Journal of Public Health for Tropical and Coastal Region (JPHTCR)
Journal homepage: https:/ejournal2.undip.ac.id/index.php/jphtr/index
ISSN: 2597- 4378

The Association Between Dietary Fiber Intake and Central Obesity With Hypertension Among High School Teachers at SMA 1 and SMA 2 Sumenep

Mariyatul Kiptiya*, Miftahul Jannah, Galih Purnasari, Dahlia Indah Amareta
Clinical Nutrition Study Program, Departement of Health, Politeknik Negeri Jember,Indonesia
*Corresponding Author: Email: mariyatulkiptiya60@gmail.com

Abstract
Introduction: Hypertension is often referred to as a *silent killer* because it generally presents without any symptoms or complaints. The number of hypertension cases in Sumenep Regency increased from 70,870 in 2022 to 103,873 in 2023. Central obesity and fiber intake play important roles in hypertension. This study aimed to analyze the association between dietary fiber intake and central obesity with the incidence of hypertension in teachers.
Methods: This analytical study used a cross-sectional design. A random sampling method was used to select 68 respondents for this study. A digital sphygmomanometer was used to monitor blood pressure, and a measuring tape was used to measure waist circumference to assess central obesity. Dietary fiber consumption was evaluated using a Semi-Quantitative Food Frequency Questionnaire. Chi-square test was used for statistical analysis.
Results: Most respondents were mostly between 25-44 years, were non-smokers, and had no family history of hypertension. Sodium intake was mostly higher than the recommended level, and fiber intake was mostly inadequate. Most of the subjects had central obesity and normotension. The study showed no association between dietary fiber intake and the incidence of hypertension among the teachers (p = 0.248). There was ans association between central obesity and the incidence of hypertension among teachers (p = 0.006), in which the ones wo had central obesity tended to had hypertension compared to the ones who had no central obesity.
Conclusion: Central obesity is associated with hypertension among high school teachers in Sumenep.

Keywords: Hypertension, Fiber Intake, Central Obesity, Teachers.

DOI: https://doi.org/10.14710/jphtcr.v8i3.28273

Article History: Received: 30th June 2025, revised: 15th Sept 2025, accepted: 29th September 2025

Introduction

Hypertension is the leading cause of death and has become a global health priority.[1] It is often referred to as the "silent killer" due to its asymptomatic nature and lack of early complaints, which can ultimately lead to death.[2] Currently, the prevalence of hypertension is higher among urban populations than that among those in rural areas. This is largely attributed to the predominance of unhealthy lifestyles in urban settings.[3] The 2018 Basic Health Research (Riskesdas) study, which found that the prevalence of hypertension was higher in urban areas, lends credence to this finding. (34.4%) compared to rural areas (33.7%).[4]

In contrast to the 2018 Basic Health Research (Riskesdas) data, the 2023 Indonesian Health Survey (SKI) indicates a decline in the prevalence of hypertension. According to blood pressure readings, the prevalence of hypertension among Indonesians aged ≥18 years decreased from 34.1% in 2018 to 30.8% in 2023.[5] Additionally, the frequency decreased from 36.3% in 2018 to 34.3% in 2023 in the East Java region. However, East Java continues to have a higher prevalence of hypertension than the national average. According to data from the Sumenep District Health Office, the number of hypertension cases increased from 70,870 to 103,873.

High blood pressure is caused by various variables, including risk factors that cannot be changed, such as age, sex, heredity, and race. In contrast, eating habits, smoking, coffee use, obesity, physical inactivity, stress at work, and educational attainment are modifiable risk factors. The 2023 Indonesian Family Health Survey (SKI) found that among people in East Java who were at least 15 years old, the prevalence of central obesity was People with central obesity or poor physical activity levels are more likely to have hypertension. Central obesity is a significant contributing factor to hypertension, as individuals with central obesity tend to have higher cardiac output and circulating blood volume than those without it. The consumption of high-fat and high-cholesterol foods, when not balanced with adequate fiber intake, can lead to central obesity.[6]

Dietary intake can influence hypertension, with fiber intake being a key component. Low fiber intake can reduce the excretion of fat and bile acids through feces, leading to their reabsorption into the bloodstream. As a result, the amount of circulating cholesterol increases, which can obstruct blood flow and contribute to elevated blood pressure.[7] The average fiber intake among the Indonesian population is 10.5 g/day, indicating that fiber consumption does not meet the body's nutritional requirements. According to the Dietary Approaches to Stop Hypertension (DASH) guidelines, the recommended fiber intake for individuals with hypertension is > 30 g/day. Dietary fiber is primarily sourced from fruits, vegetables and legumes. Based on the 2023 Indonesia Health Survey (SKI), the prevalence of inadequate fruit and vegetable consumption in East Java was 95.7%.

Occupational status is another contributing factor to hypertension incidence. According to data from the 2018 Basic Health Research (Riskesdas), employment status can influence hypertension. Among individuals aged ≥ 18 years, those working as civil servants, military personnel, police officers, or employees of state-owned and regional government-owned enterprises (PNS/TNI/Polri/BUMN/BUMD) were at a higher risk, with a prevalence rate of 36.91%. Teaching is one of the occupations that fall under the civil servant category. Teachers' roles go beyond preparing lesson plans, delivering instruction, and assessing student assignments; they are also responsible for students' academic achievement and often undertake additional tasks assigned by their superiors. High school teachers, in particular, face challenges in managing their workload effectively.[8]

Based on a survey conducted[9] at SMP Negeri 3 Tanjung Morawa, obesity among teachers is attributed to unhealthy eating patterns, such as the consumption of high-calorie and high-fat foods and low-fiber intake. Furthermore, a survey conducted among elementary school teachers in Salahutu District, Central Maluku Regency, Maluku Province, revealed that teachers with central obesity had a 6.01 times higher risk of developing hypertension than those without central obesity.

Based on a preliminary study conducted by researchers at the Branch Office of the East Java Provincial Department of Education in the Sumenep Region, it was found that there are a total of 1,200 senior high school (SMA) teachers in Sumenep Regency, consisting of 668 public school teachers and 532 private school teachers. The highest concentration of public high school teachers is located in urban areas, particularly in two schools: SMA 1 Sumenep with 73 teachers and SMA 2 Sumenep with 94 teachers

Preliminary observations involving 15 teachers from SMA 1 and 15 teachers from SMA 2 revealed that the prevalence of hypertension among them was 26.6%, which exceeds the target set by the National Medium-Term Development Plan (RPJM), namely 23.4%. Additionally, the study indicated that the teachers' fruit intake lacked variety. Based on this background, the researcher is interested in conducting a study entitled "The Relationship Between Fiber Intake and Central Obesity with the Incidence of Hypertension Among Teachers at SMA 1 and SMA 2 Sumenep."

Methods

By collecting data at a single point in time, this cross-sectional descriptive analytical observational study sought to determine the association between risk variables and their outcomes. As a result, the study participants were only seen once each. Hypertension incidence was the dependent variable in this study, whereas fiber consumption and central adiposity were the independent variables. The study was conducted between December and January 2025.

The study population consisted of all teachers employed at SMA 1 Sumenep (73 individuals) and SMA 2 Sumenep (94 individuals), resulting in a total of 167. The criteria were individuals who were willing to participate as respondents and aged between 25 and 59 years. The exclusion criteria included teachers who were currently undergoing a diet program, teachers with a history of diseases that could affect dietary intake and health status, and teachers taking antihypertensive medications such as Amlodipine, Candesartan Dexa, Spironolactone, Bisoprolol. The Lemeshow formula was used to calculate the sample size, which was 68. Simple random sampling was used for the sample selection. Interviews were conducted to gather information on the patients' age and family medical history. A digital sphygmomanometer was used to obtain a single blood pressure reading. Central obesity was assessed by measuring waist circumference using a measuring tape. Dietary fiber intake was evaluated through interviews using a Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ), with intake categorized as adequate or inadequate based on nutritional requirements. Bivariate analysis was performed using the chi-square test.

Respondent Characteristics

The study included characteristics such as age, sex, family history, and smoking habits. Based on the research findings, the distribution of the respondents' characteristics is as follows:

As shown in Table 1, based on the respondents' sociodemographic information, 36 teachers, or 53% of the total, were men. One of the risk factors for hypertension that cannot be changed is gender. Compared to women, men are more likely to have hypertension.[10] This is primarily because men are more likely to engage in unhealthy lifestyle behaviors than women. However, there is an observed increase in the prevalence of hypertension among women who have entered menopause due to the hormonal changes experienced during this stage. Estrogen protects women who have not yet experienced menopause by contributing to elevated HDL (high-density lipoprotein) levels.Higher HDL cholesterol levels serve as a protective factor against the development of atherosclerosis.[9]

Table 1 shows that most respondents were aged between 25 and 44 years (66.2%). As age increases, changes occur in the arteries of the body, which tend to widen and become stiffer. This can lead to reduced capacity and recoil of blood accommodated through blood vessels. Aging is also associated with increased peripheral plasma concentrations and the occurrence of glomerulosclerosis due to aging, as well as interstitial fibrosis, resulting in vascular changes that can elevate the blood pressure.

Based on Table 1, most respondents did not have a history of hypertension (76.5%). Heredity is a non-modifiable risk factor for developing hypertension. Individuals with parents or relatives with hypertension are more likely to develop the disease. This condition may be influenced

by genetic factors, such as polygenic hypertension.[11]

The results also indicated that most respondents did not smoke, with 51 respondents (77.9%) reporting no tobacco use. According to Aliyah and Setiawati (2018), smoking is a contributing factor to the development of high blood pressure (hypertension). This is due to the presence of substances such as nicotine and carbon monoxide in cigarettes, which can damage the endothelial lining of arterial blood vessels and potentially lead to hypertension. [12]

As shown in Table 2, the majority (60.3%) of the respondents had sodium intake exceeding the recommended limit. The average sodium intake among respondents was 2,124.597 mg/day, which was above the recommended threshold. According to the Indonesian Ministry of Health Regulation No. 30 of 2013, the recommended daily sodium intake is 2,000 mg.[13] However, the average sodium intake in this study remained below the national average sodium intake in Indonesia, which is 2,764 mg/day.[14] Excessive sodium intake can lead to hypertension, as high sodium levels may cause narrowing of the arterial diameter. This condition forces the heart to pump harder to circulate blood through the constricted vessels, resulting in increased blood pressure.[14]

Based on Table 2, the majority of respondents (76.5%) had a fiber intake that did not meet the recommended dietary requirement. Dietary fiber intake plays an important role in the development of hypertension. The mechanism by which dietary fiber reduces hypertension is related to the production of bile acids. Dietary fiber can reduce circulating cholesterol levels in plasma because it binds to bile acids, inhibits cholesterol absorption in the intestines, and increases the excretion of bile acids through the feces. This process enhances the conversion of plasma cholesterol to bile acids. The average fiber intake among respondents was 23.57 g/day, which does not meet the recommended daily fiber intake. According to the Dietary Approaches to Stop Hypertension (DASH) guidelines, the recommended fiber intake for individuals with hypertension is > 30 g/day. Daily fiber requirements vary by age and sex; adult males are advised to consume 30–37 g of fiber per day, while adult females are recommended to consume 25–32 g per day.[1] However, the average fiber intake observed in this study was still higher than the national average fiber intake among Indonesians, which is 10.5 g/day. According to the 2023 Indonesia Family Life Survey (SKI), the prevalence of insufficient fruit and vegetable consumption in East Java was 95.7%. Previous studies have shown that low fiber intake is associated with a higher risk of developing hypertension compared to individuals who consume adequate or higher amounts of dietary fiber.[15]

According to Table 3, central obesity affected 57.4% of respondents. According to the 2023 Indonesian Health Survey (Survei Kesehatan Indonesia/SKI), the prevalence of central obesity is 36.8% (Ministry of Health, Republic of Indonesia 2023). According to the 2018 Basic Health Research (Riskesdas), 31% of people have central obesity. Central obesity increases the risk of metabolic syndrome and hypertension, both of which increase the risk of cardiovascular diseases. Intra-abdominal fat generates cortisol and proteins linked to cardiometabolic disorders as hypertension and heart disease.[16]

As shown in Table 4, 66.2% of the respondents did not experience hypertension, 1.5% had low blood pressure, and 33.8% had hypertension. This figure has not yet met the RPJM target of 23.4%. Compared to the prevalence rates in East Java and Indonesia, the prevalence of hypertension in this study was higher than the national prevalence (30.8% in 2023) and slightly lower than the prevalence in East Java (34.3% in the same year 2023). [17]

Table 5 shows that hypertensive respondents with fiber intakes below the recommended level (38.5%) had a higher prevalence than those with adequate fiber intakes (18.8%). Among non-hypertensive respondents, those with adequate fiber intake (81.3%) had a higher prevalence than those with inadequate fiber intake (61.5%). A p-value of 0.248 was found by statistical analysis to indicate a correlation

between the incidence of hypertension and fiber intake. This finding suggests that the incidence of hypertension and fiber consumption are not significantly correlated among the teachers at SMA 1 and SMA 2 in Sumenep. Based on interviews using the SQFFQ, low fiber intake was primarily due to the infrequent consumption of vegetables and fruits, with some respondents consuming them only two to three times per week on average.

The results of this study indicate that there is no significant association between fiber intake and hypertension, as fiber intake is not a primary cause of hypertension. Other contributing factors, such as central obesity, may play a more prominent role. Cross-tabulation results in this study show that adequate fiber intake was more frequently observed among respondents with central obesity (25.6%) compared to those without central obesity (20.7 Central obesity is a condition characterized by the accumulation of fat in the abdominal region due to excess visceral adipose tissue. Consuming high-fiber foods may influence central obesity, as dietary fiber affects abdominal adipose tissue. Fiber binds to bile acids and facilitates their excretion through feces, thereby reducing the fat and cholesterol stored in adipose tissues, including visceral fat.[18] Excess visceral fat can reduce adiponectin levels and lead to insulin resistance, both of which may contribute to hypertension. Vascular dysfunction resulting from visceral fat further supports the potential beneficial effects of fiber intake on lowering blood pressure. Therefore, managing hypertension accompanied by central obesity requires a comprehensive and integrated approach that encompasses lifestyle modification, nutritional therapy, physical activity, and pharmacological treatment. [19,20]

Cross-tabulation results in this study indicated that respondents with inadequate fiber intake were more prevalent among those aged 25–60 years (87%) than among those aged 25–44 years (71.1%). Adulthood is a major contributing factor to the incidence of hypertension, as natural physiological changes occur with increasing age. These changes affect the heart, blood vessels, and hormones, leading to alterations in the vascular system that can cause increased blood pressure and hypertension. As individuals age, particularly those aged ≥45 years, the arterial walls progressively thicken due to collagen deposition in the muscular layer. This results in narrowing and stiffening of the blood vessels, further contributing to elevated blood pressure.[21]

The results of this study are consistent with those of[22] which showed no significant effect of fiber intake on blood pressure. The results indicated no association between vegetable and fruit consumption and the blood pressure. The absence of [23] a significant relationship in this study is likely due to the fact that low fiber intake is not a primary factor contributing to elevated blood pressure. This suggests that other factors, such as sodium intake, have a more dominant influence on blood pressure. Hypertension can also be caused by other factors, including stress, smoking, sex, and genetic predispositions. Sodium intake plays a crucial role in the development of hypertension. A low-sodium diet is an appropriate intervention for individuals with hypertensive disease. A low-sodium diet involves consuming foods without any table salt and reducing the intake of foods that are high in sodium.

Based on Table 6, among respondents with hypertension, the prevalence of central obesity (48.7%) was higher than that in those with hypertension but without central obesity (13.8%). Conversely, among respondents without hypertension, those without central obesity (86.2%) had a higher prevalence than those with central obesity (51.3%). The results of the statistical test showed a p-value of 0.006 for the association between central obesity and hypertension. This indicates a statistically significant relationship between central obesity and the incidence of hypertension among teachers at SMA 1 and SMA 2 in Sumenep, Indonesia.

Central obesity is a variable that contributes to the development of hypertension. Excessive fat accumulation in the abdomen causes this disorder. Reduced adiponectin levels, decreased mitochondrial uptake of intracellular free

fatty acids, which lowers oxygen availability, and intracellular free fatty acid buildup are physiological abnormalities caused by excess abdominal fat. An excess of free fatty acids can trigger insulin resistance (IR). In a state of hyperinsulinemia, vasoconstriction and increased sodium reabsorption in the kidneys may occur, ultimately leading to elevated blood pressure. Central obesity is a risk factor for increased blood pressure, metabolic syndrome, and elevated triglyceride levels, all of which contribute to a higher risk of cardiovascular disease. Intra-abdominal fat also produces proteins and cortisol that are associated with cardiometabolic diseases, such as heart disease and hypertension.[19] Efforts to prevent hypertension caused by central obesity include health education on hypertension and central obesity, as well as the underlying causes and preventive strategies. One such strategy is the adoption of a balanced nutritional diet aligned with dietary guidelines.

This study is consistent with the findings of[24] which indicated a significant association between central obesity and the incidence of hypertension (p = 0.01). It aligns with[25] research, which states that central obesity is significantly related to the occurrence of hypertension. Respondents with central obesity were 3.63 times more likely to develop hypertension than those without central obesity. This is in accordance with[26] the findings, which emphasized the link between central obesity and blood pressure. An unhealthy lifestyle can lead to various health complications. Obesity is a condition that facilitates a range of symptoms leading to hypertension, ultimately increasing the risk of cardiovascular disease. Central obesity, characterized by fat accumulation in the intra-abdominal area, carries a higher risk of health problems, particularly those related to cardiovascular diseases such as hypertension.

The limitation of this study is the presence of potential confounding factors that were not optimally controlled, such as physical activity and stress levels, which may influence the relationship between dietary fiber intake, central obesity, and hypertension incidence. The strength of this study lies in the use of primary data, which minimizes potential bias from secondary data sources, and the inclusion of participants from two schools, thereby increasing data variability and expanding the scope compared with using a single-school population.

Tabel 1. Respondent Characteristics

Gender	Frequency (n)	Percentage (%)
Male	35	51.5
Female	33	48.5
Respondents' Age		
25- 44 years	45	66.2
45-60 years	23	33.8
Family History of Hypertension		
Yes	16	23.5
No	52	76.5
Smoking Habits		
No	53	77.9
Yes	15	22.1

Tabel 2. Frequency Distribution of Sodium and Fiber Intake

Variable	Frequency (n)	Percentage (%)	Mean ± SD	Min - Max
Sodium Intake			2124.59±292.560 (mg)	1836 –3633(mg)
Excessive	41	60.3		
Adequate	27	39.7		
Fiber Intake			23.57 ±5.832 (g)	20 – 32.3 (g)
Adequate	16	23,5		
Inadequate	52	76.5		

Tabel 3. Frequency Distribution of Central Obesity

Central Obesity Status	Frequency (n)	Percentage (%)	Male Waist Circumference (cm)		Female Waist Circumference (cm)	
			Mean ± SD	Min – Max	Mean ± SD	Min–Max
Central Obesity	39	57.4	85.3 ±11.665	66 – 122	93.88 ± 13.657	66 – 108
Not Central Obesity	29	42.6				

Tabel 4 Frequency Distribution of Hypertension

Hypertension Status	Frequency (n)	Percentage (%)	Mean ± SD (mmHg)	Min – Max (mmHg)
Hypotension	1	1.5	133/110 ± 22/15	93/59 – 188/135
Normotensive	44	64.7		
Hypertensive	23	33.8		

Tabel 5. Association Between Fiber Intake and Hypertension

Variable		Hypertension						*P -value*
		Hypertension		Non-Hypertension		Total		
		n	%	n	%	n	%	
Fiber Intake	inadequate Intake	20	38.5	32	61.5	52	100	0.248
	Adequate Intake	3	18.8	13	81.3	16	100	

Tabel 6. Association Between Central Obesity and Hypertension Among Teachers

Variable		Hypertension						*P -value*
		Hypertension		Non-Hypertension		Total		
		n	%	N	%	n	%	
Central Obesity	Central Obesity	19	48.7	20	51.3	39	100	0.006
	Not Central Obesity	4	13.8	25	86.2	29	100	

Conclusion

The majority of the participants in this study were male (51.5%), aged 25–44 years (66.2%), had no family history of hypertension (76.5%), and were non-smokers (77.9%). A total of 60.3% of respondents had sodium intakes exceeding the recommended limit, while 76.5% had fiber intakes below the recommended level. Most respondents experienced central obesity (57.4%), and some had hypertension (33.8% prevalence). There was no significant association between fiber intake and hypertension among the high school teachers at SMA 1 and SMA 2 Sumenep (p = 0.248). However, a significant association was found between central obesity and hypertension in the same group of teachers (p = 0.006).

Recommendation

Future studies should include additional variables that may influence the occurrence of hypertension, such as sodium intake and smoking habits. It is also suggested to conduct studies in different locations and among adult populations with characteristics that are distinct from those in this study. For SMA 1 and SMA 2 Sumenep institutions, this study may serve as a foundation for implementing educational programs related to hypertension and central obesity, including their causes and preventive measures (such as a healthy diet: low in salt and high in fiber).It is hoped that the general public will become more aware of the need to control sodium intake and manage central obesity to prevent hypertension.

Ethical Approval

This study was approved by the Health Research Ethics Committee of the State Polytechnic of Jember and has been

declared to have passed the ethical review no 16102/PL17.4/PG/ 2024

Availability of Data and Materials

Owing to a privacy protection agreement between the authors and respondents, the dataset used in this study is not publicly available; however, it can be obtained from the corresponding author upon reasonable requests.

Acknowledgments

The authors express their gratitude to the teachers of SMA 1 and SMA 2 Sumenep for their willingness to participate in this study. We also thank our academic supervisors for their guidance and support, as well as all parties who contributed to the completion of this study and manuscript.

Funding

Funding: This research was self-funded by the authors.

Authors' Contributions

The author conducted an analysis and interpretation of all the respondent data. MJ, GP, and DI reviewed all the analyzed and interpreted data and made major contributions to the manuscript. All authors have read and approved the final manuscript.

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