

# A Review on Mechanism Linking between Diabetic and Obesity

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**Abstract**—Obesity is considered as a major health disaster as it causes to many health issues for aged people around the globe. Obesity functions by accumulating adipose tissue that leads to impairment of physical and psychological health. The adipose tissue with abnormal deposition of fat causes physical inactivity due to many factors such as hereditary and overeating habit. One of the risk factors of obesity is diabetes, which could also be a root cause for many other abnormalities in the human body. So, diabetes has a strong relationship with obesity. Moreover, insulin substance plays a vital in maintaining diabetes, which also has a direct relationship with body mass index. In addition, the amount of fatty acid, hormones, glycerol, cytokines etc. are the major substances involved in the diabetic development in human body. As diabetes is primarily caused by obesity, this paper aims to describe the rapport between obesity and diabetes, it's types and implications on human health.

**Index Terms**— Diabetes, Obesity, Type 1 and Type 2 diabetes.

## I. INTRODUCTION

Obesity is nowadays prevalent and has a greater impact on aged people around the world causing many health issues. Obesity is generally defined as an extra fat deposition in the body. It accumulates adipose tissue to greater amount that leads to impairment of physical and psychological health. Abnormal deposition of adipose tissue causes physical inactivity due to many factors such as hereditary and overeating habit in the modern world. Current technology is still barely determining the accurate case of obesity and the amount of fat deposition in an individual body [1]. The World Health Organization (WHO) has approved Body Mass Index (BMI) with a calculation of dividing body weight in kilograms (kg) by the square of the height in meters (m). BMI of 25 kg/m<sup>2</sup> is generally overweight. BMI of 29 kg/m<sup>2</sup> to 40 kg/m<sup>2</sup> is categorized as extreme obese. Genital and environmental factors, and lifestyle modification have a greater impact on energy, weight status, hormone imbalance linking to obesity [2]. Reports [3], [4] from various health organizations are explained below.

- In 2019, center disease control and prevention has given a report from the observation gathered from US citizen stating that 30.4 million individuals are affected by diabetes.
- In 2018, treatment objective, test range criteria, and factors that influenced diabetic were analyzed by the diabetic Association of Therapeutic Care.
- In 2017, WHO explained the cause of diabetes and the impact on different parts of the body like heart ailment, pancreas glitch issues, hypertension, kidney disappointment, nerve weakness, foot issues, glaucoma etc.

Obesity is the major reason for the cause of diabetes, which might lead to many other abnormalities in the human body, especially with aged people. So, diabetes has a strong relationship with obesity that must be explored in order to treat the patients. A substance called insulin plays a vital role in controlling and maintaining diabetes. This insulin is also correlated with BMI, which is linked with obesity. In addition, the amount of fatty acid, hormones, glycerol, cytokines etc. are the major substances involved in the diabetic development in human body. As diabetes is primarily caused by obesity, we aim to describe the rapport between obesity and diabetes, it's types and implications on human health.

This paper is further organized as follows. Section II details the importance and role of insulin in the human body. Obesity and diabetes correlation are accounted in Section III with illustration. Some evidences on obesity and mortality are explained in Section IV. Gestational diabetes causes and its impacts are discussed in Section V. Finally, summary and some conclusions drawn are mentioned in Section VI.

## II. INSULIN RESISTANCE

Insulin hormone is prepared by a gland organ, called pancreas, that assists and supplies the glucose in a human blood cells to enter fat, liver, muscles for energy in a human being. Glucose is a substance created by the food intake, sometimes secreted by the liver during empty stomach [1], [5]. As shown in Fig. 1, insulin resistance is the signal sent by the insulin hormone to the cells present in body fat, muscles, liver, etc. It plays a major role of grabbing glucose out of the blood stream and place it into human cells. Weight, genetics, age are the major factors that are directly linked to insulin resistance [6]. According to the research of National Institute of Health, women with a waist measuring 35 inch or more and men with 31.5 inches are induced to insulin resistance and metabolic syndrome. People with overweight or obese, aged 45 or more, a parent with a diabetic, physical inactivity, blood pressure, high cholesterol level, a history of gestational diabetics, history of heart diseases or stroke, Polycystic Ovarian Syndrome (PCOS), slow clearance of fat from blood and people with metabolic syndrome etc. are induced to insulin resistance. Along with these factors, certain medicines like antipsychotics, glucocorticoids, disorders of hormone like Cushing syndrome and acromegaly, sleep apnea are

highly prone to insulin resistance. In general, genetics and lifestyle modification are likely to develop insulin resistance [7], [8]. In medical term, high triglycerides ranging from 150 or higher are diagnosed for high level of blood fats which reads 130/85 mmHg or higher have higher blood pressure to be medicated. In recent study, insulin resistance linked with metabolic syndrome is prone to higher risk of cancer in breast, colon, pancreas, cervix, prostate and uterus. Higher amount of insulin resistance suppresses the body ability to protect itself from cancer cells [9].

### III. OBESITY AND DIABETES PROGRESSION

Globally, the diabetic ratio is nearly doubled between 2000 and 2011 according to the report by WHO, in 2016. According to International Diabetes Federation, nearly 1.1 million children and adolescents are prone to type 1 diabetes. Diabetes has affected overall population globally regardless of region, race, etc. From the recent global survey in the year 2011-2012, the obesity rate among

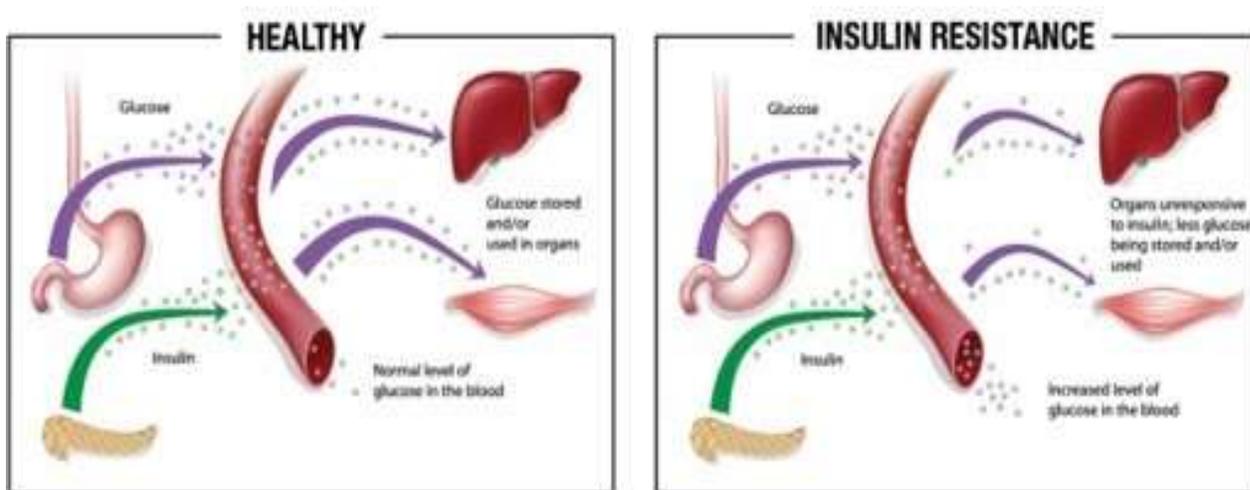


Figure 1. Insulin resistance

adults were 25 percent since there was a steady rise to 17 percent in the year 2007. According to the report of WHO nearly 423 million adult population are affected by diabetes in the year 2015 with steady rise till date. The exact count of obese may be higher when reviewed on individual point-of-view [10].

In the recent global study, 1.9 billion people, especially adult are obese and nearly 2.8 million people died due to overweight. The obesity is becoming more prevalent worldwide compared since 1980. It is estimated by the WHO that two-third of the burden globally are prone to chronic non communicable diseases. Developing countries experienced remarkable rise in the prevalence of obesity. The National Health and Nutrition Examination Survey in the year 2019 has prevailed that 39.6% are obese among rural adults compared to urban adults. In the recent study conducted by ICMR-INDIAB in Tamil Nadu found that the prevalence of obesity ranges from 11.9 to 33.6 percent and the obesity among Indian women has raised from 10.7 to 12.6 percent respectively. In India, nearly 135 million people are affected by obesity. Various factors like age, gender, socio-economic status, environment condition, lifestyle etc. are the major prevalence factors for obesity. By now, various studies have shown that obesity is higher among women when compared to men.

### IV. CURRENT EVIDENCE LINKING OBESITY AND MORTALITY

Mortality is closely associated with BMI ranging between 23.5-24.8 for men and 22.1-23.5 for women with lowest mortality. The consequences of mortality are steadily increased which may lead to death associated with obesity. Obesity was linked with superior mortality rates for both cardiovascular disease and cancer. Researches has shown certain threshold of BMI leads to increased mortality. National Health and Nutrition Examination review suggested that there is a drop in life expectancy in overweight young compared to nonobese adults. According to some researchers BMI prediction is not the exact tool for measuring the mortality of an individual where overall body fat distribution is required to exact results [5], [6]. Mortality and morbidity can be measured by calculating body fat distribution using magnetic resonance imaging. Current researches are focused on morbidities, type 2 diabetes and its related cause of insulin resistance [15].

The probability of type 2 diabetic is being obese or overweight. From the report from science, the body prepares enough insulin but the cells in the body becomes resistant to the action of insulin. The cause of insulin resistance is because of the disturbance of membranous network present inside the body cells, so-called endoplasmic reticulum. This when gets disturbed translates the insulin to sugar glucose which leads to diabetes. This causes pressure and complications to the endoplasmic reticulum to signal the insulin receptors which in turn cause insulin resistance [2], [11].

## V. RISK FACTORS OF DIABETICS

Diabetes are caused when the production of blood glucose or blood sugar is high which leads to serious issues for heart, nerves, kidney, eyes etc. as given in **Table 1** Type 2 diabetes is a disease which affects pancreas in insulin secretion. Insulin is a hormone that tends glucose enter the human body cells which gives energy. In absence of insulin, too much glucose remains in the blood stream. Type 1 diabetic patients will infer frequent urination, being very thirsty, dry and itchy skin, losing of weight, tingling in feet, blurry eyesight, etc. The risk factors [1]-[3] of diabetic type 1 are caused by the following factors:

- Family history – Parents or siblings have a type 1 history.
- Genetics – Certain genes signify increased risk of type I diabetes. The presence of certain genes indicates an increased risk of developing type 1 diabetes.
- Geography – Travelling away from equator.
- Age – Any age people can be affected by type 1 diabetes, specifically children aged 4 to 7 years old and children between 10 to 14 years old.

**Type 1** diabetes causes complications to major parts of the body including heart, lungs, nerves, eyes, kidney etc. On the comparison survey, young age population are also affected by type 1 diabetes which are highly tough to predict [13]. The diabetes Mondiale study gathered a childhood diabetic data from nearly 112 centers globally and reported approximately 2.9 percent increase annually in type 1 diabetes. Environment factors and genetic factors are also the core factors for type 1 diabetes [12]. Multiple causes for the type 1 diabetic have been researched and investigated however some factors has been shown to be ultimate cause for type 1 diabetes. The implication between weight and type 1 diabetes was researched in the year 1975 which has explored that overfeeding or hormonal dysregulation are the core causes of type 1 diabetes [4] as shown in **Fig. 2**. Research carried out by Wilkin in the 2002 found the connection between type 1 diabetes and BMI are closely related body weight which is the root cause of type 1 diabetes. The study organized in the 2003 proved a significant raise in the prevalence of being overweight in children with type 1 diabetes, from 12.7% in the period 1979–1990 to 36.9% in the period 1990-1998 [8]. To date, the exact mechanism and relationship between type 1 diabetes and obesity remains questionable and needs still more advance study [14]. A brief comparison among type1, type2, and gestational diabetes is given in **Table 2**.

Table 1. Diseases and its complications due to obesity

Diseases	Complications
Heart disease	Blood pressure, heart attack coronary artery diseases, stroke, narrowing of arteries
Kidney disease (nephropathy)	Tiny blood vessel damage due to overproduction of sugar, damage delicate filtering system, kidney failure in worst case leads to dialysis or transplantation
Damage to eye	Damages to blood vessels, blindness, glaucoma, retina blood vessel damage.
Foot injury	Insufficient blood flow to the foot causes serious infection on cuts and blisters and leg amputation
Nerve damage	tingling, numbness, burning or pain losing sense in the affected limbs
Pregnancy complication	High blood pressure causes complication to baby and mother, risk of miscarriage, birth defects, preeclampsia

Table 2. Type 1 diabetes vs type 2 diabetes vs Gestational

Type 1	Type 2	Gestational
Usually young	Usually older	First detected in pregnancy

Short history-acute onset	Indisidious onset	Routing testing
Not overweight	Often overweight	Often overweight
Insulin deficiency	Insulin resistance	Usually insulin resistance – placental hormones
Rare	Common	Becoming more common
Requires insulin from diagnosis	Diet and lifestyle changes can reverse it	Diet and lifestyle changes with medication can reverse it
Often random	Strong family history	Family history

**Type 2** diabetes is strongly related to metabolic and genetic factors. Unhealthy diet, physical inactivity, genetic factors, lifestyle modification, smoking, obesity, and history of gestational diabetes etc., are the major factors for type 2 diabetes cause. Excess body fat, a summary measure of several aspects of diet and physical activity, is the strongest risk factor for type 2 diabetes, both in terms of clearest evidence base and largest relative risk. Obesity and overweight, combined with physical inactivity, are predictable to cause a large proportion of the global diabetes burden [4]. As shown in in Fig. 3, Higher waist circumference and higher BMI are related with increased risk of type 2 diabetes, though the association may vary in different populations [5]. Populations in South-East Asia, develop diabetes at a lower level of BMI than populations of European origin. Several dietary practices are connected to unhealthy body weight and/or type 2 diabetes risk, including high intake of saturated fatty acids, high total fat intake and insufficient consumption of dietary fiber. High intake of sugar sweetened beverages, which contain significant amounts of free sugars leads high consumption of sugar-sweetened beverages and increased risk of type 2 diabetes. Early childhood nutrition affects the risk of type 2 diabetes later in life. Factors that increase risk are deprived fetal growth, low birth weight and high birth weight. Active smoking surges the risk of type 2 diabetes, with the highest risk among heavy smokers [6]. Risk remains higher for about 10 years after smoking termination, falling more quickly for lighter smokers [7].

Diabetes worldwide has drawn a greater attention and its prevalence is higher about two-thirds of the adult population. Obesity is connected to many psychological, medical, and social conditions that leads to type 1 and type 2 diabetic. Globally 172 million people were assessed to have type 2 diabetes, and it is predicted to raise to 360 million by 2030. Obesity and type 2 diabetic are closely related to insulin resistance [8]. Most obese human, with insulin resistant, do not develop hyperglycemia. Pancreatic  $\beta$ -cells of the islet of Langerhans release enough quantities of insulin that are adequate to overwhelmed insulin level reductions under normal circumstances, thus sustaining normal glucose tolerance. Throughout the natural history of type 2 diabetes, endothelial dysfunction is convoyed with obesity/insulin resistance in diabetes and prediabetes conditions. In order to develop insulin resistance and obesity, thereby causing type 2 diabetes,  $\beta$ - cells must not be able to compensate fully for decreased insulin sensitivity. The nonesterified fatty acids (NEFAs) that are produced from adipose tissue in obese group may tend to hypothesis that are linked to insulin resistance and  $\beta$ -cell dysfunction [9].

## VI. GESTATIONAL DIABETES

Diabetes is that is diagnosed for the first-time during pregnancy is called gestational diabetes. Like other types of diabetes, gestational diabetes affects how your cells use sugar (glucose). Gestational diabetes causes high blood sugar that can affect your pregnancy and your baby's health. Risk factors of Gestational diabetes are overweight, excessive weight gain during pregnancy, family history of diabetes. GDM with congenital abnormality affects infant during pregnancy. Diabetes and GDM in pregnancy increase risk in future linked with obesity and type 2 diabetes. Gestational diabetes mellitus is comparatively common problem of pregnancy [10]. The occurrence varies from 1.7% to 14%, reliant on the conditions used for evaluating glucose tolerance in studies where universal screening was implemented [11], [12]. The glucose-challenge screening test provide many false-positive results were further subjected to hostile oral glucose- tolerance tests diagnostic purpose. The diagnosis tags many pregnant

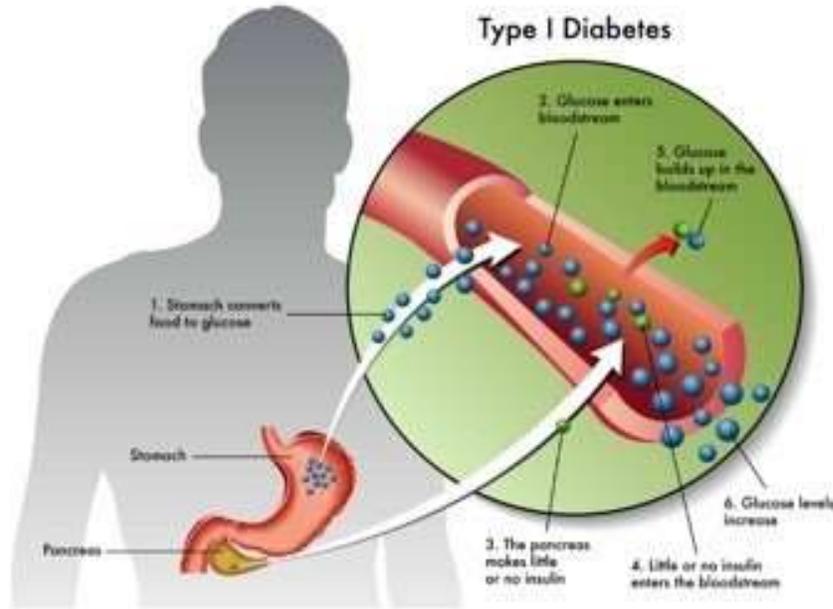


Figure 2. Type 1 diabetes

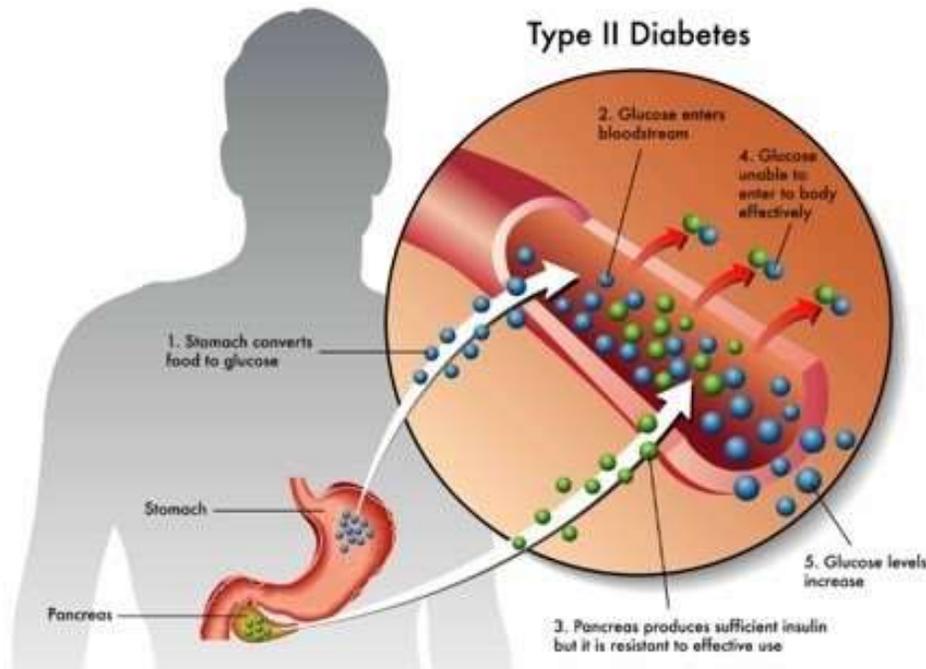


Figure 3. Type 2 diabetes

women as” high risk” and reveals them to a cascade of interventions. The researcher observes the basis in the literature for universal screening practices [13]. The research on Gestational Diabetes Mellitus are presented were the risks factors and assistances of alternative diagnosis, controls, reviews and screening approaches are reviewed in the current literature. Gestational diabetes mellitus is basically defined as carbohydrate intolerance of severity during the present pregnancy [14].

## VII. SUMMARY AND CONCLUSION

Diabetes is caused by metabolic disorder and abnormal blood sugar level which leads to insufficient level of insulin

production. India has the higher prevalence rate of diabetes. Once it was considered as a disease its impact is experienced from old age group to young age kids with severe morbidity and mortality, complications due to diabetes are the core cause of disability, reduced quality of life, and death. Diabetes consequences can disturb various parts of the body revealing in different ways for different people. Diabetes increases patients risk linked to serious health problems. More than 80 years ago, the WHO specified that health was well-defined not only by the absence of disease and susceptibility, but also by the incidence of social, mental and physical well-being. Though health care professional's emphasis on medical outcomes alone when evaluating the efficacy of their interventions. As per the medical term, there is no exact cure for diabetics but detection of diabetic at the early stage early detection can reduce the long-term consequences with reduced cost. The current machine learning algorithms used in the diabetic prediction is insane. Advancement in biotechnology and health science have led a path for significant production of data with the help of genetic and clinical information data. Machine learning and data mining plays a vital role in today's research for accurate diagnosis and management of diabetes.

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