Amerta Nutrition
e-ISSN: 2580-1163 (Online)
p-ISSN: 2580-9776 (Print)
Rumaisyah et al. | Amerta Nutrition Vol. 7 Issue 2SP (December 2023). 24-30

RESEARCH STUDY
English Version
OPEN ACCESS

Association between Types of Obesity and Hypertension in Young Adults in Indonesia

Hubungan Tipe-Tipe Obesitas dengan Hipertensi pada Usia Dewasa Muda di Indonesia

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ARTICLE INFO

Received: *15-09-2023*
Accepted: *20-12-2023*
Published online: *31-12-2023*

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DOI:
10.20473/amnt.v7i2SP.2023.24-30

Available online at:
https://e-journal.unair.ac.id/AMNT

Keywords:
Abdominal obesity, Combined obesity, General obesity, Hypertension

ABSTRACT

Background: Hypertension is the dominant risk factor for coronary heart disease, the first cause of death in Indonesia. The prevalence of hypertension in Indonesia based on blood pressure measurements reached 34.11% in 2018. An increase the prevalence and risk of hypertension occurs in young adults with obese, both obesities based on body mass index and abdominal circumference as a parameter.
Objectives: To analyze the association between types of obesity and hypertension in young adults in Indonesia.
Methods: Cross-sectional study used secondary data from Indonesia National Basic Health Research 2018. Individuals aged 25-44 years, measured blood pressure for 3 times, had complete data, and not pregnant were included in this study (35,258 participants). Univariate and bivariate analysis used chi-square and then logistic regression test as multivariate analysis. Both used α 0.05 and 95% confidence interval.
Results: Based on logistic regression, hypertension has a significant correlation with general obesity, abdominal obesity, combined obesity, age, gender, education, employment status, physical activity, smoking status, and fruit and vegetable consumption levels. In addition, the probability of developing hypertension based on the type of obesity is the largest in combined obesity, then general obesity and abdominal obesity with adjusted odds ratio 3,50; 1,87; and 1,79.
Conclusions: General obesity, abdominal obesity, and combined obesity were associated with hypertension in young adults in Indonesia. Body mass index measurement combined with abdominal circumference can be a parameter of three types of obesity and a predictor of hypertension.

INTRODUCTION

High blood pressure, often referred to as hypertension, is a condition of blood pressure exceeding normal limits. Hypertension will have implications for cardiovascular disease and be the dominant risk factor of coronary heart disease, which currently becomes the first cause of mortality in Indonesia[1,2]. An individual with hypertension also has a 17.92 times higher risk of having a stroke than an individual without hypertension[3]. Urbanization, socioeconomic changes, and unhealthy lifestyles cause epidemiological transition and shift in the trend of non-communicable diseases to communicable diseases, including hypertension.

The epidemiological transition also causes hypertension, which is not only in the elderly but also in young adults. A study regarding risk factors of hypertension according to age categories stated that men who are highly educated, have smoking habits, consume alcohol, and obesity have a higher risk of hypertension in early adulthood than in middle adulthood and late adulthood or elderly[4]. Hypertension in young adulthood and productive periods will impact the decrease of productivity and increase of economic burden[5]. This hampers the government in realizing the demographic bonus in 2030-2040, which targets the proportion of productive age more than 60% of the total population in Indonesia[6].

A study related to the risk factors of hypertension stated that an individual who is overweight and obese has a 4.37 times higher risk of hypertension than normal nutritional status[7]. A study conducted in Tianjin in 2017 regarding risk factors of hypertension based on age characteristics stated that obesity becomes the main factor of hypertension in the young adulthood group[4]. Excess fat stores in obesity cause a high level of fat in adipose cells and increase the release of leptin as one of the adipocytokines. The condition of high leptin or hyperleptinemia will lead to the activation of pro-inflammatory cytokines, which become the promoter for the development of hypertension disease[8].

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The risk of hypertension can also occur in central obesity measured from the abdominal circumference. A study by Rahma in 2019 stated that an individual with central obesity has a 6 times higher risk of hypertension than an individual with normal abdominal circumference[9]. Central obesity, which is characterized by abdominal circumference exceeding normal limits, is a sign of excess visceral fat, so it can cause an increase of blood pressure through mechanical compression damage of the kidney, activation of the Renin-Angiotensin-Aldosterone System (RAAS), sympathetic nervous system, and hyperinsulinemia[10].

An individual with obesity and central obesity has a higher prevalence than an individual with only obesity or only central obesity. Moreover, the risk of hypertension is also higher if an individual experience both types of obesity than just one type of obesity. A study stated that the average Systolic Blood Pressure (SBP) in individuals with obesity accompanied by central obesity is the highest compared to only central obesity or obesity with significant differences in statistical value[11]. A study regarding the relationship between the type of obesity and hypertension in adults in China stated that someone with obesity and central obesity has the highest risk of hypertension than only experiencing one type of obesity[12].

Various research and studies in various countries showed an increase in hypertension prevalence and high risk of hypertension in young adults with obesity measured according to Body Mass Index (BMI) and abdominal circumference as parameters. However, a study regarding the types of obesity and hypertension in Indonesia is still lacking, especially in young adulthood. Therefore, the researcher would like to study the relationship between types of obesity and hypertension in young adults in Indonesia.

METHODS

The design of the study was cross-sectional, according to the data from Indonesia National Basic Health Research 2018 (Riskesdas) of 2018. Sample calculation used a total sampling technique. The subjects of the study were individuals 25-44 years old who met inclusion and exclusion criteria, which were 25-44 years old, had blood pressure measured 3 times, had complete data on both independent and dependent variables, and were not pregnant. 35,258 individuals became the samples of this study after excluding pregnant respondents (n=6,463) and uncompleted data (n=248,476).

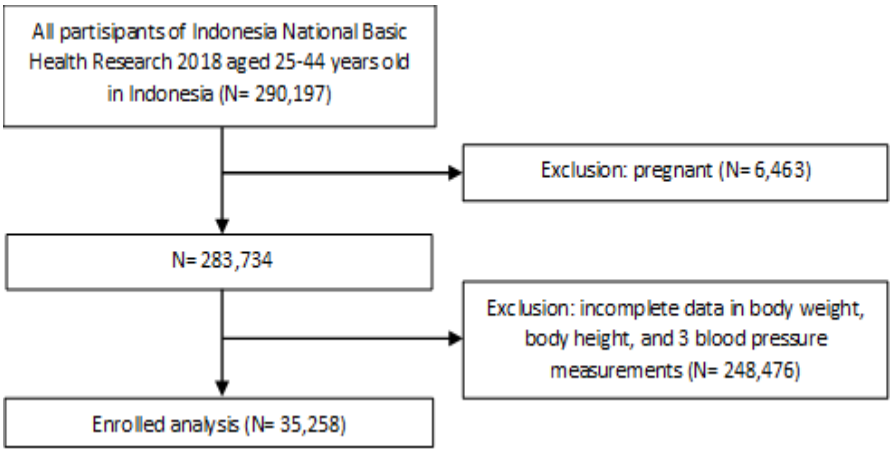

Figure 1. Sampling flow

The questionnaire used in this study was based on the questionnaire from Riskesdas in 2018. The questionnaire was prepared for national research involving all provinces and regencies/cities in Indonesia, so the preparation considers the lifestyle and habits of Indonesian people. Filling out the questionnaire was carried out by trained enumerators through interviews, measurements, and direct examination. This study submitted a data request to the Health Development Policy Agency via the website www.labmandat.litbang.kemkes.go.id.

Riskesdas's questionnaire was divided into two: household and individual questionnaires. The household questionnaire used in this study involves variables of gender, age, education, and occupation in block IV. Meanwhile, the individual questionnaire involved body height, body weight, abdominal circumference, and blood pressure in block L, as well as the level of fruit and vegetable consumption, smoking status, and physical activities in block G. An individual is stated having hypertension when during data collection, the blood pressure was measured and the results from 3 measurements had Systolic Blood Pressure (SBP) of ≥140 mmHg and/or Diastolic Blood Pressure (DBP) of ≥90 mmHg[13].

An individual is stated General Obesity (GO) if she/he has a BMI of ≥27 kg/m^2 and abdominal circumference of <90 cm in males and <80 cm in females. Abdominal Obesity (AO) is someone with an abdominal circumference of ≥90 cm in males or ≥80 cm in females and a BMI of <27 kg/m^2. Furthermore, if someone has a BMI of ≥27 kg/m^2 and abdominal circumference of ≥90 cm in males or ≥80 cm in females, it is called Combined Obesity (CO)[11,12,14]. In the covariate variable, age was divided into 35-44 years old and 25-34 years old. Gender was male and female. Education was categorized as low if an individual did not go to school or study until Senior High School and categorized as high if an individual had

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completed a diploma or above. An individual is stated to be employed if she/he has a job-generating income and stated as unemployed if she/he does not have a job. Categorizing physical activities according to the Global Physical Activity Questionnaire (GPAQ) from WHO, which assesses the level of physical activities, uses Metabolic Equivalent (MET). Physical activity is classified as less active if <600 MET minutes per week and active if ≥600 MET minutes per week [15]. Someone is stated as smoker if she/he has smoked, either every day or sometimes, and stated non-smoker if she/he never smoked until Riskesdas data collection was conducted. Meanwhile, fruit and vegetable consumption level were categorized according to STEPwise WHO, which assesses the adequacy of fruit and vegetable consumption level from the frequency and portions. The level of consumption is included in an insufficient category if the sum of fruit and vegetable consumption is <5 portions per day in a week and a sufficient category if the sum of fruit and vegetable consumption is ≥5 portions per day in a week[16].

Data processing in this study used data analysis software. Univariate and bivariate analyses used the chi-square test to find out the proportion and relationship between independent and covariate variables with dependent variables, which had categorical data types. This test used a Confident Interval (CI) of 95%. If the results of the statistical test showed p <0.05, then H0 is rejected, which means there is a significant relationship between two variables, and vice versa. Moreover, multivariate analysis using a logistic regression test to find out the most influential variable on hypertension with CI 95%, both crude odds ratio (cOR) and adjusted odds ratio (aOR) was conducted. If the results of p-value <0.05 in aOR, then the variable showed a relationship of hypertension after being controlled by other variables. This study has obtained ethical approval from the Health Research Ethics Committee of UPN "Veteran" Jakarta with No. 195/V/2023/KEPK.

RESULTS AND DISCUSSION

This study found that respondents with hypertension were 11,787 (33.4%) of 35,258 respondents (Table 1). The National Center for Health Statistics (NCHS) stated that hypertension has increased from Research 41.7% in 2013-2014 to 45.4% in 2017-2018[17]. Research conducted by Zhou in 2021 regarding the trend of the prevalence of hypertension around the world from 1990 to 2019 also stated that there was an increase in the prevalence in males of 105.6% and females of 89.1% since the last 29 years[18]. Meanwhile, nationally, the prevalence of hypertension in an individual 18 years old and over has increased 8.31% in 5 years [19].

In the hypertension group, CO had the highest prevalence of 52.7%, followed by GO of 36.9% and the last AO of 35.8% (Table 1). The results of the chi-square test showed that the three types of obesity had a significant relationship with hypertension with a sequential p-value of GO, AO, and CO (0.015, 0.000, and 0.000). A study regarding the relationship between the type of obesity and cardiovascular disease stated that CO has the highest prevalence of hypertension, and there is a relationship between the type of obesity and hypertension in Dehue, China[14]. A study in Tamil Nadu, India, also showed a significant relationship between the types of obesity and hypertension. Someone with combined obesity has the highest average of systolic blood pressure than other types of obesity[11].

The relationship between the types of obesity and hypertension can occur through the excess fat stored in adipose tissue, especially visceral fat accumulated in vital body organs, including the kidney, which will increase the renal interstitial hydrostatic pressure that reduces flow in the renal tubules and medulla, and increase sodium reabsorption in the loop of Henle. Sodium reabsorption causes vasodilation, glomerular hyperfiltration, and decreased sodium transport in the macula densa, which is one of the stimuli for renin secretion[10]. The more fat in adipose cells leads to obesity, the more the leptine hormone is produced through adipose tissue and causes hyperleptinemia. Hyperleptinemia condition will increase sympathetic nerve activity in the muscle, leading to hypertension through Hypoxia-Inducible Factor 1α-Vascular Endothelial Growth Factor (HIF1α-VEGF) in hypothalamic astrocytes that has a role in leptin signaling. The increase of leptin level will increase VEGF, which drives the hyperactivation of the sympathetic nervous system, either directly or indirectly, through chronic remodeling of the gliovascular interface in the hypothalamus[10,20]. Besides leptin increasing in obesity condition, adiponectin level actually decreases. Adiponectin will increase sensitivity to insulin, causing hyperinsulinemia and impact insulin resistance[21]. The mechanism of insulin resistance in increasing blood pressure is through insulin receptor-2-phosphorylation that activates the sympathetic nervous system and the release of neuropeptides that cause an increase in the release of the hormone leptin[10]. Moreover, insulin resistance can also activate angiotensin II excessively, causing contraction in smooth muscle, systemic vasoconstriction, and decreased blood flow to the renal medulla, resulting in increased blood pressure[22].

Table 1 showed that most of the hypertension group was in the age category of 35-44 years old (39.7%), females (36.2%), low education level (34.1%), and unemployed (38%). Meanwhile, according to lifestyle factors, the hypertension group was more likely to have a lack of physical activities (34.4%), non-smokers (28.6%), and sufficient fruit and vegetable consumption (35.6%). All covariate variables also showed a significant relationship with hypertension with all p-values of 0.000, except in the variable of fruit and vegetable consumption level with a p-value of 0.048.

Table 1. Characteristics of respondents according to hypertension status

Variable	Total (35,258)	Hypertension				p-value
		Yes (11,787)	% (33.4)	No (23,471)	% (66.56)	
General obesity						

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Variable	Total (35,258)	Hypertension				p-value
		Yes (11,787)	% (33.4)	No (23,471)	% (66.56)	
Yes	1,115	411	36.9	704	63.1	0.015*
No	34,143	11,376	33.3	22,767	66.7	
Abdominal obesity						
Yes	5,916	2,120	35.8	3,796	64.2	0.000*
No	29,342	9,667	32.9	19,675	67.1	
Combined obesity						
Yes	8,961	4,721	52.7	4,240	47.3	0.000*
No	26,297	7,066	26.9	19,231	73.1	
Age (years)						
35-44	20,290	8,065	39.7	12,225	60.3	0.000*
25-34	14,968	3,722	24.9	11,246	75.1	
Gender						
Male	15,144	4,503	29.7	10,641	70.3	0.000*
Female	20,114	7,284	36.2	12,830	63.8	
Education						
Low	20,616	7,233	34.1	13,383	65.9	0.000*
High	14,642	4,554	28.8	10,088	71.2	
Employement status						
Unemployed	10,226	3,890	38	6,336	62	0.000*
Employed	25,032	7,897	31.5	17,135	68.5	
Physical activity						
Less active	26,850	9,225	34.4	17,625	65.6	0.000*
Active	8,408	2,562	30.5	5,846	69.5	
Smoking status						
Smokers	12,158	3,475	28.6	8,683	71.4	0.000*
Non-smokers	23,100	8,312	36	14,788	64	
Fruit and vegetable consumption level						
Insufficient	33,417	11,132	33.3	22,285	66.7	0.048*
Sufficient	1,841	655	35.6	1,186	64.4	

*p-value < 0.05 using chi-square test

The prevalence of hypertension increases along with increasing age. The relationship between age and hypertension can be through structural changes and decreased organ function with increasing age, including the changes in narrowing lumen structure and arterial wall stiffness due to the buildup of collagen in the muscular layer, as well as endothelial dysfunction in the kidney, which both of them contributed to increased blood pressure[23]. In this study, the risk of hypertension in males was lower than in females. This is related to the hormonal changes during the menopause period, one of which is the hormone estrogen. Estrogen has a role in inhibiting the angiotensin system through the increase of endothelial vasodilation and the relaxing factor of nitric oxide. A decrease in the hormone estrogen causes increased activation of the renin-angiotensin system, which ultimately will increase blood pressure[24].

According to Notoatmodjo in 2007, education is an activity to provide knowledge for obtaining positive changes in behavior, and expecting that the higher the education of an individual, the broader the insights she/he has[25]. Someone with a higher education can also more easily access and process information from various media. The more useful information obtained, the more the knowledge will increase, including knowledge about health[26]. Meanwhile, the occupational risk of hypertension is also related to income. Income is related to someone's ability to access and choose food ingredients that will be consumed to meet his/her nutritional needs. If someone unemployed, then their income is low or even does not have income, so they choose food at a more affordable price and prioritize quantity over quality. The food generally tends to be energy-density with a high level of sugar and saturated fat, increasing the risks of obesity and hypertension[27].

Physical activities are significantly related to hypertension. Kowalski (2010), in the study by Damayanti in 2020, stated that when the body is active, cardiac muscle contraction will increase, which also increases blood flow and maintains the elasticity of the artery, so it reduces peripheral resistance and controls blood pressure[28]. Meanwhile, if the body has low activity when doing vigorous activities, the heart rate will tend to be higher, causing cardiac muscle contraction to work harder. The cardiac muscle that contracts too hard will burden artery walls, so it increases blood pressure. Besides physical activities, smoking status is also related to hypertension. The mechanism of cigarettes causing hypertension is through the nicotine content. Nicotine is absorbed and enters the lungs, then distributed throughout the body, including the brain. The brain gives signals to adrenal glands to release epinephrine and norepinephrine. High secretion of this hormone increases the activity of RAAS and sympathetic nervous systems, causing an increase in blood pressure. Long-term effects of smoking can impact endothelial dysfunction, increase plaque thickening, and vascular damage, all of which worsen the hypertension level[29]. Another effect of

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smoking on hypertension can be through inhaled carbon monoxide gas. Carbon monoxide gas will bind hemoglobin more strongly than oxygen, causing oxygen supply to red blood cells to decrease. The body will try to pump blood to increase oxygen, which actually increases blood pressure[30].

Fruit and vegetable consumption level has a significant relationship with hypertension cases. A study by Li (2016) stated that fruit and vegetable consumption has an inverse relationship with hypertension[31]. The lower of fruit and vegetable consumption, the higher risk of hypertension. Fruit and vegetable consumption is also related to the fiber content, which is good for health. Fiber, particularly soluble fiber, has a role in forming a gel and reducing the absorption of fat and cholesterol through binding bile acids[32]. Moreover, bile acids are trapped in thick gel to limit micelles formation required for fat absorption, which further contributes to affecting blood lipid levels. Fiber can indirectly prevent hypertension by preventing fat from thickening in organs, which can block blood pressure, cause excess fat composition in the body, and cause obesity.

In logistic regression analysis, all main variables and covariate variables had a significant relationship with hypertension, except the variable of the level of fruit and vegetable consumption with a p-value of 0.320. According to the types of obesity, CO has the highest chance of having hypertension after being controlled by the variable of fruit and vegetable consumption level with aOR of 3.50 95% 3.31-3.71, followed by GO with aOR of 1.87 95% 1.64-2.12, and AO with aOR of 1.79 95% 1.67-1.91 (Table 2). A study regarding the relationship between the types of obesity and hypertension in China also stated that the possibility of hypertension in urban areas is the highest in individuals with CO with an adjusted Prevalence Ratio (aPR) of 2.30, followed by GO and AO with aPR of 2.13 and 1.82, respectively[12]. Another study also stated that CO has a higher chance of hypertension with an OR of 4.85 than AO with an OR of 2.23[14]. The risk of hypertension is higher than the risk of other cardiovascular diseases, such as coronary heart disease and stroke.

The risk value for hypertension in individuals with CO is higher than in individuals with GO and AO, which can be caused by the accumulation of fat, not only on the entire skin surface, usually called subcutaneous fat, but also on vital body organs, namely visceral fat, including the kidneys. Starting from an increase in hydrostatic pressure in the kidney stimulating renin secretion and RAAS system, sympathetic nervous system, and insulin resistance, all of which cause the increase in blood pressure. This means that measuring obesity is not only focused on BMI but also can be combined with abdominal circumference so that it can be a parameter of the three types of obesity and a stronger predictor of hypertension or other cardiovascular disease.

Table 2. Chance of hypertension

Variable	Hypertension					
	cOR	95% CI	p-value	aOR	95% CI	p-value
General obesity						
Yes	1.871	1.647-2.126	0.000*	1.871	1.647-2.126	0.000*
No	-	-	-	-	-	-
Abdominal obesity						
Yes	1.791	1.674-1.916	0.000*	1.792	1.675-1.1917	0.000*
No	-	-	-	-	-	-
Combined obesity						
Yes	3.503	3.308-3.710	0.000*	3.505	3.310-3.712	0.000*
No	-	-	-	-	-	-
Age (years)						
35-44	1.840	1.753-1.931	0.000*	1.841	1.754-1.932	0.000*
25-34	-	-	-	-	-	-
Gender						
Male	1.351	1.249-1.462	0.000*	1.351	1.249-1.462	0.000*
Female	-	-	-	-	-	-
Education						
Low	1.288	1.195-1.389	0.000*	1.286	1.193-1.386	0.000*
High	-	-	-	-	-	-
Employement status						
Unemployed	1.177	1.111-1.247	0.000*	1.177	1.110-1.247	0.000*
Employed	-	-	-	-	-	-
Physical activity						
Less active	1.095	1.035-1.159	0.002*	1.095	1.034-1.158	0.002*
Active	-	-	-	-	-	-
Smoking status						
Smokers	0.818	0.758-0.883	0.000*	0.818	0.758-0.883	0.000*
Non-smokers	-	-	-	-	-	-
Fruit and vegetable consumption level						
Insufficient	0.949	0.856-1.052	0.320	-	-	-
Sufficient	-	-	-	-	-	-

*p-value <0.05 using logistic regression test

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However, this study had several limitations, such as the hypertension variable not including individuals who only had 2 blood pressure measurements and hypertension based on the doctor's diagnosis. Furthermore, this study used a cross-sectional design, so the resulting risk value for hypertension was the result of data collection for each variable simultaneously at one time, not within a certain period.

CONCLUSIONS

General obesity, abdominal obesity, and combined obesity have a significant relationship with hypertension. Combined obesity becomes a variable that influences hypertension in young adults in Indonesia. Besides regular weighing, measuring abdominal circumference can be one of the promotions for preventing and controlling obesity and reducing the risk of hypertension. Further studies can use different research methods so that studies regarding hypertension can be described more broadly and diversely.

ACKNOWLEDGMENTS

The researcher would like to thank the Health Development Policy Agency for providing Riskesdas data in 2018 to be analyzed and the lecturers in UPN "Veteran" Jakarta who contributed to this study.

Conflict of Interest and Funding Disclosure

This study has no conflict of interest and was not funded by any party.

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How to cite: *Rumaisyah, R., Fatmawati, I., Ayu Arini, F., & Octaria, Y. C. (2023) Association between Types of Obesity and Hypertension in Young Adults in Indonesia: Hubungan Tipe-Tipe Obesitas dengan Hipertensi pada Usia Dewasa Muda di Indonesia. Amerta Nutrition, 7(2SP), 24–30.*

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How to cite: *Rumaisyah, R., Fatmawati, I., Ayu Arini, F., & Octaria, Y. C. (2023) Association between Types of Obesity and Hypertension in Young Adults in Indonesia: Hubungan Tipe-Tipe Obesitas dengan Hipertensi pada Usia Dewasa Muda di Indonesia. Amerta Nutrition, 7(2SP), 24–30.*