SMJ- Sohag Medical Journal, Vol. 29 No(2) 2025

Print ISSN 1687-8353 Online ISSN 2682-4159

Review Article

Obesity and its Systemic Health Complications

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ABSTRACT

The epidemic of obesity is quickly spreading across all demographics and economic classes, making it one of the most pressing public health concerns of the modern era. Obesity is a medical problem in and of itself, but it also drastically raises the risk of acquiring a variety of chronic diseases, which puts a burden on healthcare systems and individual well-being. Nowadays, people of all ages and economic levels are struggling with obesity, which has become a big public health concern. Obesity is a major health concern since it increases the likelihood of developing numerous chronic diseases, which in turn strains healthcare systems and negatively impacts people's personal health. An up-to-date definition, worldwide epidemiology, underlying mechanisms, and thorough examination of the many and systemic health consequences of obesity are all part of this review article's updated overview. Cardiovascular disease, type 2 diabetes, non-alcoholic fatty liver disease, cancer, musculoskeletal disorders, respiratory issues, mental health disorders, reproductive health problems, and many more are among the many diseases and conditions that we investigate in this comprehensive overview of obesity. We also touch briefly on the economic and social impacts, as well as possible directions for research and treatment of obesity in the future. The main objectives of this study are to shed light on the multifaceted nature of obesity and the urgent need for comprehensive strategies to combat and control the condition.

Keywords : Health Complications, Cardiovascular Disease, Diabetes, obesity, Epidemiology.

DOI : 10.21608/SMJ.2025.383564.1570 **Received:** May 09 , 2025 **Accepted:** June 08 , 2025

Published: July 21, 2025

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Citation: **Mohammed Khalaf Mohammed., Obesity and its Systemic Health Complications**

SMJ,2025 Vol. 29 No (2) 2025 178 - 186

Introduction

Obesity, defined as an unhealthy accumulation of fat that is neither normal nor healthy, [1] has spread from a local problem to a global epidemic. In 2016, the World Health Organization (WHO) estimated that over 650 million people were obese. The prevalence of overweight adults exceeded 1.9 billion.[2]

These numbers have persisted in rising, which is indicative of a complicated interaction between hereditary susceptibility, environmental variables, and changes in lifestyle. [3]

Individuals' lifespans and quality of life are negatively impacted by an increased risk of many chronic diseases linked to high abdominal fat. [4]

Health care providers, politicians, and the general public must keep up with the ever-changing obesity epidemic and its health consequences. An up-to-date and all-encompassing summary of this pressing health concern is the goal of this review. Obesity will be defined and measured, the worldwide obesity epidemic will be investigated, the mechanisms connecting obesity to disease will be detailed, and the many health problems linked to obesity will be covered in great detail.

2. Defining and Measuring Obesity

To quantify obesity, many anthropometric and body composition measurements are usually used. Body Mass Index (BMI) is the most widely used statistic; it is calculated as follows: weight in kilograms divided by square of height in meters (kg/m^2). Adults are considered overweight by the World Health Organization (WHO) if their BMI is 25 kg/m^2 or above, and obese if it is 30 kg/m^2 or higher. [1]

The subcategories of obesity can be classified as Class II (BMI 35-39.9 kg/m^2), Class III (BMI > 40 kg/m^2), and Class I (BMI 30-34.9 kg/m^2), as stated in. [5]

The inability of body mass index (BMI) to differentiate between fat mass and lean mass is one of its shortcomings, despite the fact that it is widely used and practical.

This is why alternative methods of measuring body composition and fat distribution are commonly used. Some examples are:

* ***Waist Circumference (WC):*** Measures abdominal fat, which is strongly linked to metabolic risk. High WC (e.g., >102 cm in men and >88 cm in women) indicates abdominal obesity [6].

* Waist-to-Hip Ratio (WHR): Another measure of fat distribution, with higher ratios indicating greater abdominal fat accumulation. [7]

* Skinfold Thickness Measurements: Measures subcutaneous fat at specific sites using calipers.[8]

* Bioelectrical Impedance Analysis (BIA): Using electrical resistance measurements taken through bodily tissues, it attempts to estimate the body's composition, including water, fat, and lean mass. [9]

* Dual-energy X-ray Absorptiometry (DXA): Among the most reliable methods for determining total body composition, including fat mass, lean mass, and bone mineral density. [10]

* Magnetic Resonance Imaging (MRI) and Computed Tomography (CT): Cost and radiation exposure (CT) make them less common in ordinary clinical practice, although they provide precise imaging of body composition, including subcutaneous and visceral fat. [11]

Clinical context, accessible resources, and specific information needed determine the choice of measurement. In many cases, body mass index (BMI) and waist circumference (WC) are enough for general population studies and preliminary clinical evaluations. On the other hand, more advanced techniques such as DXA or MRI might be better suited for thorough research and evaluations.

3. The Global Obesity Epidemic: An Updated Perspective

Developed and emerging nations alike are feeling the effects of the growing obesity epidemic. The NCD Risk Factor Collaboration (NCD-RisC) data shows that the prevalence of obesity has been steadily rising over the last several decades on a global scale. [12]

Although there are regional differences, the increasing obesity rates in no country have been able to be stopped in the past few years. [13]

Key trends in the global obesity epidemic include:

* ***Rising Prevalence in Low- and Middle-Income Countries (LMICs):*** For a long time, many thought that high-income countries were the only ones with an obesity epidemic. On the other hand, undernutrition and obesity are on the rise in

LMICs, making malnutrition a "double burden". [14]

This is caused by a decrease in physical activity levels, an increase in the consumption of processed foods that are high in calories, and the spread of urbanization.

* ***Disparities Across Socioeconomic Groups***: Prevalence of obesity tends to show socioeconomic differences within countries. While lower-income groups tend to be hit harder by obesity in high-income nations, the problem may start off affecting wealthier urban populations in low- and middle-income countries before spreading to lower-income groups. [15]

* Childhood Obesity: Obesity in children is a major public health concern because it increases the risk that a kid may grow up to be overweight and acquire obesity-related health problems at a younger age. [16] The alarming increase in childhood obesity rates worldwide emphasizes the critical importance of implementing early intervention and preventive practices.

**** Ethnic and Racial Disparities:*** Certain ethnic and racial groups experience disproportionately higher rates of obesity, even within the same geographic location. This reflects complex interactions of genetic factors, cultural norms, socioeconomic determinants, and healthcare access. [17]

Understanding the dynamic patterns of the obesity epidemic is crucial for tailoring public health interventions and resource allocation effectively.

4. Mechanisms Linking Obesity to Health Complications

Obesity is not simply an excess of stored energy; it is a complex metabolic and endocrine disorder that disrupts numerous physiological processes, leading to a cascade of adverse health effects.
Several key mechanisms mediate the link between obesity and its complications:

**** Chronic Low-Grade Inflammation:*** Adipose tissue, particularly visceral fat, is not inert storage but an active endocrine organ. In obesity, the synthesis of anti-inflammatory adipokines like adiponectin is reduced, while larger adipocytes and infiltrated immune cells release an excess of pro-inflammatory adipokines (such as TNF-α and IL-6), as well as chemokines. [18]

Insulin resistance, malfunction of the endothelium, and systemic consequences are all driven by this chronic low-grade inflammation.

**** Insulin Resistance:*** Adipose, muscle, and liver tissue are among the target tissues that insulin signaling is impaired in by chronic inflammation and lipotoxicity. Type 2 diabetes mellitus (T2DM) develops from hyperglycemia, hyperinsulinemia, and insulin resistance. [19]

A number of diseases, including malignancies, non-alcoholic fatty liver disease, and cardiovascular disease, are associated with insulin resistance.

**** Oxidative Stress:*** Reactive oxygen species (ROS) generation and antioxidant defences are both lowered in obese people, which causes oxidative stress. [20]
Cellular antioxidant capability is impaired and mitochondrial ROS generation is increased by metabolic inefficiency and excess fat storage. Cellular damage, inflammation, and the onset of other obesity-related problems are all facilitated by oxidative stress.

* ***Dyslipidemia:*** Elevated triglycerides, higher LDL cholesterol, and lower HDL cholesterol are some of the unpleasant lipid profile abnormalities that are commonly associated with obesity. [21]

Dyslipidemia refers to a condition in which aberrant lipid profiles increase the risk of atherosclerosis and cardiovascular illnesses. Pancreatitis and non-alcoholic fatty liver disease are other conditions associated with dyslipidemia.

* ***Endocrine and Hormonal Dysregulation***: Obesity disrupts the normal function of several endocrine axes. Leptin, an adipokine that signals satiety, is produced in excess in obesity, but paradoxically, leptin resistance develops, leading to reduced satiety signaling and contributing to continued overeating. [22]

Ghrelin, a hormone that stimulates appetite, may also be dysregulated. Furthermore, obesity can affect sex hormone levels, contributing to reproductive health issues and certain cancers.

These interconnected mechanisms underscore the systemic impact of obesity and explain its wide-ranging health consequences.

5. Health Complications of Obesity: A Systemic Review

Obesity is linked to numerous health issues that impact almost every system in the body. Now, let's have a look at the main health issues associated with obesity:

5.1 Cardiovascular Diseases (CVDs)

Obesity is a major independent risk factor for various cardiovascular diseases, including:

* ***Coronary Heart Disease (CHD):*** The development of atherosclerosis is accelerated by obesity, which causes insulin resistance, inflammation, dyslipidemia, and hypertension. People who are overweight are far more likely to suffer from heart attacks and angina. (23)

* ***Stroke:*** Ischemic and hemorrhagic strokes are more likely in obese people due to the same processes, which include hypertension, atherosclerosis, and atrial fibrillation. (24)

* ***Hypertension:*** A higher blood volume, sympathetic nervous system activation, and renin-angiotensin-aldosterone system (RAAS) activation are presumably the mechanisms by which obesity is substantially linked to hypertension. (25)

* ***Heart Failure:*** Heart failure is more likely in those with obesity-related cardiomyopathy, hypertension, and coronary heart disease (CHD). Left ventricular hypertrophy, diastolic dysfunction, and subsequently systolic dysfunction describe "obesity cardiomyopathy". (26)

* *Atrial Fibrillation*: A major contributor to the prevalence of atrial fibrillation, the most prevalent kind of persistent heart arrhythmia, may be obesity. Heart remodeling, inflammation, and malfunction of the autonomic nervous system are some of the mechanisms involved. (27)

* ***Peripheral Artery Disease (PAD):*** Obesity contributes to atherosclerosis in peripheral arteries, leading to PAD and claudication. (28)

* ***Venous Thromboembolism (VTE):*** Obesity raises the risk of pulmonary embolism (PE) and deep vein thrombosis (DVT) probably because of inflammation, venous stasis, and decreased fibrinolysis. (29)

5.2 Type 2 Diabetes Mellitus (T2DM)

The most significant modifiable risk factor for T2DM is obesity. Obesity affects a large percentage of people with T2DM. The fundamental pathogenic mechanism leading to T2DMis insulin resistance, which is mediated by chronic inflammation and lipotoxicity in obesity.(19) The risk of microvascular (retinopathy, neuropathy, nephropathy) and macrovascular (hypertension) problems is increased by T2DM.

5.3 Non-Alcoholic Fatty Liver Disease (NAFLD)

NAFLD encompasses a range of liver disorders marked by excessive hepatic fat buildup in the absence of heavy alcohol consumption. One of the leading causes of NAFLD is being overweight. NAFLD can vary from non-alcoholic steatohepatitis (NASH), an inflammatory liver disease, to simple steatosis (fatty liver). Hepatocellular carcinoma, fibrosis, cirrhosis, and liver failure are all possible outcomes of NASH. (30)

5.4 Certain Cancers

Obesity has been established as a risk factor for several types of cancer, including:

* ***Endometrial Cancer***: Obesity increases estrogen levels and insulin resistance, promoting endometrial hyperplasia and cancer.(31)

* ***Breast Cancer (postmenopausal):*** Similar to endometrial cancer, increased estrogen levels in obese postmenopausal women elevate breast cancer risk. (32)

* ***Colorectal Cancer:*** Obesity-related insulin resistance, inflammation, and altered gut microbiota are implicated in colorectal cancer development. (33)

* ***Kidney Cancer (Renal Cell Carcinoma):*** Obesity is a strong risk factor, with mechanisms potentially involving insulin resistance, growth factors, and inflammation.(34)

* ***Esophageal Adenocarcinoma:*** Esophageal adenocarcinoma risk factors include obesity and gastroesophageal reflux disease (GERD).(35)

* ***Pancreatic Cancer:*** Obesity, diabetes, and chronic inflammation are thought to contribute to pancreatic cancer risk. (36)

* *Gallbladder Cancer:* Obesity increases the risk of gallstones, which is a risk factor for gallbladder cancer. (37)

* ***Liver Cancer (Hepatocellular Carcinoma):*** As mentioned earlier, NASH progression to cirrhosis increases the risk of hepatocellular carcinoma.

5.5 Musculoskeletal Disorders

Excess weight places significant stress on joints and bones, leading to:

* *Osteoarthritis (OA):* Particularly in weight-bearing joints such as the hips and knees, obesity is a significant risk factor for osteoarthritis (OA). Joint inflammation, increased loading, and changes in cartilage metabolism all play a role in the onset of OA.[38]

* ***Back Pain:*** Excess weight strains back muscles and ligaments, and alters spinal biomechanics, increasing the risk of chronic back pain. [39]

* *Gout*: Hyperuricemia and an increased incidence of gout, an inflammatory arthritis produced by the deposition of uric acid crystals in joints, are both linked to obesity. [40]

5.6 Respiratory Complications

Obesity can significantly impair respiratory function:

* Obstructive Sleep Apnea (OSA): A condition known as obstructive sleep apnea (OSA), in which the airway becomes narrowed due to excess fat in the neck area, can develop in children. Problems with blood pressure, cardiovascular health, and daytime drowsiness are all linked to obstructive sleep apnea. [41]

* Obesity Hypoventilation Syndrome (OHS): Severe obesity can impair ventilatory drive and chest wall mechanics, leading to chronic daytime hypercapnia (elevated CO2) and hypoxemia (low O2) in OHS. [42]

* *Asthma:* Asthma control can be impacted by obesity, which is also a risk factor for acquiring the condition. Possible causes include inflammation and changes in lung mechanics.[43]

5.7 Mental Health Disorders

Obesity is associated with an increased risk of various mental health conditions:

* Depression: Obesity and depression frequently co-occur. Mechanisms may involve shared inflammatory pathways, body image issues, and social stigma. [44]

* Anxiety Disorders: Similar to depression, anxiety disorders are more prevalent in obese individuals. [45] Social stigma, body image concerns, and metabolic dysfunction may contribute.

* Eating Disorders: Obesity paradoxically increases the risk of developing eating disorders, including BED, which is more common in those who are overweight. [46]

Severe episodes of binge eating, during which the sufferer feels helpless and unable to regulate their food intake, occur frequently in people with BED.

5.8 Reproductive Health Issues

Obesity can negatively impact reproductive health in both men and women:

* *Infertility:* Both men and women who are overweight may find it difficult to conceive. Issues with endometrial receptivity, anovulation, and polycystic ovarian syndrome (PCOS) in women have been reported. [47]

Men who are overweight are more likely to experience erectile dysfunction, decreased sperm quality, and hormonal imbalances.[48]

* *Polycystic Ovary Syndrome (PCOS):* There is considerable evidence linking polycystic ovary syndrome (PCOS) to both obesity and insulin resistance.[49] PCOS affects a large percentage of reproductive-age women. Symptoms of polycystic ovary syndrome (PCOS) include polycystic ovaries, hyperandrogenism, and irregular menstrual periods.

* Pregnancy Complications: Macrosomia, or a big birth weight, is more common in obese pregnant women, as are gestational diabetes, preeclampsia, premature birth, and cesarean sections.[50]

* Adverse Pregnancy Outcomes for Offspring: Young people whose mothers are overweight are more likely to be overweight, develop diabetes, and have heart problems as adults.[51]

5.9 Other Emerging Complications and Considerations

Beyond the well-established complications, emerging research highlights additional health issues linked to obesity:

* Cognitive Decline and Dementia: Cognitive decline and dementia, such as Alzheimer's disease and vascular dementia, are more likely among middle-aged people who are overweight. Damage to blood vessels, inflammation, and insulin resistance are potential mechanisms that impact brain function. [52]

* ***Sarcopenic Obesity:*** When both obesity and sarcopenia (weakness in the muscles) occur together, it is called a condition. Concerningly, sarcopenic obesity increases mortality risk, functional limits, and frailty in the elderly. (53)

* *Increased Susceptibility to Infections*: Obesity can impair immune function, increasing susceptibility to certain infections, including influenza, pneumonia, and surgical site infections. Recent evidence also suggests that obesity may be associated with more severe outcomes in COVID-19. (54)

* *Chronic Kidney Disease (CKD):* Obesity is an independent risk factor for developing CKD. Obesity-related glomerulopathy, hypertension, and diabetes contribute to kidney damage. (55)

6. Socioeconomic Impact

The health complications of obesity translate into substantial socioeconomic costs. These include:

* *Increased Healthcare Expenditures:* Obese individuals have higher healthcare utilization and costs due to the management of obesity-related complications. (56)

* A decline in economic production is associated with decreased productivity due to absenteeism, presenteeism (a decrease in productivity while at work), and disability, all of which are complications of obesity. (57)

* Discrimination and Social Stigma: Overweight people may face bias and discrimination in many aspects of society, which can harm their health, happiness, and capacity to work and go to school.

7. Future Directions and Conclusion

Obesity is still a major problem in world health, and its effects are far-reaching.

To: * Decipher the Mysterious Origins of Obesity: The complex relationship between obesity and its underlying genetic, environmental, behavioral, and socioeconomic components needs further explanation.

* Find Better Ways to Prevent and Treat Illness: Personalized strategies integrating lifestyle changes, medication, and bariatric surgery when needed should be considered with population-level initiatives aimed at the obesogenic environment.

* Investigate Causes and Create Specific Treatments for Obesity-Related Illnesses: If we want to find better ways to treat obesity and its consequences, we need to learn more about the molecular pathways that cause these conditions.

* Deal with the Socioeconomic Disparities in Obesity and Access to Healthy Lifestyles by Acknowledging and Resolving These Factors.

Conclusion

Obesity is a complicated and pervasive health condition that has far-reaching consequences for both individual health and the healthcare system as a whole. A complete and multi-faceted strategy to effectively prevent and control obesity is urgently needed, according to this latest evaluation. In order to combat the obesity pandemic and lessen its catastrophic health effects, it is necessary to implement public health programs, healthcare interventions, and personal lifestyle changes.

Improving the lives of millions impacted by this growing global health epidemic requires more effective solutions, which can only be achieved through ongoing research and innovation.

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