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OBESITY AND CARDIOVASCULAR DISEASE: A SYSTEMATIC REVIEW

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ABSTRACT
The pathophysiology of obesity includes a function for the equilibrium between the number of calories consumed and the quantity of energy expended, which is then followed by a resetting of body weight. On the other hand, this is not as straightforward as solving an equation, and there are a number of secondary processes that contribute to this difficult condition. It is believed that obesity is a state of inflammation because obese people have a greater amount of fat tissue and a lower level of adiponectin. This means that obese people are less able to stop the processes that generate inflammation, which in turn keeps the inflammation going. This adipocyte dysregulation adds to the imbalance of homeostasis as well as pro- and anti-inflammatory mechanisms in the body, which in turn contributes to metabolic difficulties caused by obesity as well as vascular damage that leads to changes in cardiometabolic function. The structure and function of the cardiovascular system, as well as the hemodynamics of the blood, are all severely influenced by obesity. Obesity also has a negative impact on the metabolic processes of the body. When a person is obese, their total blood volume as well as their cardiac output go up, which also leads to an increase in the amount of work that their heart has to do. Patients who are obese often have a higher cardiac output but a lower level of total peripheral resistance at any given level of arterial pressure. This is because obesity typically causes a decrease in total peripheral resistance. Previous research has demonstrated that patients or individuals with a body mass index (BMI) that is greater than 25, have a high risk connected with the risk of cardiovascular disease (CVD). In addition to this, the strength of this connection grows with advancing age.

Keyword: *Cardiovascular Disease, Energy, Obesity, Sedentary*

INTRODUCTION

According to statistics provided by the World Health Organization (WHO), more than half of the adult population around the globe is overweight or obese. Obesity prevalence is still quickly increasing in many parts of the world, and if current trends continue, it will reach internationally 18% in men and surpass 21% in women by 2025.[1] This would place a significant burden on individuals, societies, and health care systems worldwide. In light of these findings, obesity has been appropriately labeled as a contemporary form of many global epidemic diseases.[2–4]

In the last few decades, CVDs have become more common because of changes in the economy and the way people live. In the same way, economic growth, industrialization, a more sedentary lifestyle, and changes in diet have all contributed to more people being overweight or obese. In addition, the number of cases has doubled or even quadrupled in the last 30 years. It has been shown that people who are overweight or obese, especially those with central obesity, are more likely to get CVDs. This rise in the number of overweight and obese people around the world and the higher risk of CVDs has caused concern in many countries.[5,6]

Obesity has been linked to a wide variety of cardiovascular diseases (CVD), such as coronary heart disease (CHD), heart failure (HF), hypertension, cerebrovascular disease, atrial fibrillation (AF), ventricular arrhythmias, and sudden cardiac death. There is a wealth of evidence that links obesity to these diseases, which can be found in clinical and epidemiological studies (SCD). Obesity has also been associated to obstructive sleep apnea and other hypoventilation syndromes, both of which have been shown to have a negative impact on the function of the cardiovascular system.[3,4,7,8]

Obesity can increase the risk of developing cardiovascular disease both directly and indirectly. Direct effects are mediated by obesity-induced structural and functional adaptations of the cardiovascular system to accommodate excess body weight.[4] Direct effects are also mediated by adipokine effects on inflammation and vascular homeostasis, which lead to an environment that is pro-inflammatory and pro-thrombotic. Concomitant cardiovascular disease risk factors, such as insulin resistance, type 2 diabetes mellitus (also known as T2DM), visceral adiposity, hypertension, and dyslipidemia, operate as the mediators of indirect effects.[9–11]

The body mass index (BMI), which is defined as a person's total body weight in kilograms divided by the square of their height in meters, is the anthropometric index that is used the most frequently to characterize obesity. It has been heavily criticized for its inherent inability to differentiate between fat and lean body mass, as well as for its inability to account for different patterns of body composition and regional fat distribution.[4] Despite its simplicity and reproducibility, it has been subjected to a great deal of criticism. These limitations help to explain, at least in part, why concepts like the obesity paradox and the metabolically healthy obese (MHO) phenotype have generated skepticism and fueled conflicts within the field of obesity research.[9,10,12]

In support of the problematic use of BMI as an obesity index, various large-scale epidemiological studies including the case-control INTERHEART study, have shown that central adiposity is more strongly related to CVD risk than total adiposity expressed by BMI. It has been therefore argued that anthropometric indices of central fat distribution such as waist circumference (WC), waist-tohip ratio (WHR), waist-to-height ratio (WHtR) and imaging measurements of visceral fat by computed tomography (CT) or magnetic resonance imaging (MRI), should be assessed on top of BMI due to their better predictive power for CVD risk.[9,13]
This article investigate the association between obesity and cardiovascular disease risk.

METHODS

Protocol

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) 2020 checklist. This list served as the foundation for the rules.

Eligibility Criteria

This systematic review was developed to assess literature on "obesity" and "cardiovacular disease". These are the subjects that were thoroughly covered in the study under consideration. The following conditions must be met in order for your work to be taken into consideration: 1) In order to be accepted, articles must be written in English. 2) In order to be considered, the articles had to have been published after 2017, but before this systematic review was created. The following types of textual entries will not be considered for inclusion in the anthology: 1) Editorial letters, 2) submissions without a Digital Object Identifier (DOI), and 3) article reviews and submissions equivalent to those previously published in the journal.

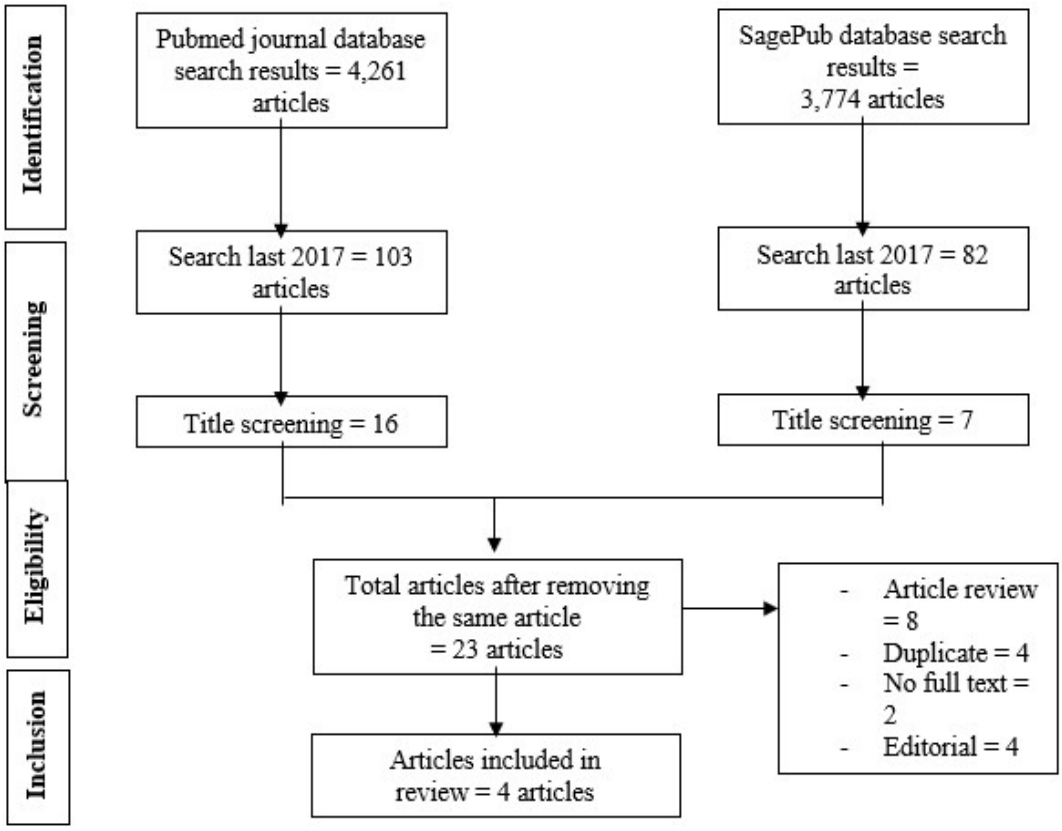

Figure 1. Article search flowchart

Search Strategy

The search for studies to be included in the systematic review was carried out from December, 15nd 2022 using the PubMed and SagePub databases by inputting the words: "obesity" and "cardiovascular disease". Where *("obeses"[All Fields] OR "obesity"[MeSH Terms] OR "obesity"[All Fields] OR "obese"[All Fields] OR "obesities"[All Fields] OR "obesity s"[All Fields]) AND ("cardiovascular diseases"[MeSH Terms] OR ("cardiovascular"[All Fields] AND "diseases"[All Fields]) OR "cardiovascular diseases"[All Fields] OR ("cardiovascular"[All Fields] AND "disease"[All Fields]) OR "cardiovascular disease"[All Fields])* is used as search keywords.

Data retrieval

After doing a literature review and evaluating the titles and abstracts of previously published research, the study's author revised the criteria for what should and should not be included in the study. The new criteria can be found in the study's appendix. This was done so that it could be determined which components of the issue should be included in the study and which should not. Following an examination of previously completed and published studies, the author came to the conclusion that these revisions were necessary.

During the compilation of the systematic review, it was established that the only research projects worthy of consideration were those that succeeded in meeting all of the parameters. This meant that the only research proposals worthy of consideration were those that were successful in meeting all of the conditions. This was done to ensure that the evaluation was as comprehensive as possible.

The purpose was to collect information about each individual study, such as its title, author, publication date, origin of study location, research study design, and research factors. This type of data can be obtained. The following are some instances of information that could be gathered: This information can be presented to you in a variety of ways, depending on the presentation manner you want.

Quality Assessment and Data Synthesis

To determine which studies should be examined, the writers conducted their own independent appraisals of a subset of the research presented in the titles and abstracts of the articles. Following that, the full texts of the studies that meet the inclusion criteria for the systematic review will be examined to determine which papers will be included as final inclusions in the review. This is done to address the question, "Which studies can we use for the review?"

RESULT

First study by Yang *et al* (2020)[14] conducted study that showed the relationship between several factors on the incidence of CVD. In this study, an electronic health record system was used to regularly follow up with 29930 participants who were selected among 101056 persons in 2014 based on their high risk of developing cardiovascular disease. According to the results of a logistic regression study, nearly 30 risk factors are associated with cardiovascular disease. These factors include being male, being old, having a high family income, smoking, drinking, being obese, having an excessively large waist circumference, having abnormal cholesterol, abnormal low-density lipoprotein, abnormal fasting blood glucose, and other factors.

Barroso, *et al* (2017)[15] conducted study with 39 participants, of which 70% were obese and 38% were hypertensive, corresponded to most of the studied sample. Abdominal circumference was 110.19 cm ± 15.88 cm; levels of triglycerides were 153.72 mg/dL ± 7.07 mg/dL; and fasting glycemia was 188.6 mg/dL ± 116 mg/dL. A significant association was found between the waist/height ratio and the findings of hypertension ($p = 0.007$); between visceral fat volume and diabetes ($p = 0.01$); between the conicity index and the findings of hypertension ($p = 0.009$) and diabetes ($p = 0.006$). No significant association was found between body mass index and waist circumference with findings of hypertension, diabetes and dyslipidemia.

Table 1. The litelature include in this study

Author	Origin	Method	Sample Size	Result
Yang, 2020[14]	China	Retrospective study	29,930	They research team's preliminary survey results indicated that a number of epidemiological factors were closely related to the occurrence of cardiovascular disease (CVD). These factors included old age, being male, living alone, being in a rural area, having a low education level, having a high BMI, having a large waist circumference, having a family history of the disease, and other factors.
Barroso, 2017[15]	Brasil	Cross-sectional study	39	Mean age of 44.18 ± 14.42 years, of which 70% were obese and 38% were hypertensive, corresponded to most of the studied sample. Abdominal circumference was 110.19 cm ± 15.88 cm; levels of triglycerides were 153.72 mg/dL ± 7.07 mg/dL; and fasting glycemia was 188.6 mg/dL ± 116 mg/dL. A significant association was found between the waist/height ratio and the findings of hypertension ($p = 0.007$); between visceral fat volume and diabetes ($p = 0.01$); between the conicity index and the findings of hypertension ($p = 0.009$) and diabetes ($p = 0.006$). No significant association was found between body mass index and waist circumference with findings of hypertension, diabetes and dyslipidemia.
Bakhtiyari, 2022[16]	Iran	Retrospective study	6,280	In women, the risk that was caused by all three metabolic risk factors was 23% (95% CI: 13–50%) for being overweight, 36% (21–64%) for being obese in general, and 52% (39–87%) for being obese in the middle. Based on the results of this study, cardiometabolic mediators have stopped more than 60% of the bad effects of high BMI on CVDs in men. Controlling metabolic risk factors in women doesn't help reduce CVDs as well as it does in men.
Bode, 2021[17]	USA	Retrospective study	4,453	25% had high blood pressure, 8% had poor high-density lipoprotein cholesterol, and 0% had high glucose, whereas the prevalence was 57%, 45%, and 11%, respectively, in female firefighters with obesity. There were independent and significant correlations between BMI and age and the prevalence of high blood pressure, high cholesterol, high triglycerides, and high glucose among male firefighters. Higher BMI category was related with an increased prevalence of high blood pressure, high triglycerides, and poor high-density lipoprotein cholesterol across all age categories, as well as an increased prevalence of high glucose and high cholesterol among those aged 40 to 49 and 50 to 59 years.

Third study showed percentage of risk that was mediated in women by all three metabolic risk variables was as follows: 23% (95% CI 13–50%) for being overweight, 36% (21–64%) for being obese overall, and 52% (39–87%) for being obese centrally. According to the findings of this research, cardiometabolic mediators have mitigated more than sixty percent of the negative impact that a high BMI has on cardiovascular diseases in males. In women, controlling metabolic risk factors does not contribute as well to the reduction of cardiovascular diseases (CVDs) as it does in males.[16]

Bode, *et al* (2021)[17] showed 25% of their patients had high BP, 8% had bad high-density lipoprotein cholesterol, and 0% of them had high glucose, whereas the prevalence of these conditions was 57%, 45%, and 11% respectively among female firefighters who were obese. In male firefighters, there were independent and substantial connections found between BMI and age, as well as the prevalence of high blood pressure, high cholesterol, high triglycerides, and high glucose levels. There was a correlation between a higher BMI category and an increased prevalence of high BP, high TG, and poor HDL-

c across all age categories. Additionally, there was a correlation between a higher BMI category and an increased prevalence of high glucose and high cholesterol among those aged 40-49 and 50-59 years.

DISCUSSION

The equilibrium between the number of calories eaten and the amount of energy expended, which is then followed by a resetting of body weight, plays a role in the pathophysiology of obesity. On the other hand, this is not as easy as solving an equation, and there are secondary processes that contribute to this complicated circumstance.[18] In addition to diet, factors in the environment and the way people act can make them more likely to be overweight. The pathogenesis of obesity is not only about how extra body fat is gained, but also about how this extra fat is processed by the body. Several metabolic factors and all the systems that control appetite or food intake are involved in the pathogenesis of obesity.[19]

Obesity is thought to be a state of inflammation because it has more fat tissue and less adiponectin, which makes it less able to stop the inflammatory processes and keeps the inflammation going. This adipocyte dysregulation contributes to the imbalance of homeostasis and pro- and anti-inflammatory mechanisms in the body, which in turn contributes to metabolic complications caused by obesity and vascular damage that leads to cardiometabolic changes. Inflammatory cell infiltrate happens at the same time that obesity does. This happens not only in adipose tissue but also in the pancreas and other tissues. Teenagers with metabolic syndrome can show early signs of this inflammatory state, and there is a clear link between inflammatory biomarkers and cardiovascular events.[20,21]

The structure and function of the cardiovascular system, as well as the hemodynamics of the blood, are both negatively impacted by obesity. The total blood volume and cardiac output both rise with obesity, which also results in an increased workload for the heart. Patients who are obese typically have a higher cardiac output but a lower level of total peripheral resistance at any given level of arterial pressure. This is because obese patients have a larger number of fat cells in their bodies.[22,23]

The majority of the increase in cardiac output that is associated with obesity is due to an increase in stroke volume; however, because of the higher sympathetic activation that is associated with obesity, heart rate is often also somewhat raised. The Frank-Starling curve frequently shifts to the left as a result of increases in filling pressure and volume, which ultimately results in an increase in CV work. Patients who are obese have an increased risk of developing hypertension compared to patients who are leaner. Additionally, weight gain is often related with increases in arterial pressure.[23]

Individuals who are overweight or obese frequently develop left ventricular (LV) chamber dilatation as a result of the increased filling pressure and volume. Even when arterial pressure and age are not taken into account, the risk of left ventricular hypertrophy (LVH) and other structural abnormalities, such as concentric remodeling (CR) and concentric LVH, is increased in obese individuals. In addition to the anatomical abnormalities of the left ventricle (LV), obesity also leads to an expansion of the left atrium (LA).[24]

This occurs both as a result of an increase in the volume of blood that is circulating as well as inappropriate LV diastolic filling. These anomalies not only raise the risk of heart failure, but they also raise the likelihood of atrial fibrillation and the morbid problems associated with it, which will be explored further on. Obesity has negative effects on both the diastolic and systolic functions of the heart, in addition to the increased risk of developing LV structural abnormalities and the tendency for more frequent and complex ventricular arrhythmias.[24]

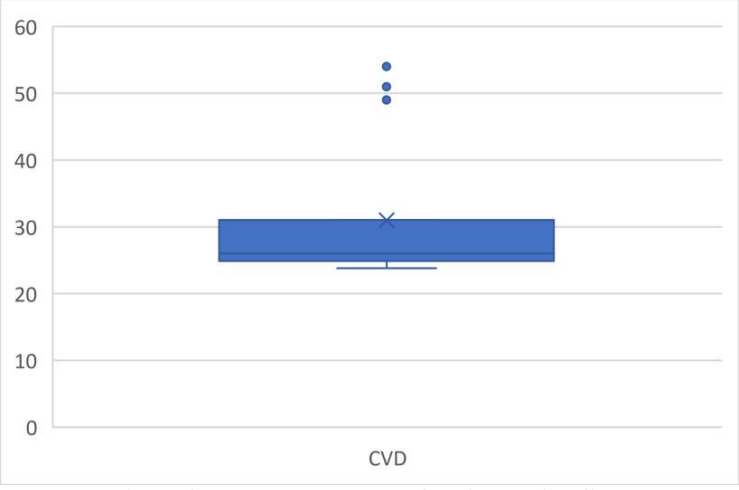

Figure 2. The average BMI of patients with CVD

Atherosclerosis of the coronary arteries is strongly linked to obesity. An investigation that was carried out on younger individuals revealed that the onset of atherosclerosis occurs several decades prior to the manifestation of coronary artery disease. Patients with higher BMI values have atherosclerotic vascular lesions that are more numerous and progressed

compared to people with normal body weight. According to studies that follow participants over time, being obese for at least two decades is likely to be considered an independent risk factor for coronary artery disease.[25]

A rise of 10 kilograms in body weight is associated with a 12% increase in the risk of coronary artery disease, as well as a rise of 3 millimeters of mercury in the systolic blood pressure and 2.3 millimeters of mercury in the diastolic blood pressure. In addition, being overweight might be regarded the most significant risk factor for having a non-ST segment elevation myocardial infarction (NSTEMI), which affects young individuals. This puts it ahead of smoking as the most significant risk factor. The risk of developing NSTEMI increases in direct proportion to the patient's BMI.[26]

The same correlation can also be shown in the case of myocardial infarction characterized by ST segment elevation (STEMI). Obesity is an independent risk factor for STEMI occurring at a young age, according to the data that is currently available; however, excess weight can also be associated to other vascular events. A rise of one unit in body mass index is associated with an increase in the chance of having a stroke of either the ischemic or hemorrhagic variety by 4% and 6%, respectively.[23,27]

The occurrence of heart failure is becoming more common; it is currently one of the leading causes of death around the world, and its prevalence in affluent nations is roughly 3%. There appears to be a strong connection between being overweight and having heart failure. According to the findings of the Framingham Heart Study, an increase in BMI of 1 kg/m2 brings about a 5% increase in the risk of heart failure in men and a 7% increase in the risk of heart failure in women. According to research conducted on heart failure, between 32-49% of people who are afflicted with this condition are fat, while between 3-40% are overweight.[28,29]

Patients who are obese or overweight are at a greater risk of developing heart failure 10 years earlier than people who have a normal body mass index (BMI). After 20 years of morbid obesity, the incidence of heart failure grows by 70%, and after 30 years of obesity, the prevalence of heart failure rises by 90%. The duration of morbid obesity is directly connected with the development of heart failure. The study found that 14% of obese females and 11% of obese males had heart failure. Simply being obese is enough to cause anatomical and functional changes in the heart, both of which lead to a decline in myocardial function. This decline in function is sometimes referred to as "obesity cardiomyopathy".[28,29]

CONCLUSION

Previous research has demonstrated that patients or individuals with a body mass index (BMI) that is greater than 25, have a high risk connected with the risk of cardiovascular disease (CVD). In addition to this, the strength of this connection grows with advancing age.

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