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An overview of the Correlation between Obesity and Hypertension

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ABSTRACT

Obesity is one of the major global health problems and the second greatest preventable cause of death. It adversely affects all cardiovascular risk factors and negatively impacts structure and function of the heart. Likewise, hypertension is also one of the main causes of the global disease burden. Obesity and hypertension are linked to higher rates of morbidity and mortality and lead to cardiovascular and renal disorders. visceral obesity causes insulin resistance and dyslipidemia. It is more significant predictor of hypertension as compared to subcutaneous obesity. The aim of this study is to understanding the relationship between obesity and hypertension as well as how to treat obesity-related hypertension. This study employs a qualitative approach using descriptive and analytical methods to explore the correlation. Data was collected from journal articles academic books. Thematic analysis is used to identify and analyze patterns within the data.The results shows that potentials mechanisms such as sympathetic nervous system overactivity, activation of renin-angiotensin-aldosterone system, sodium retention, insulin resistance, and compromised vascular endothelial dysfunction are involed in the obesity related hypertension. In obese individuals, vascular fibrosis and lipid accumulation can worsen systemic vascular resistance. In addition to being a cardiovascular risk factor obesity is believed to play a significant role in the pathophysiology of hypertension. Obese and overweight individuals are more vulnerable to the prevalence of cardiovascular diseases than those who are of normal weights. Since visceral obesity results in insulin resistance and hyperlipidemia, it contributes more to obesity-induced hypertension than subcutaneous or peripheral obesity. Furthermore, obese people are more likely to be resistant to multiple anti-hypertensive medication treatments. An in-depth and thorough evaluation of this relationship should therefore examine the pathogenetic factores and pathophysiological mechanisms linking obesity to hypertension and provide the basis for a rational therapeutic strategy.

Keywords: Dyslipidemia Hypertension, Insulin resistance, Obesity, Sympathetic nervous system

INTRODUCTION

A disorder of the body weight regulation system is obesity. If a person weight is 20 percent more than his normal weight, he is thought to be obese. The body mass index (BMI) value of the obese person is grater or equal to 30 kg/m^2. Genetic, environmental, and behavioral factors such as overeating and a sedentary lifestyle may lead to obesity. Obesity is associated with a lot health problems such as type II diabetes mellitus, hypertension, chronic heart diseases (CHD), stroke, arthritis, gall bladder disease (Satyanarayana & Chakrapani., 2021). Obesity is one of the global health concerns, as well as a major risk factor for cardiovascular diseases and earlier onset of cardiovascular morbidity (Bogaert & Linas, 2009). Recent studies show that approximately 650 million adults individuals and nearly 340 million adolescents and children (5-19 year) suffer from obesity (Sorensen., et al 2022). In developed countries, obesity is the second most common preventable cause of death after tobacco use. People who are overweight or obese are more likely to develop heart failure, coronary heart disease, arterial fibrillation, hypertension, metabolic syndrome and type II diabetes mellitus (Lavie et al., 2018).

Hypertension is one of major cause of cardiovascular diseases. It is also a public health concern worldwide. Current epidemiological studies show that around 244 million people are affected by hypertension all over the world. It is to blame for over 10 million fatalities (Zhao et al., 2023). Moreover, hypertension is a complex and heterogeneous state. Different stages and phenotypes of hypertension are related with different fundamental mechanisms, comorbidities,

clinical and biological features and responses to treatment. Thus, to alleviate the risks of cardiovascular mortality and morbidity, more attention is needed on various stages and phenotypes of hypertension (Chiolero et al., 2013).

The sympathetic nervous system and the renin-angiotensin-aldosterone system are linked with the obesity. Obesity cause activation of these two systems. Both of them contribute to the establishment of hypertension (Leggio et al., 2017). The frequency of hypertension amongst obese or overweight individuals is much higher than among those of normal weights. (Bogaert & Linas, 2009). Recent studies showed that obesity is associated with up to three-fouth of hypertension cases (Xie et al., 2024). An epidemiological survey showed that approximately 30% of the people aged between 40 to 79 are obese, with a considerable number of themes having hypertension, demonstrating 22.8% of the total population (Zhang et al., 2019).

Researches are still ongoing to determine the mechanisms by which obesity directly contributes to hypertension. Moreover, hypertension is more common in obese individuals as compare to non-obese individuals. Obesity, hypertension as well as some others risk factors increase the chances of cardiovascular diseases (Kotsis et al., 2010). Although, it is widely understood that obesity can cause hypertension and there is literature which indicate an association between obesity and hypertension, there is still a need for comprehensive and update study that examine this correlation. Apart from that a deeper exploration of the underlying mechanisms and pathways which are linking obesity to hypertension is warranted. Knowing this association can provide valuable insights for preventive and therapeutic interventions. This overview will be a comprehensive and update study to better understand the correlation between obesity, hypertension, and heart disease and potentially improve prevention and treatment strategies for these health conditions (Kotsis et al., 2010)

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MATERIALS AND METHODS

This study employs a qualitative approach, using descriptive and analytical methods to explore the correlation between obesity and hypertension. The study relies on library resources, including academic journals, books, selected based on their relevance and credibility. More than 50 original research and review articles and books were retrieved during the search, out of them 28 were ultimately used in this review paper. Thematic analysis is used to identify and analyze patterns within the data. The focus is on to understand the mechanisms that are involved in obesity-related hypertension as well as their managements

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Research objectives

To understand the correlation between obesity and hypertension.

To know, how to treat hypertension caused by obesity.

Research question

1: How do obesity and hypertension correlate with each other ?

2: How do obesity-related hypertension can be treated ?

Literature Review

Definition of Obesity

Obesity is mainly due to the excess of adipose tissues or increased deposition of the body fat. It can be defined as anyone whose weight is 20 percent more than the normal body weight. One of the main health issues is obesity. Obese people are more prone to many chronic ailments such as type II diabetes, cardiovascular disorders, Hypertension, liver disorders, metabolic diseases, skin disorders, gynecological disorders, and surgical postoperative complications (Chatterjee & Shinde, 2012).

Classification of obesity according to BMI

BMI (Body mass index) is an indirect measure of obesity. BMI co-relates to height, weight, and amount of body fat in an individual. A high body mass index value is related with an increased risk of mortality. BMI is equal to weight in kilogram divided by the height in meter square. Obesity classification based on BMI values is shown in (Table.1).

Table 1. Obesity classification on the basis of BMI Values

	Category	BMI Value in kilogram per meter square (kg/m^2)
1	Underweight	Less than: 18.5
2	Normal weight	18.5-24.9
3	overweight	25-29.5
4	obesity grade I	30-34.9
5	obesity grade II	35-39.5
6	grade III (severe or morbid obesity)	grater or equal to 40
7	obesity grade IV	grater or equal to 50
8	obesity grade V	grater or equal to 60

(Lavie et al., 2018).

Different factors such as environmental, behavioral, dietary and genetic factors all can contribute to the development and progression of hypertension. There are two different outcomes from the association between obesity and high blood pressure. First of all, cardiovascular diseases, which include coronary heart disease, congestive heart failure, chronic kidney disease, and stroke, have a high morbidity and mortality rate among individuals who are obese and have high blood pressure. Second, the risk of treatment-resistant arterial hypertension is increased by obesity. Multiple medications and device therapy, such as renal sympathetic denervation, will be necessary for this. Population studies show that patients with hypertension gain weight remarkably as compared to normal individuals. This shows that hypertension induces the risk of obesity which intimates the correlation between obesity and hypertension (DeMarco et al., 2014).

The mechanisms involved in obesity-related hypertension

In both adults and children, the correlation between obesity and hypertension is well known. Normally, those people who are obese displays higher blood pressure level as compared to non-obese individuals. The chances of cardiovascular diseases are increased by obesity, hypertension and other risk factors. The following possible mechanisms may lead to Obesity-related hypertension (**Figure 1**) (Kotsis et al., 2010)**.**

Sympathetic nervous system over-activity

Obese patients have sympathetic nervous system over-activity. Evidence shows that a high amount of calories intake increases noradrenaline turnover in the peripheral tissues. Fats and carbohydrate-rich diets stimulate alpha and beta-adrenergic peripheral receptors. As a result, the sympathetic nervous system activity is increased, which causes hypertension. In addition, it increases free fatty acid level. Normally in obesity-related hypertension phenotype alpha-adrenergic vascular sensitivity increases which results in arterial tone. The region of the fat deposition in the body also has a role in the sympathetic nervous system activation. Fat deposits in two regions, the visceral and subcutaneous. Sympathetic nervous system activation is greatly associated with visceral or central obesity as compared to subcutaneous obesity (Leggio et al., 2017).

The mechanisms which cause sympathetic nervous system over-activity in obesity include increase level of blood free-fatty acids, reduction of the baroreceptor sensitivity, insulin resistance or hyperinsulinemia, angiotensin II, leptin or other

Hypertension

According to the guidelines of the European Society of Hypertension and the European Society of Cardiology, hypertension is defined as a systolic blood pressure greater or equal to 140 mmHg or a diastolic blood pressure greater or equal to 90 mmHg. (Williams et al., 2018). Similarly, in accordance with the latest American Heart Association (AHA)/American College of Cardiology (ACC) guidelines a person is considered to be having hypertension if his systolic blood pressure is greater or equal to 130 mmHg or diastolic blood pressure is greater or equal to 80 mmHg (Whelton., 2017). It is a comorbid state that is commonly seen in correlation with obesity (Landsberg et al., 2013). Moreover, hypertension is one of the leading risk factors for mortality and morbidity throughout the Globe. It results in 10.4 million deaths annually and 182 million disability-adjusted life years (GBD., 2017).

Correlation between obesity and hypertension

adipokines and lifestyle factors. Conversely, the activity of the sympathetic nervous system can be suppress by moderate weight reduction (Kotsis et al., 2010).

Renin-angiotensin-aldosterone system (RAAS) activation

In obese patients, improper activation of the renin-angiotensin-aldosterone system result in insulin resistance, sympthetic nervous system activation, abnormal renal sodium handling and dysfunctional immunity. These can collectively lead to cardiovascular and renal dysfunction. Angiotensin II is synthesied by intravascular and internal renin-angiotensin-aldosterone system. vascular stiffness, renal and endothelial function is directly regualted by angiotensin II. Increase production of angiotensin II by perivascular fat tissues leads to decrease vascular function. Morevoer, obese individuals has increased plasma aldosterone levels, which might also subsidize to the progression of hypertension (DeMarco et al., 2014).

Change in renal function

One of the risk factors for end-stage renal disease and chronic kidney disease is obesity. Renal sodium retention and impaired pressure are linked to obesity-related hypertension (Leggio et al., 2017). Obesity increases sodium reabsorption in the renal tubules, which can lead to hypertension. The second reason is that obesity alters the renal medulla histologically, compressing the vasa recta and loops of Henle, which alters internal pressure and causes pressure natriuresis to shift toward hypertension. It can also cause activation of the RAAS which enhances reabsorption of sodium. Some studies reveal that lipid accumulation is due to the change in fat metabolism. Several other factors that cause renal injury are:

- Overexpression of angiotensin II
- Increase proliferative factors like plasminogen activator inhibitor and transforming growth factor beta..
- Protein rich diet
- Hyperinsulinemia

The above factors may lead to alteration in the glomeruli (Kotsis et al., 2010).

Vascular Endothelial dysfunction

Vascular resistance is significantly regulated by the vascular endothelium. Visceral obesity is directly related to impaired vasoreactivity. Insulin resistance, hypertension, obesity, and other cardiovascular risk factors are all associated with vascular endothelial dysfunction. Reduction in weight can improve endothelial function (Kotchen, 2010).

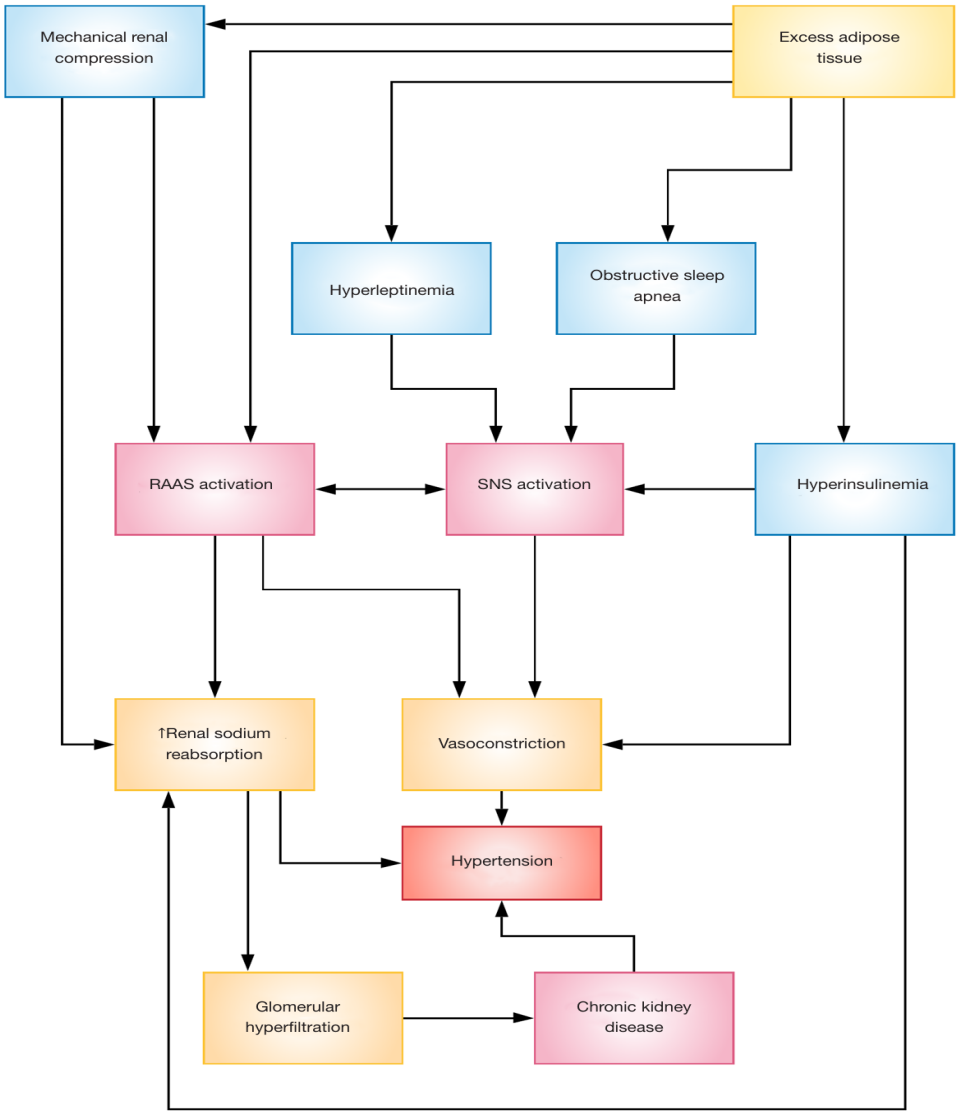

Figure 1. Schematic representation of the pathophysiological mechanisms underlying obesity-related hypertension. SNS, stands for sympathetic nervous system; RAAS, stands for Renin-angiotensin-aldosterone system.

Management of obesity-associated hypertension

The main purposes of treating obesity-related hypertension are to improve health, lower the risk of cardiovascular and renal diseases, and reduce weight (since these reverses the pathophysiological mechanisms that cause hypertension). The reduction in blood pressure appears to be directly correlated with the weight loss, with a drop of approximately 1 mmHg for every kilogram of weight lost (Neter et al., 2003). This can be obtained by using a low-risk treatment such as a change in lifestyle, change in diet and increased physical activity (Jensen et al., 2013). In addition, the proper management of obesity-related complications includes the management of dyslipidemia, glycemic control, blood pressure, pulmonary disorder, and psychological disturbance (Tsigos et al., 2008).

Pharmacological treatments for obesity

In accordance with guideline from the ACC/AHA (Jensen et al., 2013) and the Endocrine Society (Apovian et al., 2015), obese patient whose BMI value is greater than ≥30 kilogram per square meter or in those with BMI value more than ≥27 kg/m^2 and associated obesity-related diseases such as dyslipidemia, type II diabetes mellitus and hypertension. pharmacological treatments may be

considered as beneficial adjuncts along with the lifestyle modifications.

The United State Food and Drug Administration (FDA) recently approved these five medications for long-term weight control:

1. Lorcaserin
2. Phenteramine topiramate
3. Naltrexone-bupropion
4. Liraglutide.
5. Orlistat

Except Orlistat, which inhibits pancreatic and gastric lipase and reduces intestinal digestion of fat, the rest of the above-mentioned drug promote weight loss by early satiety and decreasing food intake (Saunders et al., 2018).

Many short-term clinical trials indicate that even moderate weight loss leads to:

- Decrease in the blood pressure
- Improvement of insulin sensitivity
- Enhancement of vascular endothelial function (Kotchen, 2010).

Pharmacological treatment of hypertension in obese people

Most obese hypertensive patients require treatment with one or more antihypertensive medications to control their high blood pressure, in addition to weight loss and lifestyle modifications. Keeping in view the role of the renin-angiotensin-aldosterone-system (RAAS) in the development of obesity-related hypertension, ACEIs and ARBs are prescribed as first-line therapies, they can also improve insulin sensitivity (Koh et al., 2010) as well as nephroprotective in diabetic individuals, which is often comorbidity in obese people (Lewis et al., 1993). As sympathetic nervous system activation is also concerned in the obesity-associated hypertension, therefore, Beta-blockers would seem to be pharmacologically an effective therapeutic option. But, several drugs including in this group can cause insulin resistance and weight gain, so, they should be used only in obese persons with particular cardiovascular diseases such as myocardial infraction or heart failure (Lee et al., 2011). Dihydropyridine class of Calcium channel blocker has an impartial effect on weight gain and glucose metabolism and frequently prescribed as second-line therapy combined with ACEIs/ARBs (Allcock et al., 2010). Furthermore, Thiazide diuretics also help to reduce the volume overload conditions associated with obesity-related hypertension.

These medications have the potential to cause metabolic adverse effects, such as insulin resistance and dyslipidemia, in obese patients (Cooper-De Hoff et al., 2010).

Antihypertensive medicines used in obese patients with high blood pressure are:

- ACE inhibitors such as lisinopril
- Beta-blocker e.g. Atenolol
- Calcium channel blocker
- Thiazide diuretics such as Hydrochlorthiazide (Kotchen, 2010).

are more likely resistant to the treatment with multiple anti-hypertensive drugs. There are several mechanisms that cause obesity-related hypertension such as over-activation of the sympathetic nervous system, inappropriate activation of the Renin-angiotensin-aldosterone system, endothelial dysfunction, and change in the renal function, insulin resistance, and adipokines alteration. Further studies, such as research in pre-clinical models are required for the improved comprehension of these mechanisms.

CONCLUSION

Obesity is one of the utmost public health concerns in the recent periods, and a major risk factors for diabetes, cardiovascular and renal diseases. Obese people are more susceptible to hypertension as compared to those who have normal weight. Visceral obesity as compared to subcutaneous or peripheral obesity contributes more to obesity-induced hypertension as it causes hyperlipidemia and insulin resistance. In addition, obese persons

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