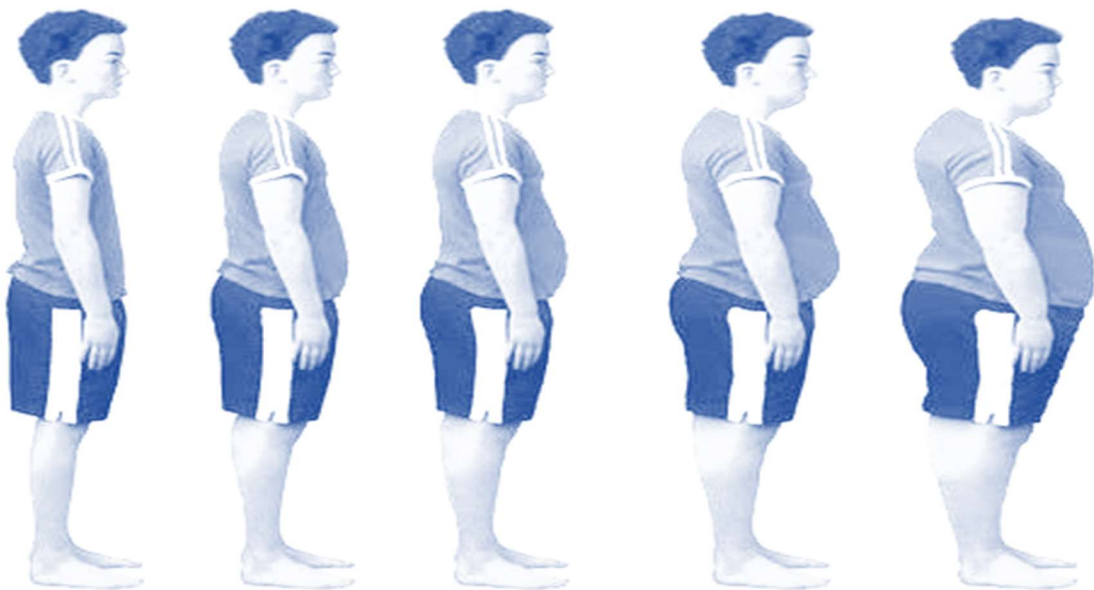


# OVERWEIGHT AND OBESITY

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## INTRODUCTION

According to the World Health Organization (WHO), “Overweight and obesity are defined as abnormal or excessive fat accumulation that may impair health.” Obesity, a ticking time bomb, has enormous potential to harm our economy and health. According to the World Bank, globally about 6% of children aged under 5 years, 20% of children aged 5–19 years, and 44% of adults aged 20 years and older were overweight or obese in 2016. Now overweight and obesity become about three times since 1975 and accounts for about 7% of deaths from all causes globally, about two-thirds of which are because of cardiovascular diseases. They account for about 5% of global disability-adjusted life years (DALYs) loss from all causes. Type 2 diabetes and osteoarthritis cause the largest increase in DALYs loss.



**Figure 1. External appearances of normal weight people to overweight and obese people**

## MEASUREMENT OF OVERWEIGHT AND OBESITY

Generally, excessive fat accumulation of the whole body (referred to as overweight and obesity) is measured by Body Mass Index (BMI) (an index of weight relative to length or height), and excessive fat accumulation of the abdomen (referred to as abdominal obesity, visceral obesity or central obesity) is measured by the waist circumference and the waist to hip ratio. The waist circumference and the waist to hip ratio are used as additional measures to

compliment the measurement of BMI, to identify individuals at increased risk of obesity-related morbidity because of accumulation of the abdominal fat.

## I. BMI Method

BMI is calculated by dividing the subject's weight in kilogram by the square of his or her length or height in meter i.e.

$$\text{BMI} = \text{Weight in kilogram} / \text{length or height in meter}^2$$

BMI diagnoses wasting or thinness (underweight) as well as overweight and obesity. BMI is interpreted according to sex and age. BMI-for-age is suitable for children from birth to 19 years of age. BMI-for-age Z-score based classifications of overweight and obesity for the children aged 0-5 years and 5-19 years are given below in Table 1 and Table 2, respectively:

<b>Table 1. Classification of the children aged 0-5 years according to BMI-for-age Z-score cut-offs</b>	
<b>Classification</b>	<b>BMI-for-age (kg/m<sup>2</sup>) Z-score cut-off points</b>
Severely wasted	<-3
Moderately wasted	≥-3 to <-2
Normal weight	≥-2 to ≤+1
Risk of overweight	>+1 to ≤+2
Overweight	>+2 to ≤+3
Obese	>+3

**Source:** Kristen Cashin and Lesley Oot. 2018. *Guide to Anthropometry: A Practical Tool for Program Planners, Managers, and Implementers*. Washington, DC: Food and Nutrition Technical Assistance III Project (FANTA)/ FHI 360, p 220.

<b>Table 2. Classification of the children aged 5-19 years according to BMI-for-age Z-score cut-offs</b>	
<b>Classification</b>	<b>BMI-for-age (kg/m<sup>2</sup>) Z-score cut-off points</b>
Severely wasted	<-3
Moderately wasted	≥-3 to <-2
Normal weight	≥-2 to ≤+1
Overweight	>+1 to ≤+2
Obese	>+2

**Source:** Kristen Cashin and Lesley Oot. 2018. *Guide to Anthropometry: A Practical Tool for Program Planners, Managers, and Implementers*. Washington, DC: Food and Nutrition Technical Assistance III Project (FANTA)/ FHI 360, p 220.

Classification of adult according to BMI irrespective of sex is given in Table 3 below:

<b>Table 3. Classification of adults according to BMI irrespective of sex</b>	
<b>Classification</b>	<b>BMI (kg/m<sup>2</sup>) cut-off points</b>
Underweight/thin (Europids & Asians)	<18.5
Severely thin	<16.0
Moderately thin	16.0 -16.9
Mildly thin	17.0 - <18.5
Normal weight	
Europids	18.5 – 24.9
Asians	18.5 – 22.9
Overweight/Pre-obese	
Europids	25.0 - 29.9
Asians	23.0 - 24.9
Obese	
Obese I	
Europids	30.0 - 34.9
Asians	25.0 - 29.9
Obese II	
Europids	35.0 - 39.9
Asians	≥ 30.0
Obese III (Europids)	≥ 40.0
<b>Sources:</b>	
1. The Asia-Pacific perspective: Redefining obesity and its treatment. WHO, IASO and IOTF document, 2000, pp 17 & 18.	
2. Kristen Cashin and Lesley Oot. 2018. Guide to Anthropometry: A Practical Tool for Program Planners, Managers, and Implementers. Washington, DC: Food and Nutrition Technical Assistance III Project (FANTA)/ FHI 360, p 20.	

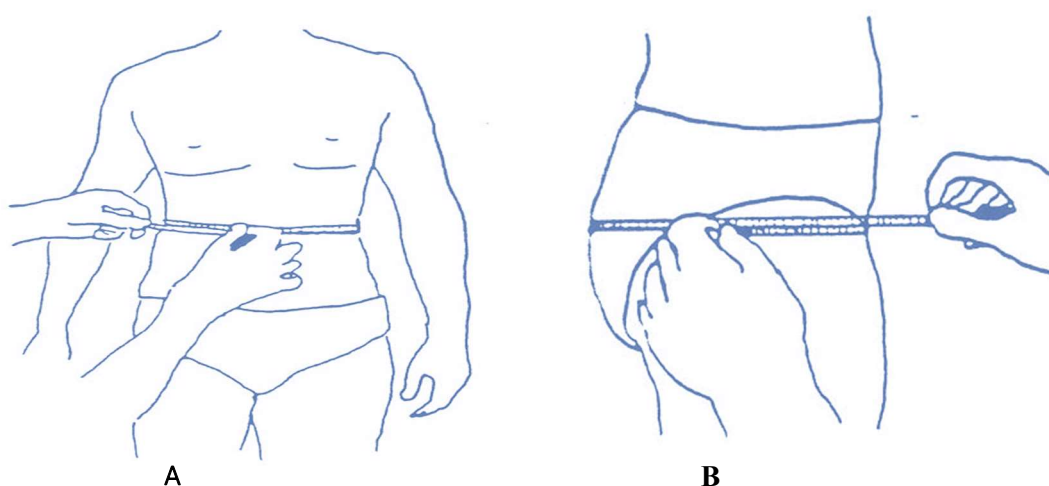
## II. Waist-Hip Ratio (WHR) and Waist Methods

### 1. Waist-hip ratio (WHR) method

Waist–hip ratio is a ratio obtained dividing the waist circumference (circumference of the waist, just 2.5 cm above the umbilicus or navel) by the hip circumference (the largest circumference of the hip). Waist-hip ratio is used as an additional measure of body fat distribution. The ratio can be measured more accurately than skin folds, and can act as an index of both subcutaneous and intra-abdominal adipose tissue. In Asian men, abdominal obesity (measured as waist–hip ratio) was found to remain associated with an increased risk of myocardial infarction, stroke and premature death, whereas these diseases were not associated with BMI. In women, BMI was associated with enhanced risk of these diseases; however, the association of waist–hip ratio was stronger than that of BMI.

Table 4 shows the epidemiological criteria for assessing the severity of excess fat accumulation based on the prevalence of overweight and obesity in adults and children.

<b>Table 4. Proposed cutoff values for public health significance of prevalence of overweight/obesity in adults and children</b>	
<b>Prevalence group</b>	<b>Prevalence of overweight/obesity</b>
<i>Adults aged 20 years and older</i>	
Low	<20%
Medium	≥20-29%
High	≥30-39%
Very high	≥40%
<i>Children aged 5-19 years</i>	
Low	<10%
Medium	≥10-14%
High	≥15-19%
Very high	≥20%
<i>Children under 5 years</i>	
Low	<10%
Medium	≥10-14%
High	≥15-19%
Very high	≥20%
<b>Source:</b> Obesity: Health and Economic Consequences of an Impending Global Challenge. Meera Shekar and Barry Popkin, Editors. World Bank Group, 2020, p 51.	



**Figure 2. Measurements of waist circumference (A) and hip circumference (B)**

The WHO defines abdominal obesity as a waist-hip ratio  $>0.90$  for men and  $>0.85$  for women, or a body mass index (BMI)  $\geq 30.0$ . The National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) defines abdominal obesity as a waist-to-hip circumference ratio of  $>1.0$  for men and  $>0.8$  for women, which remains associated with higher levels of cholesterol. The German Society for Sports Medicine (Prevention Deutsche

Gesellschaft für Sportmedizin und Prävention. V. i.e., DGSP) specifies different WHR cut-off points to classify men and women as normal, overweight and obese (Table 5).

Classification	DGSP		WHO		NIDDK	
	Men	Women	Men	Women	Men	Women
Normal weight	<0.90	<0.80	-	-	-	-
Overweight	0.90-0.99	0.80-0.84	-	-	-	-
Obese	>1.00	>0.85	>0.90	>0.85	>1.00	>0.80

**Source:** Waist-hip ratio [https://en.wikipedia.org/wiki/Waist%E2%80%93hip\\_ratio](https://en.wikipedia.org/wiki/Waist%E2%80%93hip_ratio) (Accessed on 24 September, 2022)

## 2. Waist circumference method

Abdominal obesity is further defined by waist circumference. A study published in the *European Heart Journal* April 2007 showed that waist circumference was predictor of cardiovascular events. Several WHO publications recommend waist as one of the components of metabolic syndrome which is characterized by glucose intolerance, IGT (impaired glucose tolerance) or diabetes mellitus, and/or insulin resistance together with two or more components which include abdominal obesity in addition to high arterial pressure, high plasma triglycerides and microalbuminuria.

Waist circumference cut-off points proposed by different agencies are shown in Table 6 below:

Agency	Cut-off points
WHO	<b>Increased risk of disease</b> Men: >94 cm; Women: >80 cm <b>Substantially increased risk of disease</b> Men: >102 cm; Women: >88 cm
International diabetes federation	Men (Asian—refers to South Asian, Chinese, and Japanese): > 90 cm; Men (European): >94 cm Women (European and Asian): > 80 cm
U.S. National Cholesterol Education Program	Men: >102 cm; Women: >88 cm

**Source:** Kristen Cashin and Lesley Oot. 2018. *Guide to Anthropometry: A Practical Tool for Program Planners, Managers, and Implementers*. Washington, DC: Food and Nutrition Technical Assistance III Project (FANTA)/ FHI 360, p 141.

# **CAUSES OF OVERWEIGHT AND OBESITY**

## **I. Fundamental Causes**

The most cases of obesity and overweight are the result of an energy imbalance between calories consumed and calories expended. An excessive energy consumption because of increased intake of energy-dense foods and a less energy expenditure because of an increase in physical inactivity are primarily responsible for this energy imbalance.

### **1. Increased consumption of energy-dense foods**

Because of easy accessibility i.e., cheapness and palatability of diet, there has been a global shifting towards consuming an increased amounts of energy-dense foods that are high in fat and sugars/carbohydrates. This increased consumption of energy-dense foods remains responsible for the most cases of obesity. Most of the excess food energy comes from increased carbohydrate consumption. Excess food energy derived from increased fat consumption is lower than that derived from increased carbohydrate consumption. The main sources of the extra carbohydrates are sweetened beverages (such as soft drinks, fruit drinks, and iced tea), potato chips, and fast-food meals.

### **2. Decreased physical activity**

Like increased consumption of energy-dense foods, a sedentary lifestyle (characterized by minimal physical activity) also remains associated with the most cases of obesity. Globally, there has been a large shifting towards work demanding less physical activity, and at present about 30% of the world's population gets insufficient physical exercise. This is mainly because of increasing use of mechanized transportation and labor-saving technology in the work place and home. In children, there has been a decrease in the amounts of physical activities like walking and physical education, likely because of safety concerns, less interaction with neighborhood children, and inadequate public spaces for safe physical activity. In both children and adults, television viewing remains associated with increased risk of obesity proportionate to time spent watching television.

### **3. Lack of supportive policies appropriate to development related environmental and societal changes**

Changes in dietary and physical activity patterns inducing obesity are often the result of development related environmental and societal changes and lack of supportive policies in sectors like health, agriculture, environment, transport, urban planning, food processing, distribution, marketing, and education.

## **II. Other Causes**

A limited number of obesity cases are due primarily to following causes:

## 1. Insufficient sleep

In shift workers, shorter sleeping periods cause overweight and obesity. Children show a more consistent correlation between sleep debt and obesity compared to adults.

## 2. Abnormal physiological conditions

Abnormal conditions like hypothyroidism, Cushing's syndrome, growth hormone deficiency, and the eating disorders (binge-eating disorder and night eating syndrome) can increase the risk of obesity.

## 3. Medications

Some medications like taking of insulin, steroids, sulfonylureas, thiazolidinediones, atypical psychotics, antidepressants, pizotifen, and some anticonvulsants (phenytoin and valproate) and hormonal contraceptives may cause overweight and obesity.

## 4. Epigenetic factors

Obesity is the combined result of genetics, epigenetics, and environmental factors. Epigenetic changes may take place in response to environmental exposures like overnutrition. Epigenetic mechanisms are defined as heritable modulation of gene function without changes of DNA sequence. Epigenetic changes include DNA methylation, non-coding RNAs and histone.

## 5. Undernutrition

Childhood undernutrition causes obesity in grown-up stage. Endocrine changes that take place during the periods of undernutrition may facilitate the storage of fat when more calories are available.

## 6. Genetics

Genetics can also cause weight gain. Polymorphisms of appetite and metabolism controlling genes put at risk of obesity when sufficient calories are available. More than 41 such genes are found to promote obesity when environment is favorable. People with two copies of the FTO gene (fat mass and obesity associated gene) are found to have 3-4 kg more weight and a 1.67 folds higher risk of obesity than those without the risk allele.

Obesity is an important characteristic of many genetic defects related syndromes like Bardet-Biedl syndrome, Cohen syndrome, MOMO syndrome (Macrosomia-obesity-macrocephaly-ocular syndrome), and Prader-Willi syndrome. Studies focused on inheritance patterns have shown that 80% of the offspring of two obese parents were obese and less than 10% of the offspring of two obese parents were normal in weight. Different people exposed to the same environment have different risks of obesity because of their underlying genetics. Some ethnic groups may be at more risk of obesity in similar environment.

## 7. Late age pregnancy

Pregnancy at later stage may cause the children susceptible to obesity.



## 8. Cold environment

Cold ambient temperature can cause obesity. Cold environment influencing the hormones related to the hunger increases appetite leading to overeating and then inactivity.

## 9. Decreased smoking

Decreased rate of smoking causes obesity, because suppression of appetite by smoking gets reduced or stopped.

# **PATHOPHYSIOLOGY OF OVERWEIGHT AND OBESITY**

Pathophysiology of obesity is the study of abnormal physiological processes that induce, arise from, or are otherwise associated with obesity. There are several possible pathophysiological mechanisms which may remain associated with the development and maintenance of obesity. Two most well understood pathophysiological mechanisms involved in the development and maintenance of obesity are ghrelin and leptin mediated mechanisms.

Ghrelin and leptin are complementary in their influence on appetite. Ghrelin, being produced by the stomach, mediates short-term appetite controls (i.e., to start eating when the stomach is empty and to stop eating when the stomach is stretched). Leptin, being produced by adipose tissue, gives signal regarding fat storage in the body, and thereby mediates long-term appetite controls (i.e., to eat more when fat storages are low and to eat less when fat storages are high).

Ghrelin and leptin control appetite through their actions on the hypothalamus. There are many circuitous pathways within the hypothalamus that integrates appetite. The most well understood melanocortin pathway begins from the arcuate nucleus of the hypothalamus, that sends outputs to the lateral hypothalamus (LH) which acts as feeding or appetite center and the ventromedial hypothalamus (VMH) which acts as satiety center. The arcuate nucleus sends outputs through two groups of neurons. The first group co-expresses neuropeptide Y (NPY) and agouti-related peptide (AgRP) which stimulate the LH and inhibit the VMH. The second group co-expresses pro-opiomelanocortin (POMC) and cocaine- and amphetamine-regulated transcript (CART) which stimulate the VMH and inhibit the LH. Thus, NPY/AgRP neurons stimulate feeding and inhibit satiety, while POMC/CART neurons stimulate satiety and inhibit feeding in normal individuals.

Ghrelin shows an increase in plasma levels before meals (That is why it is called hunger hormone), and a decrease in plasma levels after meals that remains associated with a change in plasma leptin levels. Ghrelin stimulates the LH to produce a sensation of hunger that leads to food intake and promotes a weight gain. Ghrelin stimulates the LH through AgRP/NPY neurons (orexigenic neurons), which inhibit POMC/CART neurons (anorexigenic neurons) through GABA projections. Leptin stimulates the VMH to produce a sensation of satiety. Furthermore, leptin inhibits ghrelin-mediated stimulation of the LH to inhibit the effects of ghrelin. Normally, high circulating leptin levels inhibit food intake and promote a weight loss. Leptin remains in balance with ghrelin to maintain proper energy homeostasis and healthy body weight. A deficiency in leptin activity, because of either leptin deficiency or leptin resistance, causes overfeeding and may be responsible for some genetic and acquired forms of obesity.



## CONSEQUENCES OF OVERWEIGHT AND OBESITY

### I. Health Risks or Consequences

Overweight and obesity have been linked to a broad spectrum of health risks or consequences which can cost life, cause premature death, and reduce life expectancy. The most common health risks or consequences associated with obesity are outlined below:

#### 1. Cardiovascular diseases

Cardiovascular diseases (CVD) linked to obesity mainly include the following:

**(i) Coronary heart disease (CHD)/Coronary artery disease (CAD)/Ischemic heart disease (IHD)/Myocardial ischemia/Atherosclerotic heart disease (AHD)/Atherosclerotic vascular disease (AVD)** – It is an abnormal condition characterized mainly by the decreased supply of blood and oxygen to the heart muscle because of narrowing of coronary arteries by atherosclerotic plaque (an abnormal flat structure made of fat, cholesterol, calcium and other components of blood) build-up. Its common symptoms are chest pain (angina pectoris) during exercise and emotional stress, that lasts for less than a few minutes and improve on rest, and shortness of breath. When it leads to sudden block of coronary artery, myocardial infarction or heart attack occurs.

**(ii) Heart failure (HF)/ Congestive heart failure (CHF)** - It is an abnormal condition in which the heart cannot pump (less systolic) or fill (less diastolic) adequately. It is mainly caused by CAD, atrial fibrillation, hypertension, and heart attack.

**(iii) Hypertension** - Too high blood pressure is known as hypertension. High blood pressure is diagnosed as hypertension if the systolic blood pressure is  $\geq 140$  mmHg and/or the diastolic blood pressure is  $\geq 90$  mmHg consistently at least on two different days.

**(iv) Stroke or Cerebrovascular accident (CVA)** – It refers to the sudden brain cell death resulting in rapid loss of brain functions, which occurs because of a lack of blood supply to the brain owing to the blocking of an artery by a blood clot (ischemic stroke) or the leakage of blood.

**(v) Atrial fibrillation (AF)** - It is a condition of an abnormal heart rhythm, a kind of arrhythmia (arrhythmia includes atrial and ventricular fibrillations, irregular heartbeats, bradycardia [too slow heartbeats i.e.,  $< 60$  beats per minute in adults], and tachycardia [too fast heartbeats i.e.,  $> 100$  beats per minute in adults]), characterized by rapid and irregular beating of the atrial chambers, which results in poor blood flow and remains associated with a high risk of heart failure, stroke, and dementia.

**(vi) Heart attack or Myocardial infarction (MI)** – It refers to tissue death (infarction) of the heart muscle (myocardium), which occurs because of a lack of blood supply (that leads to the lack of oxygen delivery to myocardial tissue) to the heart owing to the total blocking of an artery by a blood clot initiated by the ruptures of atherosclerotic plaque.

**(vii) Cardiac arrest and Sudden cardiac death** – It refers to sudden and unexpected stopping of heart beat, which without immediate medical intervention leads within minutes to sudden cardiac death. Cardiac arrest occurs mainly because of CAD and heart failure, and is diagnosed by the absence of pulse.

**(viii) Idiopathic intracranial hypertension** – It is a condition characterized by increased intracranial pressure (pressure surrounding the brain), headache and vision problems without a detectable cause.

**(ix) Deep vein thrombosis** – It refers to a blockage in the deep veins of legs or pelvis caused by thrombus (blood clot) formation,

**(x) Pulmonary embolism** – It refers to a blockage in an artery of the lungs by a thrombus that has come from another part of the body.

**(xi) Hypercholesterolemia** – It is a condition of too high cholesterol level in blood. High cholesterol level is diagnosed as hypercholesterolemia if total cholesterol level is  $>6.2$  mmol/L or  $> 240$  mg/dL.

The group of CVDs is the first leading cause of death globally (about 32% of all deaths globally). Therefore, **World Heart Day** is being observed every year on 29 September by World Heart Federation & WHO from 1999, to improve awareness, prevention and management of CVDs globally.

## 2. Neurological diseases

Neurological diseases linked to obesity mainly include the following:

**(i) Dementia** -It is characterized by decreased ability to think and remember, and results from a variety of diseases and injuries that affect the brain, such as Alzheimer's disease or stroke.

**(ii) Multiple sclerosis (MS)** – It is a disease of the nervous system, which damages the myelin sheath of brain and spinal cord,

**(iii) Meralgia paresthetica/ Lateral femoral cutaneous neuropathy** - It is a chronic disorder characterized by burning sensation, tingling, numbness or pain in outer thigh. It is caused by injury, damage, or compression of the lateral femoral cutaneous nerve that passes through the inguinal ligament and provides sensation to the skin covering thigh.

**(iv) Migraines** – It is a neurological disorder characterized by recurrent severe headaches, and nausea (vomiting tendency).

**(v) Carpel tunnel syndrome** – Its symptoms are numbness, and tingling in the thumb, index, middle and ring fingers. It occurs when the median nerve, which runs from the forearm into the hand, gets compressed or squeezed at the carpel tunnel of the wrist.

### 3. Endocrine & Reproductive diseases

Endocrine & reproductive diseases linked to obesity mainly include the following:

**(i) Diabetes mellitus type 2** – It is characterized by too high blood sugar, and insulin resistance and or relative insulin deficiency. High blood sugar is diagnosed as diabetes mellitus if fasting plasma glucose level is  $\geq 7.0$  mmol/L (126 mg/dL), and plasma glucose level 2 hours after ingestion of 75g oral glucose load is  $\geq 11.1$  mmol/L (200 mg/dL), or glycated hemoglobin (HbA<sub>1c</sub>) is  $\geq 48$  mmol/mol ( $\geq 6.5$  DCCT%) [DCCT - Diabetes Control and Complication Trial].

Diabetes mellitus is responsible for about 3.6% of all deaths globally. Therefore, **World Diabetes Day** is being observed every year on 14 November by International Diabetes Federation & WHO from 1991 to promote diabetes care, prevention and a cure worldwide creating awareness about diabetes.

**(ii) Polycystic ovarian syndrome** - It refers to the presence of many small, fluid-filled sacs or cysts inside the ovaries.

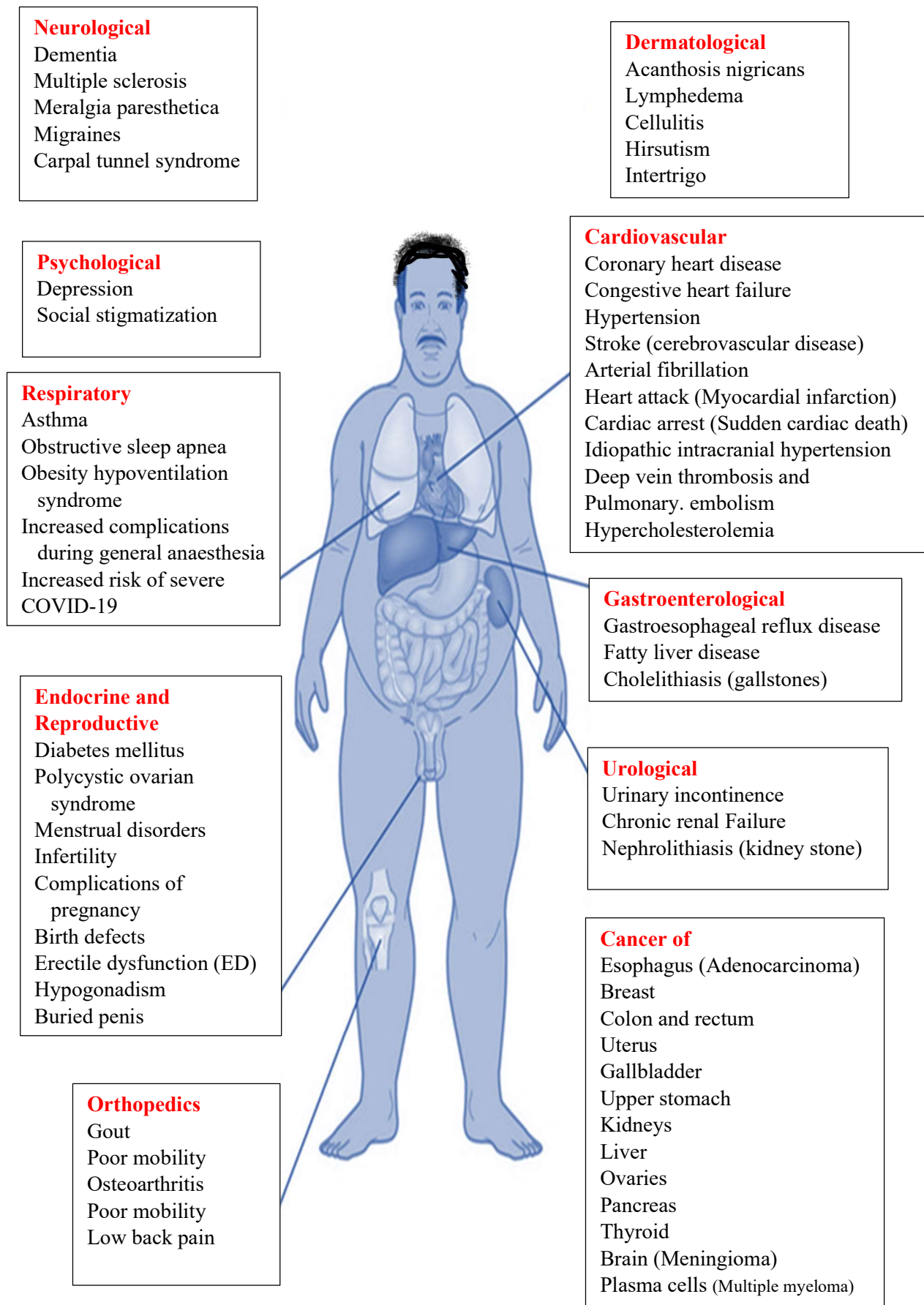
**(iii) Menstrual disorders** - Menstrual abnormalities mainly include amenorrhea (absence of menstruation), and/or abnormal uterine bleeding (i.e., menorrhagia or hypermenorrhea [heavy or prolonged bleeding], oligomenorrhea [menstruations occurring at intervals of  $> 35$  days], polymenorrhea [menstruations occurring at intervals of  $< 21$  days], and hypomenorrhea [menstruations of decreased bleeding and or of very short period], dysmenorrhea [menstruation associated painful involuntary contraction of uterine muscle]).

**(iv) Infertility** – It is characterized by the failure of the male or female reproductive system to achieve a pregnancy after 1 year or longer of regular unprotected sexual intercourse, and irregular ovulation.

**(v) Complications of pregnancy** – Complications of pregnancy mainly include hemorrhaging, internal bleeding, coma, miscarriages, stillbirth (intrauterine fetal death), and death of both the infant and the mother.

**(vi) Birth defects** - Birth defects mainly include heart defects, neural tube defects and Down syndrome.

**(vii) Erectile dysfunction/ Impotence** – It refers to the failure of penis to stay erect during sexual activity.



**Figure 3. Complications associated with obesity**

**(viii) Hypogonadism** - It refers to decreased functional activity of the gonads (the testes or the ovaries) that may cause reduced production of sex hormones - testosterone and estrogen.

**(ix) Buried penis/ Hidden penis** - It is a condition in which a normal sized penis gets concealed partially or completely by the surrounding subcutaneous fat and soft tissues of the scrotum, thighs, or hypogastrium. The condition may cause urinary difficulties, inhibition of normal sexual function, poor hygiene, and infection.

#### 4. Cancer

According to the Centers for Disease Control and Prevention (CDC), overweight and obesity are associated with increased risk of following 13 types of cancer:

- (i) Adenocarcinoma of the esophagus
- (ii) Breast (in women who have gone through menopause)
- (iii) Colon and rectum
- (iv) Uterus
- (v) Gallbladder
- (vi) Upper stomach
- (vii) Kidneys
- (viii) Liver
- (ix) Ovaries
- (x) Pancreas
- (xi) Thyroid
- (xii) Meningioma (a type of brain cancer)
- (xiii) Multiple myeloma/ Myeloma (cancer of plasma cells [a type of white blood cell] associated with bone pain)

Cancer is the second leading cause of death globally (about 16% of all deaths globally). Therefore, **World Cancer Day** is being observed every year on 4 February by International Union Against Cancer & WHO from 2005 to create awareness about cancer and to encourage its prevention, detection, and proper treatment.

#### 5. Respiratory diseases

Respiratory diseases linked to obesity mainly include the following:

**(i) Asthma** – It is a condition in which the small airways in the lungs get narrow because of inflammation and tightening of the muscles around the small airways, leading to cough, wheeze, shortness of breath and chest tightness.

**(ii) Obstructive sleep apnea** – It refers to recurrent episodes of complete or partial obstruction of the upper airway leading to complete cessation of breathing (apnea) or partial cessation of breathing (hypopnea) during sleep.

**(iii) Obesity hypoventilation syndrome** – It is a condition in which obese people fail to breathe rapidly or deeply enough, leading to low oxygen levels and high carbon dioxide levels in blood.

**(iv) Increased complications during general anaesthesia** – The complications mainly include:

(a) a difficulty in placing a breathing tube in the trachea of an obese person to breathe under the anaesthesia

(b) getting anaesthesia more harmful in an obese person than in a normal weight person for having lower oxygen levels in an obese person than in a normal weight person

(c) a difficulty in finding a vein to place canula for a general anaesthesia

(d) a difficulty in carrying out another anesthetic technique such as epidural, spinal or nerve block

(e) obese person's taking longer time to come round and recover from a general anaesthesia

(f) obstructive sleep apnea of obese person making general anaesthesia (that causes one to lose consciousness) riskier for obese person

**(v) Increased risk of severe COVID-19**

Obesity increases the risk of severe illness from COVID-19, which may be because of impaired immune function linked to obesity. Obesity may triple the risk of hospitalization due to COVID-19 infection.

## 6. Orthopedic diseases

Orthopedic diseases linked to obesity mainly include the following:

**(i) Gout** – The symptoms of gout include joint pain, swelling and redness. It is caused by the deposition of uric acid and its salts. When its level increases to 380  $\mu\text{mol/l}$ , crystallization and deposition of uric acid and its salts occur predominantly in the articular tissue, soft tissues around the joints, helix, and in the renal parenchyma.

**(ii) Osteoarthritis** - It is a degenerative change in joints due to biochemical degradation of hyaline cartilage. It also leads to damage of the subchondral bone, formation of osteophytes (bone spurs), inflammatory process in the synovium, etc. Its common symptoms are joint pain, stiffness, joint swelling, and decreased motion.

**(iii) Poor mobility** – It a condition of having difficulty in walking and moving.

**(iv) Low back pain (LBP)/ Lumbago** - It is a painful disorder affecting the muscles, nerves, and bones of the back, in between the lowest rib and the upper part of the buttocks.

## 7. Psychiatric or psychological disorders

Psychiatric or psychological disorders linked to obesity mainly include the following:

- (i) **Depression** - It is a mental disorder characterized by low mood and aversion to activity.
- (ii) **Social stigmatization** – Obese persons often get disapproval and unfair treatment publicly, because of their obesity. This anti-fat bias of society causes mental stress in obese persons, which has negative health outcomes.

## 8. Dermatological diseases

Dermatological diseases linked to obesity mainly include the following:

- (i) **Acanthosis nigricans** – It refers to brown-to-black, velvety hyperpigmentation of the skin in the folds of the neck, armpits, groin, navel, forehead and other areas.
- (ii) **Lymphedema** – It is a condition of excess fluid accumulation leading to swelling (edema) in a limb due to lymphatic hypoplasia (primary) or to obstruction or disruption (secondary) of lymphatic vessels.
- (iii) **Cellulitis** - It is a bacterial skin infection characterized by redness, swelling, and pain in the infected area of the skin.
- (iv) **Hirsutism** - It is a condition of man-like excessive hair growth in the face, chest and back of women because of hormonal imbalance.
- (v) **Intertrigo** - It refers to a type of inflammatory rash (dermatitis) of the superficial skin that occurs within a person's body folds, that is caused by skin-to-skin friction (rubbing) and intensified by heat and moisture.

## 9. Gastroenterological diseases

Gastroenterological diseases linked to obesity mainly include the following:

- (i) **Gastroesophageal reflux disease (GERD)** – It is a chronic condition in which stomach acid repeatedly flows back up into the esophagus. Many people experience acid reflux from time to time as the reflux irritates the lining of the esophagus.
- (ii) **Fatty liver disease/ Hepatic steatosis** – It is a condition of excessive fat accumulation in liver that may lead to liver cirrhosis and cancer.
- (iii) **Cholelithiasis/ Gallstone** – It is a hardened deposit formed within the gallbladder from the precipitated bile components leading to inflammation.

## 10. Urological diseases

Urological diseases linked to obesity mainly include the following:

- (i) **Urinary incontinence** - It is an abnormal condition of involuntary urination.



**(ii) Chronic renal failure** – It is a chronic condition of kidneys' inability to filter and clean blood, which leads to increased levels of waste products in blood and remains linked to increased risk of death.

**(iii) Nephrolithiasis/ Kidney stone disease/ Urolithiasis** - It is a hardened deposit of material (kidney stone) formed in the urinary tract. A small stone may pass through urine without causing any symptom. If a stone gets larger than 5 millimeters, it can block the ureter, resulting in sharp and severe pain in the lower back or abdomen, and sometimes blood in the urine, vomiting, or painful urination.

## **11. Vitamin D deficiency**

An increased risk of vitamin D deficiency (a condition of vitamin D level below normal range of 30–50 ng/mL or 75–125 nmol/L) is found to remain associated with overweight and obese people. This relationship is not understood clearly. Inadequate exposure to sunlight of adequate ultraviolet B rays (UVB) and inadequate dietary intake of vitamin could contribute to this relationship.

## **II. Economic Consequences**

Overweight and obesity also impose a huge economic burden on each of the three entities, namely individual, family, and nation. In 2014, the global economic impact of overweight and obesity was estimated to be at 2.8% of the global gross domestic product (GDP). Overweight and obesity impose costs in the form of excess health care expenditure, lost productivity and foregone economic growth because of lost work days, lower productivity, mortality and permanent disability. Obesity with a BMI of 30–35 decreases life expectancy by two to four years, while severe obesity with a BMI  $\geq$  40 decreases life expectancy by ten years.

## **PREVENTIVE MEASURES OF OVERWEIGHT AND OBESITY**

Overweight and obesity, and their related noncommunicable diseases, are largely preventable. Supportive environments and communities are crucial to prevent overweight and obesity by shaping people's choices, making healthier foods and regular physical activity.

To reduce the burden of overweight and obesity, a number of preventive measures need to be undertaken involving individual, family, and community. Preventive intervention measures of obesity may include changes in lifestyle, medications, or surgery. The main preventive measure encompasses weight loss by changing lifestyle that include weight loss by healthy diet measures and increased physical activity.

### **I. Healthy Diet Measures**

The United States Department of Agriculture and United States Department of Health and Human Services recommends the following dietary guidelines for achieving healthy weight and overall health:

## 1. Eating a diet that is mainly composed of:

- (i) Diversified vegetables like dark green, leafy green, red and orange vegetables, and legumes (beans and peas)
- (ii) Whole fruits
- (iii) Whole grains
- (iv) High protein foods like lean meats, eggs, poultry, seafood, legumes, seeds, nuts, and soy products
- (v) Low fat and fatless dairy products – like milk, cheese, and yogurt

## 2. Avoiding or limiting the following items:

- (i) Trans fats
- (ii) Saturated fats (not exceeding 10% of total daily calories)
- (iii) Added sugars (not exceeding 10% of total daily calories)
- (iv) Salt (less than 2,300 mg of salt per day)
- (v) Alcohol (not exceeding 1 drink per day for women and 2 drinks a day for men)



**Figure 4. Diversified vegetables**

To get rid of excessive weight, following steps may be undertaken:

### 1. Increasing protein intake

A high protein diet increases thermogenesis and decreases appetite, leading to a decrease in weight.

### 2. Modifying plate size

Using smaller plates may help people to consume smaller amounts of foods. People consistently eat more food when offered larger plate size foods than when offered smaller plate-size foods.

### **3. Increasing soup intake**

Compared to solid foods, soup consumption decreases the amount of calorie intake. When soup is consumed before a meal, there is a 20% decrease in calorie intake during the meal.

### **4. Choosing low-calorie foods**

A modest decrease in calorie intake causes a slow weight loss, which is often more beneficial in the long run than rapid weight loss. The condition of low calorie intake can be achieved by choosing low calorie and low fat alternative foods. For example, choosing low fat meats reduces the intakes of calories and cholesterol.

### **5. Increasing intake of dairy items**

A diet high in dairy items reduces body fat. This occurs because a high dietary calcium increases fat excretion from the body. A calcium intake equal to or greater than 2300 mg is considered as a high calcium intake and a calcium intake less than or equal to 700 mg is considered as a low calcium intake. Calcium of dairy items causes greater weight loss than supplemental calcium intake, which may be because of the milk's other bioactive compounds that may induce metabolic efficiency and fat loss. Moreover, dairy items induce satiety by their whey protein and protein/calcium combinations, which causes weight loss facilitating energy loss.

### **6. Increasing fruit and vegetable intake**

Fruits and vegetables increase satiety and decrease hunger. These foods have a low energy density mainly because of the high water content and partly because of fiber content. The low energy density induces satiety and the dietary fiber slows gastric emptying. These two factors are responsible for the satiating effect of vegetables and fruits. Dietary fiber reduces energy intake decreasing hunger. Dietary fiber decreases weight by inducing satiety and decreasing absorption of macronutrients. Generally, a large intake of dietary fiber at breakfast leads to less food intake at a lunch.

### **7. Increasing caffeine intake**

Caffeine increases energy expenditure and subsequent weight loss. Caffeine is present in coffee, tea, and cocoa. Caffeine induces thermogenesis in the body by increasing the activity of sympathetic nervous system, which regulates of energy expenditure.

### **8. Increasing green tea intake**

Green tea contains catechins which decreases blood glucose, inhibits hepatic and body fat accumulation, and stimulates thermogenesis. Green tea increases energy expenditure and fat oxidation independent of its caffeine. Catechins also play a major role in inducing satiety. Thus, Green tea may be useful in preventing obesity.

## **II. Regular Physical Activity**

Physical activity refers to all body movements produced by skeletal muscles, which demands energy expenditure. Both moderate and vigorous physical activities improve health.

Popular physical activities include walking, cycling, wheeling, sports, active recreation and play, and can be done by everybody. Regular physical activity helps prevent and manage noncommunicable diseases like heart disease, stroke, hypertension, diabetes and a number of cancers. Besides, it helps maintain healthy body weight, decrease symptoms of depression and anxiety, and improve thinking, learning and judgment skills.



**Figure 5. Different types of physical activity**

According to WHO,

**(1)** *Infants (less than 1 year) should:*

be physically active many times every day in various ways, particularly through interactive floor-based play while awake; more is better.

**(2)** *Children 1-2 years of age should:*

do various physical activities including moderate and vigorous physical activities for at least 180 minutes every day while awake; more is better.

**(3)** *Children 3-4 years of age should:*

do various physical activities for at least 180 minutes every day, including moderate and vigorous physical activities of at least 60 minutes, while awake; more is better.

**(4)** *Children and adolescents aged 5-17 years should:*

(i) do moderate and vigorous physical activities (mostly aerobic) for at least 60 minutes per day throughout the week.

(ii) restrict the amount of time spent being sedentary.

**(5) Adults aged 18–64 years should:**

(i) do moderate aerobic physical activities for at least 150–300 minutes; or vigorous aerobic physical activities for at least 75–150 minutes throughout the week.

(ii) restrict the amount of time spent being sedentary.

**(6) Adults aged 65 years and above should:**

(i) do physical activity same as for adults aged 18-65 years; and

(ii) as part of their weekly physical activity, they should do varied multicomponent moderate or vigorous physical activities that improve functional balance and strength for 3 or more days a week, to increase functional capacity and to stop falls.

Globally, 28% of adults (men 23% and women 32%) aged 18 and over were insufficiently physically active in 2016. i.e., 28% of adults did not meet the WHO recommendations of doing moderate physical activity for at least 150 minutes, or doing vigorous physical activity for 75 minutes per week.

Globally, 81% of adolescents (85% of adolescent boys and 78% of adolescent girls) aged 11-17 years were insufficiently physically active in 2016. Adolescent girls were less active than adolescent boys, with 85% vs. 78% i.e., 81% of adolescents did not meet the WHO recommendations of doing moderate and vigorous physical activities for at least 60 minutes per day throughout the week.

### **III. Medications and Surgery**

Medications can be followed to decrease appetite or to reduce fat absorption. If diet, exercise, and medication do not work, a gastric balloon surgery or a bariatric surgery may be done to decrease stomach volume or intestine length, which causes early feeling of fullness, or decreases the absorption of food nutrients

To help people achieve and maintain a healthy weight, take appropriate treatment, and reverse the obesity crisis creating awareness about obesity including their impact and prevention among the people, **World Obesity Day** is being observed every year on 4 March from 2020 (having previously been observed on 11 October from 2015). **Anti-obesity day** is also being observed on 26 November from 2001 by VLCC (Vandana Luthra Curls and Curves), with the same aim.