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Obesity As A Risk Factor For Hypertension

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ABSTRACT

Background: In Baruharjo Public Health Center in Trenggalek, hypertension is ranked 1 as the most common cases in 2021. Based on the results of Riskesdas in 2018, the increase in cases of hypertension in Indonesia is in line with the prevalence of obesity.

Method: This study is a Systematic review. 34 journals published at least 5 years ago were acquired. Journals contain the topic of health problems about obesity as a risk factor for hypertension.

Result: Through the process of reviewing and selecting articles, researchers obtained 34 journals that matched the inclusion and exclusion criteria, and were relevant to this research. From all the 34 journals that we have reviewed, most of them found a significant relationship between obesity and hypertension. Only 1 journal that showed if there was no relationship between obesity and hypertension, but there is still no further explanation about the reason why there was no relationship between both of them.

Discussion: Someone with an overweight/obese BMI is four until eight times more likely to have hypertension than a person with normal BMI. Obesity can cause hypertension through various mechanisms, either directly or indirectly. The pathophysiology of obesity induced hypertension involve activation of the sympathetic nervous system and the RAAS or renin-angiotensin-aldosterone system. In addition, the occurrence of endothelial dysfunction and the abnormalities in kidney function are also important factors in the occurrence of hypertension in obese people. Every 10 percent increase in body weight can increase systolic levels by about 5.6 mmHg.

Conclusion: Obesity is strongly associated with hypertension. Losing even a small amount of weight if you're overweight or obese and or controlling your weight can help reduce your blood pressure.

Keywords: Hypertension, Obesity, Risk factor.

INTRODUCTION

Hypertension is a chronic disease that causes morbidity and mortality in most of the world's population. (Cheung, et. al., 2020. Oparil et. al., 2019). According to the 2017 American College of Cardiology/American Heart Association (ACC/AHA) about hypertension clinical practice guideline, the definition of hypertension is someone with systolic blood pressure > 130 mmHg or diastolic > 80 mmHg. Hypertension can be divided into primary and secondary forms. Primary (essential) hypertension refers to someone whose the etiology of their high blood pressure is unknown, while secondary hypertension occurs in 10% of cases and due to an underlying disease (Carey et. al., 2019).

Risk factors of hypertension are classified into modifiable and non modifiable factors. Modifiable factors including nutritional status, body mass index, smoking, physical activity, alcohol consumption, salt consumption and consumption of high-fat foods. Meanwhile for the factors that cannot be changed are age, gender, and family history (Maulidina et. Al, 2019). However, the strongest risk factor for developing hypertension is an increase in body mass index with obesity (Aronow, Wilbert S., 2017).

Obesity is a case that is found all over the world (Fruh, Sharon M., Obesity: , 2017) Obesity is an excessive or abnormal accumulation of fat or adipose tissue in the body (Panuganti, et. al., 2021) Obesity is classified into generalized and central obesity. General obesity is determined based on body mass index in kg/m^2. WHO classifies body mass index $\geq$ 30 kg/m2 as obese. Central obesity is determined based on waist circumference (Fruh, Sharon M., Obesity: , 2017). WHO defined obesity as waist circumference more than 90 cm (35.5 inches) for men and > 80 cm (31.5 inches) for women (Owolabi, et. al., 2017).

According to the Framingham study, a person who is overweight or obese has an eight times higher risk of developing hypertension (Te'ne CA, Karjadidjaja I., 2022) The prevalence of hypertension increases with weight gain. The presumed mechanism of obesity induced hypertension is the interaction between renal, metabolic, and neuroendocrine pathways. (Shariq, et. al. 2020) Obesity can lead to hypertension through the mechanism of increased cardiac output, hyperinsulinemia or insulin resistance, mechanisms of the sympathetic nervous system and regulation of salt-regulating hormones. Insulin in the blood will result in sodium resistance in the kidneys and also can causing blood pressure to rise. (Tiara U. I., 2020)

In Indonesia, the results of the Basic Health Research (Riskesdas) in 2018, the prevalence of hypertension incidence is 34.1% (Kementerian Kesehatan, 2019). Meanwhile the prevalence of people with high blood pressure in East Java is 36.3%. The estimated number of people aged ≥ 15 years old with hypertension in East Java is around 11,008,334 cases, with the proportion of men 48.83% and women 51.17%. (Dinkes Jatim., 2021)

The prevalence of hypertension based on measurements in the population aged over 18 years old in Trenggalek Regency is 40.1% (Ministry of Health, 2018). In 2021, hypertension is ranked 1 as the most common cases in Baruharjo Public Health Center (Puskesmas Baruharjo, 2022). Based on data from measurements of weight and height in patients who visited the Baruharjo Health Center in 2021, it was found that 51.2% of patients had a body mass index > 30 kg/m2 (Puskesmas Baruharjo, 2022).

Based on the results of Riskesdas in 2018, the increase in cases of hypertension in Indonesia is in line with the prevalence of obesity (Kementerian Kesehatan, 2018). In addition, in a study by Monica, the percentage of hypertension in individuals who are overweight is 24.5% and in obese individuals is 27.5%.

METHODS

The method in this research is a systematic/literature review which is we reviewed several journals obtained from 34 reference sources through searches on google scholars, PubMed, research gate, science direct, cochrane library and proquest published at least 5 years ago (2017-2022). The inclusion criteria used were:

1. Journals included in this study come in the forms of research articles. Editorials, comments, literature reviews in quantitative, qualitative or mixed methods research
2. Health or related research articles published at least 5 years ago
3. Journal contain the topic of health problems about obesity as a risk factor for hypertension

Based on a literature review of several scientific articles/journals obtained from the database, there are 34 literatures that meet the inclusion criteria. Furthermore, these 34 scientific articles/journals were studied further for the relationship between obesity and hypertension.

RESULTS AND DISCUSSION

Through the process of reviewing and selecting articles, researchers obtained 34 journals that matched the inclusion and exclusion criteria, and were relevant to this research. All articles used are articles in English and Indonesian. From all the journals that we reviewed, most of them found a significant relationship between nutritional status, especially obesity and hypertension. This might be due to the higher body mass index means more blood is needed to supply oxygen and nourishment to the body's tissues. This causes the heart to work harder, so that blood pressure increases indirectly through stimulation of the activity of the sympathetic nervous system and the Renin Angiotensin Aldosterone System (RAAS) by mediators such as hormones, cytokines, adipokines, and etc. Aldosterone hormone is a hormone that is closely related to water and sodium retention so that it can increase blood volume.

Leptin secreted by adipose cells binds to receptors in the hypothalamus and increases renal sodium and water excretion which can alter vasoactive substances such as nitric oxide in the blood vessels. In addition, high body fat is associated with high plasma levels of insulin, lipids and lipoproteins which may increase dose-dependently on cardiovascular risk. Only 1 journal found that there was no relationship between obesity and the incidence of hypertension, but there is still no further explanation about the reason why there was no relationship between both of them.

A study conducted by Simbolon, et al (2019) said that overweight and/or obese male adolescents had a three times higher risk of developing hypertension (OR = e 0.656 + 1.924 1.447 = 3.1), while female adolescents with overweight/obese were twice as likely to develop hypertension (OR = e 0.656 = 1.92) compared to adolescents with normal BMI, and someone with an overweight/obese BMI is four times more likely to have hypertension than a person with normal BMI (Simbolon, et. al., 2019).

This is also in line with the research by Setyawati et al (2017) which showed a relationship between body mass index (BMI) and the incidence of hypertension. Women who have a BMI above normal (overweight and obese categories) have a 2.05 times greater risk of having blood pressure above normal compared to women who have a normal BMI (Setyawati B., et.al., 2017). Obesity can trigger an increase in the amount of blood needed because the large body mass of a person causes the amount of blood circulating through the blood vessels to also increase and causes high blood pressure (Ramadhani E.T., Sulistyorini Y., 2018).

The prevalence of obesity and overweight in Indonesia is quite high and is likely to increase based on the 2007 National Basic Health Research data report. According to the 2013 National Basic Health Research, the prevalence of obesity in Indonesia has increased significantly. The number of obesity in men which was originally 15% in 2010, in 2013 became 20%. Likewise in women, the percentage increased from 26% to 35% in 2010. The incidence of obesity was found mostly at a young age. This is an important concern because obesity in children and adolescents is correlated with an increased risk of cardiovascular disease, such as hypertension, dyslipidemia, and other diseases. Overweight and obesity are also correlated with increased rates of morbidity and mortality. The results of a study in the British Virgin Islands found that an increased prevalence of overweight and obesity was positively associated with an increased risk of four cardiovascular diseases, including hypertension. Research findings prove that adolescent BMI affects adult blood pressure where the effect is modified by gender. There is a theory that obesity in children and adolescents will have an impact on glucose intolerance, hypertension, dyslipidemia, inflammation, and obesity that continues into adolescence. This situation will then affect the occurrence of cardiovascular disease in adults 17 (Simbolon, et. al., 2019).

A systematic review of 11 studies provided evidence of cardiometabolic disease in adults with diabetes, stroke, coronary heart disease, and hypertension. The pathophysiology of obesity induced

hypertension involve activation of the sympathetic nervous system and the RAAS or renin-angiotensin-aldosterone. In addition, the occurrence of endothelial dysfunction and kidney function abnormalities are also important factors in the occurrence of hypertension in obese people. A higher body mass index means more blood is needed to supply oxygen and nourishment to the body's tissues. When the volume of blood circulating through the blood vessels increases, it puts greater pressure on the artery walls, resulting in hypertension (Simbolon, et. al., 2019).

Similar results also found in a study by Ramadhani and Sulistyorini (2018). From 257,519 cases of hypertension in a men group in 2015 and then increased in 2016 become 387,913 cases. While hypertension cases in women also increased, in 2015 there were 428,475 cases and in 2016 become 547,823 cases. On the other side, the number of obesity cases in men were 58,558 cases in 2015 and increased in 2016 with 91,323 cases. Obesity in the female group also increased, in 2015 there are 134,168 cases and in 2016 become 224,189 cases. From this data, 2 years in a row, the case of obesity are found higher in a women group. Using the Spearman correlation test between the number of hypertension cases and the number of obesity cases in East Java in 2015-2016, they found a result that there was a significance value of 0.01 ($p = 0.01$), so there is a relationship between hypertension and obesity. The strength of the correlation in this study was 0.49, which is a moderately strong relationship between cases of hypertension and obesity. Excess body weight and body fat are associated with high levels of plasma insulin, lipids and lipoproteins which can increase dose-dependently on cardiovascular risk, so obesity can trigger high blood pressure in a person 19 (Ramadhani E.T., Sulistyorini Y., 2018).

The presence of obesity in hypertensive patients will determine the severity of hypertension. As said before, the larger a person's body, the more blood is needed to supply nutrients and oxygen to other tissues and muscles. This is because obesity will increases the length of the blood vessels which then results in increased blood resistance. As resistance increases, blood pressure becomes higher. This situation will get worse by fat cells that produce compounds that can harm the heart and blood vessels (Tiara U. I., 2020).

Obesity can cause hypertension through various mechanisms, either directly or indirectly. Obesity can cause an increase in cardiac output because the higher body mass index means more blood is needed to supply oxygen and nourishment to the body's tissues. This causes the heart to work harder, so that blood pressure increases indirectly through stimulation of the activity of the sympathetic nervous system and the Renin Angiotensin Aldosterone System (RAAS) by mediators such as hormones, cytokines, adipokines, and etc. Aldosterone hormone is a hormone that is closely related to water and sodium retention so that it can increase blood volume. Leptin secreted by adipose cells binds to receptors in the hypothalamus and increases renal sodium and water excretion which can alter vasoactive substances such as nitric oxide in the blood vessels. The main function of leptin is to interact with the hypothalamus to control body weight and fat accumulation by inhibiting appetite and increasing metabolic rate (Ramadhani E.T., Sulistyorini Y., 2018).

Ebrahim et al (2020) conducted a study consist of 7612 subjects (48% men and 52% women) with the mean age of the participants was 47 ± 0.15 years old (range from 30 to 93 years old), and most of the subjects (35, 1%) were in the 30-39 age group in both gender. Approximately 37.4% (95% CI : (36, 38)) of the subjects were overweight, 25.1% (95% CI : (24.26)) were obese, and 6.1% (95% CI : (5 ,3, 7)) of whom were diabetics (≥126). The findings showed that 40% (95% CI : (37, 44)) and 17% (95% CI : (14, 22)) of hypertension cases were obese and diabetic, respectively. In the study it was found that the prevalence of high blood pressure (HBP) in the subjects studied was 7.4% for men and 10.8% for women over 30 years old. In previous studies, it was also found that 27% of the prevalence of HBP in men and 19% in women over 30 years old were obese. While 17% of the prevalence of HBP was found in men and 9% in women over 30 years old were overweight (Ebrahim, Babee; et al. 2020).

Based on a research by Nurdiantami et al (2017), from a total of 313,714 women aged 18 or above, the overall rate of hypertension was 32.8% and it is significantly associated with BMI and other factors. They found that women with higher BMI resulted in higher prevalence of hypertension. In this study, 48.8% of obese people have hypertension by using Indonesian cut-off value, and 54.1% of obese people have hypertension by using WHO cut-off value. Several mechanisms support the effect of weight gain on increasing blood pressure such as insulin resistance, which results in greater fatty acid release attributable to hypertension and the other mechanism which is adipokines release such as leptin by increasing sympathetic outflow (Owolabi, 2017).

Before menopause, because of the cardioprotective effect of estrogen on women, they are protected against hypertension, compared to men of the same age. However, in women with obesity and type 2 diabetes, this protection mechanism will lost. Clinical studies in populations have shown that premenopausal women who are obese have a significantly higher risk of developing hypertension (43-56%) than men (20-27%). Weight loss of 5-10 kg in obese women significantly reduces the risk of developing hypertension by 25% (Natsis, Michail, et al. 2019).

This is also in line with a research by Kartika, (2020) that showed the incidence of hypertension in the pre-elderly (45-59 years old) is 65% and there is a significant relationship between obesity in the elderly and the incidence of hypertension ($p=0.029$, $OR=2.53$). From all the respondents (65 pre-elderly respondents who had hypertension), 39 of them were obese (60%). It was concluded that obesity was associated with the incidence of hypertension in pre-elderly with a risk of 2.53 times greater than the non obese group. This might be due to the fact that when a person is >45 years old, the arterial wall become thicker which causes the blood vessels to slowly narrow and become stiff, causing hypertension. In addition, the prevalence of hypertension will increase with age and can be seen starting from the age of 45 years old (Kartika J., Purwaningsih E., 2020).

Based on the study by Yunita & Sartika (2021), they found that large majority of elderly population of Indonesia is characterized by high blood pressure, and noteworthy, overweight/obesity

is one of the risk factors that can accompanied hypertension. This study analyzed 1255 elderly respondents (≥ 60years old), 324 respondents are overweight/obese and the rest has normal BMI. From that 324 overweight/obese respondents, 71.9% has high blood pressure or hypertension. A little bit different from other study, the criteria for overweight/obese in this study was normal weight < 25 kg/m2 and overweight/obesity ≥ 25 kg/m2 (Yunita, J & Sartika, R. 2021).

Other research from Langingi (2017) also got the same results which there is an association of obesity with the incidence of hypertension with the details if someone with obesity would have a chance of 55 times to have hypertension. From 36 hypertensive patients in Neurology Ward, F Installation of Prof. Dr. R. D. Kandou Manado Hospital, seen that as many as 21 respondents (58.3%) belonging to obesity grade II while 15 respondents or about 41.7% belonging to obesity grade I (Langingi, A. 2017)

Another study that got the same results is a study by Akpa, et al (2020) that analyzed a relationship between hypertension and obesity from various strata of age, gender, region, and comorbid conditions in Africa, and the results showed that there is a strong relationship between an increasing age in obese women with the incidence of hypertension. As said before, this can be due to the association between activation of the renin-angiotensin-aldosterone system and increased procoagulation activity, insulin resistance, sympathetic activity, leptin resistance, and endothelial dysfunction in obese people, especially women who are older (Akpa, M Onoja; et al. 2020)

According to the Framingham study, every 10 percent increase in body weight can increase systolic BP levels by about 5.6 mm Hg. Based on the findings of the global burden of obesity study, the number of people who are overweight and obese will greatly increase by 2030 and reach 1.35 billion and 573 million, respectively. Based on a national study (SuRFNCD-2007) in Iran which was conducted to determine risk factors for non-communicable diseases in people aged between 15-64 years old, the prevalence of diabetes, hypertension, and obesity, respectively, were 8.7%, 26.6%, and 22.3% (Ebrahim, Babee; et al. 2020).

A study from Lin et al (2019) revealed a positive correlation between all obesity indices (BMI, waist circumference, and body fat percentage) and hypertension. From a total of 396 participants 200 had hypertension (Systolic Blood Pressure ≧ 140 mmHg or Diastolic Blood Pressure ≧ 90 mmHg), with a prevalence of 50.5% and the average age was 64.44 years old. The participants with hypertension had higher levels of BMI, waist circumference, and body fat percentage which waist circumference has a strongest association with hypertension development. Abdominal obesity also known as central or visceral obesity refers to the abdominal fat mass. Visceral obesity or central obesity or abdominal obesity which assessed by measuring waist circumference, and leptin play a crucial role in the development of hypertension in patients with obesity. Fat is an important endocrine organ in patients with obesity. Adipokines, such as adiponectin, leptin and resistin, may result in arterial stiffness and predispose individuals to endothelial dysfunction and hypertension. This study

suggested that the optimal cut-off point for predicting hypertension with BMI was 25.45 kg/m2, with body fat percentage was 35.15% and waist circumference was 88.5 cm (Lin Y-A, et. Al. 2019).

Another study by Hastuty (2018) analyzed 40 samples. The inclusion of their samples are people with BMI ≥ 25 kg/m^2 and aged ≥ 20 and < 60 year and then divided into two groups: 20 people from visceral obesity group and 20 people from non visceral obesity group said that systolic blood pressure in visceral obesity was higher than non-visceral ($p<0.05$) while diastolic blood pressure was found to be higher in visceral obesity than non-visceral but not significant ($p>0.05$). They than explain if abdominal or visceral obesity is indeed more strongly associated with hypertension and dyslipidemia. This is probably because of visceral fat tissue (VAT) has more glucocorticoid and androgen receptors, more active metabolism, more sensitive to lipolysis and more insulin resistant than subcutaneous fat tissue (SCAT). VAT has larger capacity that can generates FFA, increasing glucose and are more sensitive to adrenergic stimulation, and we all already knew that adrenergic activity contribute to an increase in blood pressure (Hastuty, Y. 2018).

A study by Rahma (2017), that analyzed the relationship between obesity and hypertension in the population aged 25-65 years old showed that 31% of the population had hypertension and 43.9% of the population was obese. Similar result also found in a research conducted by Modjadji, et al with a cross-sectional method conducted on 312 truck driver employees at a logistics company regarding the relationship between obesity and hypertension then they found a significant relationship with a p-value of 0.05. This is in line with other studies by Asyfah (2020), that the prevalence of people with obesity experiencing hypertension is 56.5% and people with pre-obesity experiencing hypertension is 18.5%. And there are statistical test results using the chi square test, a p-value of 0.036 is obtained, which can be concluded that there is a significant relationship between obesity and hypertension.

Modjadji et al's research that conducted on several truck drivers, found that the high prevalence of overweight/obesity among truck drivers was associated with a lifestyle of consuming junk food, sugary foods, and drinks that were often consumed during long-distance driving. It is also exacerbated by socioeconomic factors (eg, income), occupation (ie, driving for long hours), and behavioral factors (ie, alcohol use). Obesity which is characterized by accumulation of fat in the abdomen also leads to the development of insulin resistance and glucose metabolism, which can then lead to cardiovascular disease. Hypertension and diabetes share similar metabolic pathways and risk factors, such as genetics, lack of physical activity, dyslipidemia, insulin resistance, and obesity. These factors collectively contribute to the development of arterial stiffness, which promotes the development of hypertension. Researchers have found that truck drivers are at increased risk of being overweight or obese, which is associated with high blood pressure (Modjadji, Perpetua; et. al. 2022)

Another the research conducted by Rhokuswara and Syarif in 2017 with a cross-sectional approach method using secondary data taken from the PTM Posbindu activities in Bandung showed that obesity is significantly related to the incidence of hypertension grade 1. Most researchers focus

on the pathophysiology of three main things of hypertension, such as disorders of the autonomic system, insulin resistance and abnormalities of the structure and function of blood vessels. These three things can influence each other. In obesity, peripheral resistance is reduced, whereas sympathetic nerves are elevated with low plasma renin activity. Obesity is associated with increased intravascular volume and cardiac output. The pumping power of the heart and circulating blood volume of hypertensive patients is higher than that of hypertensive patients with normal weight. Weight loss is the most important element in the prevention and treatment of hypertension. In addition, based on the results of previous studies, it showed that every kilogram of weight loss can reduce systolic blood pressure by 1.05 mmHg and diastolic by 0.92 mmHg (Rohkuswaraa T. D., Syarif S., 2022).

A result of another study showed that obese people in urban area have a 2.87 times higher risk of developing hypertension compared to the people who have a normal body mass index, while obese rural people have a 2.75 times higher risk of experiencing hypertension compared to people who have a normal body mass index. Someone who lives in an urban area is 1.36 times more likely to be obese than someone who lives in a rural area. The prevalence of obesity is higher in people living in urban areas compared to people living in rural areas under various social conditions. The level of consumption of fast food in urban areas is higher than in rural areas, this factor is one of a risk factor for obesity. Excess energy can occur when the consumption of food exceeds the energy needed by the body. This excess energy will be converted into body fat and can triggers obesity. Another condition is the lifestyle. Lifestyle such as sitting while playing gadgets or smartphones, watching television, and hanging out at fast food places can make someone to have a higher risk for obesity because the lack of activity (Ramadhani E.T., Sulistyorini Y., 2018).

A research by Zhao et al (2020) that studied 1288 high school freshmen with a mean age of 16.5±0.5 years old stated that the prevalence of hypertension was significantly higher in adolescents with overweight and obesity, than their normal-weight counterparts (18.2% vs 31.4% vs 11.9%, $P < .001$) where overweight and obesity that used here were defined as BMI above the 85th and 95th percentiles, respectively, of age- and sex-specific reference values for Chinese adolescents (Zhao W, Mo L, Pang Y. 2021).

Meanwhile a study from Chandra et al (2021) that studied the relationship between diet and obesity with the incidence of hypertension at the Rawasari Public Health Center in Jambi City in 2019 showed that there was no relationship between obesity and hypertension ($p= 0.0162$) but there is still no further explanation about the reason why there was no relationship between both of them (Chandra F, et. Al. 2021).

Weight loss is recommended to reduce blood pressure in overweight and obese patients with hypertension because various studies have shown that weight loss diets reduce body weight and blood pressure. In a metaanalysis, the mean SBP and DBP reductions associated with an average weight

loss of 5.1 kg were 4.4 and 3.6 mmHg, respectively. Weight loss stabilizes neurohormonal activity and causes clinically significant reductions in blood pressure. Medical nutrition therapy, lifestyle changes, medical and/or surgical methods contribute to the control of weight loss and blood pressure values in obese hypertensive patients (Canan E., Alparslan E., 2019).

CONCLUSION

From all the 34 journals and articles, most of them showed that obesity is one of the risk factors for hypertension which is a factor that can be changed or we usually called it a non modifiable factor. A person who is overweight or obese has a four-eight times greater risk of developing hypertension. Obesity in elderly men increases the risk of hypertension 3 times, while obesity in elderly women increases the risk of hypertension 2 times. And someone who lives in an urban area has a 1.36 times greater risk of obesity compared to someone who lives in a rural area, this is also correlated with the risk of developing hypertension. Losing even a small amount of weight if you're overweight or obese and or controlling your weight can help reduce your blood pressure. An average weight loss of 5.1 kg can reduce blood pressure by 4.4 and 3.6 mmHg.

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