April – June, 2024
Original Article
DOI: http://dx.doi.org/10.30867/action.v9i2.1668

AcTion: Aceh Nutrition Journal
Pages: 280 – 289
p-issn 2527-3310; e-issn 2548-5741

The influences of nutritional status and abdominal circumference systolic blood pressure in adult men

Pengaruh status gizi dan lingkar perut terhadap tekanan darah sistol pada laki-laki dewasa

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Article History:
Received: December 20, 2023; Revised: February 15, 2024; Accepted: March 08, 2024; Published: June 16, 2024.

Publisher:
Politeknik Kesehatan Aceh
Kementerian Kesehatan RI

Abstract

The prevention and management of hypertension through healthy lifestyle modifications is a challenge for public health. The prevalence of hypertension among Indonesians was 34,1%. Lifestyle behaviors such as body mass index, central obesity, and sodium intake are associated with the risk of hypertension. This study aimed to analyze the influence of nutritional status and abdominal circumference on blood pressure in adult men. This cross-sectional research was conducted in Sukajadi Village, Bogor, between 2022-2023. The subjects were 73 purposively selected adult men. Data on subject characteristics were obtained through interviews. Anthropometric data were obtained by measuring abdominal circumference, body weight, and body height to assess the body mass index (BMI). Consumption data were collected using SQ-FFQ. The data analysis was performed using a linear regression test with a significance level of 95%. The results showed that Body mass index (p=0,007) and abdominal circumference (p=0,005) affected systolic blood pressure, while sodium intake (p=0,906) was not related to systolic blood pressure in adult men. Conclusions: Body mass index and abdominal circumference greatly influenced the systolic blood pressure. Further studies are needed to determine the various factors that influence systolic blood pressure and the risk of hypertension.

Keywords: Adult men, body mass index, hypertension, obesity

Abstrak

Pencegahan dan penatalaksanaan hipertensi melalui modifikasi gaya hidup sehat masih menjadi suatu tantangan bagi kesehatan masyarakat. Prevalensi masyarakat Indonesia yang menderita hipertensi sebesar 34,1% pada tahun 2018. Perilaku gaya hidup seperti indeks massa tubuh, obesitas sentral, dan asupan natrium, berhubungan dengan risiko hipertensi. Penelitian bertujuan untuk menganalisis pengaruh status gizi dan lingkar perut terhadap tekanan darah pada pria dewasa. Penelitian berdesain cross-sectional telah dilakukan di Desa Sukajadi, Bogor, tahun 2022-2023. Sampel yaitu laki-laki dewasa berjumlah 73 subjek terpilih secara purposive. Data karakteristik subjek diperoleh dengan wawancara. Data antropometri diperoleh dari pengukuran lingkar perut, penimbangan berat badan dan pengukuran tinggi badan untuk menilai indeks massa tubuh (IMT). Data konsumsi dikumpulkan menggunakan SQ-FFQ. Analisis data menggunakan uji regresi linier dengan tingkat signifikansi 95%. Hasil penelitian menunjukkan indeks massa tubuh (p=0,007) dan lingkar perut (p=0,005) berpengaruh terhadap tekanan darah sistol sedangkan asupan natrium (p=0,906) tidak berhubungan dengan tekanan darah sistol pada laki-laki dewasa. Terdapat pengaruh antara

indeks massa tubuh dan lingkar perut dengan tekanan darah sistol. Perlu pengamatan lebih lanjut untuk melihat berbagai faktor yang mempengaruhi tekanan darah dan risiko hipertensi.
Kata Kunci: Hipertensi, IMT, laki-laki dewasa, obesitas

Introduction

Hypertension remains a major global health problem, as its trend and prevalence increase every year worldwide (Mills et al., 2020). The increase in deaths due to hypertension reached 10,4 million deaths/year. Globally, in 2019, there were one billion people with hypertension, and it is estimated that this number will increase by 30% by 2025 (Zhou et al., 2021).

The prevalence of hypertension in Indonesia among people aged ≥18 years continues to increase. Based on Riskesdas data, the prevalence of hypertension in 2014 was 25,8%, which increased to 34,1% in 2018. West Java was ranked second in the province with the highest prevalence of hypertension in 2018 at 39,60% (Kemenkes, 2019) The number of cases of hypertension residents who received health services in Bogor Regency was 830,741 (63,24%) people (Dinas Kesehatan Kabupaten Bogor, 2020).

Hypertension occurs in individuals with a blood pressure of 140 mmHg/90 mmHg (Unger et al., 2020). Hypertension is a chronic pathological condition that is a major predictor of cardiovascular disease, stroke, kidney disease, and death (Onuh & Aliani, 2020). Hypertension is often considered a "silent killer" because it tends to be asymptomatic; therefore, sufferers do not realize that they have hypertension until complications occur and even damage organs in the body (Fatima & Mahmood, 2021).

Risk factors for hypertension are divided into two categories: factors that cannot be modified and factors that can be modified. Factors that cannot be modified include sex, age, sensitivity or sensitivity to sodium, and history of hypertension (Haas et al., 2021; Kifle et al., 2022). Factors that can be modified are obesity or overweight conditions, high sodium intake, sedentary lifestyle, stress levels, and smoking habits (Nur & Gunawan, 2018; Olack et al., 2015).

West Java Province Riskesdas reported that the prevalence of obesity in men in Bogor Regency was 12,94%, while the proportion of abdominal obesity was 16,09% (Kemenkes, 2019). Being overweight or obese is one of the strongest predictors of hypertension (Foti et al., 2022; Lee et al., 2020). Several studies have shown that obesity is correlated with systolic blood pressure levels (Lelong et al., 2015). In addition, abdominal obesity, characterized by an increase in abdominal circumference, is associated with increased blood pressure (Sari et al., 2016). Male individuals with an abdominal circumference ≥80 cm are at a higher risk of developing hypertension and various other health problems.

In addition to obesity, the habit of consuming foods high in sodium is also known to be a major risk factor for hypertension (Mente et al., 2021). People in the West Java area are known to often consume animal-side dishes with high sodium content in the form of salted fish (Khomsan et al., 2014). High sodium intake is significantly associated with increased blood pressure in adulthood. Meta-analysis studies have shown that reducing salt intake has an effect on reducing blood pressure (Graudal et al., 2020; Stamler et al., 2018).

The prevalence of obesity and the habit of consuming foods high in sodium in Bogor Regency can be risk factors for increased blood pressure, which can lead to hypertension. In addition, based on research results, Sekiyama et al. (2015), Most of the subjects in this study had insufficient nutritional intake during childhood. Malnutrition in early childhood is associated with the risk of developing hypertension in adulthood.

Therefore, based on the background description, the aim of this research was to analyze the relationship between individual characteristics, nutritional status, abdominal circumference, and sodium intake and blood pressure in a group of adult men in Sukajadi Village, Tamansari District, Bogor Regency.

Methods

This quantitative research used a cross-sectional design and was carried out in Sukajadi Village, Tamansari District, Bogor Regency, West Java. This research was conducted from November 2022 to March 2023. This research is part of longitudinal research entitled "Growth of rural children in West Java, Indonesia: a twenty-year follow-up study" with the main researcher Prof.

Dr. Katrin Roosita, S.P., M.Sc. This research was a collaborative research between Tokyo University and the Department of Public Nutrition, Faculty of Human Ecology, IPB University.

The population in this study was residents of Sukajadi Village, Tamansari District, Japan. The sample in this study refers to the main research data, and screening and sampling were conducted using purposive sampling. Sample selection was carried out based on established criteria, namely male sex. The inclusion criteria for this study were as follows: (1) subjects from the main research "Growth of rural children in West Java, Indonesia: a twenty-year follow-up study, (2) male, (3) aged 18-49 years and (4) willingness to be a research subject. Based on these criteria, 73 participants were recruited.

Data collection was performed by a research team, assisted by trained enumerators. Data on participant characteristics and intake were collected through direct interviews with the participants. Intake data were obtained from a semiquantitative food frequency questionnaire (SQ-FFQ) using a food photo book. The SQ-FFQ was created based on the results of a survey of foods that were frequently consumed at the research location. The data obtained from the SQ-FFQ were then processed using Nutri survey into sodium intake data by multiplying the portion size of each food consumed per day by the nutritional content.

Body weight and height were measured anthropometric measurements using a stature meter and BIA. The nutritional status variable based on BMI was obtained by calculating body weight (kg) divided by the square of body height (meters) to obtain the BMI value in the form of continuous data (kg/m2). The BMI classification is grouped based on the Ministry of Health's reference into 5, namely the "obese" category with a BMI > 27 kg/m2, the "obese" category with a BMI between 25,1 kg/m2 - 27 kg/m2, the "normal" category with a BMI between 18,5 kg/m2 – 25,0 kg/m2, the “thin” category with a BMI between 17 kg/m2 – 18,4 kg/m2 and the “very thin” category with a BMI <17 kg/m2 (Kemenkes, 2014).

Abdominal circumference was measured using a measuring tape (Medline) with an accuracy of 0,1 cm. Abdominal circumference was measured at the midpoint between the edge of the lowest rib and the endpoint of the arch of the groin. The subjects were measured in an upright standing position and breathing normally. The threshold for central obesity for Asian residents is an abdominal circumference ≥90 cm for men and ≥88 cm for women (WHO, 2011).

Trained health workers performed blood pressure measurements using a sphygmomanometer. Two measurements were taken in a sitting position the morning before the subject was active. The average of the measurement results was taken as blood pressure data. Normal blood pressure values are < 130 mmHg for systolic blood pressure and < 85 mmHg for diastolic blood pressure (Unger et al., 2020).

The data processing stages in this research included the editing stage, coding stage, data cleaning, and data analysis. The data processed and analyzed included subject characteristics, sodium intake, nutritional status, abdominal circumference, and blood pressure. Univariate, bivariate, and multivariate analyses were performed.

The analysis of the research results was performed using a computer application. The results of the normality test carried out using the Kolmogorov-Smirnov test showed that the data were not normally distributed ($p<0,05$). The power of the test was 95% and was considered significant when $p < 0,05$. Multiple linear regression statistical test analysis was used to determine the effect of the dependent variables, namely BMI and abdominal circumference, on the independent variable systolic blood pressure. This research was approved by the Ethics Committee for Research Involving Human Subjects of IPB University (number 271/IT3).KEPMSM-IPB/SK/2020.

Result and Discussion

Characteristics subject

The subjects consisted of 73 adult men in Sukajadi Village who met the inclusion criteria. The characteristic data are presented in Table 1.

Most of the subjects were aged 18-29 years (56,2%) and were included in the early adulthood category. The majority of subjects' educational level was classified as low, with 58,9% of subjects not attending school or having completed primary school at most. Only 2,7% of the participants received education until graduating from high school. A total of 72,6% of the participants did not have a family history of hypertension. Most of the subjects were active

smokers (75,3%), with 67,1% being moderate smokers and 8,2% being heavy smokers.

Table 1. Characteristics of research subjects (n=73)

Characteristics subject	n	%
Age		
18-29 years	41	56,2
30-49 years	32	43,8
Education		
Low	43	58,9
Medium	28	38,4
High	2	2,7
Family history of hypertension		
Yes	20	27,4
No	53	72,6
Smoking habit		
Not a smoker	17	24,7
Moderate smoker	49	67,1
Heavy smoker	7	8,2
Nutritional status		
Very thin	4	5,5
Thin	18	24,7
Normal	41	56,2
Fat	2	2,7
Obesity	8	11,0

Table 2 shows that the average BMI of the subjects was 21,2 ± 3,9 kg/m2 which was included in the normal BMI category and the majority of subjects (56,2%) had a normal BMI. Approximately 11% of the participants were classified as obese. Based on data from Riskesdas West Java Province, the prevalence of obesity in men in Bogor Regency was 12,94% (Kemenkes, 2019).

Table 2. Distribution of data on BMI, abdominal circumference, sodium intake and blood pressure in adult men

Research Variable	Mean±SD	Min-Max
BMI (kg/m^2)	21,24±3,93	16,1-35
Abdominal circumference (cm)	74,94±11,04	53-105
Sodium intake (g/hari)	2133,9±876,3	384,9-4474,3
systolic blood pressure(mmHg)	108±11,6	90-160
dystolic blood pressure(mmHg)	74,6±7,2	60-100

Overweight and obesity are conditions in which excessive or abnormal fat accumulates, causing various health risks (WHO, 2021). More than half of Indonesia's population, both in urban and rural areas, is associated with a higher likelihood of being overweight owing to changes in sedentary lifestyles and unhealthy eating patterns (Oddo et al., 2019; Omer, 2020; Silveira et al., 2022). The Framingham Heart Study showed a positive relationship between being overweight and the relative risk of hypertension and cardiovascular disease (Koenen et al., 2021).

The mean abdominal circumference of the subjects was 74,94 ± 11,04 cm, which was included in the normal category. In total, 12,3% of the subjects were included in the central obesity category. The percentage of subjects with central obesity in this study was still smaller than the data on the proportion of central obesity in the male population aged ≥15 years in West Java (16,09 %) (Kemenkes, 2019). Central obesity is associated with a poor quality of life and an increased risk of various diseases, especially non-communicable diseases (Huai et al., 2022; Sudikno et al., 2018).

The total mean sodium intake of subjects was 2133,9 ± 876,3 mg/day with the proportion of subjects consuming more than the recommended limit of 54,8%. The subjects' average sodium intake was higher than the sodium intake limit set by Minister of Health Regulation No. 30 of 2013, that is, <2000 mg/day. Data from the 2014 Individual Food Consumption Survey (SKMI) shows that the average sodium consumption of the Indonesian population was 2764 mg/person/day (Prihatini et al., 2016).

Sodium is an important mineral that naturally occurs in food and can be added during the manufacturing process. Sodium is not only limited to table salt but is also contained in almost all foods consumed (Prihatini et al., 2016). Sodium is an important nutrient in the body that is required for various physiological processes, including the maintenance of cellular homeostasis and fluid and electrolyte balance. Sodium levels in the body are tightly regulated through various mechanisms to maintain them

within the normal range (Lowell, 2019; Mente et al., 2021). Excessive sodium intake is associated with increased blood pressure and is a major risk factor for cardiovascular disease (Wang et al., 2023).

Relationship between sodium intake and blood pressure

Relationship between sodium intake and blood pressure (Grillo et al., 2019; Mente et al., 2021). The relationship between sodium intake and blood pressure (Welsh et al., 2019). Sodium intake of more than five grams per day is known to significantly increase blood pressure which is associated with the risk of hypertension and cardiovascular complications (Grillo et al., 2019)

Table 3. The relationship between sodium intake, BMI, and abdominal circumference on blood pressure

Variable	Systolic Blood Pressure	
	p	r
Sodium Intake	0,771	0,03
BMI	0,026*	0,26
Abdominal circumference	0,016*	0,28

**Significant p<0,05*

High sodium intake can trigger thirst and increase fluid intake, thereby triggering water retention, which causes an increase in arterial blood pressure. Consistent long-term increases in blood pressure can lead to endothelial inflammation and microvascular functional disorders even in subjects with normal blood pressure (Marketou et al., 2019). Furthermore, excessive salt intake can damage the structure and elasticity of large blood vessels, thereby triggering organ damage (Grillo et al., 2019).

In this study, sodium intake was determined based on an individual's total consumption, which allows for bias, making potential relationships more difficult to identify. Finally, this study is cross-sectional in nature, with variable measurements carried out only at one time; thus, it is difficult to determine the causality of the variables studied.

Influence of Nutritional Status (BMI) on Blood Pressure (BP)

Bivariate analysis in Table 3 using the Spearman test between the nutritional status of Body Mass Index (BMI) and systolic blood pressure showed that there was a significant positive correlation (p=0,026; r=0,261).

Linear Regression statistical test analysis (Table 4) showed the results of p= 0,007 and r = 0,315. The results of the analysis showed that BMI influences systolic blood pressure as a marker of hypertension risk. An increase in an individual's BMI value affects an increases systolic blood pressure. The coefficient of determination (R2) was 0,099, indicating that the linear equation can explain 9,9% of the risk factors for systolic blood pressure. Furthermore, from the obtained line equation, systolic blood pressure can be predicted from the BMI value. The systolic blood pressure value will increase by 0,92 points for every 1 kg/m2 increase in the BMI. The higher the BMI, the higher is the systolic blood pressure. Research by Lelong et al. (2015) states that increasing BMI by 1 kg/m2 increases blood pressure by 1 mm/Hg. Blood pressure values in overweight and obese individuals tend to be higher than those in individuals with normal weight (Foti et al., 2022). Research on the prevalence of prehypertension or blood pressure values ranging from 120–139/80–89 mmHg in the Chinese population shows that prehypertension occurs in 42% of overweight and 42% of obese individuals (Hu et al., 2017).

Obesity is characterized by excessive accumulation of adipocytes and an increase in BMI of ≥ 30 kg/m2. In individuals with obesity, there is a change in the composition of adipose tissue, both in size and quantity (Mair et al., 2020). These changes can lead to adipose tissue dysfunction, which significantly contributes to vascular damage, hypertension, and cardiovascular diseases (Koenen et al., 2021). Fat deposits around the kidneys in obese individuals cause structural changes, thereby triggering impaired sodium reabsorption and volume expansion (Jiang et al., 2016). The mechanisms underlying obesity-related hypertension are both complex and interrelated. The main factors that play a role in this are genetic and environmental factors, activation of the sympathetic nervous system, impaired renal and adrenal function, endothelial dysfunction, adipokines, natriuretic peptide deficiency, and the development of insulin resistance (Lambert et al., 2019).

Table 4. The influence of BMI and abdominal circumference on the risk of hypertension in adult men in Sukajadi Village, Bogor Regency

Variable	r	R^2	Parameter estimasion	Standard erorr	Line Equations	Value p
Sodium intake	0,014	0,000	0,000	0,002	BP= 108,408+ (0,000)*Sodium intake	0,906
BMI	0,315	0,099	0,926	0,331	BP = 88,337+(0,926)*BMI	0,007*
Abdominal circumference	0,327	0,107	0,342	0,117	BP = 82,380+(0,34)*Abdominal circumference	0,005*

BP= Blood pressure

One of the main mechanisms thought to play an important role in the pathophysiology of obesity-related hypertension is increased activity of the sympathetic nervous system and the renin-angiotensin-aldosterone system (RAAS). Physiological manifestations of sympathetic nervous system activity include increased heart rate, cardiac output, and sodium reabsorption (as a direct result of stimulation of α-adrenergic and β-adrenergic receptors, as well as indirect influence by activation of other systems such as the RAAS). The accumulation of fat tissue in obese individuals also triggers increased activity of the RAAS, which results in an increase in blood pressure. The increased production of angiotensin II induces systemic vasoconstriction, thereby stimulating aldosterone production in the adrenal cortex. The production of angiotensin II and aldosterone increases reabsorption or reabsorption of sodium, which increases water retention in the renal tubules, resulting in widening of intravascular volume and hypertension (Shariq & Mckenzie, 2020). In addition, vascular changes, including structural changes, endothelial dysfunction, and changes in elasticity that are common in obesity are also known to contribute to the development of hypertension (Lee et al., 2018).

Influence of Abdominal Circumference on Blood Pressure

The results of the correlation test (Table 3) showed that abdominal circumference was significantly associated to systolic blood pressure (p=0,016; r=0,218). Based on the results of the regression analysis in Table 4, abdominal circumference had an influence on systolic blood pressure (p= 0,005 and r = 0,327). A coefficient of determination (R2) value of 0,107 indicated that abdominal circumference had an influence of 10,7% on systolic blood pressure, while the rest was influenced by other variables. Furthermore, based on the obtained line equation, systolic blood pressure can be predicted from the abdominal circumference value. The systolic blood pressure value will increase by 0,34 points for every 1 cm increase in abdominal circumference. The higher the abdominal circumference, the higher the systolic blood pressure.

Sari et al. (2016) showed a significant relationship between abdominal circumference and systolic blood pressure in a male sample (p= 0,006). An increase in the abdominal circumference can increase the risk of hypertension, diabetes, hypercholesterolemia, and hyperuricemia. High abdominal circumference in 2020 was significantly associated with an increased prevalence of hypertension, even in individuals with normal metabolic profile (Cheng et al., 2022).

Abdominal circumference is a simple and ideal anthropometric measurement to assess a person's level of metabolic risk (Ponnalagu et al., 2019). Assessment of central obesity using abdominal circumference or waist-to-hip ratio is known to better predict the risk of cardiovascular disease than BMI because it can describe the distribution of fat in the body (Sahakyan et al., 2015). Male individuals with an abdominal circumference of >90 cm were categorized as centrally obese.

An increase in abdominal circumference indicates a build-up of visceral or retroperitoneal fat. Accumulation of fatty tissue triggers inflammation, decreased secretion of vasodilation, and increased secretion of leptin and angiotensin II, which results in an increase in blood pressure (Koenen et al., 2021), and the accumulation of visceral and retroperitoneal fat can cause mechanical compression of the kidney and expansion of the extracellular matrix of the renal medulla, thereby increasing renal sodium reabsorption (Shariq & McKenzie, 2020). These visceral fat deposits can also increase the risk of various other serious

diseases such as stroke and cardiovascular disease (Goswami et al., 2020).

The limitations of this research are that the sample size was relatively small and it was only conducted on one population; therefore, it may not represent variations in demographic and environmental conditions. In addition, collecting consumption data using the SQ FFQ allows for bias and limitations in the accuracy of sodium intake assessment. The cross-sectional study design also only provided a picture at one point in time. Other factors may not have been considered in this study. Further observations using cohort studies are important to determine the various factors that influence systolic blood pressure and the risk of hypertension.

Conclusion

Most of the subjects in this research were in the age range of 18-29 years with relatively low educational backgrounds. The majority of respondents had a normal nutritional status. Nutritional status based on BMI and abdominal circumference had a significant influence on systolic blood pressure in adult men in Sukajadi Village, Bogor Regency.

Policy makers should develop effective strategies and educational efforts for the public to maintain normal body weight, reduce salt intake, and prevent an increase in abdominal circumference as a preventive measure for hypertension. Future researchers are advised to use other more accurate methods to measure sodium intake, such as urine excretion.

Acknowledgements

The author would like to thank the entire research team "Growth of rural children in West Java, Indonesia: a twenty-year follow-up study" for allowing the use of some of the data for analysis by the author.

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