16.74 per 100,000 population (Jaiswal et al., 2025).

Hypertension is influenced by both modifiable and non-modifiable risk factors. Modifiable factors include obesity, smoking behaviour, phy-

sical inactivity, high salt intake, dyslipidaemia, excessive alcohol consumption, and stress, while non-modifiable factors include age, sex, and heredity (Ministry of Health Republic of Indonesia, 2024a). In addition, someone who is centrally obese is more likely to have hypertension (Chen et al., 2023). The measurement of central obesity through waist circumference with greater than 90 cm for men and 80 cm for women (Sudikno et al., 2018).

Around 1.28 billion adults worldwide, aged 30-79 years, are suffered from hypertension, whilst 78% of them live in low- and middle-income countries (WHO, 2023). According to *Riset Kesehatan Dasar* 2018 or basic health research conducted by the Ministry of Health, Republic of Indonesia (2019), the prevalence of hypertension in Indonesia was 34.11% in 2018–2019. Moreover, the prevalence of hypertension in West Java stands at 39.6%, representing the highest rate of all provinces in Indonesia. According to the 2018 Bogor city health profile, 25.5% of the population was identified as having risk factors for hypertension (Dinas Kesehatan Kota Bogor, 2019; Dinas Kesehatan Kota Bogor, 2022). In 2018, the cumulative incidence of central obesity in five urban villages of Bogor City was 55.4% (Sudikno et al., 2018). As reported by the Ministry of Health Republic of Indonesia (2019), 31% of Indonesians aged 15 and older had central obesity in 2018.

A global meta-analysis comprising studies from various regions, including 11 studies from Western Europe, 10 from Northern Europe, 10 from Eastern Europe, 21 from Southern Europe, 100 from East Asia, 25 from West Asia, 30 from Central and South Asia, 8 from Southeast Asia, 31 from North America, 5 from Central America, 21 from South America, and 16 from Africa, reported a prevalence of central obesity of 41.5% among individuals aged 15 years and older, with an obvious increase since the 1990s from 31.3% (1985–1999) to 48.3% (2010–2014) (Wong et al., 2020). A higher prevalence was found in older individuals, female subjects, urban residents, Caucasians, and populations of higher income level countries. This increasing trend of prevalence in central obesity could be attributed to economic development and urbanization which could lead to an unfavorable change in dietary habits (consumption of high-calorie foods and sweetened beverages), physical inactivity, sedentary behaviours (smartphone use, computer use, TV or video viewing), stress and cortisol secretion (Wong et al., 2020). The high incidence of hypertension in Indonesia emphasizes the urgent need for prevention and control strategies. Preventive strategies should prioritize modifiable risk factors, including obesity, smoking, and unhealthy dietary habits. In particular, individuals with central obesity are at a significantly higher risk of developing hypertension (Rahma & Gusrianti, 2019), which justifies the need to examine its role in the Indonesian population. This study aims to investigate the relationship between central obesity and hypertension, providing results that can serve as a valuable reference for individuals and practitioners focused on preventing central obesity. While most previous studies have utilized a cross-sectional design, the criteria for assessing central obesity vary across countries. However, central obesity remains a modifiable risk factor that is relatively easy to measure and highly responsive to intervention.

Indonesian health survey reported a 36.8% prevalence of central obesity (Ministry of Health, Republic of Indonesia, 2024a) which emphasize need for effective strategies aimed at helping individuals manage and prevent central obesity. Therefore, this study aims to examine the association between central obesity and hypertension in a cohort in Bogor City from 2011 to 2021. The results specifically focus on the urban population, as urban residents often exhibit lifestyle patterns distinct from those in rural areas, including higher levels of sedentary behavior, dietary shifts, and greater exposure to fast food, all of which contribute to an increased risk of obesity and hypertension. Moreover, this study utilizes data from the Bogor Cohort Study, in which all respondents, based on univariate results, resided in urban areas. Bogor was

also selected because of the relatively low population mobility and the diversity of its residents in terms of ethnicity and dietary habits (Riyadina et al., 2020).

Methods

This study employed a quantitative approach using a retrospective "population-based" cohort study design with a dynamic open cohort. The data were derived from secondary sources from studies conducted in five districts in Central Bogor, Bogor City: Kebon Kalapa, Babakan Pasar, Babakan, Ciwaringin, and Panarangan (Senewe et al., 2021). The study criteria included subjects aged 25 to 64 years who were not diagnosed with hypertension at the outset. The sample size was calculated using the Leme-show formula for hypothesis testing related to relative risk, resulting in a minimum requirement of 995 samples.

Based on Diagram 1, the initial dataset comprised 5,329 respondents. Data that did not meet the age inclusion criteria were excluded, resulting in 5,310 respondents. The dataset was further refined by additional inclusion criteria, specifically excluding individuals who either did not have the condition under investigation or did not have hypertension at the baseline of this study. After this elimination process, the remaining dataset included 3,638 respondents. Subsequently, missing data regarding the independent variables were removed, leading to a final sample size of 3,586 data points used in the study.

This study uses secondary data collected by the Health Development Policy Agent (Previously

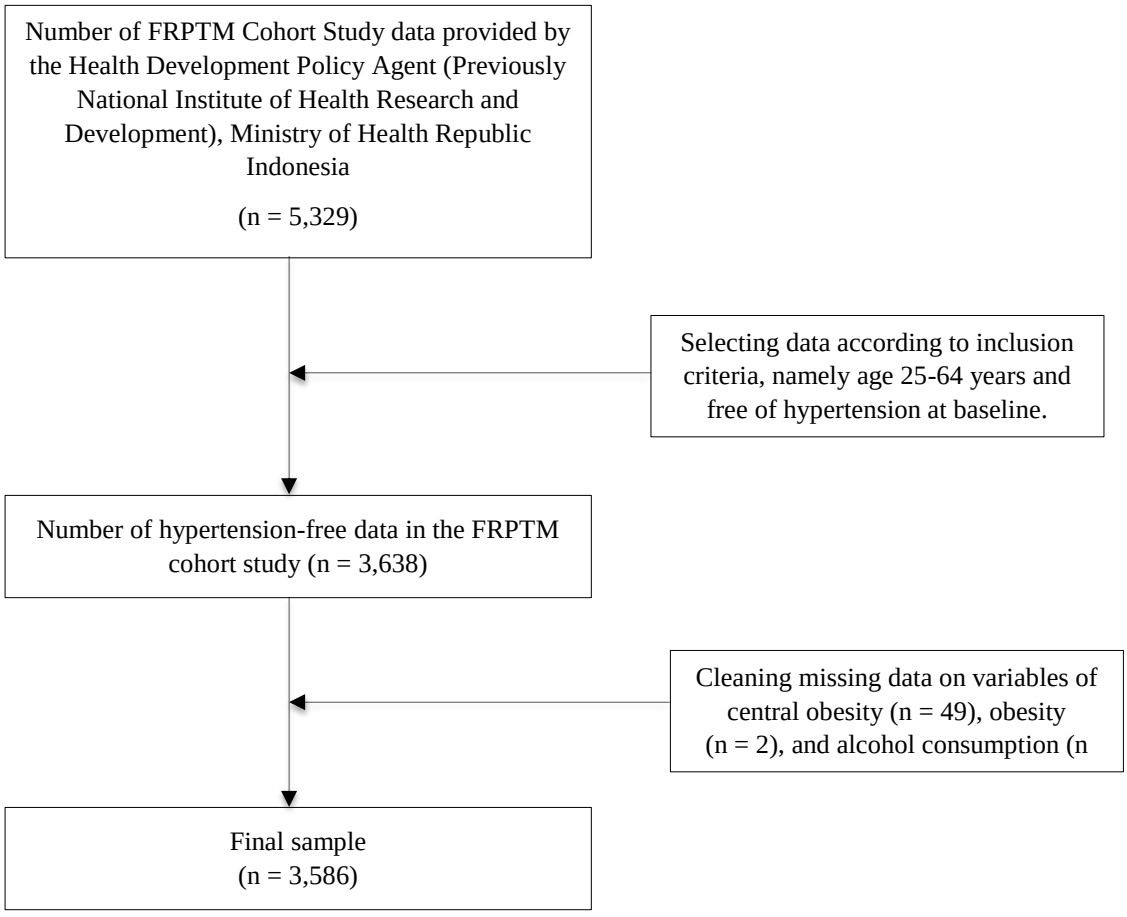

Figure 1. Respondent Flow Diagram

National Institute of Health Research and Development), Ministry of Health Republic Indonesia in the "Non-Communicable Disease Risk Factor Cohort Study *(Studi Kohor Faktor Risiko Penyakit Tidak Menular/*FRPTM)" in Bogor City (Senewe et al., 2021). FRPTM is a cohort study conducted since 2011 using primary data collection methods such as interviews on various NCD risk factors through questionnaires, health status measurements (Anthropometry, blood pressure), and examinations (biomedical, neurological, CBE, IVA, EKG, lung function, chest X-ray, ultrasound, etc) (Senewe et al., 2021).

Nutritional intake data were gathered by a 24-hour recall questionnaire, and dietary patterns were evaluated using the food frequency questionnaire. Supportive examination data included anthropometric measurements, blood pressure readings, electrocardiogram evaluations, neurological assessments, and blood analyses, each recorded using standardized forms appropriate to the respective procedures. Subsequent evaluations were performed utilizing specified follow-up forms while morbidity case occurrences were gathered by a morbidity questionnaire, and death cases were evaluated using autopsy verbal instruments.

In this study, the dependent variable was hypertension, with central obesity identified as the primary independent variable. Other independent variables, treated as covariates, including age, gender, educational status, residence, employment status, marital status, physical activity, smoking habits, salt and alcohol consumption, mental health conditions (stress), obesity, diabetes, total cholesterol, triglycerides, low-density lipoprotein (LDL), and high-density lipoprotein (HDL) levels. A multivariable analysis was performed using a Cox regression model, excluding the residence variable, to conduct confounder analysis. This analysis aimed to determine the association between central obesity and hypertension after adjusting for confounding variables. The final results were derived from the Adjusted Relative Risk (RR) values obtained from the model fit.

This study was conducted with the approval of the *Komite Etik Penelitian* (Ethical Research Committee) of Universitas Pembangunan Nasional "Veteran" Jakarta, under approval letter number 135/V/2024/KEP. An ethics review was undertaken to ensure the protection of respondents' data. The data utilized were specifically requested and had undergone an approval process with the relevant authorities.

Results

Table 1 shows that the incidence of hypertension over the 10-year observation period (120 months) was 24.5%, corresponding to 879 individuals, while 2,707 respondents remained non-hypertensive. Table 2 indicates that 36% of participants exhibited central obesity, and 37.6% were aged over 45 years. Women accounted for 63.5% of the sample, and 52.4% had low educational attainment. All participants resided in urban areas, with 92.8% employed. Additionally, 85.7% of the sample were married and engaged in sufficient physical activity. Mean-while, 57.6% of respondents were non-smokers. Subjects generally consume little salt, and most abstain from alcohol. Approximately three-fourths of the sample did not experience mental-emotional disorders. 61.1% of respondents were not obese, 96.9% had no history of diabetes, 56.4% exhibited normal total cholesterol levels, 84.2% had normal triglycerides, 78.6% had elevated LDL levels, and 64% of respondents had high HDL levels.

In Table 3, the percentage of hypertension among

Table 1. The Characteristics of Respondents on the Hypertension Variable

Variable	n	%
Non-Hypertension	2,707	75.5
Hypertension	879	24.5

Table 2. The Characteristics of Respondents on Hypertension Risk Factors

Variable	n	%
Central Obesity		
No	2,295	64.0
Yes	1,291	36.0
Age		
< 45 years old	2,238	62.4
≥ 45 years old	1,348	37.6
Gender		
Male	1,309	36.5
Female	2,277	63.5
Education		
Tertiary	292	8.1
Secondary	1,416	39.5
Primary	1,878	52.4
Residence		
Urban	3,586	100
Employment		
Unemployment	257	7.2
Employment	3,329	92.8
Marital Status		
Unmarried	272	7.6
Married	3,073	85.7
Divorced	241	6.7
Physical Activity		
Sufficient	3,255	90.8
Deficient	331	9.2
Smoking Status		
Non-smokers	2,067	57.6
Light Smokers	825	23.0
Moderate Smokers	543	15.1
Heavy Smokers	129	3.6
Unable to Recall	15	0.4
Unknown	7	0.2
Salt Consumption		
Low	2,827	78.8
High	245	6.8
Unknown	514	14.3
Alcohol Consumption		
No	2,763	77.0
Yes	823	23.0
Mental Emotional Disorder (Stress)		
No	2,622	73.1
Yes	964	26.9
Obesity		
No	2,192	61.1
Yes	1,394	38.9
History of Diabetes		
No	3,474	96.9
Yes	87	2.4
Unknown	25	0.7
Total Cholesterol		
Normal	2,022	56.4
High	1,552	43.3
Unknown	12	0.3

Table 2. The Characteristics of Respondents on Hypertension Risk Factors (cont'd)

Variable	n	%
Triglycerides		
Normal	3,019	84.2
High	555	15.5
Unknown	12	0.3
Low-Density Lipoprotein		
Normal	755	21.1
High	2,819	78.6
Unknown	12	0.3
High-Density Lipoprotein		
High	2,296	64.0
Low	1,278	35.6
Unknown	12	0.3

subjects with central obesity is 35.6%. The prevalence of hypertension in subjects aged 45 years or older is 30.7%. The percentage of hypertension in women is at 27.4%. For individuals with varying educational levels, the percentages of hypertension are as follows: 27.1% in those with low education, 21.6% in those with secondary education, and 21.9% in those with higher education. The percentage of hypertensive individuals who are employed is 24.2%. Among unmarried individuals, hypertension prevalence is 17.3%, while it rises to 29.0% for divorced individuals. The percentage of hypertension in subjects with lower levels of physical activity is 23.6%. Regarding smoking habit, the percentages of hypertension are 28.3% in non-smokers, 19.4% in light smokers, 19.7% in moderate smokers, and 20.2% in heavy smokers. The prevalence of hypertension among subjects who consume a high-salt diet is 29%. For those who consume alcohol, the percentage is 19.9%. The percentage of hypertensive subjects who have experienced mental disorders or stress is 21.5%. The percentage of hypertensive individuals with obesity is 35.2%. Among hypertensive subjects, 23% have a history of diabetes. The percentages for hypertensive subjects with elevated cholesterol levels are as follows: 27.5% have high total cholesterol, 30.8% have high triglycerides, 25.8% have high LDL, and 25.6% have low HDL.

In Table 4, the central obesity variable shows a significant influence on the incidence of hypertension, with an adjusted RR value of 1.415 (1.181–1.694). For the age variable, the adjusted RR value is 1.588 (1.389–1.816). Regarding smoking habit, moderate smokers have an adjusted RR value of 0.759 (0.614–0.939), light smokers have an adjusted RR value of 0.725 (0.608–0.864), and heavy smokers show an adjusted RR value of 0.653 (0.439–0.969). Lastly, the adjusted RR value for obesity is 1.616 (1.351–1.933).

During the 10-year observation period, there were 879 new cases of hypertension, with a total person-time of 374,040 person-months, equivalent to 31,170 person-years. This results in an incidence rate of 0.028, or 28 cases per 1,000 person-years. At the start of the study, there were 3,586 individuals at risk. Consequently, the cumulative incidence of hypertension is calculated to be 0.25. The attributable risk percentage was derived from the RR of central obesity, which is 1.415, yielding an attributable risk of 29.3%.

Discussion

The incidence of hypertension in this study was observed at a rate of 28 cases per 1,000 person-years after 10 years of monitoring. Incidence serves as a metric for how frequently a disease occurs in a specific population over a designated timeframe, offering a quick assessment of new disease diagnoses (Tenny & Boktor, 2023).

Table 3. Results of Bivariate Analysis

Variable	Hypertension				Total		Crude RR	p
	No		Yes					
	n	%	n	%	n	%		
Central Obesity								
No	1,876	81.75	419	18.3	2,295	100	Ref	
Yes	831	64.6	460	35.6	1,291	100	2.107 (1.845–2.405)	0.000
Age								
< 45 years old	1,773	79.2	465	20.8	2,238	100	Ref	
≥ 45 years old	934	69.3	414	30.7	1,348	100	1.576 (1.381–1.800)	0.000
Gender								
Male	1,054	80.5	255	19.5	1,309	100	Ref	
Female	1,653	72.6	624	27.4	2,277	100	1.473 (1.273–1.703)	0.000
Education								
Tertiary	228	78.1	64	21.9	292	100	Ref	
Secondary	1,110	78.4	306	21.6	1,416	100	0.975 (0.744–1.276)	0.851
Primary	1,369	72.9	509	27.1	1,878	100	1.261 (0.972–1.635)	0.081
Employment								
Unemployment	184	71.6	73	28.4	257	100	Ref	
employment	2,523	75.8	806	24.2	3,329	100	0.826 (0.650–1.050)	0.118
Marital Status								
Unmarried	225	82.7	47	17.3	272	100	Ref	
Married	2,311	75.2	762	24.8	3,073	100	1.476 (1.099–1.981)	0.010
Divorced	171	71.0	70	29.0	241	100	1.766 (1.220–2.556)	0.003
Physical Activity								
Sufficient	2,454	75.4	801	24.6	3,255	100	Ref	
Deficient	253	76.4	78	23.6	331	100	0.940 (0.745–1.185)	0.599
Smoking Status								
Non-smokers	1,483	71.7	584	28.3	2,067	100	Ref	
Light Smokers	665	80.6	160	19.4	825	100	0.658 (0.553–0.784)	0.000
Moderate Smokers	436	80.3	107	19.7	543	100	0.666 (0.542–0.818)	0.000
Heavy Smokers	103	79.8	26	20.2	129	100	0.697 (0.471–1.033)	0.072
Unable to Recall	13	86.7	2	13.3	15	100	0.438 (0.109–1.755)	0.244
Salt Consumption								
Low	2,141	75.7	686	24.3	2,827	100	Ref	
High	174	71.0	71	29.0	245	100	1.217 (0.953–1.554)	0.115
Alcohol Consumption								
No	2,048	74.1	715	25.9	2,763	100	Ref	
Yes	659	80.1	164	19.9	823	100	0.743 (0.627–0.880)	0.001
Mental Emotional Disorder (Stress)								
No	1,950	74.4	672	25.6	2,622	100	Ref	
Yes	757	78.5	207	21.5	964	100	0.824 (0.705–0.963)	0.015
Obesity								
No	1,803	82.3	389	17.7	2,192	100	Ref	
Yes	904	64.8	490	35.2	1,394	100	2.139 (1,873–2,444)	0.000
History of Diabetes								
No	2,619	75.4	855	24.6	3,474	100	Ref	
Yes	67	77.0	20	23.0	87	100	0.948 (0.609–1.477)	0.814
Total Cholesterol								
Normal	1,572	77.7	450	22.3	2,022	100	Ref	
High	1,125	72.5	427	27.5	1,552	100	1.283 (1.124–1.465)	0.000
Triglycerides								
Normal	2,313	76.6	706	23.4	3,019	100	Ref	
High	384	69.2	171	30.8	555	100	1.361 (1.152–1.609)	0.000

Table 3. Results of Bivariate Analysis (cont'd)

Variable	Hypertension				Total		Crude RR	p
	No		Yes					
	n	%	n	%	n	%		
Low-Density Lipoprotein								
Normal	606	80.3	149	19.7	755	100	Ref	
High	2,091	74.2	728	25.8	2,819	100	1.359 (1.140–1.621)	0.001
High-Density Lipoprotein								
High	1,746	76.0	550	24.0	2,296	100	Ref	
Low	951	74.4	327	25.6	1,278	100	1.073 (0.936–1.231)	0.310

Table 4. Results of Multivariate Analysis

Variable	Hypertension				Total		Adjusted RR	p
	No		Yes					
	n	%	n	%	n	%		
Central Obesity								
No	1,876	81.75	419	18.3	2,295	100	Ref	
Yes	831	64.6	460	35.6	1,291	100	1.415 (1.181–1.694)	0.000
Age								
< 45 years old	1,773	79.2	465	20.8	2,238	100	Ref	
≥ 45 years old	934	69.3	414	30.7	1,348	100	1.588 (1.389–1.816)	0.000
Smoking Status								
Non-smokers	1,483	71.7	584	28.3	2,067	100	Ref	
Light Smokers	665	80.6	160	19.4	825	100	0.725 (0.608–0.864)	0.000
Moderate Smokers	436	80.3	107	19.7	543	100	0.759 (0.614–0.939)	0.011
Heavy Smokers	103	79.8	26	20.2	129	100	0.653 (0.439–0.969)	0.035
Unable to Recall	13	86.7	2	13.3	15	100	0.433 (0.108–1.735)	0.237
Obesity								
No	1,803	82.3	389	17.7	2,192	100	Ref	
Yes	904	64.8	490	35.2	1,394	100	1.616 (1.351–1.933)	0.000

Overall, the incidence of hypertension exhibits temporal variations, underscoring the need for continuous monitoring and investigation to identify contributing factors. International reports, such as those from Italy, indicate a rising trend in new hypertension cases, with incidence rates increasing from 2.11 per 100 person-years during 2017–2019 to 5.20 in 2020–2022, and further rising to 6.76 in 2023 (Trimarco et al., 2024).

Numerous factors contribute to hypertension, making regular health examinations essential (Gebrina, 2024). In addition to standard health assessments, measuring waist circumference is also important (Ministry of Health, Republic of Indonesia, 2024b). The 2023 SKI results indicate that the prevalence of central obesity among individuals aged 15 years and above is 36.8% (Ministry of Health, Republic of Indonesia, 2024a). The analysis indicates a significant association between central obesity and hypertension. At the start of the study, respondents with central obesity had a 1.415-fold higher likelihood of developing hypertension (95% CI: 1.181–1.694) compared to those without central obesity. These results are consistent with the study by Rhee et al. (2018), which reported that central obesity increased the risk of hypertension irrespective of physical activity levels. Specifically, individuals with central obesity who exercised more than three times per week exhibited a 1.741-fold higher risk of developing hypertension compared to other groups. The results are consistent with the study by Chen et al. (2023), which utilized a cross-

sectional study design and indicated that individuals with central obesity had a 1.97-fold heightened risk of hypertension. A study by Ren et al. (2023) demonstrated that individuals with normal-weight central obesity had a 1.49-fold increased risk of hypertension compared to those without central obesity. This study indicated that central obesity accounted for 29.3% of hypertension cases in the at-risk population, with other factors contributing to the remainder.

Prevention and control of hypertension can begin with addressing central obesity. The Mediterranean diet is an effective intervention for preventing sustained weight gain while also reducing waist circumference (Bosomworth, 2019). Lifestyle modifications, such as adopting a low-calorie diet, represent another viable option (Kesztyüs et al., 2018). Routine measurement of waist circumference, the obesity variable, presents a risk factor of 1.616. This study corroborates the results of Sulistiowati and Sihombing (2020), who examined risk factors for newly diagnosed hypertension among respondents without diabetes using data up to 2017. Their study reported that obese respondents had a 1.89-fold higher risk of developing hypertension compared to non-obese individuals. Furthermore, Kristanti and Prihartono (2019) reported that obese individuals have a risk 1.84 times greater than individuals who do not fall into the obesity category. Obesity is defined as an autoimmune disorder that is associated with persistent low-grade inflammation. Inflammatory signals released by adipose tissue in obese people facilitate the onset of additional chronic disorders, including hypertension (Khanna et al., 2022). Moreover, weight loss has demonstrated the ability to stabilize neurohormonal activity, leading to clinically significant decreases in blood pressure (El Meouchy et al., 2022).

The smoking variable in the multivariate analysis shows a protective factor of 0.759 for moderate smokers, 0.725 for light smokers, and 0.653 for heavy smokers. A study conducted by Fan and Zhang (2022), which focused on female respondents, identified smoking as a protective factor with a value of 0.80 in comparison to non-smokers. Male respondents were divided into four categories: non-smokers, light smokers, moderate smokers, and heavy smokers. According to Gao et al. (2023), light smokers and moderate smokers who use machine cigarettes exhibit similar risk levels, at 0.99 times and 0.93 times, respectively. In contrast, heavy smokers face a 1.50-fold higher risk of developing hypertension compared to non-smokers. Cigarette smoke induces oxidative stress, which can damage cells and tissues, impairing the endothelium, the innermost layer of blood vessels, and potentially leading to vasoconstriction and increased peripheral resistance, thereby contributing to hypertension. Additionally, nicotine stimulates the sympathetic nervous system, triggering the fight-or-flight response, which results in elevated heart rate, vasoconstriction, and increased blood pressure (Fountoulakis et al., 2023).

This study has several limitations. First, information bias, particularly recall bias, may have influenced the results. A key limitation of this study is that data collection relied on respondents' recollection of past behaviors, such as smoking habits and salt consumption, which may have been inaccurate or incomplete. This type of recall bias is common in studies dependent on long-term memory and could affect the validity of the results. Additionally, selection bias was identified, particularly regarding the protective effect observed in the smoking status variable. Such bias has the potential to either overestimate or underestimate RR (Haine et al., 2018). Finally, the categorization of variables used in this study may require further reconsideration to minimize misclassification and improve the robustness of future analyses.

The results of this study have several practical implications for public health practice. First, routine measurement of waist circumference should be integrated into primary health care services alongside standard height and weight assessments, as it provides a simple and low-cost method for identifying individuals at risk

of hypertension. Second, health promotion programs targeting urban populations should emphasize lifestyle modifications, such as adopting healthier dietary patterns, increasing physical activity, and reducing sedentary behavior, to prevent central obesity and its associated complications. One of the health promotion strategies can involves utilizing mass media for health counseling (Haryani et al., 2016). The results of the study on health education through printed media showed that direct and mass media health education were significantly associated with hypertension treatment in adult. Health education via printed media became a dominant factor in the treatment of hypertension. This research recommends that regular health education should be done by means of leaflets, magazines and posters (Haryani et al., 2016). Finally, local governments and health authorities could use the evidence from this study to design community-based interventions and policies that specifically address obesity and hypertension in urban settings, thereby contributing to the broader effort to reduce the burden of non-communicable diseases in Indonesia.

Conclusion

In conclusion, central obesity is linked to hypertension. Individuals with central obesity have a 1.4 times greater risk of developing hypertension compared to those without it. Addressing and managing central obesity offers an important strategy for controlling hypertension. One practical approach is to incorporate routine waist circumference measurements into primary healthcare, alongside standard height and weight assessments. Following these evaluations, patient support can be strengthened through direct counseling and the provision of informational materials, such as brochures or flyers.

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