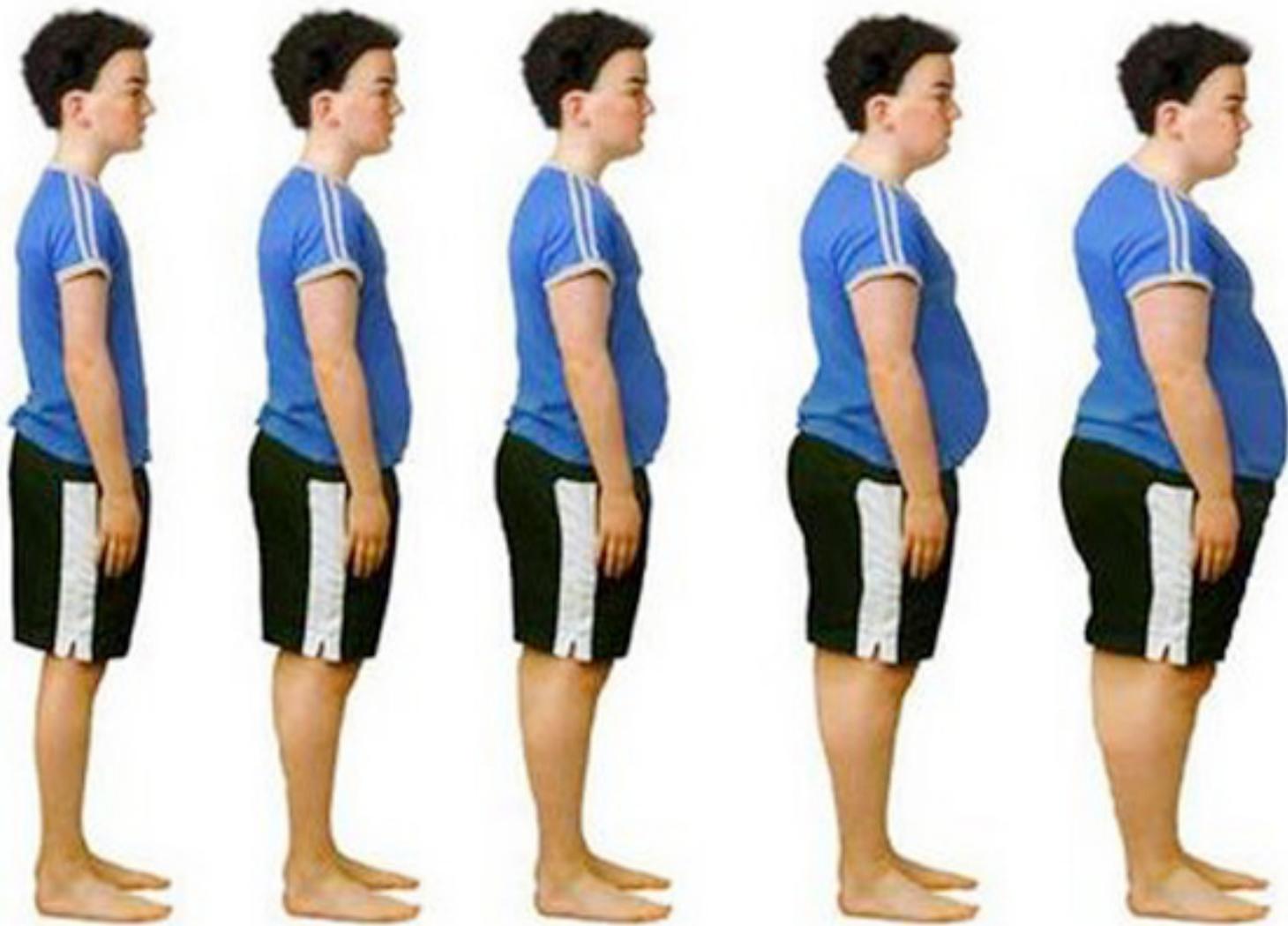


# Obesity



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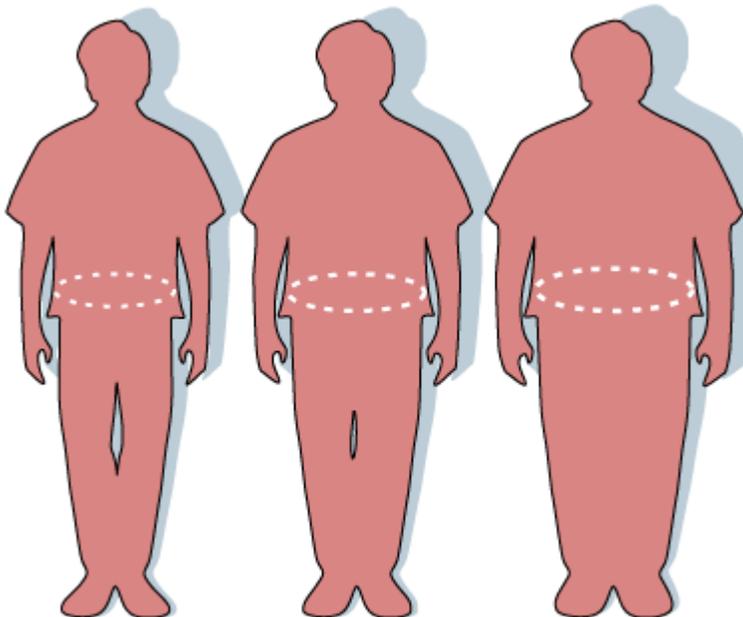
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# Chapter 1

## Obesity

### Obesity



Silhouettes and waist circumferences representing normal, overweight, and obese

<b>ICD-10</b>	E66.
<b>ICD-9</b>	278
<b>OMIM</b>	601665
<b>DiseasesDB</b>	9099
<b>MedlinePlus</b>	003101

**eMedicine**                      med/1653

**MeSH**                              C23.888.144.699.500

**Obesity** is a medical condition in which excess body fat has accumulated to the extent that it may have an adverse effect on health, leading to reduced life expectancy and/or increased health problems. Body mass index (BMI), a measurement which compares weight and height, defines people as overweight (pre-obese) if their BMI is between 25 kg/m<sup>2</sup> and 30 kg/m<sup>2</sup>, and obese when it is greater than 30 kg/m<sup>2</sup>.

Obesity increases the likelihood of various diseases, particularly heart disease, type 2 diabetes, breathing difficulties during sleep, certain types of cancer, and osteoarthritis. Obesity is most commonly caused by a combination of excessive dietary calories, lack of physical activity, and genetic susceptibility, although a few cases are caused primarily by genes, endocrine disorders, medications or psychiatric illness. Evidence to support the view that some obese people eat little yet gain weight due to a slow metabolism is limited; on average obese people have a greater energy expenditure than their thin counterparts due to the energy required to maintain an increased body mass.

Dieting and physical exercise are the mainstays of treatment for obesity. Moreover, it is important to improve diet quality by reducing the consumption of energy-dense foods such as those high in fat and sugars, and by increasing the intake of dietary fiber. To supplement this, or in case of failure, anti-obesity drugs may be taken to reduce appetite or inhibit fat absorption. In severe cases, surgery is performed or an intragastric balloon is placed to reduce stomach volume and/or bowel length, leading to earlier satiation and reduced ability to absorb nutrients from food.

Obesity is a leading preventable cause of death worldwide, with increasing prevalence in adults and children, and authorities view it as one of the most serious public health problems of the 21st century. Obesity is stigmatized in much of the modern world (particularly in the Western world), though it was widely perceived as a symbol of wealth and fertility at other times in history, and still is in some parts of the world.

### ***Classification***

Obesity is a medical condition in which excess body fat has accumulated to the extent that it may have an adverse effect on health. It is defined by body mass index (BMI) and further evaluated in terms of fat distribution via the waist-hip ratio and total cardiovascular risk factors. BMI is closely related to both percentage body fat and total body fat.



A "super obese" male with a BMI of  $47 \text{ kg/m}^2$ : weight 146 kg (322 lb), height 177 cm (5 ft 10 in)

In children, a healthy weight varies with age and sex. Obesity in children and adolescents is defined not as an absolute number, but in relation to a historical normal group, such that obesity is a BMI greater than the 95th percentile. The reference data on which these percentiles are based are from 1963 to 1994, and thus have not been affected by the recent increases in weight.

<b>BMI</b>	<b>Classification</b>
< 18.5	underweight
18.5–24.9	normal weight
25.0–29.9	overweight
30.0–34.9	class I obesity
35.0–39.9	class II obesity
$\geq 40.0$	class III obesity

BMI is calculated by dividing the subject's mass by the square of his or her height, typically expressed either in metric or US "customary" units:

$$\text{Metric: } BMI = \text{kilograms} / \text{meters}^2$$

$$\text{US customary and imperial: } BMI = lb * 703 / in^2$$

where *lb* is the subject's weight in pounds and *in* is the subject's height in inches.

The most commonly used definitions, established by the World Health Organization (WHO) in 1997 and published in 2000, provide the values listed in the table at right.

Some modifications to the WHO definitions have been made by particular bodies. The surgical literature breaks down "class III" obesity into further categories whose exact values are still disputed.

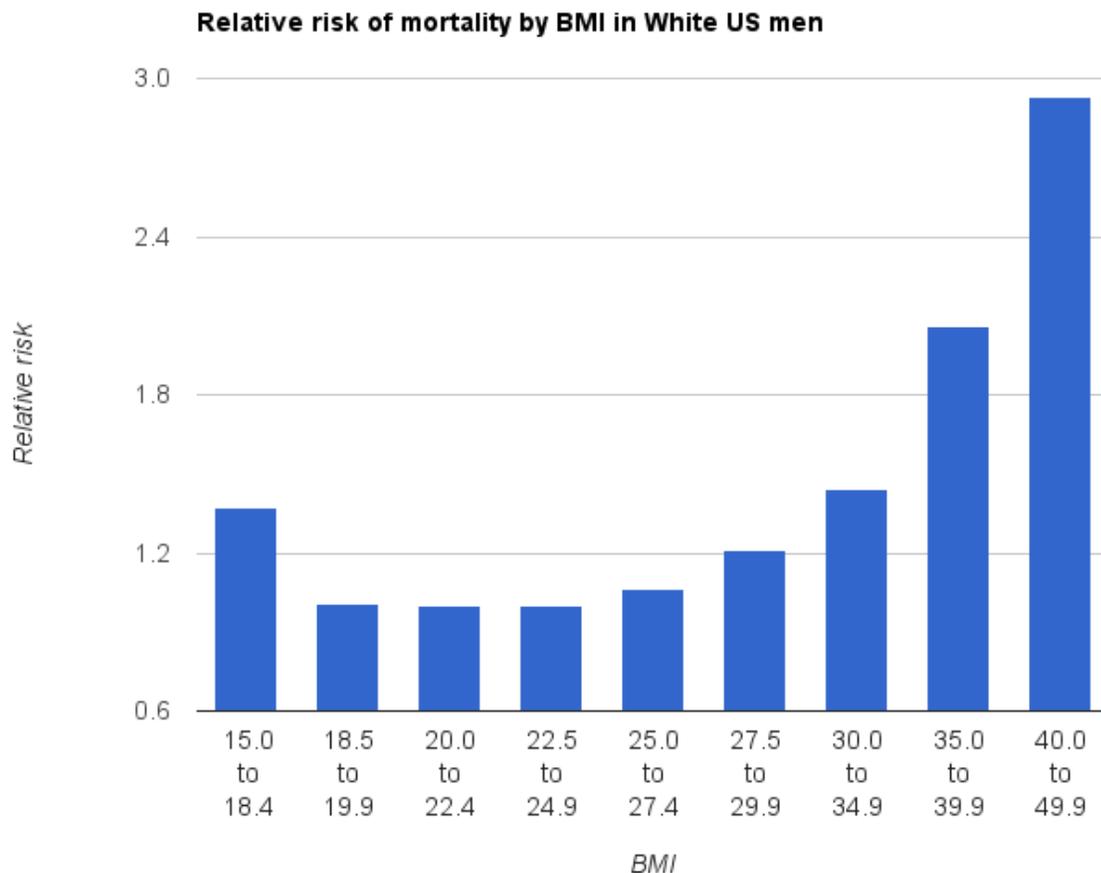
- Any BMI  $\geq 35$  or 40 is *severe obesity*
- A BMI of  $\geq 35$  or 40–44.9 or 49.9 is *morbid obesity*
- A BMI of  $\geq 45$  or 50 is *super obesity*

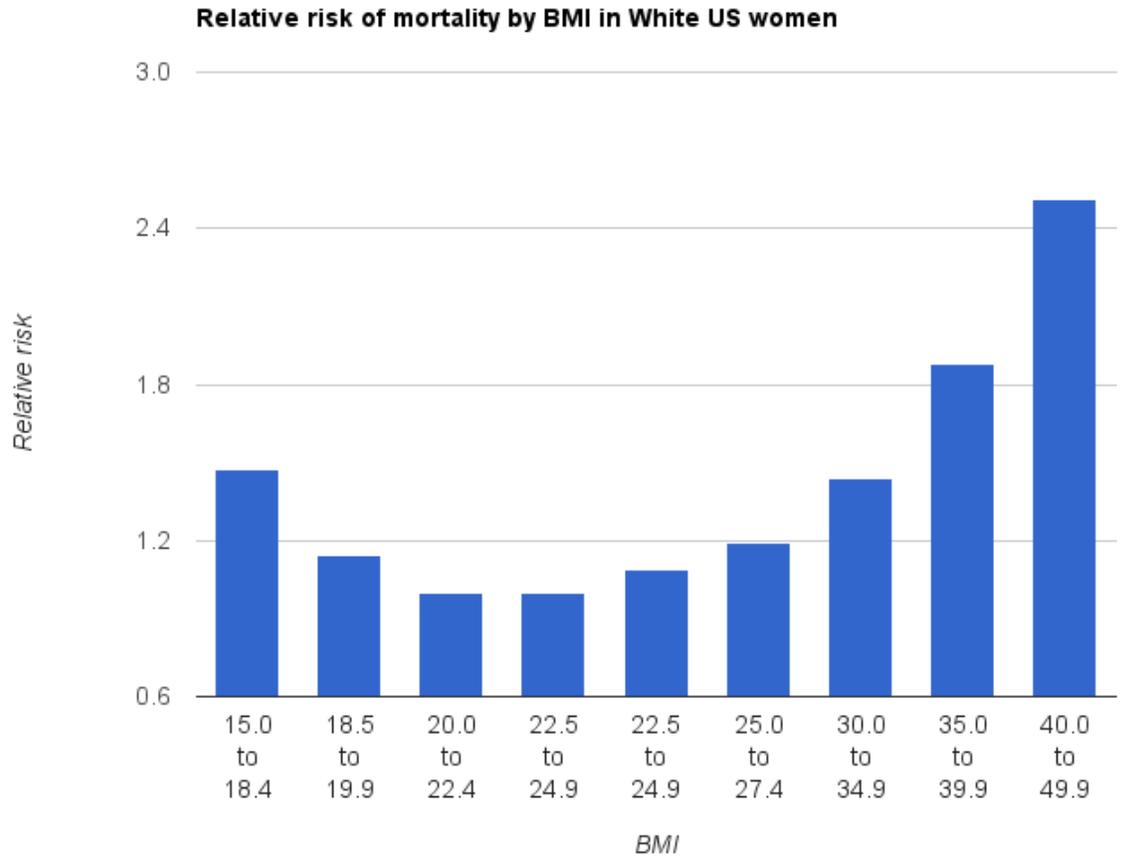
As Asian populations develop negative health consequences at a lower BMI than Caucasians, some nations have redefined obesity; the Japanese have defined obesity as any BMI greater than 25 while China uses a BMI of greater than 28.

### Effects on health

Excessive body weight is associated with various diseases, particularly cardiovascular diseases, diabetes mellitus type 2, obstructive sleep apnea, certain types of cancer, and osteoarthritis. As a result, obesity has been found to reduce life expectancy.

### Mortality





Relative risk of death for White men (left) and women (right) who have never smoked in the United States by BMI.

Obesity is one of the leading preventable causes of death worldwide. Large-scale American and European studies have found that mortality risk is lowest at a BMI of 20–25 kg/m<sup>2</sup> in non-smokers and at 24–27 kg/m<sup>2</sup> in current smokers, with risk increasing along with changes in either direction. A BMI above 32 has been associated with a doubled mortality rate among women over a 16-year period. In the United States obesity is estimated to cause an excess 111,909 to 365,000 deaths per year, while 1 million (7.7%) of deaths in the European Union are attributed to excess weight. On average, obesity reduces life expectancy by six to seven years: a BMI of 30–35 reduces life expectancy by two to four years, while severe obesity (BMI > 40) reduces life expectancy by 10 years.

**Morbidity**

Obesity increases the risk of many physical and mental conditions. These comorbidities are most commonly shown in metabolic syndrome, a combination of medical disorders which includes: diabetes mellitus type 2, high blood pressure, high blood cholesterol, and high triglyceride levels.

Complications are either directly caused by obesity or indirectly related through mechanisms sharing a common cause such as a poor diet or a sedentary lifestyle. The strength of the link between obesity and specific conditions varies. One of the strongest is the link with type 2 diabetes. Excess body fat underlies 64% of cases of diabetes in men and 77% of cases in women.

Health consequences fall into two broad categories: those attributable to the effects of increased fat mass (such as osteoarthritis, obstructive sleep apnea, social stigmatization) and those due to the increased number of fat cells (diabetes, cancer, cardiovascular disease, non-alcoholic fatty liver disease). Increases in body fat alter the body's response to insulin, potentially leading to insulin resistance. Increased fat also creates a proinflammatory state, and a prothrombotic state.

Medical field	Condition	Medical field	Condition				
Cardiology	<ul style="list-style-type: none"> <li>ischemic heart disease: angina and myocardial infarction</li> <li>congestive heart failure</li> <li>high blood pressure</li> <li>abnormal cholesterol levels</li> <li>deep vein thrombosis and pulmonary embolism</li> </ul>	Dermatology	<ul style="list-style-type: none"> <li>stretch marks</li> <li>acanthosis nigricans</li> <li>lymphedema</li> <li>cellulitis</li> <li>hirsutism</li> <li>intertrigo</li> </ul>				
	Endocrinology and Reproductive medicine		<ul style="list-style-type: none"> <li>diabetes mellitus</li> <li>polycystic ovarian syndrome</li> <li>menstrual disorders</li> <li>infertility</li> <li>complications during pregnancy</li> <li>birth defects</li> <li>intrauterine fetal death</li> </ul>	Gastrointestinal	<ul style="list-style-type: none"> <li>gastroesophageal reflux disease</li> <li>fatty liver disease</li> <li>cholelithiasis (gallstones)</li> </ul>		
			Neurology		<ul style="list-style-type: none"> <li>stroke</li> <li>meralgia paresthetica</li> <li>migraines</li> <li>carpal tunnel syndrome</li> <li>dementia</li> <li>idiopathic</li> </ul>	Oncology	<ul style="list-style-type: none"> <li>breast, ovarian</li> <li>esophageal, colorectal</li> <li>liver, pancreatic</li> <li>gallbladder, stomach</li> <li>endometrial, cervical</li> </ul>

	intracranial hypertension		<ul style="list-style-type: none"> <li>• prostate, kidney</li> <li>• non-Hodgkin's lymphoma, multiple myeloma</li> </ul>
	<ul style="list-style-type: none"> <li>• multiple sclerosis</li> </ul>		<ul style="list-style-type: none"> <li>• obstructive sleep apnea</li> <li>• obesity hypoventilation syndrome</li> </ul>
Psychiatry	<ul style="list-style-type: none"> <li>• depression in women</li> <li>• social stigmatization</li> </ul>	Respirology	<ul style="list-style-type: none"> <li>• asthma</li> <li>• increased complications during general anaesthesia</li> </ul>
Rheumatology and Orthopedics	<ul style="list-style-type: none"> <li>• gout</li> <li>• poor mobility</li> <li>• osteoarthritis</li> <li>• low back pain</li> </ul>	Urology and Nephrology	<ul style="list-style-type: none"> <li>• erectile dysfunction</li> <li>• urinary incontinence</li> <li>• chronic renal failure</li> <li>• hypogonadism</li> </ul>

### Obesity survival paradox

Although the negative health consequences of obesity in the general population are well supported by the available evidence, health outcomes in certain subgroups seem to be improved at an increased BMI, a phenomenon known as the obesity survival paradox. The paradox was first described in 1999 in overweight and obese people undergoing hemodialysis, and has subsequently been found in those with heart failure and peripheral artery disease (PAD).

In people with heart failure, those with a BMI between 30.0–34.9 had lower mortality than those with a normal weight. This has been attributed to the fact that people often lose weight as they become progressively more ill. Similar findings have been made in other types of heart disease. People with class I obesity and heart disease do not have greater rates of further heart problems than people of normal weight who also have heart disease. In people with greater degrees of obesity, however, risk of further events is increased. Even after cardiac bypass surgery, no increase in mortality is seen in the overweight and obese. One study found that the improved survival could be explained by the more aggressive treatment obese people receive after a cardiac event. Another found that if one takes into account chronic obstructive pulmonary disease (COPD) in those with PAD the benefit of obesity no longer exists.

## Causes

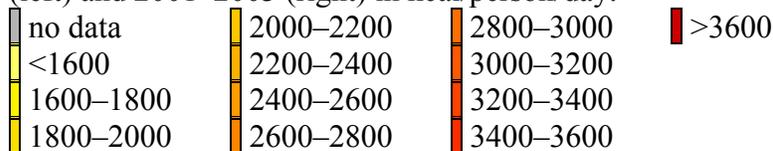
At an individual level, a combination of excessive caloric intake and a lack of physical activity is thought to explain most cases of obesity. A limited number of cases are due primarily to genetics, medical reasons, or psychiatric illness. In contrast, increasing rates of obesity at a societal level are felt to be due to an easily accessible and palatable diet, increased reliance on cars, and mechanized manufacturing.

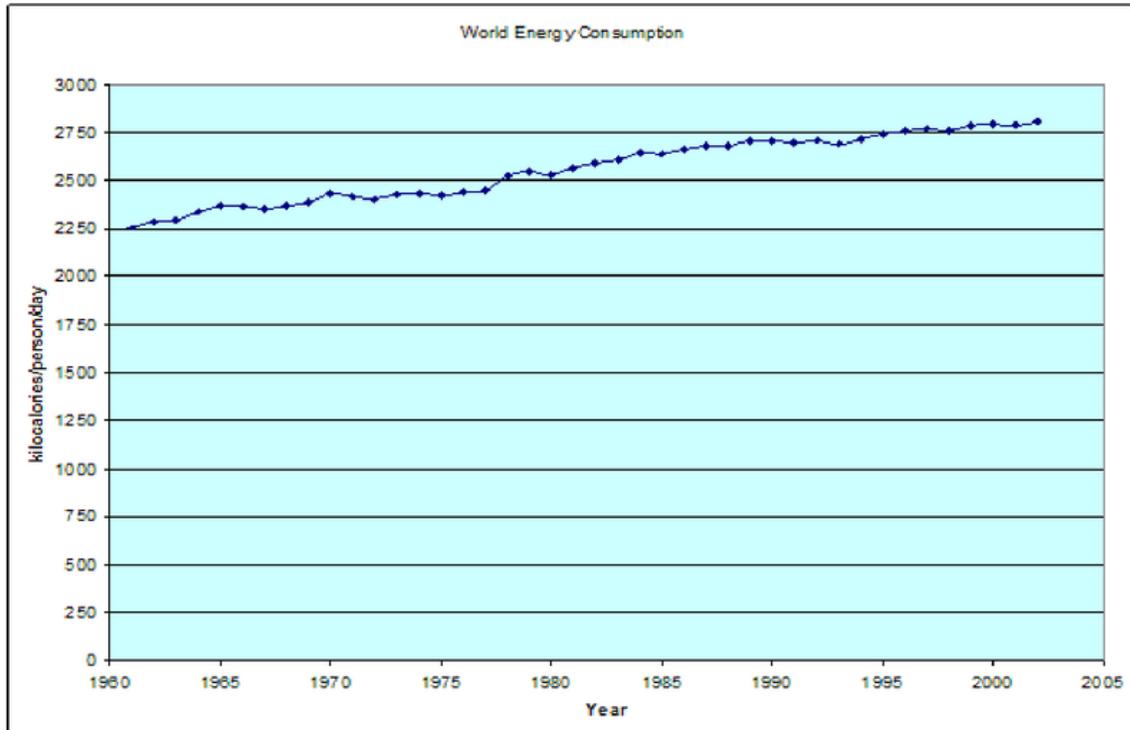
A 2006 review identified ten other possible contributors to the recent increase of obesity: (1) insufficient sleep, (2) endocrine disruptors (environmental pollutants that interfere with lipid metabolism), (3) decreased variability in ambient temperature, (4) decreased rates of smoking, because smoking suppresses appetite, (5) increased use of medications that can cause weight gain (e.g., atypical antipsychotics), (6) proportional increases in ethnic and age groups that tend to be heavier, (7) pregnancy at a later age (which may cause susceptibility to obesity in children), (8) epigenetic risk factors passed on generationally, (9) natural selection for higher BMI, and (10) assortative mating leading to increased concentration of obesity risk factors (this would not necessarily increase the number of obese people, but would increase the average population weight). While there is substantial evidence supporting the influence of these mechanisms on the increased prevalence of obesity, the evidence is still inconclusive, and the authors state that these are probably less influential than the ones discussed in the previous paragraph.

## Diet



Map of dietary energy availability per person per day in 1961 (left) and 2001–2003 (right) in kcal/person/day.





Average per capita energy consumption of the world from 1961 to 2002

The per capita dietary energy supply varies markedly between different regions and countries. It has also changed significantly over time. From the early 1970s to the late 1990s the average calories available per person per day (the amount of food bought) has increased in all parts of the world except Eastern Europe. The United States had the highest availability with 3,654 calories per person in 1996. This increased further in 2003 to 3,754. During the late 1990s Europeans had 3,394 calories per person, in the developing areas of Asia there were 2,648 calories per person, and in sub-Saharan Africa people had 2,176 calories per person. Total calorie consumption has been found to be related to obesity.

The widespread availability of nutritional guidelines has done little to address the problems of overeating and poor dietary choice. From 1971 to 2000, obesity rates in the United States increased from 14.5% to 30.9%. During the same period, an increase occurred in the average amount of calories consumed. For women, the average increase was 335 calories per day (1,542 calories in 1971 and 1,877 calories in 2004), while for men the average increase was 168 calories per day (2,450 calories in 1971 and 2,618 calories in 2004). Most of these extra calories came from an increase in carbohydrate consumption rather than fat consumption. The primary sources of these extra carbohydrates are sweetened beverages, which now account for almost 25 percent of daily calories in young adults in America. Consumption of sweetened drinks is believed to be contributing to the rising rates of obesity.

As societies become increasingly reliant on energy-dense, big-portion, fast-food meals, the association between fast-food consumption and obesity becomes more concerning. In the United States consumption of fast-food meals tripled and calorie intake from these meals quadrupled between 1977 and 1995.

Agricultural policy and techniques in the United States and Europe have led to lower food prices. In the United States, subsidization of corn, soy, wheat, and rice through the U.S. farm bill has made the main sources of processed food cheap compared to fruits and vegetables.

Obese people consistently under-report their food consumption as compared to people of normal weight. This is supported both by tests of people carried out in a calorimeter room and by direct observation.

### **Sedentary lifestyle**

A sedentary lifestyle plays a significant role in obesity. Worldwide there has been a large shift towards less physically demanding work, and currently at least 60% of the world's population gets insufficient exercise. This is primarily due to increasing use of mechanized transportation and a greater prevalence of labor-saving technology in the home. In children, there appear to be declines in levels of physical activity due to less walking and physical education. World trends in active leisure time physical activity are less clear. The World Health Organization indicates people worldwide are taking up less active recreational pursuits, while a study from Finland found an increase and a study from the United States found leisure-time physical activity has not changed significantly.

In both children and adults, there is an association between television viewing time and the risk of obesity. A 2008 meta-analysis found 63 of 73 studies (86%) showed an increased rate of childhood obesity with increased media exposure, with rates increasing proportionally to time spent watching television.

## Genetics



A 1680 painting by Juan Carreno de Miranda of a girl presumed to have Prader-Willi syndrome

Like many other medical conditions, obesity is the result of an interplay between genetic and environmental factors. Polymorphisms in various genes controlling appetite and metabolism predispose to obesity when sufficient calories are present. As of 2006 more than 41 of these sites have been linked to the development of obesity when a favorable environment is present. People with two copies of the FTO gene (fat mass and obesity associated gene) has been found on average to weigh 3–4 kg more and have a 1.67-fold greater risk of obesity compared to those without the risk allele. The percentage of obesity that can be attributed to genetics varies, depending on the population examined, from 6% to 85%.

Obesity is a major feature in several syndromes, such as Prader-Willi syndrome, Bardet-Biedl syndrome, Cohen syndrome, and MOMO syndrome. (The term "non-syndromic obesity" is sometimes used to exclude these conditions.) In people with early-onset severe obesity (defined by an onset before 10 years of age and body mass index over three standard deviations above normal), 7% harbor a single point DNA mutation.

Studies that have focused upon inheritance patterns rather than upon specific genes have found that 80% of the offspring of two obese parents were obese, in contrast to less than 10% of the offspring of two parents who were of normal weight.

The thrifty gene hypothesis postulates that certain ethnic groups may be more prone to obesity in an equivalent environment. Their ability to take advantage of rare periods of abundance by storing energy as fat would be advantageous during times of varying food availability, and individuals with greater adipose reserves would be more likely survive famine. This tendency to store fat, however, would be maladaptive in societies with stable food supplies. This is the presumed reason that Pima Indians, who evolved in a desert ecosystem, developed some of the highest rates of obesity when exposed to a Western lifestyle.

## **Medical and psychiatric illness**

Certain physical and mental illnesses and the pharmaceutical substances used to treat them can increase risk of obesity. Medical illnesses that increase obesity risk include several rare genetic syndromes (listed above) as well as some congenital or acquired conditions: hypothyroidism, Cushing's syndrome, growth hormone deficiency, and the eating disorders: binge eating disorder and night eating syndrome. However, obesity is not regarded as a psychiatric disorder, and therefore is not listed in the DSM-IVR as a psychiatric illness. The risk of overweight and obesity is higher in patients with psychiatric disorders than in persons without psychiatric disorders.

Certain medications may cause weight gain or changes in body composition; these include insulin, sulfonylureas, thiazolidinediones, atypical antipsychotics, antidepressants, steroids, certain anticonvulsants (phenytoin and valproate), pizotifen, and some forms of hormonal contraception.

## **Social determinants**

While genetic influences are important to understanding obesity, they cannot explain the current dramatic increase seen within specific countries or globally. Though it is accepted that calorie consumption in excess of calorie expenditure leads to obesity on an individual basis, the cause of the shifts in these two factors on the societal scale is much debated. There are a number of theories as to the cause but most believe it is a combination of various factors.

The correlation between social class and BMI varies globally. A review in 1989 found that in developed countries women of a high social class were less likely to be obese. No

significant differences were seen among men of different social classes. In the developing world, women, men, and children from high social classes had greater rates of obesity. An update of this review carried out in 2007 found the same relationships, but they were weaker. The decrease in strength of correlation was felt to be due to the effects of globalization. Among developed countries, levels of adult obesity, and percentage of teenage children who are overweight, are correlated with income inequality. A similar relationship is seen between US states: more adults, even in higher social classes, are obese in more unequal states.

Many explanations have been put forth for associations between BMI and social class. It is thought that in developed countries, the wealthy are able to afford more nutritious food, they are under greater social pressure to remain slim, and have more opportunities along with greater expectations for physical fitness. In undeveloped countries the ability to afford food, high energy expenditure with physical labor, and cultural values favoring a larger body size are believed to contribute to the observed patterns. Attitudes toward body mass held by people in one's life may also play a role in obesity. A correlation in BMI changes over time has been found between friends, siblings, and spouses. Stress and perceived low social status appear to increase risk of obesity.

Smoking has a significant effect on an individual's weight. Those who quit smoking gain an average of 4.4 kilograms (9.7 lb) for men and 5.0 kilograms (11.0 lb) for women over ten years. However, changing rates of smoking have had little effect on the overall rates of obesity.

In the United States the number of children a person has is related to their risk of obesity. A woman's risk increases by 7% per child, while a man's risk increases by 4% per child. This could be partly explained by the fact that having dependent children decreases physical activity in Western parents.

In the developing world urbanization is playing a role in increasing rate of obesity. In China overall rates of obesity are below 5%; however, in some cities rates of obesity are greater than 20%.

Malnutrition in early life is believed to play a role in the rising rates of obesity in the developing world. Endocrine changes that occur during periods of malnutrition may promote the storage of fat once more calories become available.

## **Infectious agents**

The study of the effect of infectious agents on metabolism is still in its early stages. Gut flora has been shown to differ between lean and obese humans. There is an indication that gut flora in obese and lean individuals can affect the metabolic potential. This apparent alteration of the metabolic potential is believed to confer a greater capacity to harvest energy contributing to obesity. Whether these differences are the direct cause or the result of obesity has yet to be determined unequivocally.

An association between viruses and obesity has been found in humans and several different animal species. The amount that these associations may have contributed to the rising rate of obesity is yet to be determined.

### ***Pathophysiology***

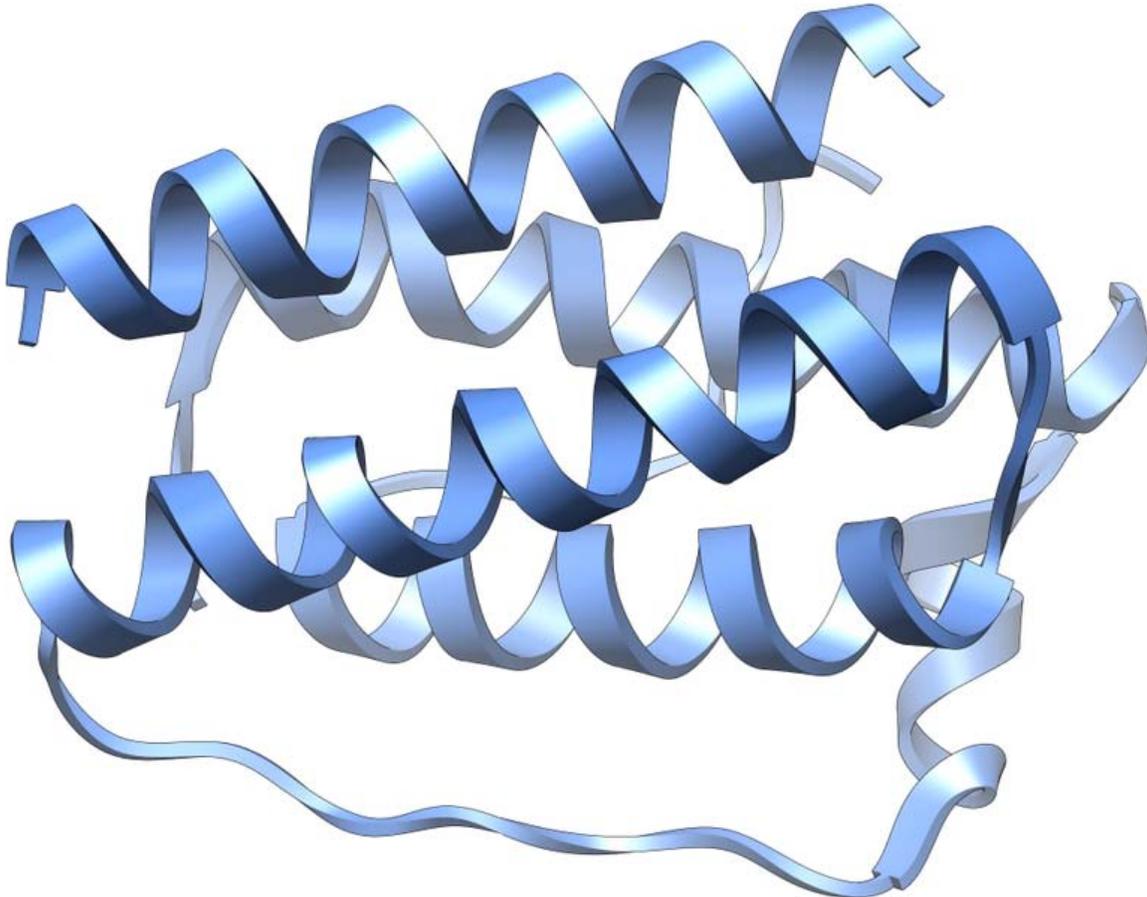


A comparison of a mouse unable to produce leptin thus resulting in obesity (left) and a normal mouse (right)

Flier summarizes the many possible pathophysiological mechanisms involved in the development and maintenance of obesity. This field of research had been almost unapproached until leptin was discovered in 1994. Since this discovery, many other hormonal mechanisms have been elucidated that participate in the regulation of appetite and food intake, storage patterns of adipose tissue, and development of insulin resistance. Since leptin's discovery, ghrelin, insulin, orexin, PYY 3-36, cholecystokinin, adiponectin, as well as many other mediators have been studied. The adipokines are mediators produced by adipose tissue; their action is thought to modify many obesity-related diseases.

Leptin and ghrelin are considered to be complementary in their influence on appetite, with ghrelin produced by the stomach modulating short-term appetitive control (i.e. to eat when the stomach is empty and to stop when the stomach is stretched). Leptin is produced by adipose tissue to signal fat storage reserves in the body, and mediates long-term appetitive controls (i.e. to eat more when fat storages are low and less when fat storages are high). Although administration of leptin may be effective in a small subset of

obese individuals who are leptin deficient, most obese individuals are thought to be leptin resistant and have been found to have high levels of leptin. This resistance is thought to explain in part why administration of leptin has not been shown to be effective in suppressing appetite in most obese people.



A graphic depiction of a leptin molecule

While leptin and ghrelin are produced peripherally, they control appetite through their actions on the central nervous system. In particular, they and other appetite-related hormones act on the hypothalamus, a region of the brain central to the regulation of food intake and energy expenditure. There are several circuits within the hypothalamus that contribute to its role in integrating appetite, the melanocortin pathway being the most well understood. The circuit begins with an area of the hypothalamus, the arcuate nucleus, that has outputs to the lateral hypothalamus (LH) and ventromedial hypothalamus (VMH), the brain's feeding and satiety centers, respectively.

The arcuate nucleus contains two distinct groups of neurons. The first group coexpresses neuropeptide Y (NPY) and agouti-related peptide (AgRP) and has stimulatory inputs to the LH and inhibitory inputs to the VMH. The second group coexpresses pro-opiomelanocortin (POMC) and cocaine- and amphetamine-regulated transcript (CART) and has stimulatory inputs to the VMH and inhibitory inputs to the LH. Consequently,

NPY/AgRP neurons stimulate feeding and inhibit satiety, while POMC/CART neurons stimulate satiety and inhibit feeding. Both groups of arcuate nucleus neurons are regulated in part by leptin. Leptin inhibits the NPY/AgRP group while stimulating the POMC/CART group. Thus a deficiency in leptin signaling, either via leptin deficiency or leptin resistance, leads to overfeeding and may account for some genetic and acquired forms of obesity.

## Management



Orlistat (Xenical) the most commonly used medication to treat obesity and sibutramine (Meridia) a recently withdrawn medication due to cardiovascular side effects

The main treatment for obesity consists of dieting and physical exercise. Diet programs may produce weight loss over the short term, but maintaining this weight loss is frequently difficult and often requires making exercise and a lower calorie diet a permanent part of a person's lifestyle. Success rates of long-term weight loss maintenance with lifestyle changes are low ranging from 2–20%.

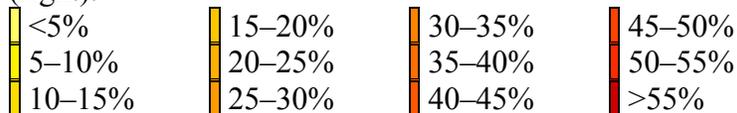
One medication, orlistat (Xenical), is current widely available and approved for long term use. Weight loss however is modest with an average of 2.9 kg (6.4 lb) at 1 to 4 years and there is little information on how these drugs affect longer-term complications of obesity. Its use is associated with high rates of gastrointestinal side effects.

The most effective treatment for obesity is bariatric surgery. Surgery for severe obesity is associated with long-term weight loss and decreased overall mortality. One study found a weight loss of between 14% and 25% (depending on the type of procedure performed) at 10 years, and a 29% reduction in all cause mortality when compared to standard weight loss measures. However, due to its cost and the risk of complications, researchers are searching for other effective yet less invasive treatments.

## **Epidemiology**



World obesity prevalence among males (left) and females (right).



Before the 20th century, obesity was rare; in 1997 the WHO formally recognized obesity as a global epidemic. As of 2005 the WHO estimates that at least 400 million adults (9.8%) are obese, with higher rates among women than men. The rate of obesity also increases with age at least up to 50 or 60 years old and severe obesity in the United States, Australia, and Canada is increasing faster than the overall rate of obesity.

Once considered a problem only of high-income countries, obesity rates are rising worldwide and affecting both the developed and developing world. These increases have been felt most dramatically in urban settings. The only remaining region of the world where obesity is not common is sub-Saharan Africa.

## **Public health**

The World Health Organization (WHO) predicts that overweight and obesity may soon replace more traditional public health concerns such as undernutrition and infectious diseases as the most significant cause of poor health. Obesity is a public health and policy problem because of its prevalence, costs, and health effects. Public health efforts seek to understand and correct the environmental factors responsible for the increasing prevalence of obesity in the population. Solutions look at changing the factors that cause excess calorie consumption and inhibit physical activity. Efforts include federally reimbursed meal programs in schools, limiting direct junk food marketing to children, and decreasing access to sugar-sweetened beverages in schools. When constructing urban environments, efforts have been made to increase access to parks and to develop pedestrian routes.

Many countries and groups have published reports pertaining to obesity. In 1998 the first US Federal guidelines were published, titled "Clinical Guidelines on the Identification,

Evaluation, and Treatment of Overweight and Obesity in Adults: The Evidence Report". In 2006 the Canadian Obesity Network published the "Canadian Clinical Practice Guidelines (CPG) on the Management and Prevention of Obesity in Adults and Children". This is a comprehensive evidence-based guideline to address the management and prevention of overweight and obesity in adults and children.

In 2004, the United Kingdom Royal College of Physicians, the Faculty of Public Health and the Royal College of Paediatrics and Child Health released the report "Storing up Problems", which highlighted the growing problem of obesity in the UK. The same year, the House of Commons Health Select Committee published its "most comprehensive inquiry [...] ever undertaken" into the impact of obesity on health and society in the UK and possible approaches to the problem. In 2006, the National Institute for Health and Clinical Excellence (NICE) issued a guideline on the diagnosis and management of obesity, as well as policy implications for non-healthcare organizations such as local councils.

A 2007 report produced by Sir Derek Wanless for the King's Fund warned that unless further action was taken, obesity had the capacity to cripple the National Health Service financially. In the United States organizations such as the Bill Clinton Foundation's Alliance for a Healthier Generation and Action for Healthy Kids are working to combat childhood obesity. Additionally, the Centers for Disease Control and Prevention co-hosted the first-ever Weight of the Nation Conference in 2009 with the goal of focusing national attention on the obesity epidemic.

Comprehensive approaches are being looked at to address the rising rates of obesity. The Obesity Policy Action (OPA) framework divides measure into 'upstream' policies, 'midstream' policies, 'downstream' policies. 'Upstream' policies look at changing society, 'midstream' policies try to alter individuals' behavior to prevent obesity, and 'downstream' policies try to treat currently afflicted people.

## ***Economic impact***



Services must accommodate obese people with specialist equipment such as much wider chairs.

In addition to its health impacts, obesity leads to many problems including disadvantages in employment and increased business costs. These effects are felt by all levels of society from individuals, to corporations, to governments.

The estimate range for annual expenditures on diet products is \$40 billion to \$100 billion in the US alone. In 1998, the medical costs attributable to obesity in the US were \$78.5 billion or 9.1% of all medical expenditures, while the cost of obesity in Canada was estimated at CA\$2 billion in 1997 (2.4% of total health costs).

Obesity prevention programs have been found to reduce the cost of treating obesity-related disease. However, the longer people live, the more medical costs they incur. Researchers therefore conclude that reducing obesity may improve the public's health, but it is unlikely to reduce overall health spending.

Obesity can lead to social stigmatization and disadvantages in employment. When compared to their normal weight counterparts, obese workers on average have higher

rates of absenteeism from work and take more disability leave, thus increasing costs for employers and decreasing productivity. A study examining Duke University employees found that people with a BMI over 40 filed twice as many workers' compensation claims as those whose BMI was 18.5–24.9. They also had more than 12 times as many lost work days. The most common injuries in this group were due to falls and lifting, thus affecting the lower extremities, wrists or hands, and backs. The US state of Alabama Employees' Insurance Board approved a controversial plan to charge obese workers \$25 per month if they do not take measures to reduce their weight and improve their health. These measures started in January 2010 and apply to those with a BMI of greater than 35 kg/m<sup>2</sup> who fail to make improvements in their health after one year.

Some research shows that obese people are less likely to be hired for a job and are less likely to be promoted. Obese people are also paid less than their non-obese counterparts for an equivalent job. Obese women on average make 6% less and obese men make 3% less.

Specific industries, such as the airline and food industries, have special concerns. Due to rising rates of obesity, airlines face higher fuel costs and pressures to increase seating width. In 2000, the extra weight of obese passengers cost airlines US\$275 million. Costs for restaurants are increased by litigation accusing them of causing obesity. In 2005 the US Congress discussed legislation to prevent civil law suits against the food industry in relation to obesity; however, it did not become law.

## ***History and culture***

### **Etymology**

*Obesity* is from the Latin *obesitas*, which means "stout, fat, or plump." *Ēsus* is the past participle of *edere* (to eat), with *ob* (over) added to it. *The Oxford English Dictionary* documents its first usage in 1611 by Randle Cotgrave.

## Historical trends



During the Middle Ages and the Renaissance obesity was often seen as a sign of wealth, and was relatively common among the elite: *The Tuscan General Alessandro del Borro*, attributed to Charles Mellin, 1645

The Greeks were the first to recognize obesity as a medical disorder. Hippocrates wrote that "Corpulence is not only a disease itself, but the harbinger of others". The Indian surgeon Sushruta (6th century BCE) related obesity to diabetes and heart disorders. He recommended physical work to help cure it and its side effects. For most of human history mankind struggled with food scarcity. Obesity has thus historically been viewed as a sign of wealth and prosperity. It was common among high officials in Europe in the Middle Ages and the Renaissance as well as in Ancient East Asian civilizations.

With the onset of the industrial revolution it was realized that the military and economic might of nations were dependent on both the body size and strength of their soldiers and workers. Increasing the average body mass index from what is now considered underweight to what is now the normal range played a significant role in the development of industrialized societies. Height and weight thus both increased through the 19th century in the developed world. During the 20th century, as populations reached their genetic potential for height, weight began increasing much more than height, resulting in obesity. In the 1950s increasing wealth in the developed world decreased child mortality, but as body weight increased heart and kidney disease became more common. During this time period insurance companies realized the connection between weight and life expectancy and increased premiums for the obese.

Many cultures throughout history have viewed obesity as the result of a character flaw. The *obesus* or fat character in Greek comedy was a glutton and figure of mockery. During Christian times food was viewed as a gateway to the sins of sloth and lust. In modern Western culture, excess weight is often regarded as unattractive, and obesity is commonly associated with various negative stereotypes. People of all ages can face social stigmatization, and may be targeted by bullies or shunned by their peers. Obesity is once again a reason for discrimination.



*Venus of Willendorf* created 24,000–22,000 BC

Public perceptions in Western society regarding healthy body weight differ from those regarding the weight that is considered ideal – and both have changed since the beginning of the 20th century. The weight that is viewed as an ideal has become lower since the 1920s. This is illustrated by the fact that the average height of Miss America pageant winners increased by 2% from 1922 to 1999, while their average weight decreased by 12%. On the other hand, people's views concerning healthy weight have changed in the opposite direction. In Britain the weight at which people considered themselves to be overweight was significantly higher in 2007 than in 1999. These changes are believed to be due to increasing rates of adiposity leading to increased acceptance of extra body fat as being normal.

Obesity is still seen as a sign of wealth and well-being in many parts of Africa. This has become particularly common since the HIV epidemic began.

## **The arts**

The first sculptural representations of the human body 20,000–35,000 years ago depict obese females. Some attribute the Venus figurines to the tendency to emphasize fertility while others feel they represent "fatness" in the people of the time. Corpulence is, however, absent in both Greek and Roman art, probably in keeping with their ideals regarding moderation. This continued through much of Christian European history, with only those of low socioeconomic status being depicted as obese.

During the Renaissance some of the upper class began flaunting their large size, as can be seen in portraits of Henry the VIII and Alessandro del Borro. Rubens (1577–1640) regularly depicted full-bodied women in his pictures, from which derives the term Rubenesque. These women, however, still maintained the "hourglass" shape with its relationship to fertility. During the 19th century, views on obesity changed in the Western world. After centuries of obesity being synonymous with wealth and social status, slimness began to be seen as the desirable standard.

## Size acceptance



Overweight people, such as U.S. President William Howard Taft, have been ridiculed at various times.

The principal goal of the fat acceptance movement is to decrease discrimination against people who are overweight and obese. However, some in the movement are also attempting to challenge the established relationship between obesity and negative health outcomes.

A number of organizations exist that promote the acceptance of obesity. They have increased in prominence in the latter half of the 20th century. The US-based National Association to Advance Fat Acceptance (NAAFA) was formed in 1969 and describes itself as a civil rights organization dedicated to ending size discrimination.

The International Size Acceptance Association (ISAA) is a non-governmental organization (NGO) which was founded in 1997. It has more of a global orientation and describes its mission as promoting size acceptance and helping to end weight-based discrimination. These groups often argue for the recognition of obesity as a disability under the US Americans With Disabilities Act (ADA). The American legal system, however, has decided that the potential public health costs exceed the benefits of extending this anti-discrimination law to cover obesity.

Multiple books such as *The Diet Myth* by Paul Campos argue that the health risks of obesity are mostly unproven and the real problem is the social stigma facing the obese. Similarly, *The Obesity Epidemic* by Michael Gard argues that obesity is a moral and ideological construct, rather than a health problem. Other groups are also trying to challenge obesity's connection to poor health. The Center for Consumer Freedom, an organization partly supported by the restaurant and food industry, has run ads saying that obesity is not an epidemic but "hype".

People are known to select potential partners based on a similar body mass. The rising rates of obesity have therefore provided greater opportunities for overweight people to find partners. Certain subcultures also label themselves as particularly attracted to the obese. Chubby culture and fat admirers are examples.

### ***Childhood obesity***

The healthy BMI range varies with the age and sex of the child. Obesity in children and adolescents is defined as a BMI greater than the 95th percentile. The reference data that these percentiles are based on is from 1963 to 1994 and thus has not been affected by the recent increases in rates of obesity. Childhood obesity has reached epidemic proportions in 21st century, with rising rates in both the developed and developing world. Rates of obesity in Canadian boys have increased from 11% in 1980s to over 30% in 1990s, while during this same time period rates increased from 4 to 14% in Brazilian children.

As with obesity in adults, many different factors contribute to the rising rates of childhood obesity. Changing diet and decreasing physical activity are believed to be the two most important in causing the recent increase in the rates. Because childhood obesity often persists into adulthood and is associated with numerous chronic illnesses, children who are obese are often tested for hypertension, diabetes, hyperlipidemia, and fatty liver. Treatments used in children are primarily lifestyle interventions and behavioral techniques. Medications are not FDA approved for use in this age group.

### ***In other animals***

Obesity in pets is common in many countries. Rates of overweight and obesity in dogs in the United States range from 23% to 41% with about 5.1% obese. Rates of obesity in cats was slightly higher at 6.4%. In Australia the rate of obesity among dogs in a veterinary setting has been found to be 7.6%. The risk of obesity in dogs is related to whether or not

their owners are obese; however, there is no similar correlation between cats and their owners.

## Chapter 2

# Classification of Obesity



An obese male with a body mass index of  $46 \text{ kg/m}^2$ : weight 146 kg (322 lb), height 177 cm (5 ft 10 in)

Obesity is a medical condition in which excess body fat has accumulated to the extent that it may have an adverse affect on health. Relative weight and body mass index (BMI) are nearly identical and are reasonable estimates of body fatness as measured by percentage body fat. However, BMI does not account for the wide variation in body fat distribution, and may not correspond to the same degree of fatness or associated health risk in different individuals and populations. Other measurements of fat distribution include the waist-hip ratio and body fat percentage. Normal weight obesity is a condition of having normal body weight, but high body fat percentages with the same health risks of obesity.

## **BMI**

Body mass index or BMI is a simple and widely used method for estimating body fat mass. BMI was developed in the 19th century by the Belgian statistician and anthropometrist Adolphe Quetelet. BMI is an accurate reflection of body fat percentage in the majority of the adult population. It however is less accurate in people such as body builders and pregnant women. A formula combining BMI, age and gender can be used to estimate a person's body fat percentage to an accuracy of 4%. An alternative method, body volume index (BVI), is being developed in an effort to better take into account different body shapes.

<b>BMI</b>	<b>Classification</b>
< 18.5	underweight
18.5–24.9	normal weight
25.0–29.9	overweight
30.0–34.9	class I obesity
35.0–39.9	class II obesity
≥ 40.0	class III obesity

BMI is calculated by dividing the subject's mass by the square of his or her height, typically expressed either in metric or US "Customary" units:

$$\text{Metric: } BMI = \text{kilograms} / \text{meters}^2$$
$$\text{US/Customary and imperial: } BMI = \text{lb} \times 703 / \text{in}^2$$

where *lb* is the subject's weight in pounds and *in* is the subject's height in inches.

The most commonly used definitions, established by the World Health Organization (WHO) in 1997 and published in 2000, provide the values listed in the table at right.

Some modifications to the WHO definitions have been made by particular bodies. The surgical literature breaks down "class III" obesity into further categories who's exact values are still disputed.

- Any BMI ≥ 35 or 40 is *severe obesity*
- A BMI of ≥ 35 or 40–44.9 or 49.9 is *morbid obesity*
- A BMI of ≥ 45 or 50 is *super obese*

As Asian populations develop negative health consequences at a lower BMI than Caucasians, some nations have redefined obesity. The Japanese have defined obesity as any BMI greater than 25 while China uses a BMI of greater than 28.

## ***Waist circumference and waist–hip ratio***

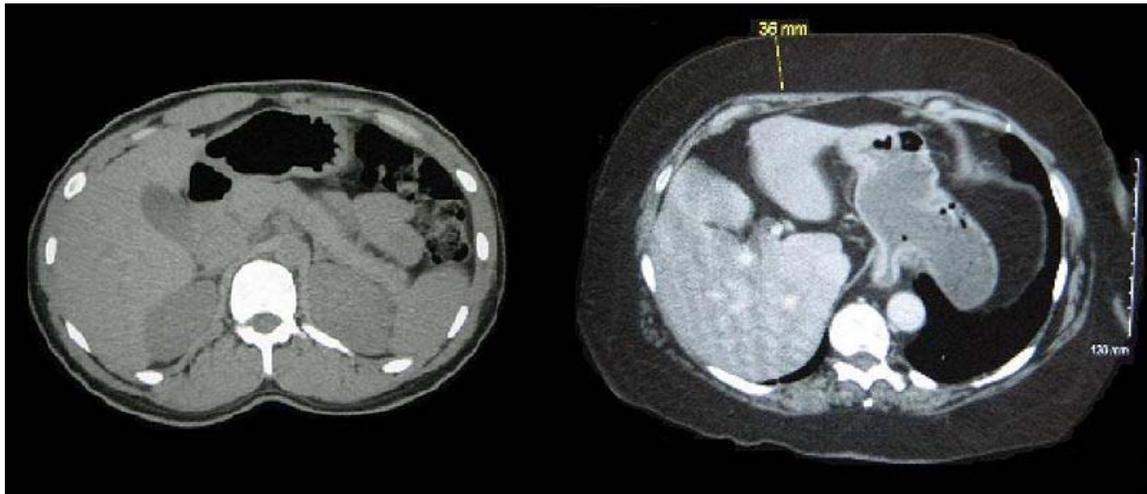
In the United States a waist circumference of >102 cm in men and >88 cm in women or the waist–hip ratio (the circumference of the waist divided by that of the hips of >0.9 for men and >0.85 for women) are used to define central obesity.

In the European Union waist circumference of  $\geq 94$  cm in men and  $\geq 80$  cm in non pregnant women are used as cut offs for central obesity.

A lower cut off of 90 cm has been recommended for South Asian and Chinese men, while a cut off of 85 cm has been recommended for Japanese men.

In those with a BMI under 35, intra-abdominal body fat is related to negative health outcomes independent of total body fat. Intra-abdominal or visceral fat has a particularly strong correlation with cardiovascular disease. In a study of 15,000 people, waist circumference also correlated better with metabolic syndrome than BMI. Women with abdominal obesity have a cardiovascular risk similar to that of men. In people with a BMI over 35, measurement of waist circumference however adds little to the predictive power of BMI as most individuals with this BMI have an abnormal waist circumferences.

## ***Body fat percentage***



Cross-sections of the torso of a person of normal weight (left) and an obese person (right), taken by CT scan. Note the 3.6 cm (1.4 inches) of subcutaneous fat on the obese person.

Body fat percentage is total body fat expressed as a percentage of total body weight. There is no generally accepted definition of obesity based on total body fat. Most researchers have used >25% in men, and >30% in women, as cut-points to define obesity. However, the finding that metabolic disturbance increases with increasing body fat percentage suggests that focusing exclusively on cut-points of body fat percent may be of limited value.

Body fat percentage can be estimated from a person's BMI by the following formula:

$$\text{Bodyfat}\% = (1.2 * \text{BMI}) + (0.23 * \text{age}) - 5.4 - (10.8 * \text{gender})$$

where gender is 0 if female and 1 if male

This formula takes into account the fact that body fat percentage tends to be 10 percentage points greater in women than in men for a given BMI. It recognizes that a person's percentage body fat tends to increase as they age, even if their weight and BMI remain constant. The results of this formula have been shown to have an accuracy of 4% in one group of individuals.

There are many other methods used to determine body fat percentage. Hydrostatic weighing, one of the most accurate methods of body fat calculation, involves weighting a person underwater. Two other simpler and less accurate methods have been used historically but are now not recommended. The first is the skinfold test, in which a pinch of skin is precisely measured to determine the thickness of the subcutaneous fat layer. The other is bioelectrical impedance analysis which uses electrical resistance. Bioelectrical impedance has not been shown to provide an advantage over BMI.

Body fat percentage measurement techniques used mainly for research include computed tomography (CT scan), magnetic resonance imaging (MRI), and dual energy X-ray absorptiometry (DEXA). These techniques provide very accurate measurements, but it can be difficult to obtain in the severely obese due to weight limits of most equipment and insufficient diameter of many CT or MRI scanners.

## ***Childhood obesity***



Variations in apparent body fat among children

The healthy BMI range varies with the age and sex of the child. Obesity in children and adolescents is defined as a BMI greater than the 95th percentile. The reference data that these percentiles are based on is from 1963 to 1994 and thus has not been affected by the recent increases in rates of obesity.

Childhood obesity has reached epidemic proportions in 21st century with rising rates in both the developed and developing world. Rates of obesity in Canadian boys have increased from 11% in 1980s to over 30% in 1990s, while during this same time period rates increased from 4 to 14% in Brazilian children.

As with obesity in adults many different factors contribute to the rising rates of childhood obesity. Changing diet and decreasing physical activity are believed to be the two most important in causing the recent increase in the rate of obesity. Activities from self propelled transport, to school physical education, and organized sports has been declining in many countries.

Because childhood obesity often persists into adulthood, and is associated with numerous chronic illnesses, it is important that children who are obese be tested for hypertension, diabetes, hyperlipidemia, and fatty liver.

Treatments used in children are primarily lifestyle interventions and behavioral techniques. Medications are not FDA approved for use in this age group.

## Chapter 3

# Abdominal Obesity

### Central obesity



A morbidly obese male. Weight 146 kg/322 lbs, height 177 cm/5 ft 10 in. The body mass index is 46.

**ICD-10**

E66

**ICD-9**

278

**Abdominal obesity**, colloquially known as **belly fat** or clinically as **central obesity**, is the accumulation of abdominal fat resulting in an increase in waist size. There is a strong correlation between central obesity and cardiovascular disease.

Visceral fat, also known as organ fat or *intra-abdominal fat*, is located inside the peritoneal cavity, packed in between internal organs and torso, as opposed to subcutaneous fat which is found underneath the skin, and intramuscular fat which is

found interspersed in skeletal muscle. Visceral fat is composed of several adipose depots including mesenteric, epididymal white adipose tissue (EWAT) and perirenal fat. An excess of visceral fat is known as central obesity, the "pot belly" or "beer belly" effect, in which the abdomen protrudes excessively. This body type is also known as "apple shaped", as opposed to "pear shaped", in which fat is deposited on the hips and buttocks.

## **Causes**

The immediate cause of obesity is net energy imbalance — the organism consumes more usable calories than it expends, wastes, or discards via elimination. The fundamental cause of obesity is not well understood, but is presumably a combination of the organism's genes and environment. The specific cause of central fat is also not well understood.

In humans, central obesity is correlated with overeating and a sedentary lifestyle. Hypercortisolism, such as in Cushing's syndrome also leads to central obesity. Many prescription drugs can also have side effects resulting in obesity.

Because fat in the midsection contains the greatest amount of cortisol receptors, fat is created and stored in the midsection, specifically in fat cell deposits deep in the abdomen.

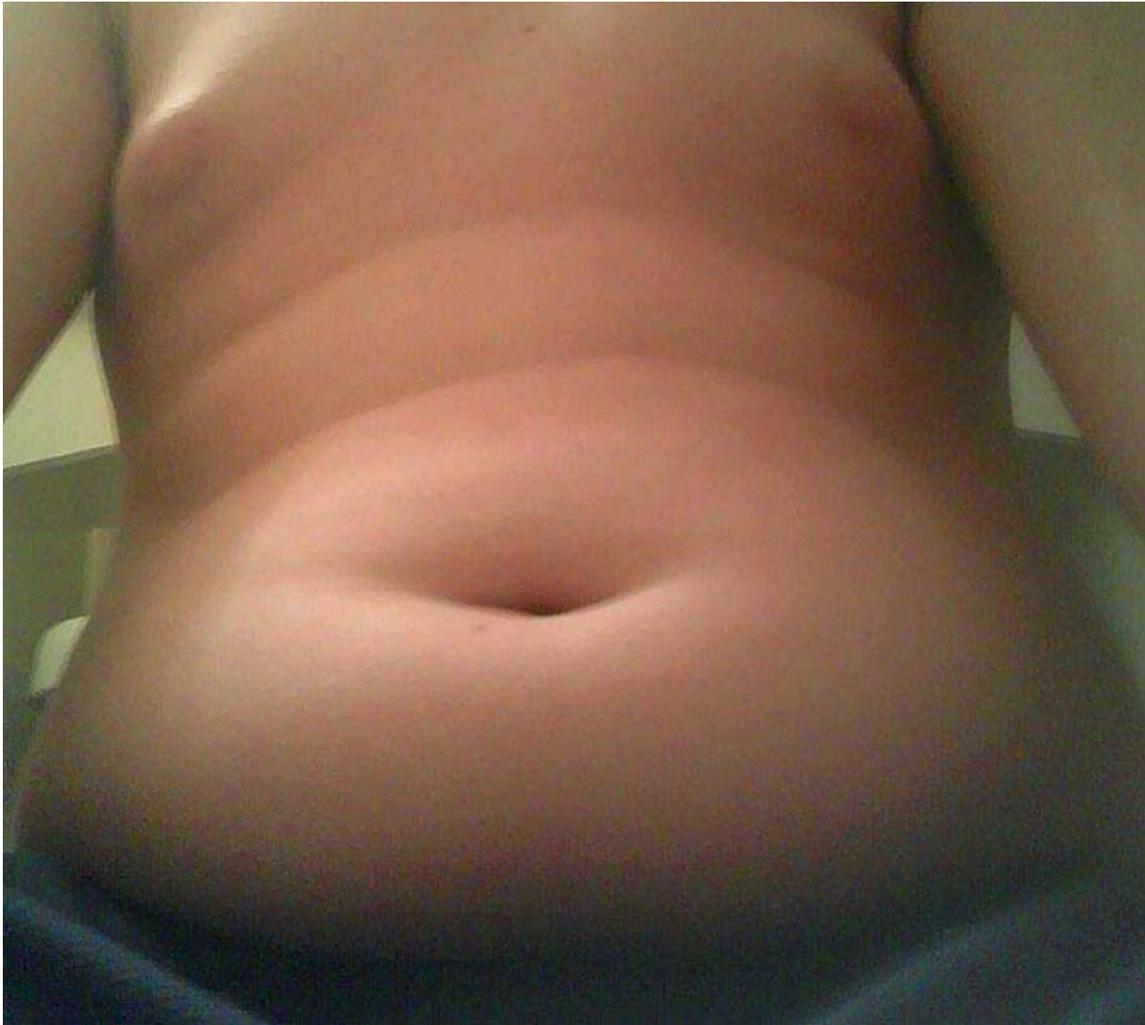
## **Diagnosis**

While central obesity can be obvious just by looking at the naked body, the severity of central obesity is determined by taking waist and hip measurements. The absolute waist circumference (>102 centimetres (40 in) in men and >88 centimetres (35 in) in women) and the waist-hip ratio (>0.9 for men and >0.85 for women) are both used as measures of central obesity. A differential diagnosis includes distinguishing central obesity from ascites and intestinal bloating. In the cohort of 15,000 people participating in the National Health and Nutrition Examination Survey (NHANES III), waist circumference explained obesity-related health risk better than the body mass index (or BMI) when metabolic syndrome was taken as an outcome measure and this difference was statistically significant. In other words, excessive waist circumference appears to be more of a risk factor for metabolic syndrome than BMI.

An increasing acceptance of the importance of central obesity within the medical profession as an indicator of health risk has led to new developments in obesity diagnosis such as the Body Volume Index, which measures central obesity by measuring a person's body shape and their weight distribution.

BVI is based upon the principle that excess abdominal weight, measured by part volume as a percentage of total volume, constitutes a greater health risk. Recent validation has concluded that total and regional body volume estimates correlate positively and significantly with biomarkers of cardio-vascular risk and BVI calculations correlate significantly with all biomarkers of cardio-vascular risk.

## ***Health risks***



Excess adipose tissue on a male

Central obesity is associated with a statistically higher risk of heart disease, hypertension, insulin resistance, and Diabetes Mellitus Type 2. Belly fat is a symptom of metabolic syndrome, and is an indicator used in the diagnosis of that disorder.

Central obesity can be a feature of lipodystrophies, a group of diseases which is either inherited, or due to secondary causes (often protease inhibitors, a group of medications against AIDS). Central obesity is a symptom of Cushing's syndrome and is also common in patients with polycystic ovary syndrome (PCOS). Central obesity is associated with glucose intolerance and dyslipidemia.

### **Relationship with diabetes**

There are numerous theories as to the exact cause and mechanism in Type 2 Diabetes. Central obesity is known to predispose individuals for insulin resistance. Abdominal fat

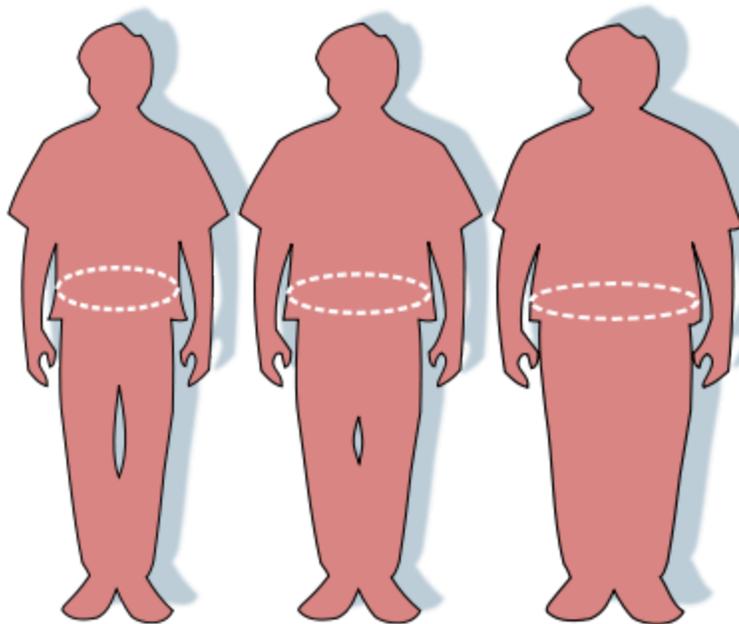
is especially active hormonally, secreting a group of hormones called adipokines that may possibly impair glucose tolerance.

Insulin resistance is a major feature of Diabetes Mellitus Type 2 (T2DM), and central obesity is correlated with both insulin resistance and T2DM itself. Increased adiposity (obesity) raises serum resistin levels, which in turn directly correlate to insulin resistance. Studies have also confirmed a direct correlation between resistin levels and T2DM. And it is waistline adipose tissue (central obesity) which seems to be the foremost type of fat deposits contributing to rising levels of serum resistin. Conversely, serum resistin levels have been found to *decline* with decreased adiposity following medical treatment.

### **Relationship with Alzheimer's Disease**

A US study reported in May 2010 *Annals of Neurology* examining over 700 adults found evidence to suggest higher volumes of visceral fat, regardless of overall weight, were associated with smaller brain volumes and increased risk of dementia.

### ***Waist-hip ratio***



Silhouettes and waist circumferences representing normal, overweight, and obese

The absolute waist circumference (>102 cm in men and >88 cm in women) and the waist-hip ratio (the circumference of the waist divided by that of the hips of >0.9 for men and >0.85 for women) are both used as measures of central obesity.

In those with a BMI under 35, intra-abdominal body fat is related to negative health outcomes independent of total body fat. Intra-abdominal or visceral fat has a particularly strong correlation with cardiovascular disease.

## **Sex differences**

Female sex hormone causes fat to be stored in the buttocks, thighs, and hips in women. Men are more likely to have fat stored in the belly due to sex hormone differences. When women reach menopause and the estrogen produced by ovaries declines, fat migrates from their buttocks, hips and thighs to their waists; later fat is stored in the belly.

## ***Prevention and treatments***

Performing adequate aerobic exercise and eating a healthy diet can prevent central obesity, and losing weight via these methods is the main way to reverse the condition.

Adjunctive therapies which may be prescribed by a physician are orlistat or sibutramine, although the latter has been associated with increased cardiovascular events and strokes and has been withdrawn from the market in the United States, the UK, the EU, Australia, Canada, Hong Kong, Thailand and Mexico.

In the presence of diabetes mellitus type 2, the physician might instead prescribe metformin and thiazolidinediones (rosiglitazone or pioglitazone) as anti-diabetic drugs rather than sulfonylurea derivatives. Thiazolidinediones may cause slight weight gain but decrease "pathologic" abdominal fat, and therefore may be prescribed for diabetics with central obesity.

## **Sit-ups myth**

There is a common misconception that spot exercise (that is, exercising a specific muscle or location of the body) most effectively burns fat at the desired location, but this is not the case. Spot exercise is beneficial for building specific muscles, but it has little effect, if any, on fat in that area of the body, or on the body's distribution of body fat. The same logic applies to sit-ups and belly fat. Sit-ups, crunches and other abdominal exercises are useful in building the abdominal muscles, but they have little effect, if any, on the adipose tissue located there.

## **Slang terms**



Love handles are made up of excess fat around hips.

Several colloquial terms used to refer to central obesity, and to people who have it, refer to beer drinking. However, there is little scientific evidence that beer drinkers are more prone to abdominal obesity, despite it being known colloquially as "beer belly", "beer gut", or "beer pot". One of the few studies conducted on the subject did not find that beer drinkers are more prone to abdominal obesity than nondrinkers or drinkers of wine or spirits. Chronic alcoholism can lead to cirrhosis, symptoms of which include gynecomastia (enlarged breasts) and ascites (abdominal fluid). These symptoms can suggest the appearance of central obesity.

"Love handles" and "spare tire" are colloquial terms for a layer of fat that is deposited around a person's midsection, especially visible on the sides over the abdominal external oblique muscle.

"Muffin top" is a pejorative term used for a person whose midsection spills over the waistline of his or her trousers in a manner that resembles the top of a muffin spilling over its baking pan.

"Pot belly" is another colloquial term used to describe a person who has an excessive amount of abdominal fat. This is especially pronounced and visible over clothing and may be indicative of other health related problems.

## Chapter 4

# Childhood Obesity

### Childhood obesity



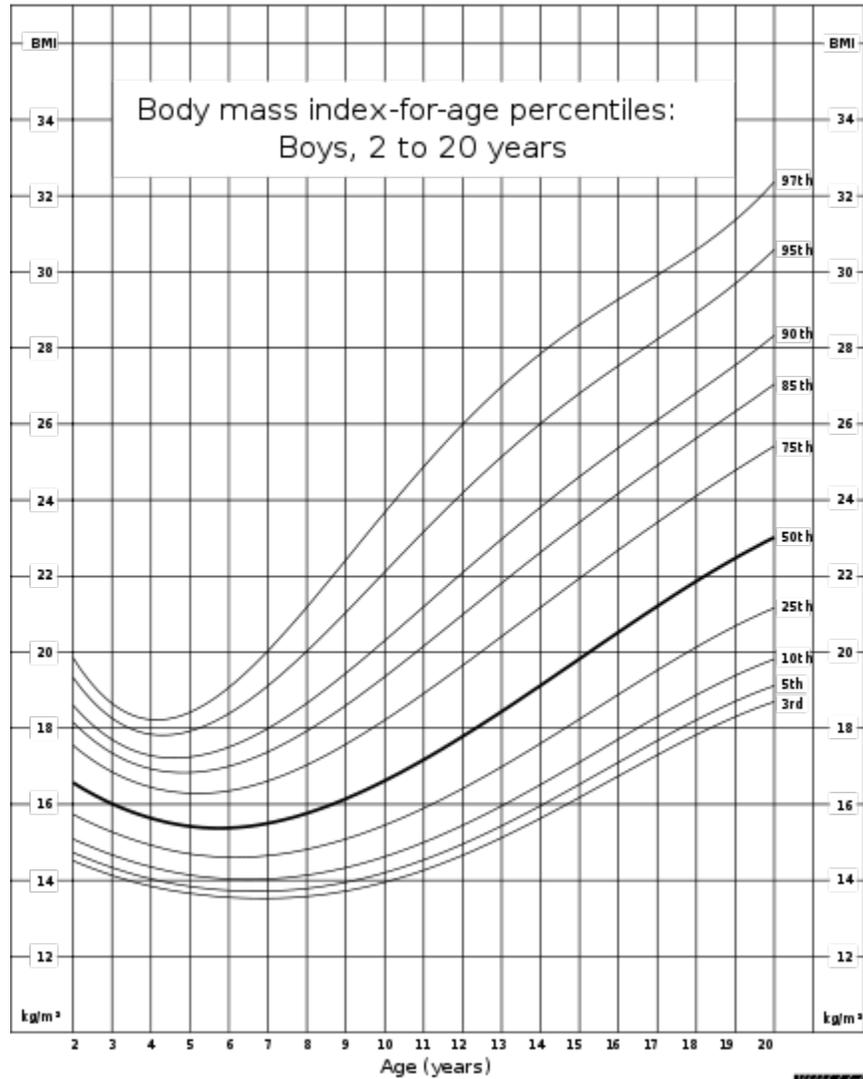
Children with varying degrees of body fat.

<b>ICD-10</b>	E66.
<b>ICD-9</b>	278
<b>DiseasesDB</b>	9099
<b>MedlinePlus</b>	003101
<b>eMedicine</b>	med/1653
<b>MeSH</b>	<i>C23.888.144.699.500</i>

**Childhood obesity** is a condition where excess body fat negatively affects a child's health or wellbeing. As methods to determine body fat directly are difficult, the diagnosis of obesity is often based on BMI. Due to the rising prevalence of obesity in children and its many adverse health effects it is being recognized as a serious public health concern. The term overweight rather than obese is often used in children as it is less stigmatizing.

# Classification

CDC Growth Charts United States



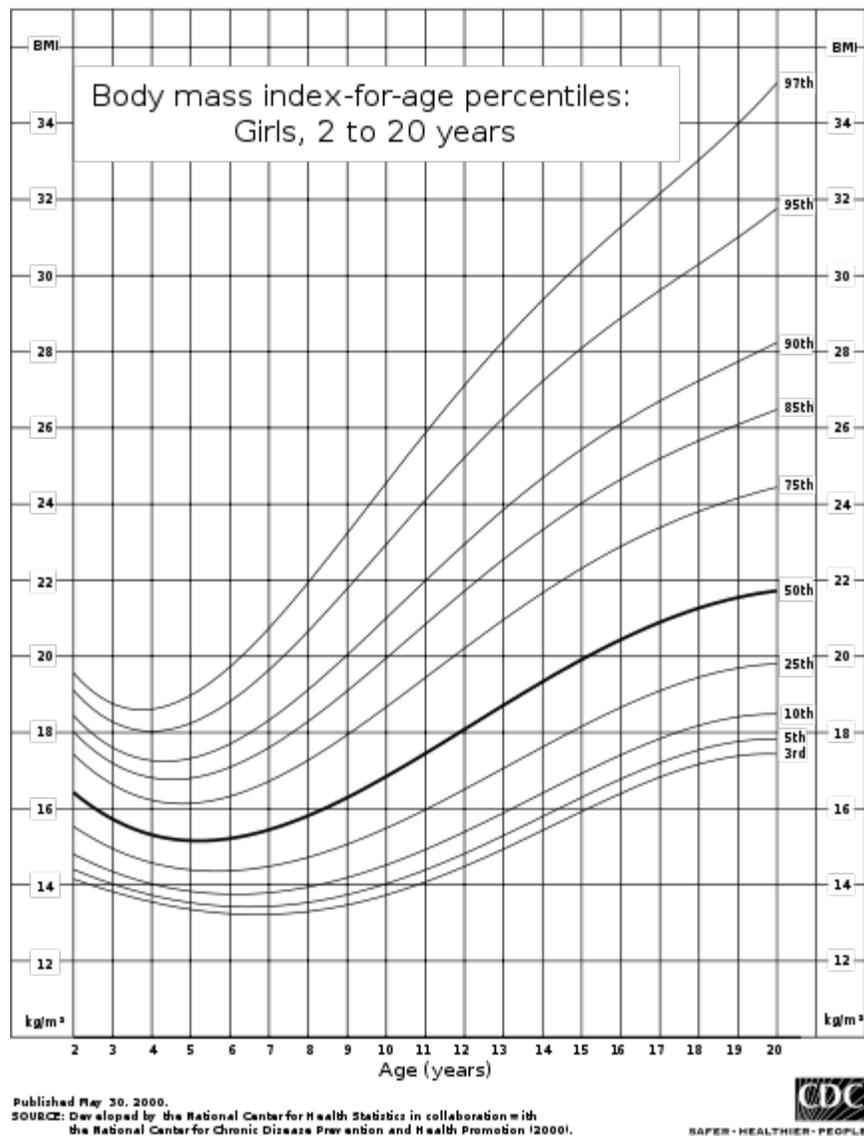
Published May 30, 2000.  
SOURCE: Developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (2000).



SAFER • HEALTHIER • PEOPLE

BMI for age percentiles for boys 2 to 20 years of age.

## CDC Growth Charts United States



BMI for age percentiles for girls 2 to 20 years of age.

Body mass index (BMI) is acceptable for determining obesity for children two years of age and older. The normal range for BMI in children vary with age and sex. The Center for Disease Control defines obesity as a BMI greater than the 95th percentile. It has published tables for determining this in children.

### ***Effects on health***

The first problems to occur in obese children are usually emotional or psychological. Childhood obesity however can also lead to life-threatening conditions including diabetes, high blood pressure, heart disease, sleep problems, cancer, and other disorders. Some of the other disorders would include liver disease, early puberty or menarche,

eating disorders such as anorexia and bulimia, skin infections, and asthma and other respiratory problems. Studies have shown that overweight children are more likely to grow up to be overweight adults. Obesity during adolescence has been found to increase mortality rates during adulthood.

Obese children often suffer from teasing by their peers. Some are harassed or discriminated against by their own family. Stereotypes abound and may lead to low self esteem and depression.

A 2008 study has found that children who are obese have carotid arteries which have prematurely aged by as much as thirty years as well as abnormal levels of cholesterol.

<b>System</b>	<b>Condition</b>	<b>System</b>	<b>Condition</b>
Endocrine	<ul style="list-style-type: none"> <li>• Impaired glucose tolerance</li> <li>• Diabetes mellitus</li> <li>• Metabolic syndrome</li> <li>• Hyperandrogenism</li> <li>• Effects on growth and puberty</li> <li>• Nulliparity and nulligravidity</li> </ul>	Cardiovascular	<ul style="list-style-type: none"> <li>• Hypertension</li> <li>• Hyperlipidemia</li> <li>• Increased risk of coronary heart disease as an adult</li> </ul>
Gastrointestinal	<ul style="list-style-type: none"> <li>• Nonalcoholic fatty liver disease</li> <li>• Cholelithiasis</li> </ul>	Respiratory	<ul style="list-style-type: none"> <li>• Obstructive sleep apnea</li> <li>• Obesity hypoventilation syndrome</li> </ul>
Musculoskeletal	<ul style="list-style-type: none"> <li>• Slipped capital femoral epiphysis (SCFE)</li> <li>• Tibia vara (Blount disease)</li> </ul>	Neurological	<ul style="list-style-type: none"> <li>• Idiopathic intracranial hypertension</li> </ul>
Psychosocial	<ul style="list-style-type: none"> <li>• Distorted peer relationships</li> <li>• Poor self esteem</li> <li>• Anxiety</li> <li>• Depression</li> </ul>	Skin	<ul style="list-style-type: none"> <li>• Furunculosis</li> <li>• Intertrigo</li> </ul>

## **Causes**

As with many conditions, childhood obesity can be brought on by a range of factors which often act in combination.

### **Dietary**

The effects of eating habits on childhood obesity are difficult to determine. A three year randomized controlled study of 1,704 3rd grade children which provided two healthy meals a day in combination with an exercise program and dietary counsellings failed to show a significant reduction in percentage body fat when compared to a control group. This was partly due to the fact that even though the children believed they were eating less their actual calorie consumption did not decrease with the intervention. At the same time observed energy expenditure remained similar between the groups. This occurred even though dietary fat intake decreased from 34% to 27%. A second study of 5,106 children showed similar results. Even though the children ate an improved diet there was no effect found on BMI. Why these studies did not bring about the desired effect of curbing childhood obesity has been attributed to the interventions not being sufficient enough. Changes were made primarily in the school environment while it is felt that they must occur in the home, the community, and the school simultaneously to have a significant effect.

Calorie-rich drinks and foods are readily available to children. Consumption of sugar-laden soft drinks may contribute to childhood obesity. In a study of 548 children over a 19 month period the likelihood of obesity increased by 1.6 for every additional soft drink consumed per day.

Calorie-dense, prepared snacks are available in many locations frequented by children. As childhood obesity has become more prevalent, snack vending machines in school settings have been reduced by law in a small number of localities. Eating at fast food restaurants is very common among young people with 75% of 7th to 12th grade students consuming fast food in a given week. The fast food industry is also at fault for the rise in childhood obesity. This industry spends about \$42 billion on advertisements aimed at young children. McDonald's alone has thirteen websites that are viewed by 365,000 children and 294,000 teenagers each month. In addition, fast food restaurants give out toys in children's meals, which helps to entice children. Forty percent of children ask their parents to take them to fast food restaurants on a daily basis. To make matters worse, out of 3000 combinations created from popular items on children's menus at fast food restaurants, only 13 meet the recommended nutritional guidelines for young children. Some literature has found a relationship between fast food consumption and obesity. Including a study which found that fast food restaurants near schools increases the risk of obesity among the student population.

Whole milk consumption verses 2% milk consumption in children of one to two years of age had no effect on weight, height, or body fat percentage. Therefore, whole milk

continues to be recommended for this age group. However the trend of substituting sweetened drink for milk has been found to lead to excess weight gain.

## **Sedentary lifestyle**

Physical inactivity of children has also shown to be a serious cause, and children who fail to engage in regular physical activity are at greater risk of obesity. Researchers studied the physical activity of 133 children over a three week period using an accelerometer to measure each child's level of physical activity. They discovered the obese children were 35% less active on school days and 65% less active on weekends compared to non-obese children.

Physical inactivity as a child could result in physical inactivity as an adult. In a fitness survey of 6,000 adults, researchers discovered that 25% of those who were considered active at ages 14 to 19 were also active adults, compared to 2% of those who were inactive at ages 14 to 19, who were now said to be active adults. Staying physically inactive leaves unused energy in the body, most of which is stored as fat. Researchers studied 16 men over a 14 day period and fed them 50% more of their energy required every day through fats and carbohydrates. They discovered that carbohydrate overfeeding produced 75–85% excess energy being stored as body fat and fat overfeeding produced 90–95% storage of excess energy as body fat.

Many children fail to exercise because they are spending time doing stationary activities such as computer usage, playing video games or watching television. TV and other technology may be large factors of physically inactive children. Researchers provided a technology questionnaire to 4,561 children, ages 14, 16, and 18. They discovered children were 21.5% more likely to be overweight when watching 4+ hours of TV per day, 4.5% more likely to be overweight when using a computer one or more hours per day, and unaffected by potential weight gain from playing video games. A randomized trial showed that reducing TV viewing and computer use can decrease age-adjusted BMI; reduced calorie intake was thought to be the greatest contributor to the BMI decrease.

Technological activities are not the only household influences of childhood obesity. Low-income households can affect a child's tendency to gain weight. Over a three week period researchers studied the relationship of socioeconomic status (SES) to body composition in 194 children, ages 11–12. They measured weight, waist girth, stretch stature, skinfolds, physical activity, TV viewing, and SES; researchers discovered clear SES inclines to upper class children compared to the lower class children.

Childhood inactivity is linked to obesity in the United States with more children being overweight at younger ages. In a 2009 preschool study 89% of a preschoolers' day was found to be sedentary while the same study also found that even when outside, 56 percent of activities were still sedentary. One factor believed to contribute to the lack of activity found was little teacher motivation, but when toys, such as balls were made available, the children were more likely to play.

## Genetics

Childhood obesity is often the result of an interplay between many genetic and environmental factors. Polymorphisms in various genes controlling appetite and metabolism predispose individuals to obesity when sufficient calories are present. As such obesity is a major feature of a number of rare genetic conditions that often present in childhood.

- Prader-Willi syndrome with an incidence between 1 in 12,000 and 1 in 15,000 live births is characterized by hyperphagia and food preoccupations which leads to rapid weight gain in those affected.
- Bardet-Biedl syndrome
- MOMO syndrome
- Leptin receptor mutations
- Congenital leptin deficiency
- Melanocortin receptor mutations

In children with early-onset severe obesity (defined by an onset before ten years of age and body mass index over three standard deviations above normal), 7% harbor a single locus mutation. One study found that 80% of the offspring of two obese parents were obese in contrast to less than 10% of the offspring of two parents who were of normal weight. The percentage of obesity that can be attributed to genetics varies from 6% to 85% depending on the population examined. Compare: secondhand obesity.

## Home environment

Children's food choices are also influenced by family meals. Researchers provided a household eating questionnaire to 18,177 children, ranging in ages 11–21, and discovered that four out of five parents let their children make their own food decisions. They also discovered that compared to adolescents who ate three or fewer meals per week, those who ate four to five family meals per week were 19% less likely to report poor consumption of vegetables, 22% less likely to report poor consumption of fruits, and 19% less likely to report poor consumption of dairy foods. Adolescents who ate six to seven family meals per week, compared to those who ate three or fewer family meals per week, were 38% less likely to report poor consumption of vegetables, 31% less likely to report poor consumption of fruits, and 27% less likely to report poor consumption of dairy foods. The results of a survey in the UK published in 2010 imply that children raised by their grandparents are more likely to be obese as adults than those raised by their parents. An American study released in 2011 found the more mothers work the more children are more likely to be overweight or obese.

## Developmental factors

Various developmental factors may affect rates of obesity. Breast-feeding for example may protect against obesity in later life with the duration of breast-feeding inversely associated with the risk of being overweight later on. A child's body growth pattern may

influence the tendency to gain weight. Researchers measured the standard deviation (SD [weight and length]) scores in a cohort study of 848 babies. They found that infants who had an SD score above 0.67 had catch up growth (they were less likely to be overweight) compared to infants who had less than a 0.67 SD score (they were more likely to gain weight).

A child's weight may be influenced when he/she is only an infant. Researchers did a cohort study on 19,397 babies, from their birth until age seven and discovered that fat babies at four months were 1.38 times more likely to be overweight at seven years old compared to normal weight babies. Fat babies at the age of one were 1.17 times more likely to be overweight at age seven compared to normal weight babies.

## **Medical illness**

Cushing's syndrome (a condition in which the body contains excess amounts of cortisol) may also influence childhood obesity. Researchers analyzed two isoforms (proteins that have the same purpose as other proteins, but are programmed by different genes) in the cells of 16 adults undergoing abdominal surgery. They discovered that one type of isoform created oxo-reductase activity (the alteration of cortisone to cortisol) and this activity increased 127.5 pmol mg sup when the other type of isoform was treated with cortisol and insulin. The activity of the cortisol and insulin can possibly activate Cushing's syndrome.

Hypothyroidism is a hormonal cause of obesity, but it does not significantly affect obese people who have it more than obese people who do not have it. In a comparison of 108 obese patients with hypothyroidism to 131 obese patients without hypothyroidism, researchers discovered that those with hypothyroidism had only 0.077 points more on the caloric intake scale than did those without hypothyroidism.

## **Psychological factors**

Researchers surveyed 1,520 children, ages 9–10, with a four year follow up and discovered a positive correlation between obesity and low self esteem in the four year follow up. They also discovered that decreased self esteem led to 19% of obese children feeling sad, 48% of them feeling bored, and 21% of them feeling nervous. In comparison, 8% of normal weight children felt sad, 42% of them felt bored, and 12% of them felt nervous. Stress can influence a child's eating habits. Researchers tested the stress inventory of 28 college females and discovered that those who were binge eating had a mean of 29.65 points on the perceived stress scale, compared to the control group who had a mean of 15.19 points. This evidence may demonstrate a link between eating and stress.

Feelings of depression can cause a child to overeat. Researchers provided an in-home interview to 9,374 adolescents, in grades seven through 12 and discovered that there was not a direct correlation with children eating in response to depression. Of all the obese adolescents, 8.2% had said to be depressed, compared to 8.9% of the non-obese

adolescents who said they were depressed. Antidepressants, however, seem to have very little influence on childhood obesity. Researchers provided a depression questionnaire to 487 overweight/obese subjects and found that 7% of those with low depression symptoms were using antidepressants and had an average BMI score of 44.3, 27% of those with moderate depression symptoms were using antidepressants and had an average BMI score of 44.7, and 31% of those with major depression symptoms were using antidepressants and had an average BMI score of 44.2.

## ***Management***

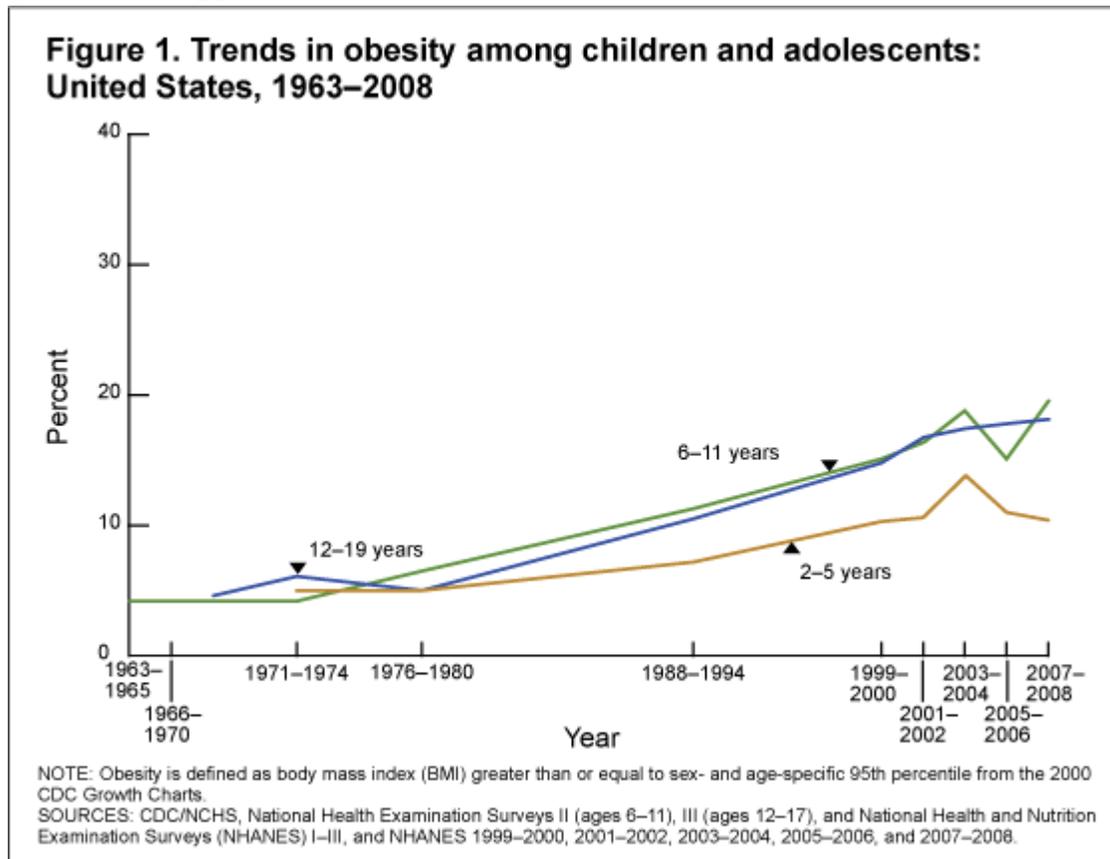
### **Lifestyle**

Exclusive breast-feeding is recommended in all newborn infants for its nutritional and other beneficial effects. It may also protect against obesity in later life.

### **Medications**

There are no medications currently approved for the treatment of obesity in children. Orlistat and sibutramine may however be helpful in managing moderate obesity in adolescence. Sibutramine is approved for adolescents older than 16. It works by altering the brain's chemistry and decreasing appetite. Orlistat is approved for adolescents older than 12. It works by preventing the absorption of fat in the intestines.

## Epidemiology



Prevalence of overweight among children 2 to 19 years in the USA.

Rates of childhood obesity have increased greatly between 1980 and 2010. Currently 10% of children worldwide are either overweight or obese.

### Canada

The rate of overweight and obesity among Canadian children has decreased dramatically in recent years. In boys, the rate decreased from 11% in 1980s to 3% in 1990s.

### Brazil

The rate of overweight and obesity in Brazilian children increased from 4% in the 1980s to 14% in the 1990s.

### United States

The rate of obesity among children and adolescents in the United States has nearly tripled between the early 1980s and 2000. It has however not changed significantly between 2000 and 2006 with the most recent statistics showing a level just over 17 percent. In

2008, the rate of overweight and obese children in the United States was 32%, and had stopped climbing.

## **Australia**

Since the onset of the 21st Century, Australia has found that childhood obesity has followed trend with the United States. Information garnered has concluded that the increase has occurred in the lower socioeconomic areas where poor nutritional education has been blamed.

## **India**

Childhood Obesity is a Silent epidemic shaping in India, which has characteristically been seen in the upper socio economic strata of the society.

## **Research**

A study of 1800 children aged 2 to 12 in Colac, Australia tested a program of restricted diet (no carbonated drinks or sweets) and increased exercise. Interim results included a 68% increase in after school activity programs, 21% reduction in television viewing, and an average of 1 kg weight reduction compared to a control group.

A survey carried out by the American Obesity Association into parental attitudes towards their children's weight showed the majority of parents think that recess should not be reduced or replaced. Almost 30% said that they were concerned with their child's weight. 35% of parents thought that their child's school was not teaching them enough about childhood obesity, and over 5% thought that childhood obesity was the greatest risk to their child's long term health.

A Northwestern University study indicates that inadequate sleep has a negative impact on a child's performance in school, their emotional and social welfare, and increases their risk of being overweight. This study was the first nationally represented, longitudinal investigation of the correlation between sleep, Body Mass Index (BMI) and overweight status in children between the ages of 3 and 18. The study found that an extra hour of sleep lowered the children's risk of being overweight from 36% to 30%, while it lessened older children's risk from 34% to 30%.

## Chapter 5

# Obesity-Associated Morbidity



Gynecomastia as seen in an obese male.

Whether obesity should be considered a disease on its own, it is also an important risk factor for many chronic physical and mental illnesses.

## ***Cardiology***

### **Ischemic heart disease**

Obesity is associated with cardiovascular diseases including angina and myocardial infarction. A 2002 report concluded that 21% of ischemic heart disease is due to obesity while a 2008 European consensus puts the number at 35%.

### **Congestive heart failure**

Having a BMI of greater than 30 increases ones risk of heart failure by two.

### **High blood pressure**

More than 85% of hypertension occurs in people with a BMI of greater than 25. The risk of hypertension is 5 times higher in the obese as compared to those of normal weight. A definitive link between obesity and hypertension has been found using animal and clinical studies, from these it has been realized that many mechanisms are potential causes of obesity induced hypertension. These mechanisms include the activation of the sympathetic nervous system as well as the activation of the renin–angiotensin-aldosterone system.

### **Abnormal cholesterol levels**

Obesity is associated with an increased LDL cholesterol and a lowered HDL cholesterol.

### **Deep vein thrombosis and Pulmonary embolism**

Obesity increases one's risk of venous thromboembolism by 2.3 fold.

## ***Dermatology***



Stretch marks on the abdomen.

- stretch marks
- acanthosis nigricans
- lymphedema
- cellulitis
- hirsutism
- intertrigo

## ***Endocrinology and reproductive medicine***

### **Diabetes mellitus**

One of the strongest links between obesity and disease is that with type 2 diabetes. These two conditions are so strongly linked that researchers in the 1970s started calling it “diabesity”. Excess weight is behind 64% of cases of diabetes in men and 77% of cases in women.

### **Polycystic ovarian syndrome (PCOS)**

Due to its association with insulin resistance, the risk of PCOS increases with adiposity. In the US approximately 60% of patients with PCOS have a BMI of greater than 30.

### **Menstrual disorders**

#### **Infertility**

Obesity leads to infertility in both men and women. This is primarily due to excess estrogen interfering with normal ovulation in women and altering spermatogenesis in men. It is believed to cause 6% of primary infertility.

### **Complications of pregnancy**

Obesity is related to many complications in pregnancy including: haemorrhage, infection, increased hospital stays for the mother, and increased NICU requirements for the infant. Obese women have more than twice the rate of C-sections compared to women of normal weight. Obese women also have increased risk of preterm births and low birth weight infants.

### **Birth defects**

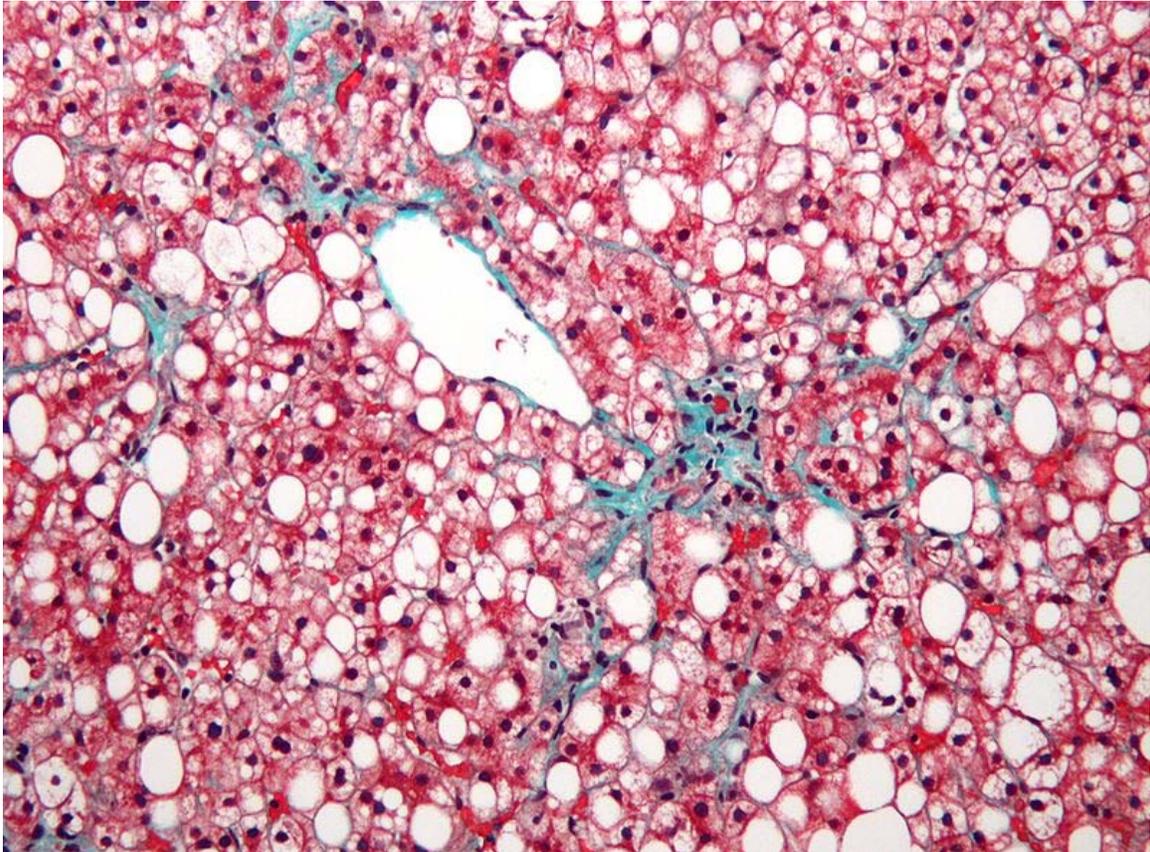
Those who are obese during pregnancy have a greater risk of have a child with a number of congenital malformations including: neural tube defects such as anencephaly and spina bifida, cardiovascular anomalies, including septal anomalies, cleft lip and palate, anorectal malformation, limb reduction anomalies, and hydrocephaly.

### ***Gastrointestinal***

#### **Gastroesophageal reflux disease**

Several studies have show that the frequency and severity of GERD symptoms are higher in those who are obese.

## **Fatty liver disease**



Non-alcoholic fatty liver disease

## ***Neurology***

### **Stroke**

Ischemic stroke is increased in both men and women who are obese. For women with BMI of greater than 30 their risk of ischemic stroke was 1.7 times greater. While men with a BMI of greater than 30 had a risk of stroke 2.0 times greater.

### **Dementia**

Those who are obese have a rate of dementia 1.4 times greater than those of normal weight.

## Multiple sclerosis

Women that are obese at age 18 have a greater than twofold increased risk of MS.

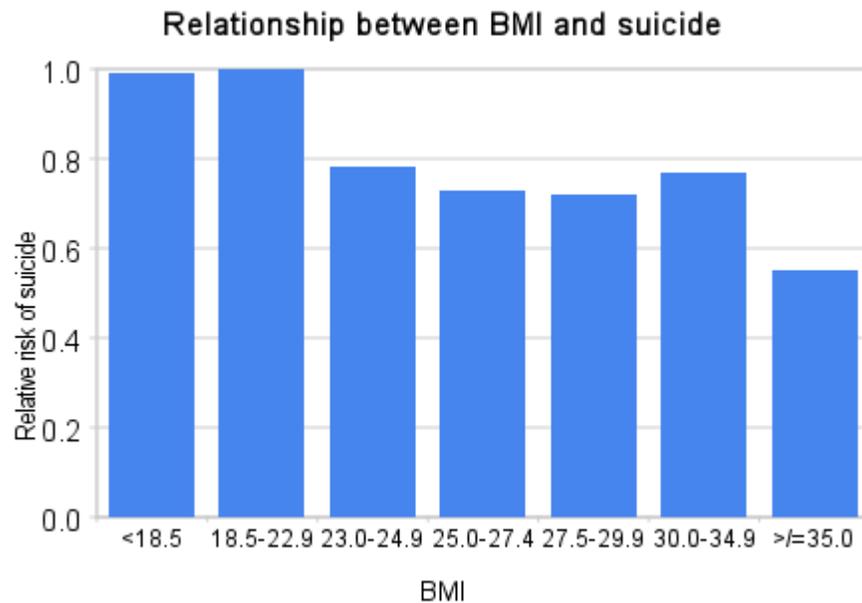
## Oncology

Many cancers occur at increased frequency in those who are overweight or obese. A study from the United Kingdom found that approximately 5% of cancer is due to excess weight. These cancers include:

- breast, ovarian
- esophageal, colorectal
- liver, pancreatic
- gallbladder, stomach
- endometrial, cervical
- prostate, kidney
- non-Hodgkin's lymphoma, multiple myeloma

## Psychiatry

### Depression



Risk of suicide decreases with increased body mass index in the United States.

Obesity has been associated with depression. The relationship is strongest in those who are more severely obese, those who are younger, and in women. Suicide rate however decreases with increased BMI.

## **Social stigmatization**

In the United States young women who are overweight complete 0.3 year less school, are 20% less likely to get married, and make \$6,710 less than their normal weight counterparts.

## **Respirology**

### **Obesity hypoventilation syndrome**



CPAP machine commonly used in OHS

Obesity hypoventilation syndrome is defined as the combination of obesity, hypoxia during sleep, and hypercapnia during the day, resulting from hypoventilation. Based on its definition it occurs only in the obese.

### **Chronic lung disease**

Obesity is associated with a number of chronic lung diseases including: Asthma and COPD. It is believed that a systemic pro-inflammatory state induced by some causes of obesity may be contributing to airway inflammation and thus leading to asthma.

## ***Rheumatology and Orthopedics***

### **Gout**

Compared to men with a BMI of 21 - 23, men with a BMI of 30 - 35 have 2.3 times more gout and men with a BMI of greater than 35 have 3.0 times more gout. Weight loss decreases these risks.

### **Poor mobility**

There is a strong association between obesity and musculoskeletal pain and disability

### **Osteoarthritis**

Increased rates of arthritis are seen in both weight bearing and non weight bearing joint. Those with a BMI greater than 26.4 had rate of osteoarthritis of the knees 6 times greater than those with a BMI of less than 23.4, well rates of osteoarthritis in the hand was about 1.5 times greater.

### **Low back pain**

Obese individuals are twice to four times more likely to have lower back pain than their normal weight peers.

## ***Urology and Nephrology***

### **Erectile dysfunction**

One third of obese men with erectile dysfunction who lose weight have improvement in their sexual functioning.

### **Urinary incontinence**

Urge, stress, and mixed incontinence all occur at higher rates in the obese. The rates are about double that found in the normal weight population. Urinary incontinence improves with weight lose.

### **Chronic renal failure**

Obesity increases ones risk of renal failure by three to four times.

## Chapter 6

# Parental Obesity

**Maternal obesity** refers to obesity (often including being overweight) of a woman during pregnancy. **Parental obesity** refers to obesity of either parent during pregnancy.

Maternal obesity has a significant impact on maternal metabolism and offspring development. Insulin resistance, glucose homeostasis, fat oxidation and amino acid synthesis are all disrupted by maternal obesity and contribute to adverse outcomes. Modification of lifestyle is an effective intervention strategy for improvement of maternal metabolism and the prevention of adverse outcomes.

Obesity is defined as having a Body Mass Index (BMI) of 30 or greater. A 5-foot-5-inch tall woman would be considered obese if she weighs 180 pounds or more and a 5-foot-8-inch tall woman would be considered obese if she weighs 200 pounds or more.

### ***Effects on the fetus***

#### **Defects/ impairments**

Between 18 and 38% of pregnant women of American women are classified as obese. However, little is known about the link between maternal obesity and diabetic effects in offspring. Maternal obesity is associated with increased odds of pregnancies affected by congenital anomalies, including neural tube defects and spina bifida. The chances of having neural tube defects in the newborn of an obese woman has been shown to be twice that of a non-obese pregnant female. Some other anomalies that were increased among mothers with obesity included septal anomalies, cleft palate, cleft lip and palate, anorectal atresia, hydrocephaly, and limb reduction anomalies. Babies are also more likely to be admitted to neonatal intensive care units because of affects from the obese mother. Each year, nearly 2,500 babies are born with these defects, and many other affected pregnancies end in miscarriage and stillbirth.

## **Mental or physical affects on the fetus**

Maternal obesity is linked with elective preterm delivery, neonatal death, and delivery of an extremely low birth weight infant. In follow-up studies of babies whose birth weights were below 1000g, it was shown that 40% to 45% of the survivors had severe neurodevelopmental impairments.

It has been demonstrated through a study on rats that when a pregnant mother ate a diet rich in fat, sugar, and salt, that mother's offspring was more likely to overeat and have a preference for junk food. Even when the offspring were not given the option of junk food, their bodies metabolized food differently than offspring whose mother ate healthier. Offspring of mothers who ate badly had higher levels of cholesterol and triglycerides in their bloodstream and higher risk of heart disease. In addition, these offspring had higher levels of glucose and insulin, which indicate development of type 2 diabetes. The rats were studied through adulthood and were found to be fatter than the offspring whose mothers ate healthier. This study showed that the diet of mothers not only effects the offspring's chemical physiology but also their likelihood of becoming even more unhealthy through their natural preference to bad habits.

## **Paternal obesity effects on the fetus**

Researchers from the NIH's National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) conducted a study and found that early-onset paternal obesity is connected with an increased risk of liver disease in their kin. Researchers found that obese fathers had an elevated level of serum alanine aminotransferase (ALT), a liver enzyme, compared to fathers who were not obese. They did a secondary analysis that excluded obese offspring. Children who were a normal weight but had obese fathers still had elevated ALT levels, which indicated that a child's ALT levels are not dependent upon the child's own BMI.

## ***Obesity effects on the mother***

### **Disease**

Obese women have an increased risk of pregnancy-related complications, including hypertension, gestational diabetes, and blood clots. Maternal obesity is also known to be associated with increased rates of complications in late pregnancy such as cesarean delivery, and shoulder dystocia. In addition, morbidly obese women who have not had children before are at increased risk of all-cause preterm deliveries. It is well recognized that obese women are at increased risk of preeclampsia and that women who have never been pregnant are at higher risk of preeclampsia than women who have had children in the past.

## **Effects of negative diets**

Poor glycemic control can lead to neural tube defects. The usual increase in insulin resistance seen in late pregnancy is enhanced in obese mothers, causing an postprandial increase in glucose, lipids, and amino acids, as well as excessive fetal exposure to fuel sources. This, in turn, increases fetal size, fat storage, and potential risk for disease. For mothers, impaired glucose tolerance and hyperlipidemia are more common among obese mothers.

## ***Modifying the risks***

There are many options available in treating obesity, such as: altering one's diet and exercising regularly. Moderate forms of exercise, such as walking, can lead to healthy weight loss. Some people who are obese turn to gastric bypass surgery in order to reduce their appetites. It is always advised to consult a physician regarding any obesity treatment.

It is recommended that obese women should try to lose weight before becoming pregnant, yet women should not diet during pregnancy because sufficient nutrition is important for pregnant women and women planning pregnancy. Women with gastric banding can have normal pregnancies and better outcomes than women who do not have the surgery, but in most cases, doctors have agreed that pregnancy should wait until surgery-related weight loss has stabilized. Clinicians have been encouraged to talk to women who are pregnant or may become pregnant about getting enough folic acid, quitting smoking, and avoiding alcohol. Women are also recommended to have appropriate calorie intake and exercise adequately.

## ***Nutrition recommendations***

Nutrition in pregnancy includes avoiding foods that are high in saturated or trans fats or that are high in sugar, such as potato chips and other processed foods. Enhance your diet with whole grains, vegetables, fruits and lean proteins. Foods that contain factors such as choline, folic acid, and omega-3 fatty acids are important for the proper development of the fetus. Foods such as soybeans, grape juice, and cabbage are a high source of choline; eggs, yeast, mushrooms, citrus fruits, green vegetables, milk, chicken, tuna, and salmon contain folic acid. Omega-3 fatty acids can be found in flaxseed oil, cottage cheese, or yogurt. Vitamin D can be obtained from food sources or by adequate exposure to natural sunlight.

Pregnant women that ate more sweets, such as candy and processed juices, in early pregnancy were at higher risk of gaining excessive weight. A healthy, well-balanced diet during pregnancy can also help to minimize some pregnancy symptoms such as nausea and constipation.

## ***Exercise recommendations***

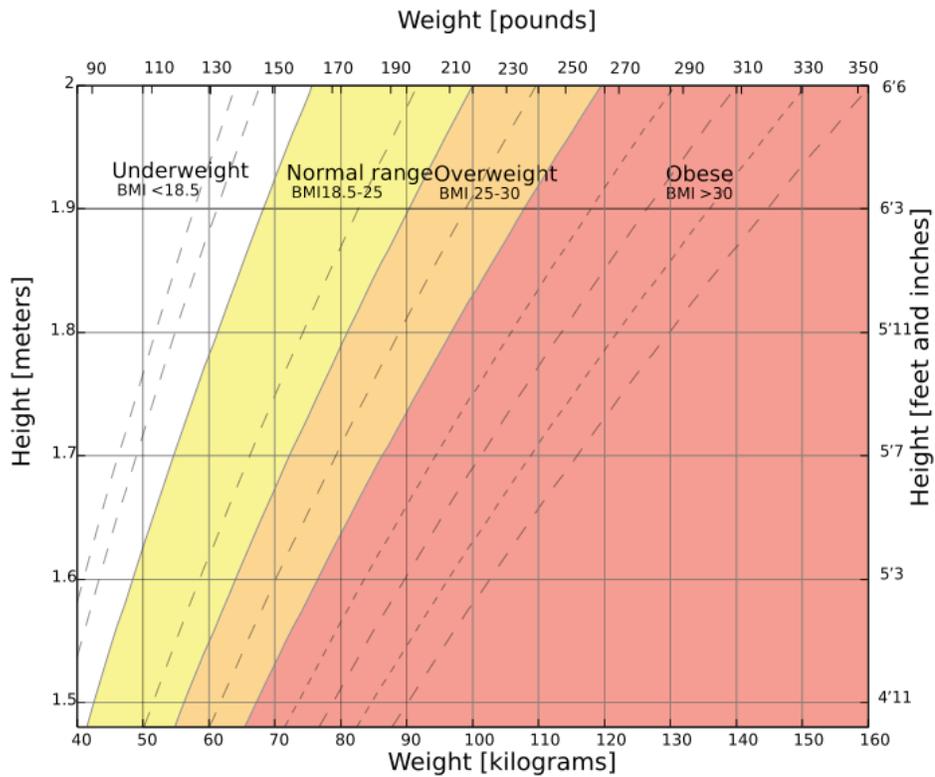
During pregnancy, doctors recommend light exercise. Doctors state that exercise can help the comfort of the mother and the well-being of the unborn child. Some benefits include, but are not limited to: reduced back pain, decrease in constipation, less likely to gain excess weight, decreased chance of gestational diabetes, easier labor, quicker recovery, and better physical and emotional health of the baby.

If negative signs and symptoms occur after exercising, pregnant females should stop immediately. Some signs include: dizziness, faintness, headache, shortness of breath, uterine contractions, vaginal bleeding, fluid leaking, or heart palpitations.

# Chapter 7

# Overweight

## Overweight



The overweight range according to the Body Mass Index (BMI) is the area on the chart where  $BMI > 25$ .

ICD-10	E66.
ICD-9	278.02
MeSH	D050177

**Overweight** is generally defined as having more body fat than is optimally healthy. Being overweight is a common condition, especially where food supplies are plentiful and lifestyles are sedentary. As much as 64% of the United States adult population is considered either overweight or obese, and this percentage has increased over the last four decades.

Excess weight has reached epidemic proportions globally, with more than 1 billion adults being either overweight or obese. Increases have been observed across all age groups.

A healthy body requires a minimum amount of fat for the proper functioning of the hormonal, reproductive, and immune systems, as thermal insulation, as shock absorption for sensitive areas, and as energy for future use. But the accumulation of too much storage fat can impair movement and flexibility, and can alter the appearance of the body.

## ***Classification***

The degree to which a person is overweight is generally described by body mass index (BMI). Overweight is defined as a BMI of 25 or more, thus it includes pre-obesity defined as a BMI between 25 and 30 and obesity as defined by a BMI of 30 or more. Pre obese and overweight however are often used interchangeably thus giving overweight a common definition of a BMI of between 25 -30. There are however several other common ways to measure the amount of adiposity or fat present in an individual's body.

- Body mass index

The body mass index (BMI) is a measure of a person's weight taking into account their height. It is given by the formula: BMI equals a person's weight (mass) in kilograms divided by the square of the person's height in metres. The units therefore are  $\text{kg/m}^2$  but BMI measures are typically used and written without units.

BMI provides a significantly more accurate representation of body fat content than simply measuring a person's weight. It is only moderately correlated with both body fat percentage and body fat mass ( $R^2$  of 0.68.) It does not take into account certain factors such as pregnancy or bodybuilding; however, the BMI is an accurate reflection of fat percentage in the majority of the adult population.

- Body volume index

The body volume index (BVI) was devised in 2000 as a computer, rather than manual, measurement of the human body for obesity and an alternative to the BMI

Body volume index uses 3D software to create an accurate 3D image of a person so BVI can differentiate between people with the same BMI rating, but who have a different shape and different weight distribution.



An obese man on a motorcycle



### Childhood obesity

BVI measures where a person's weight and the fat are located on the body, rather than total weight or total fat content and places emphasis on the weight carried around the abdomen, commonly known as central obesity. There has been an acceptance in recent years that abdominal fat and weight around the abdomen constitute a greater health risk.

- Simple weighing

The person's weight is measured and compared to an estimated ideal weight. This is the easiest and most common method, but by far the least accurate, as it only measures one quantity (weight) and often does not take into account many factors such as height, body type, and relative amount of muscle mass.

- Skinfold calipers or "pinch test"

The skin at several specific points on the body is pinched and the thickness of the resulting fold is measured. This measures the thickness of the layers of fat located under the skin, from which a general measurement of total amount of fat in the body is calculated. This method can be reasonably accurate for many people, but it does assume particular patterns for fat distribution over the body which may not apply to all individuals, and does not account for fat deposits which may not be directly under the skin. Also, as the measurement and analysis generally involves a high degree of practice and interpretation, for an accurate result it must be performed by a professional and cannot generally be done by patients themselves.

- Bioelectrical impedance analysis

A small electrical current is passed through the body to measure its electrical resistance. As fat and muscle conduct electricity differently, this method can provide a direct measurement of the body fat percentage, in relation to muscle mass. In the past, this technique could only be performed reliably by trained professionals with specialized equipment, but it is now possible to buy home testing kits which allow people to do this themselves with a minimum of training. Despite the improved simplicity of this process over the years, however, there are a number of factors which can affect the results, including hydration and body temperature, so it still needs some care when taking the test to ensure that the results are accurate.

- Hydrostatic weighing

Considered one of the more accurate methods of measuring body fat, this technique involves complete submersion of a person in water, with special equipment to measure the person's weight while submerged. This weight is then compared with "dry weight" as recorded outside the water to determine overall body density. As fat is less dense than muscle, careful application of this technique can provide a reasonably close estimate of fat content in the body. This technique does, however, require expensive specialized equipment and trained professionals to administer it properly.

- Dual energy X-ray absorptiometry (DEXA)

Originally developed to measure bone density, DEXA imaging has also come to be used as a precise way to determine body fat content by using the density of various body tissues to identify which portions of the body are fat. This test is generally considered to be very accurate, but requires a great deal of expensive medical equipment and trained professionals to perform.

The most common method for discussing this subject and the one used primarily by researchers and advisory institutions is BMI. Definitions of what is considered to be

overweight vary by ethnicity. The current definition proposed by the US National Institutes of Health (NIH) and the World Health Organization (WHO) designates whites, Hispanics and blacks with a BMI of 25 or more as overweight. For Asians, overweight is a BMI between 23 and 29.9 and obesity for all groups is a BMI of 30 or more.

BMI, however, does not account extremes of muscle mass, some rare genetic factors, the very young, and a few other individual variations. Thus it is possible for an individuals with a BMI of less than 25 to have excess body fat, while others may have a BMI that is significantly higher without falling into this category. Some of the above methods for determining body fat are more accurate than BMI but come with added complexity.

If an individual is overweight and has excess body fat it could, but won't always, create or lead to health risks. Reports are surfacing, however, that being mildly overweight to slightly obese – BMI being between 24 and 31.9 – may be actually beneficial and that people with BMI between 24 and 31.9 could actually live longer than normal weight or underweight persons.

### ***Health-related implications***



Animals can suffer from obesity as well. This German Shepherd dog is noticeably overweight.

While the negative health outcomes associated with obesity are accepted within the medical community, the health implications of the overweight category are more controversial. The generally accepted view is that being overweight causes similar health

problems to obesity, but to a lesser degree. Adams et al. estimated that the risk of death increases by 20 to 40 percent among overweight people, and the Framingham heart study found that being overweight at age 40 reduced life expectancy by three years.

Flegal et al., however, found that the mortality rate for individuals who are classified as overweight (BMI 25 to 30) may actually be lower than for those with an "ideal" weight (BMI 18.5 to 25).

Being overweight has been identified as a cause of cancer, and is projected to overtake smoking as the primary cause of cancer in developed countries as cases of cancer linked to smoking dwindle.

Psychological well-being is also at risk in the overweight individual due to social discrimination. However, children under the age of eight are normally not affected.

Being overweight does not increase mortality in older people.

## ***Causes***

Being overweight is generally caused by the intake of more calories (by eating) than are expended by the body (by exercise and everyday living). Factors which may contribute to this imbalance include:

- Alcoholism
- Eating disorders (such as binge eating)
- Genetic predisposition
- Hormonal imbalances (e.g. hypothyroidism)
- Insufficient or poor-quality sleep
- Limited physical exercise and sedentary lifestyle
- Poor nutrition
- Metabolic disorders, which could be caused by repeated attempts to lose weight by weight cycling
- Overeating
- Psychotropic medication (e.g. olanzapine)
- Smoking cessation and other stimulant withdrawal
- Stress

People who have insulin dependant diabetes and chronically overdose insulin may gain weight, while people who already are overweight may develop insulin tolerance, and in the long run type II diabetes.

## ***Treatment***

A large number of people undergo some form of treatment to attempt to reduce their weight, usually either in an attempt to improve their health, to improve their lifestyle, or for cosmetic reasons. The generally recommended treatment for being overweight is a

modified or controlled diet in conjunction with increased physical exercise. For those who are obese rather than overweight, more intensive therapies such as anti-obesity drugs and/or bariatric surgery are sometimes used.

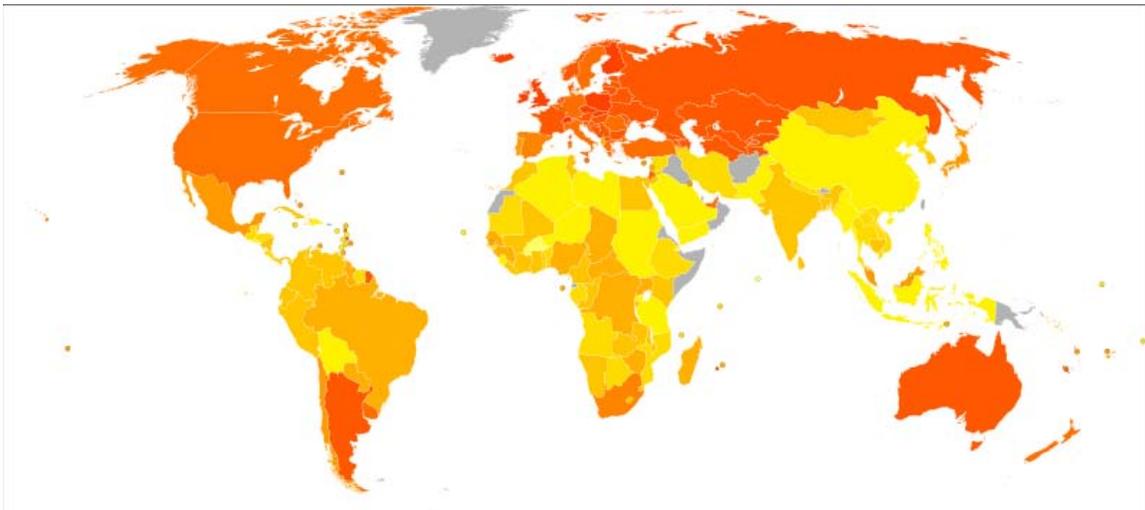
Recent evidence indicates that the spice turmeric may help prevent growth of new fat tissue without making other changes to the diet. The evidence is based on studies with mice. Researchers next will attempt studies in humans.

Studies suggest that reducing calorie intake by itself (dieting) may have short-term effects but does not lead to long-term weight loss, and can often result in gaining back all of the lost weight and more in the longer term. For this reason, it is generally recommended that weight-loss diets not be attempted on their own but instead in combination with increased exercise and long-term planning and weight management.

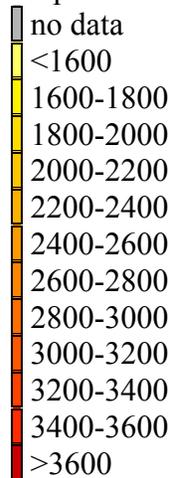
The health benefits of weight loss are also somewhat unclear. While it is generally accepted that for significantly obese patients, losing weight can reduce health risks and improve quality of life, there is some evidence to suggest that for merely overweight patients, the health effects of attempting to lose weight may actually be more detrimental than simply remaining overweight. Moreover, for all individuals, repeatedly losing weight and then gaining it back ("weight cycling" or "yo-yo dieting"), is believed to do more harm than good and can be the cause of significant additional health problems. This is caused by the loss of more muscle than fat.

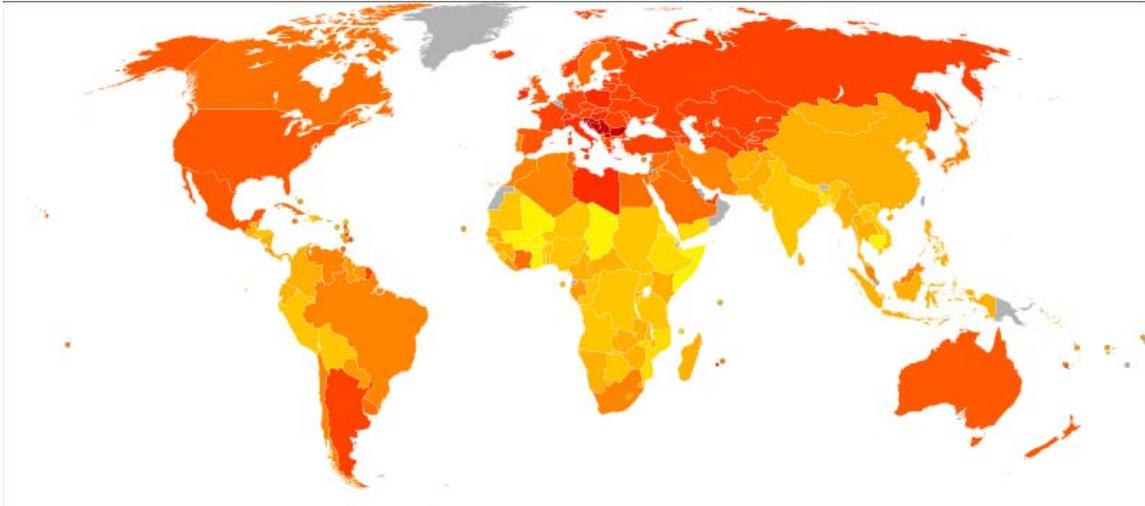
## Chapter 8

# Diet and Obesity

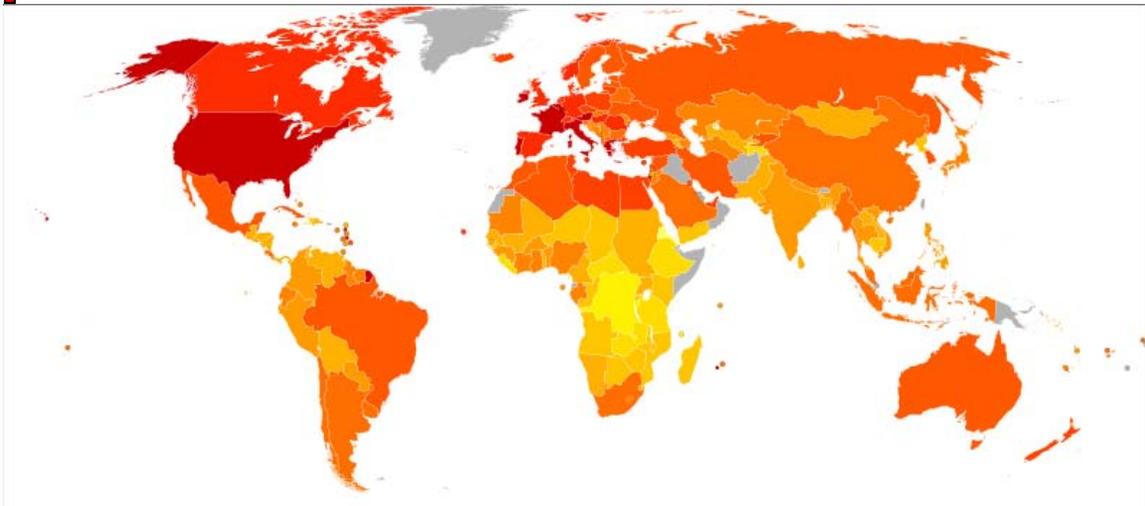
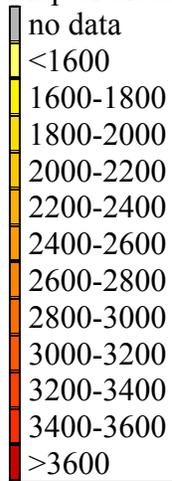


Map of dietary energy availability per person per day in 1961 (kcal/person/day).

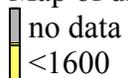


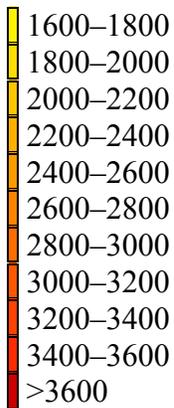


Map of dietary energy availability per person per day in 1979-1981 (kcal/person/day).



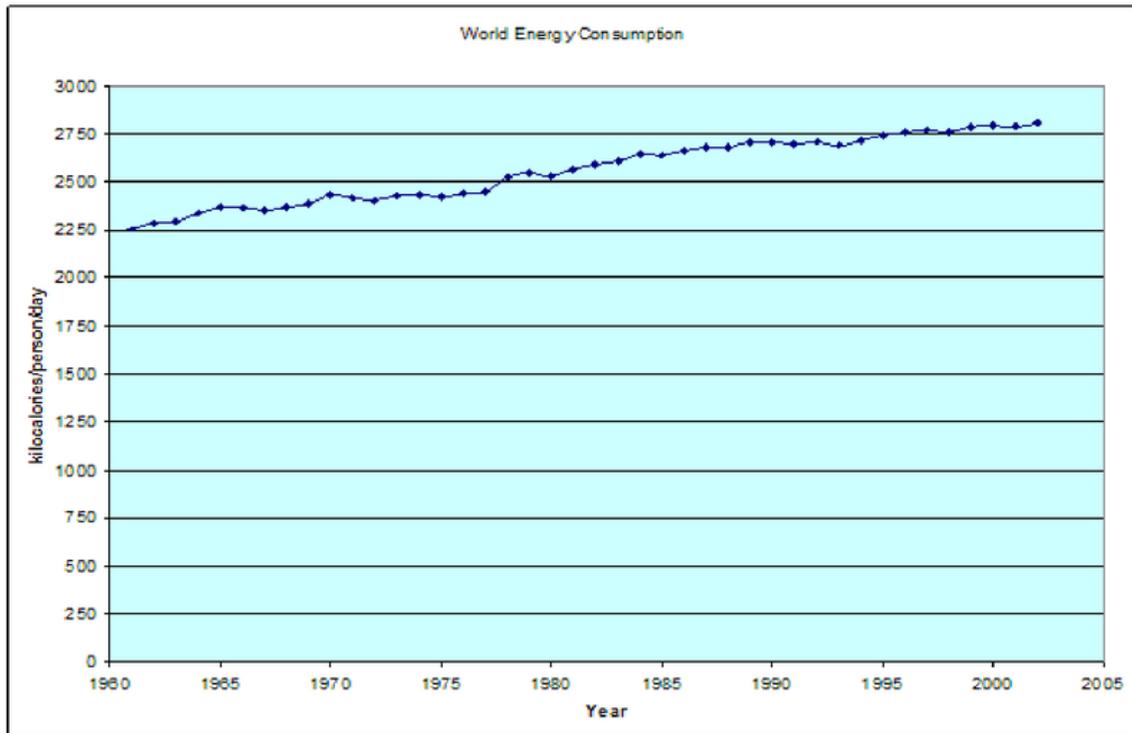
Map of dietary energy availability per person per day in 2001-2003 (kcal/person/day).





Diet plays an important role in the genesis of obesity. Personal choices, advertising, social customs and cultural influences, as well as food availability and pricing all play a role in determining what and how much we eat.

### ***Dietary energy supply***



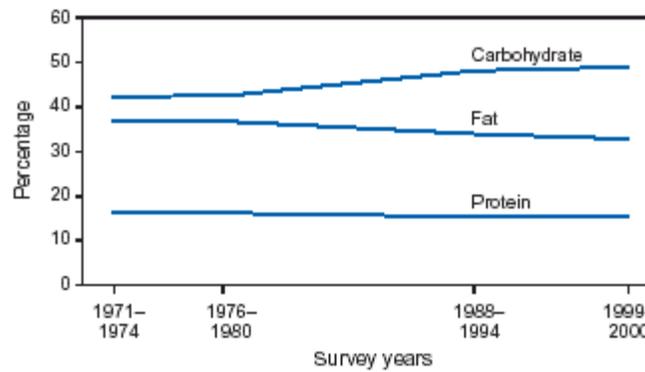
Average per capita energy consumption of the world from 1961 to 2002

The dietary energy supply is the food available for human consumption, usually expressed in kilocalories per person per day. It gives an overestimate of the total amount of food consumed as it reflects both food consumed and food wasted. The per capita dietary energy supply varies markedly between different regions and countries. It has also changed significantly over time. From the early 1970s to the late 1990s, the average calories available per person per day (the amount of food bought) has increased in all part

of the world except Eastern Europe and parts of Africa. The United States had the highest availability with 3654 calories per person in 1996. This increased further in 2002 to 3770. During the late 1990s, Europeans had 3394 calories per person, in the developing areas of Asia there were 2648 calories per person, and in sub-Saharan Africa people had 2176 calories per person.

### **Average calorie consumption**

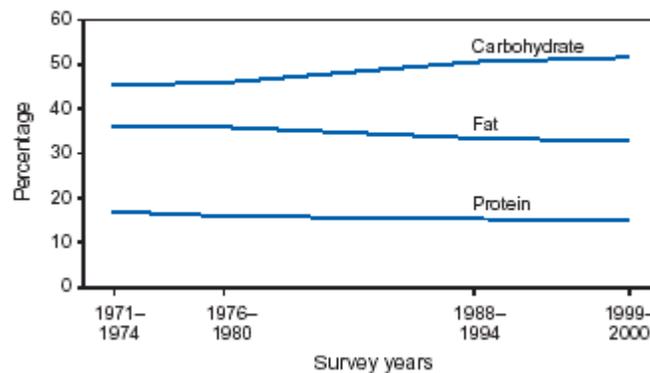
FIGURE 1. Percentage of kilocalories from macronutrient intake among men aged 20–74 years\*, by survey years — National Health and Nutrition Examination Surveys (NHANES), United States, 1971–2000



\*Age adjusted by direct standardization to the 2000 U.S. Census population by using age groups 20–39, 40–59, and 60–74 years.

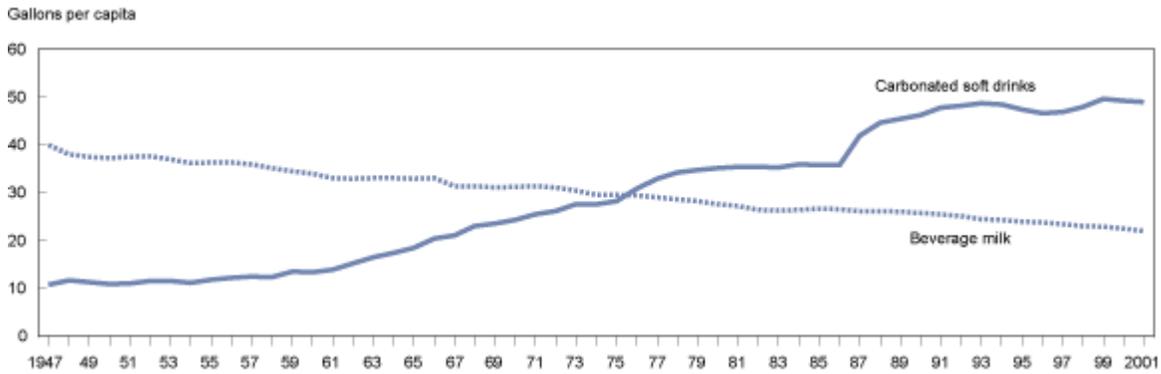
Change over time of the macronutrient composition of the US male diet.

FIGURE 2. Percentage of kilocalories from macronutrient intake among women aged 20–74 years\*, by survey years — National Health and Nutrition Examination Surveys (NHANES), United States, 1971–2000



\*Age adjusted by direct standardization to the 2000 U.S. Census population by using age groups 20–39, 40–59, and 60–74 years.

Change over time of the macronutrient composition of the US female diet.



USDA chart showing the increase in soda consumption and the decrease in milk consumption from 1947 to 2001.

In the period 1971 – 2004, the average number of calories which women consumed in the United States increase by 335 calories per day (1542 calories in 1971 and 1877 calories in 2004). For men the average increase was 168 calories per day (2450 calories in 1971 and 2618 calories in 2004). Most of these extra calories came from an increase in carbohydrate consumption rather than an increase in fat consumption. The primary sources of these extra carbohydrates were sweetened beverages, which now accounts for almost 25 percent of daily calories in young adults in America. As these estimates are based on a person's recall, they may underestimate the amount of calories actually consumed.

### ***Fast food***

As societies become increasingly reliant on energy-dense fast-food meals, the association between fast food consumption and obesity becomes more concerning. In the United States consumption of fast food meal has tripled and calorie intake from fast food has quadrupled between 1977 and 1995. Consumption of sweetened drinks is also believed to be a major contributor to the rising rates of obesity.

### ***Portion size***



A comparison of a typical cheeseburger 20 years ago (left) which had 333 calories with a modern cheeseburger (right) which contains 590 calories as per the National Heart, Lung, and Blood Institute

The portion size of many prepackage and restaurant foods have increased in both the United States and Denmark since the 1970s. Fast food serving for example 2 to 5 times larger than they were in the 1980s. Evidence has shown that larger portions of energy-dense foods lead to greater energy intake and thus to greater rates of obesity.

### ***Social policy and change***

Agricultural policy and techniques in the United States and Europe have led to lower food prices. In the United States, subsidization of corn, soy, wheat, and rice through the U.S. farm bill has made the main sources of processed food cheap compared to fruits and vegetables.

### ***Metabolism***

Evidence does not support the commonly expressed view that some obese people eat little yet gain weight due to a slow metabolism. On average obese people have a greater energy expenditure than normal weight or thin people. This is because it takes more energy to maintain an increased body mass. Obese people also underreport how much food they consume compared to those of normal weight. Tests of human subjects carried out in a calorimeter support this conclusion.

## Chapter 9

# Sedentary Lifestyle



Increases in sedentary behaviors such as watching television are characteristic of a sedentary lifestyle



A typical couch potato

**Sedentary lifestyle** is a medical term used to denote a type of lifestyle with no or irregular physical activity. A person who lives a sedentary lifestyle may colloquially be known as a **couch potato**. It is commonly found in both the developed and developing world. Sedentary activities include sitting, reading, watching television and computer use for much of the day with little or no vigorous physical exercise. A sedentary lifestyle can contribute to many preventable causes of death.

### ***Health effects***

A lack of physical activity is one of the leading causes of preventable death worldwide.

A sedentary lifestyle and lack of physical activity can contribute to or be a risk factor for:

- Anxiety
- Cardiovascular disease
- Mortality in elderly men by 30% and double the risk in elderly women
- Depression
- Diabetes
- Colon cancer
- High blood pressure

- Obesity
- Osteoporosis
- Lipid disorders
- Kidney Stones

## **Solutions**

One response that has been adopted by many organizations concerned with health and environment is the promotion of active travel, which seeks to promote walking and cycling as safe and attractive alternatives to motorized transport. Given that many journeys are for relatively short distances, there is considerable scope to replace car use with walking or cycling, though in many settings this may require some infrastructure modification.

## **History**

It is characterized by sitting or remaining inactive for most of the day with little or no exercise.

### **Historical Trend:**

Scavenging, to subsistence, to savannas, to sedentism, to steak houses, to supersizing, to *Dancing With The Stars*. That sums up a good portion of the last few million years of Western human roots. For millions of years, human types moved their bodies in meaningful ways. They were active all those years and then, over a few decades starting shortly after the Second World War, they stopped moving. It was as though a plague descended upon humanity. A plague named addiction. At the same daily calorie intake rose and Westerners increased the consumption of non-nutritive food high in sugar and corn syrup, fat, and salt.

Is a sedentary lifestyle an addiction? If you try to get someone to stop this pattern you will have your answer.

For their own health and happiness, those afflicted with the plague could remind themselves that movement is a wondrous thing and the best recreational activity individuals, friends, and families can do. And it's number one on the wellness checklist. Yes, may even trump diet but it's better not to think that way. Better to just do the right thing with everything. Don't try to do it, there is no value there. The magic is in doing it.

Starting in the 20th century, wellness and medicine have grown into not always profitable gigantic industries, in attempts to deal with (critics say "contribute to") the pandemic of unwell people. As the piles of data and articles deluge the throngs of overburdened and inactive public, an obvious and sensible option emerges. Instead of being consumed by all of this data, people would be better off the couch or desk, engaged in movement.

Lack of exercise causes muscle atrophy, i.e. shrinking and weakening of the muscles and accordingly increases susceptibility to physical injury. Additionally, physical fitness is correlated with immune system function; a reduction in physical fitness is generally accompanied by a weakening of the immune system. A review in Nature Reviews Cardiology suggests that since illness or injury are associated with prolonged periods of enforced rest, such sedentariness has physiologically become linked to life-preserving metabolic and stress related responses such as inflammation that aid recovery during illness and injury but which due to being nonadaptive during health now lead to chronic diseases.

Despite the well-known benefits of physical activity, many adults and many children lead a relatively sedentary lifestyle and are not active enough to achieve these health benefits.

In the 2008 United States American National Health Interview Survey (NHIS) 36% of adults were considered inactive. 59% of adult respondents never participated in vigorous physical activity lasting more than 10 minutes per week.

## Chapter 10

# Exercise Trends

Worldwide there has been a large shift towards less physically demanding work. This has been accompanied by increasing use of mechanized transportation, a greater prevalence of labor saving technology in the home, and less active recreational pursuits. At least 60% of the world's population does not get sufficient exercise. This is true in almost all developed and developing countries, and among children.

These exercise trends are contributing to the rising rates of chronic diseases including: obesity, heart disease, stroke and high cholesterol. Active transport ( walking, bicycling, etc. ) has been found to be inversely related to obesity in Europe, North America, and Australia. Thus exercise has been associated with a decrease in mortality.

### ***Causes of lack of exercise***

One of the causes most prevalent in the developing world is urbanization. As more of the population moves to cities, population over-crowding, increased poverty, increased levels of crime, high-density traffic, low air quality and lack of parks, sidewalks and recreational sports facilities leads to a less active lifestyle.

Physical inactivity is increasing or high among many groups in the population including: young people, women, and the elderly.

A number of factors has been associated with physical inactivity at a population level including: female gender, older age, living with a partner, smoking, little schooling and poverty.

Studies in children and adults have found an association between the number of hours of television watched and the prevalence of obesity. A 2008 meta analysis found that 63 of 73 studies (86%) showed an increased rate of childhood obesity with increased media exposure, and rates increasing proportionally to time spent watching television.

## **Symptoms**

Noncommunicable diseases, partly due to a lack of exercise, are currently the greatest public health problem in most countries around the world. Each year at least 1.9 million people die as a result of physical inactivity, which makes inactivity one of the leading preventable causes of death worldwide.

## **Countries**

### **Australia**

Australian children between 1961 and 2002 have had a marked decline in their aerobic fitness.

### **Canada**

Obese people are less active than their normal weight counterparts. In Canada, 27.0% of sedentary men are obese as opposed to 19.6% of active men. Lean people are more fidgety than their obese counterparts; this relationship is maintained even if normal weight people eat more or the obese person loses weight.

National data indicates that only 10% of Canadian youth are meeting the guideline for screen time of less than 2 hours per day. As well, although 2/3 of families live close enough for their children to bike or walk to school, only 1/3 report actually walking to school and 80% report never having cycled to school.

### **Asia and China**

A study from China found urbanization reduces daily energy expenditure by about 300–400 kcal and going to work by car or bus reduced it by a further 200 kcal.

A rapid decline in physical activity has occurred between the 1980s and the 2000s. The decline in physical activity is attributed to increasing technology in the workplace and changing leisure activities. In 1989 65% of Chinese had jobs that required heavy labor. This decreased to 51% in the year 2000.

Among Asian children between 1917 and 2003 little change has been seen in power and speed however endurance has decreased substantially in the last 10–15 years.

### **Denmark**

Between 1986 and 1998 school boys in Denmark have become less fit and more fat. This change was not observed among the girls.

## Finland

In Finland leisure-time physical activity has increased, while occupational and commuting physical activity has decreased from 1972 to 2002. Leisure-time physical activity increased from 66% (1972) to 77% (2002) in men and from 49% (1972) to 76% (2002) in women. Physically demanding work decreased from 60% (1972) to 38% (2002) in men and from 47% (1972) to 25% (2002) in women. Daily commuting activity decreased from 30% (1972) to 10% (2002) in men and from 34% (1972) to 22% (2002) in women.

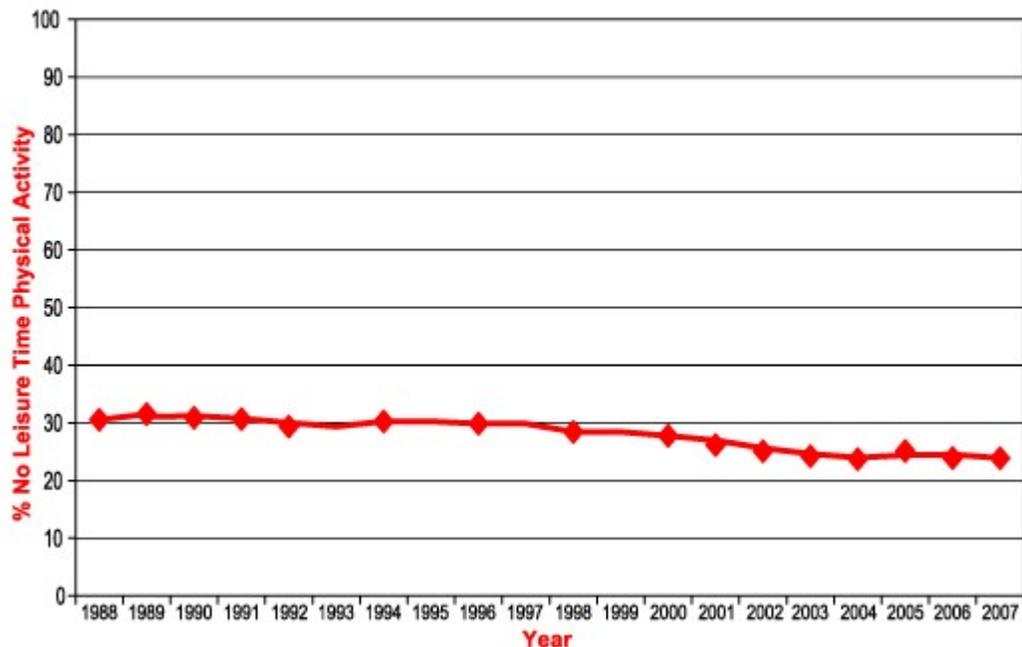
## South America

Over 60% of the population of Brazil, Chile, and Peru do not meet the recommended levels of physical activity needed to maintain health. A study of a southern Brazilian population found that >80% of the population was physically inactive.

## Sweden

A study of Swedish males found a significant decrease in total physical exercise even though recreational exercise has increased. This was due to a decrease in work place exercise and physical exercise in transportation.

## United States



Graph showing the trend in the proportion of the U.S. population which reported no leisure-time physical activity, 1988 - 2007.

Americans have become less physically active overall between 1955 and 2005. While the rate of leisure-time physical activity has not changed significantly there has been a decrease in work-related activity, human powered transportation, activity in the home, and increasing sedentary activity. During 2000 and 2005 the number of adults who were never physically active increased from 9.4% to 10.3% while the number who were engaged in the highest level of physical activity decreased from 18.7% to 16.7%. Pertaining to leisure-time physical activity, people involved in no activity increased from 38.5% to 40.0% while those who spent most of their day sitting increased from 36.8% to 39.9%.

In 2000 the CDC estimated that more than 40% of the US population was sedentary, another 30% was active but not sufficiently and less than 30% had an adequate level of physical activity. There has been a trend toward decreased physical activity in part due to increasingly mechanized forms of work, changing modes of transportation, and increasing urbanization. Obesity rates have increased in relation to expanding suburbs. This has been attributed to increased time spent commuting, leading to less exercise and less meal preparation at home. Driving one's children to school has become increasingly popular. In the USA the proportion of children who walk or bike to school declined between 1969 (42%) and 2001 (16%) resulting in less exercise.

## **UK**

In England both walking and cycling have declined since 1975 being replaced by motorized transport. The average British citizen in the year 2005 walks 317 km (197 miles) per year, a fall of 106 km (58 miles) since 1975. Similar trends are seen in the United States. In 1983 9% of all trips were on foot. This decreased to 7% in 1990.

## ***Children***

Physical activity among children in activities from self propelled transport, to school physical education, and organized sports is declining in many countries. A 2008 meta analysis found that 63 of 73 studies (86%) showed an increased rate of childhood obesity with increased media exposure, and rates increasing proportionally to time spent watching television.

## ***Public health measure***

Many measures have been attempted to address low levels of physical activity. Some of these include: Walking bus, Riding school bus, Mall walking, and Girls on the Run.

## Chapter 11

# Genetics of Obesity



A 1680 painting by Juan Carreno de Miranda of a girl presumed to have Prader-Willi syndrome

Like many other medical conditions, obesity is the result of an interplay between genetic and environmental factors. Polymorphisms in various genes controlling appetite and metabolism predispose to obesity when sufficient calories are present. The percentage of obesity that can be attributed to genetics varies depending on the population examined from 6% to 85%. As of 2006 more than 41 of these sites have been linked to the development of obesity when a favorable environment is present.

## Genes

Although genetic deficiencies are currently considered rare, variations in these genes may predispose to common obesity. Many candidate genes are highly expressed in the central nervous system.

Several additional loci have been identified. Also, several quantitative trait loci for BMI have been identified.

Confirmed and hypothesized associations include:

Condition	OMIM	Locus	Notes
leptin deficiency	164160	7q31.3	
leptin receptor deficiency	601007	1p31	
prohormone convertase-1 deficiency	600955	5q15-q21	
proopiomelanocortin deficiency	609734	2p23.3	
melanocortin-4 receptor polymorphism (MC4R)	155541	18q22	
<i>BMIQ1</i>		7q32.3	near D7S1804
<i>BMIQ2</i>		13q14	near D13S257
<i>BMIQ3</i>		6q23-q25	near D6S1009, GATA184A08, D6S2436, and D6S305
<i>BMIQ4</i>		11q24	near D11S1998, D11S4464, and D11S912
<i>BMIQ5</i>		16p13	near ATA41E04
<i>BMIQ6</i>		20pter-p11.2	near D20S482
INSIG2		2q14.1	
FTO		16q12.2	Adults who were homozygous for a particular <i>FTO</i> allele weighed about 3 kilograms more and had a 1.6-fold greater

rate of obesity than those who had not inherited this trait. This association disappeared, though, when those with *FTO* polymorphisms participated in moderately intensive physical activity equivalent to three to four hours of brisk walking.

TMEM18	2p25.3
GNPDA2	4p13
NEGR1	1p31.1
BDNF	11p13
KCTD15	19q13.12
SH2B1	16p11.2
MTCH2	11p11.2
PCSK1	5q15-q21
NPC1	18q11-q12

Some studies have focused upon inheritance patterns without focusing upon specific genes. One study found that 80% of the offspring of two obese parents were obese, in contrast to less than 10% of the offspring of two parents who were of normal weight.

The thrifty gene hypothesis postulates that certain ethnic groups may be more prone to obesity in an equivalent environment. Their ability to take advantage of rare periods of abundance by storing energy as fat would be advantageous during times of varying food availability, and individuals with greater adipose reserves would be more likely survive famine. This tendency to store fat, however, would be maladaptive in societies with stable food supplies. This is the presumed reason that Pima Indians, who evolved in a desert ecosystem, developed some of the highest rates of obesity when exposed to a Western lifestyle.

Numerous studies of laboratory rodents provide strong evidence that genetics plays an important role in obesity.

### ***Genetic syndromes***

Obesity is also a major feature in several syndromes, such as Prader-Willi syndrome, Bardet-Biedl syndrome, Cohen syndrome, Ayazi syndrome, and MOMO syndrome. (The term "non-syndromic obesity" is sometimes used to exclude these conditions.) In people with early-onset severe obesity (defined by an onset before 10 years of age and body mass index over three standard deviations above normal), 7% harbor a single locus mutation.

## Chapter 12

# Management of Obesity

The main treatment for obesity consists of dieting and physical exercise. Diet programs may produce weight loss over the short term, but maintaining this weight loss is frequently difficult and often requires making exercise and a lower calorie diet a permanent part of a person's lifestyle. Success rates of long-term weight loss maintenance with lifestyle changes are low ranging from 2–20%.

One medication, orlistat (Xenical), is current widely available and approved for long term use. Weight loss however is modest with an average of 2.9 kg (6.4 lb) at 1 to 4 years and there is little information on how these drugs affect longer-term complications of obesity. Its use is associated with high rates of gastrointestinal side effects.

The most effective treatment for obesity is bariatric surgery. Surgery for severe obesity is associated with long-term weight loss and decreased overall mortality. One study found a weight loss of between 14% and 25% (depending on the type of procedure performed) at 10 years, and a 29% reduction in all cause mortality when compared to standard weight loss measures. However, due to its cost and the risk of complications, researchers are searching for other effective yet less invasive treatments.

Studies have found significant benefits in mortality in certain populations from weight loss. In a prospective study of obese women with weight related diseases, intentional weight loss of any amount was associated with a 20% reduction in mortality. In obese women without obesity related illnesses a weight loss of greater than 9 kg (20 lb) was associated with a 25% reduction in mortality. A recent review concluded that certain subgroups such as those with type 2 diabetes and women show long term benefits in all cause mortality, while outcomes for men do not seem to be improved with weight loss. A subsequent study has found benefits in mortality from intentional weight loss in those who have severe obesity.

### ***Dieting***

Diets to promote weight loss are generally divided into four categories: low-fat, low-carbohydrate, low-calorie, and very low calorie. A meta-analysis of six randomized

controlled trials found no difference between three of the main diet types (low calorie, low carbohydrate, and low fat), with a 2–4 kilogram (4.4–8.8 lb) weight loss in all studies. At two years these three methods resulted in similar weight loss irrespective of the macronutrients emphasized.

Very low calorie diets provide 200–800 kcal/day, maintaining protein intake but limiting calories from both fat and carbohydrates. They subject the body to starvation and produce an average weekly weight loss of 1.5–2.5 kilograms (3.3–5.5 lb). These diets are not recommended for general use as they are associated with adverse side effects such as loss of lean muscle mass, increased risks of gout, and electrolyte imbalances. People attempting these diets must be monitored closely by a physician to prevent complications.

## **Exercise**

With use, muscles consume energy derived from both fat and glycogen. Due to the large size of leg muscles, walking, running, and cycling are the most effective means of exercise to reduce body fat. Exercise affects macronutrient balance. During moderate exercise, equivalent to a brisk walk, there is a shift to greater use of fat as a fuel. To maintain health the American Heart Association recommends a minimum of 30 minutes of moderate exercise at least 5 days a week.

A meta-analysis of 43 randomized controlled trials by the Cochrane Collaboration found that exercising alone led to limited weight loss. In combination with diet, however, it resulted in a 1 kilogram weight loss over dieting alone. A 1.5 kilogram (3.3 lb) loss was observed with a greater degree of exercise. Even though exercise as carried out in the general population has only modest effects, a dose response curve is found, and very intense exercise can lead to substantial weight loss. During 20 weeks of basic military training with no dietary restriction, obese military recruits lost 12.5 kg (27.6 lb). High levels of physical activity seem to be necessary to maintain weight loss. A pedometer appears useful for motivation. Over an average of 18-weeks of use physical activity increased by 27% resulting in a 0.38 decreased in BMI.

Signs that encourage the use of stairs as well as community campaigns have been shown to be effective in increasing exercise in a population. The city of Bogota, Colombia for example blocks off 113 kilometers (70 miles) of roads every Sunday and on holidays to make it easier for its citizens to get exercise. These pedestrian zones are part of an effort to combat chronic diseases, including obesity.

## **Weight loss programs**

Weight loss programs often promote lifestyle changes and diet modification. This may involve eating smaller meals, cutting down on certain types of food, and making a conscious effort to exercise more. These programs also enable people to connect with a group of others who are attempting to lose weight, in the hopes that participants will form mutually motivating and encouraging relationships.

A number of popular programs exist, including Weight Watchers, Overeaters Anonymous, and Jenny Craig. These appear to provide modest weight loss (2.9 kg, 6.4 lb) over dieting on one's own (0.2 kg, 0.4 lb) over a two year period. Internet-based programs appear to be ineffective. The Chinese government has introduced a number of "fat farms" where obese children go for reinforced exercise, and has passed a law which requires students to exercise or play sports for an hour a day at school.

In a structured setting, 67% of people who lost greater than 10% of their body mass maintained or continued to lose weight one year later. An average maintained weight loss of more than 3 kg (6.6 lb) or 3% of total body mass could be sustained for five years.

## Medication



Orlistat (Xenical) the most commonly used medication to treat obesity and sibutramine (Meridia) a recently withdrawn medication due to cardiovascular side effects

Only one anti-obesity medications orlistat (Xenical) is currently approved by the FDA for long term use. It reduces intestinal fat absorption by inhibiting pancreatic lipase. Rimonabant (Acomplia), a second drug, works via a specific blockade of the endocannabinoid system. It has been developed from the knowledge that cannabis smokers often experience hunger, which is often referred to as "the munchies". It had been approved in Europe for the treatment of obesity but has not received approval in the United States or Canada due to safety concerns. European Medicines Agency in October 2008 recommended the suspension of the sale of rimonabant as the risk seem to be greater than the benefits. Sibutramine (Meridia), which acts in the brain to inhibit

deactivation of the neurotransmitters, thereby decreasing appetite was withdrawn from the UK market in January 2010 and United States and Canadian markets in October 2010 due to cardiovascular concerns.

Weight loss with these drugs is modest. Over the longer term, average weight loss on orlistat is 2.9 kg (6.4 lb), sibutramine is 4.2 kg (9.3 lb) and rimonabant is 4.7 kg (10.4 lb). Orlistat and rimonabant lead to a reduced incidence of diabetes, and all three drugs have some effect on cholesterol. However, there is little information on how these drugs affect the longer-term complications or outcomes of obesity. In 2010 it was found that sibutramine increases the risk of heart attacks and strokes in people with a history of cardiovascular disease.

There are a number of less commonly used medications. Some are only approved for short term use, others are used off-label, and still others are used illegally. Most are appetite suppressants that act on one or more neurotransmitters. Phendimetrazine (Bontril), diethylpropion (Tenuate), and phentermine (Adipex-P) are approved by the FDA for short term use, while bupropion (Wellbutrin), topiramate (Topamax), and zonisamide (Zonegran) are sometimes used off-label. Recombinant human leptin is very effective in those with obesity due to congenital complete leptin deficiency via decreasing energy intake and possibly increases energy expenditure. This condition is, however, rare and this treatment is not effective for inducing weight loss in the majority of people with obesity. It is being investigated to determine whether or not it helps with weight loss maintenance.

The usefulness of certain drugs depends upon the comorbidities present. Metformin (Glucophage) is preferred in overweight diabetics, as it may lead to mild weight loss in comparison to sulfonylureas or insulin. The thiazolidinediones, on the other hand, may cause weight gain, but decrease central obesity. Diabetics also achieve modest weight loss with fluoxetine (Prozac), orlistat and sibutramine over 12–57 weeks. Preliminary evidence has however found higher number of cardiovascular events in people taking sibutramine versus control (11.4% vs. 10.0%). The long-term health benefits of these treatments remain unclear.

Fenfluramine and dexfenfluramine were withdrawn from the market in 1997, while ephedrine (found in the traditional Chinese herbal medicine *má huáng* made from the *Ephedra sinica*) was removed from the market in 2004. Dexamphetamines are not approved by the FDA for the treatment of obesity due to concerns regarding addiction and abuse potential. The use of these drugs is not recommended due to potential side effects. However, people do occasionally use these drugs illegally.

## **Surgery**

Bariatric surgery ("weight loss surgery") is the use of surgical intervention in the treatment of obesity. As every operation may have complications, surgery is only recommended for severely obese people (BMI > 40) who have failed to lose weight following dietary modification and pharmacological treatment. Weight loss surgery relies

on various principles: the two most common approaches are reducing the volume of the stomach (e.g. by adjustable gastric banding and vertical banded gastroplasty), which produces an earlier sense of satiation, and reducing the length of bowel that comes into contact with food (gastric bypass surgery), which directly reduces absorption. Band surgery is reversible, while bowel shortening operations are not. Some procedures can be performed laparoscopically. Complications from weight loss surgery are frequent.

Surgery for severe obesity is associated with long-term weight loss and decreased overall mortality. One study found a weight loss of between 14% and 25% (depending on the type of procedure performed) at 10 years, and a 29% reduction in all cause mortality when compared to standard weight loss measures. A marked decrease in the risk of diabetes mellitus, cardiovascular disease and cancer has also been found after bariatric surgery. Marked weight loss occurs during the first few months after surgery, and the loss is sustained in the long term. In one study there was an unexplained increase in deaths from accidents and suicide, but this did not outweigh the benefit in terms of disease prevention. When the two main techniques are compared, gastric bypass procedures are found to lead to 30% more weight loss than banding procedures one year after surgery.

The effects of liposuction on obesity are less well determined. Some small studies show benefits while others show none. A treatment involving the placement of an intragastric balloon via gastroscopy has shown promise. One type of balloon led to a weight loss of 5.7 BMI units over 6 months or 14.7 kg (32.4 lb). Regaining lost weight is common after removal, however, and 4.2% of people were intolerant of the device.

### ***Clinical protocols***

Much of the Western world has created clinical practice guidelines in an attempt to address rising rates of obesity. Australia, Canada, the European Union, and the United States have all published statements since 2004.

In a clinical practice guideline by the American College of Physicians, the following five recommendations are made:

1. People with a BMI of over 30 should be counseled on diet, exercise and other relevant behavioral interventions, and set a realistic goal for weight loss.
2. If these goals are not achieved, pharmacotherapy can be offered. The person needs to be informed of the possibility of side-effects and the unavailability of long-term safety and efficacy data.
3. Drug therapy may consist of sibutramine, orlistat, phentermine, diethylpropion, fluoxetine, and bupropion. For more severe cases of obesity, stronger drugs such as amphetamine and methamphetamine may be used on a selective basis. Evidence is not sufficient to recommend sertraline, topiramate, or zonisamide.
4. In people with a BMI over 40 who fail to achieve their weight loss goals (with or without medication) and who develop obesity-related complications, referral for bariatric surgery may be indicated. The person needs to be aware of the potential complications.

5. Those requiring bariatric surgery should be referred to high-volume referral centers, as the evidence suggests that surgeons who frequently perform these procedures have fewer complications.

A clinical practice guideline by the US Preventive Services Task Force (USPSTF) concluded that the evidence is insufficient to recommend for or against routine behavioral counseling to promote a healthy diet in unselected people in primary care settings, but that intensive behavioral dietary counseling is recommended in those with hyperlipidemia and other known risk factors for cardiovascular and diet-related chronic disease. Intensive counseling can be delivered by primary care clinicians or by referral to other specialists, such as nutritionists or dietitians.

Canada developed and published evidence-based practice guidelines in 2006. The guidelines attempt to address the prevention and management of obesity at both the individual and population levels in both children and adults. The European Union published clinical practice guidelines in 2008 in an effort to address the rising rates of obesity in Europe. Australia came out with practice guidelines in 2004.

## **Research**

Lorcaserin has been found to be effective in the treatment of obesity with a weight loss of 5.8 kg at one year as opposed to 2.2 kg with placebo. It however, failed to get FDA approval in 2010 due to concerns regarding cancer. Temporary, controllable gastric pseudo-bezoars (swallowable, swellable foreign bodies in the stomach meant to reduce gastric volume from inside the organ) are being tested. Treatment with naltrexone plus bupropion in a phase three trial resulted in a weight loss of 5–6% versus 1% for a placebo. Another combination that is in trials is phentermine and topiramate (Qnexa). In October 2010 the FDA refused approval due to inadequate evidence regarding potential birth defects and cardiac side effects.

## Chapter 13

# Anti-Obesity Medication



Orlistat (Xenical) the most commonly used medication to treat obesity and sibutramine (Meridia) a recently withdrawn medication due to cardiovascular side effects

**Anti-obesity medication** or weight loss drugs are all pharmacological agents that reduce or control weight. These drugs alter one of the fundamental processes of the human body, weight regulation, by either altering appetite, metabolism, or absorption of calories. It is common for them to be tried and if there is little or no benefit from them to discontinue

treatment. The main treatment modalities for overweight and obesity remain dieting and physical exercise.

Only one anti-obesity medication orlistat (Xenical) is currently approved by the FDA for long term use. It reduces intestinal fat absorption by inhibiting pancreatic lipase. Rimonabant (Acomplia), a second drug, works via a specific blockade of the endocannabinoid system. It has been developed from the knowledge that cannabis smokers often experience hunger, which is often referred to as "the munchies". It had been approved in Europe for the treatment of obesity but has not received approval in the United States or Canada due to safety concerns. The European Medicines Agency in October 2008 recommended the suspension of the sale of rimonabant as the risks seem to be greater than the benefits. Sibutramine (Meridia), which acts in the brain to inhibit deactivation of the neurotransmitters, thereby decreasing appetite was withdrawn from the United States and Canadian markets in October 2010 due to cardiovascular concerns.

Because of potential side effects, it is recommended that anti-obesity drugs only be prescribed for obesity where it is hoped that the benefits of the treatment outweigh its risks.

### ***Mechanisms of action***

Anti-obesity drugs operate through one or more of the following mechanisms:

- Suppression of the appetite. Catecholamines and their derivatives (such as phentermine and other amphetamine-based drugs) are the main tools used for this, although other classes of drugs such as anti-depressants and mood stabilizers have been anecdotally used for appetite suppression (see: bupropion and topiramate). Drugs blocking the cannabinoid receptors may be a future strategy for appetite suppression.
- Increase of the body's metabolism.
- Interference with the body's ability to absorb specific nutrients in food. For example, Orlistat (also known as Xenical and Alli) blocks fat breakdown and thereby prevents fat absorption. The OTC fiber supplements glucomannan and guar gum have been used for the purpose of inhibiting digestion and lowering caloric absorption

Anorectics are primarily intended to suppress the appetite, but most of the drugs in this class also act as stimulants (dexedrine, e.g.), and patients have abused drugs "off label" to suppress appetite (e.g. digoxin).

### ***History***

The first described attempts at producing weight loss are those of Soranus of Ephesus, a Greek physician, in the second century AD. He prescribed elixirs of laxatives and purgatives, as well as heat, massage, and exercise. This remained the mainstay of treatment for well over a thousand years. It was not until the 1920s and 1930s that new

treatments began to appear. Based on its effectiveness for hypothyroidism, thyroid hormone became a popular treatment for obesity in euthyroid people. It had a modest effect but produced the symptoms of hyperthyroidism as a side effect, such as palpitations and difficulty sleeping. Dinitrophenol (DNP) was introduced in 1933; this worked by uncoupling the biological process of oxidative phosphorylation in mitochondria, causing them to produce heat instead of ATP. The most significant side effect was a sensation of warmth, frequently with sweating. Overdose, although rare, led to a rise in body temperature and, ultimately, fatal hyperthermia. By the end of 1938 DNP had fallen out of use because the FDA had become empowered to put pressure on manufacturers, who voluntarily withdrew it from the market.

Amphetamines (marketed as Benzedrine) became popular for weight loss during the late 1930s. They worked primarily by suppressing appetite, and had other beneficial effects such as increased alertness. Use of amphetamines increased over the subsequent decades, culminating in the "rainbow pill" regime. This was a combination of multiple pills, all thought to help with weight loss, taken throughout the day. Typical regimens included stimulants, such as amphetamines, as well as thyroid hormone, diuretics, digitalis, laxatives, and often a barbiturate to suppress the side effects of the stimulants. In 1967/1968 a number of deaths attributed to diet pills triggered a Senate investigation and the gradual implementation of greater restrictions on the market. This culminated in 1979 with the FDA banning the use of amphetamines, then the most effective of the diet drugs, in diet pills.

Meanwhile, phentermine had been FDA approved in 1959 and fenfluramine in 1973. The two were no more popular than other drugs until in 1992 a researcher reported that the two caused a 10% weight loss which was maintained for more than two years. *Fen-phen* was born and rapidly became the most commonly prescribed diet medication. Dexfenfluramine (Redux) was developed in the mid-1990s as an alternative to fenfluramine with less side-effects, and received regulatory approval in 1996. However, this coincided with mounting evidence that the combination could cause valvular heart disease in up to 30% of those who had taken it, leading to withdrawal of *Fen-phen* and dexfenfluramine from the market in September 1997.

Ephedra was removed from the US market in 2004 over concerns that it raises blood pressure and could lead to strokes and death.

### ***Contemporary anti-obesity drugs***

Some patients find that diet and exercise is not a viable option; for these patients, anti-obesity drugs can be a last resort. Some prescription weight loss drugs are stimulants, which are recommended only for short-term use, and thus are of limited usefulness for extremely obese patients, who may need to reduce weight over months or years.

## **Orlistat**

Orlistat (Xenical) reduces intestinal fat absorption by inhibiting pancreatic lipase. Orlistat may cause frequent, oily bowel movements (steatorrhea), but if fat in the diet is reduced, symptoms often improve. Originally available only by prescription, it was approved by the FDA for over-the-counter sale in February 2007. On May 26, 2010, the U.S. Food and Drug Administration (FDA) has approved a revised label for Xenical to include new safety information about cases of severe liver injury that have been reported rarely with the use of this medication.

## **Sibutramine**

Sibutramine (Reductil or Meridia) is an anorectic or appetite suppressant, reducing the desire to eat. Sibutramine may increase blood pressure and may cause dry mouth, constipation, headache, and insomnia.

Sibutramine has been withdrawn from the market in the United States, the UK, the EU, Australia, Canada and Hong Kong. Its risks (non-life threatening MI and stroke) have been shown to outweigh the benefits.

## **Rimonabant**

Rimonabant (Acomplia) is a recently developed anti-obesity medication. It is a cannabinoid (CB1) receptor antagonist that acts centrally on the brain thus decreasing appetite. It may also act peripherally by increasing thermogenesis and therefore increasing energy expenditure.

Weight loss with Rimonabant however has not been shown to be greater than other available weight-loss medication. Due to safety concerns, primarily psychiatric in nature, the drug has not received approval in the United States or Canada, either as an anti-obesity treatment or as a smoking-cessation drug.

Sanofi-Aventis has received approval to market Rimonabant as a prescription anti-obesity drug in the European Union, subject to some restrictions, however, in October 2008, the European Medicines Agency (EMA) recommended that Acomplia no longer be available in UK. One month later, Sanofi-Aventis decided it would no longer study rimonabant for any indication.

## **Metformin**

In people with Diabetes mellitus type 2, the drug metformin (Glucophage) can reduce weight.

## **Exenatide**

Exenatide (Byetta) is a long-acting analogue of the hormone GLP-1, which the intestines secrete in response to the presence of food. Among other effects, GLP-1 delays gastric emptying and promotes a feeling of satiety. Some obese people are deficient in GLP-1, and dieting reduces GLP-1 further. Byetta is currently available as a treatment for Diabetes mellitus type 2. Some, but not all, patients find that they lose substantial weight when taking Byetta. Drawbacks of Byetta include that it must be injected subcutaneously twice daily, and that it causes severe nausea in some patients, especially when therapy is initiated. Byetta is recommended only for patients with Type 2 Diabetes. A somewhat similar drug, Symlin, is currently available for treating diabetes and is in testing for treating obesity in non-diabetics.

## **Pramlintide**

Pramlintide (Symlin) is a synthetic analogue of the hormone Amylin, which in normal people is secreted by the pancreas in response to eating. Among other effects, Amylin delays gastric emptying and promotes a feeling of satiety. Many diabetics are deficient in Amylin. Currently, Symlin is only approved to be used along with insulin by Type 1 and Type 2 diabetics. However, Symlin is currently being tested in non-diabetics as a treatment for obesity. A drawback is that Symlin must be injected at mealtimes.

## **Other drugs**

ZGN-433, is undergoing initial human trials, starting in early 2011.

Lorcaserin, a serotonin-blocking drug, is undergoing FDA trials, as of 2009.

Human growth hormone is also said to increase fat loss and increase strength.

Dinitrophenol (DNP) is another agent that increases strength and promotes fat loss.

Other weight loss drugs have also been associated with medical complications, such as fatal pulmonary hypertension and heart valve damage due to Redux and Fen-phen, and hemorrhagic stroke due to phenylpropanolamine. Many of these substances are related to amphetamine.

Unresearched nonprescription products or programs for weight loss are heavily promoted by mail and print advertising and on the internet. The US Food and Drug Administration recommends caution with use of these products, since many of the claims of safety and effectiveness are unsubstantiated. Individuals with anorexia nervosa and some athletes try to control body weight with laxatives, diet pills or diuretic drugs, although these generally have no impact on body fat. Products that work as a laxative can cause the blood's potassium level to drop, which may cause heart and/or muscle problems. Pyruvate is a popular product that may result in a small amount of weight loss. However,

pyruvate, which is found in red apples, cheese, and red wine, has not been thoroughly studied and its weight loss potential has not been scientifically established.

## ***Alternative medicine***

Alternative medicine has insufficient evidence to support its use.

## ***Side effects***

Some anti-obesity drugs have severe or life-threatening side effects, fen-phen being a famous example. These side effects are often associated with their mechanism of action. In general, stimulants carry a risk of high blood pressure, faster heart rate, palpitations, closed-angle glaucoma, drug addiction, restlessness, agitation, and insomnia.

Another drug, orlistat, blocks absorption of dietary fats, and as a result may cause oily spotting bowel movements (steatorrhea), oily stools, stomach pain, and flatulence. A similar medication, designed for patients with Type 2 diabetes, is Acarbose which partially blocks absorption of carbohydrates in the small intestine, and produces similar side effects including stomach pain, and flatulence.

## ***Limitations of current knowledge***

The limitation of drugs for obesity is that we do not fully understand the neural basis of appetite and how to modulate it. Appetite is clearly a very important instinct to promote survival. Arguably any drug that would abolish appetite may carry a high mortality risk and may be unsuitable for clinical use.

Because the human body uses various chemicals and hormones to protect its stores of fat (a reaction probably useful to our ancestors when food was scarce in the past,) there has not yet been found a 'silver bullet', or a way to completely circumvent this natural habit of protecting excess food stores. Because of this, anti-obesity drugs are not a practical long-term solution for people who are overweight.

In order to circumvent the number of feedback mechanisms that prevent most monotherapies from producing sustained large amounts of weight loss, it has been hypothesized that combinations of drugs may be more effective by targeting multiple pathways and possibly inhibiting feedback pathways that work to cause a plateau in weight loss. This was evidenced by the success of the combination of phentermine and fenfluramine or dexfenfluramine, popularly referred to phen-fen, in producing significant weight loss but fenfluramine and dexfenfluramine were pulled from the market due to safety fears regarding a potential link to heart valve damage. The damage was found to be a result of activity of fenfluramine and dexfenfluramine at the 5-HT<sub>2B</sub> serotonin receptor in heart valves. Newer combinations of SSRIs and phentermine, known as phenpro, have been used with equal efficiency as fenphen with no known heart valve damage due to lack of activity at this particular serotonin receptor due to SSRIs. There has been a recent resurgence in combination therapy clinical development with the development of 3

combinations: Qnexa (topiramate + phentermine), Empatic (bupropion + zonisamide) and Contrave (bupropion + naltrexone).

### ***Future developments***

Other classes of drugs in development include lipase inhibitors, similar to orlistat. Another lipase inhibitor, called GT 389-255, is being developed by Peptimmune (licensed from Genzyme). This is a novel combination of an inhibitor and a polymer designed to bind the undigested triglycerides therefore allowing increased fat excretion without side effects such as oily stools that occur with orlistat. The development seems to be stalled as Phase 1 trials were conducted in 2004 and there has been no further human clinical development since then.

Another potential long-term approach to anti-obesity medication is through the development of ribonucleic acid interference (RNAi). Animal studies have illustrated that the deletion of the RIP140 gene in mice by genetic knockdown results in the lack of fat accumulation, even when mice are fed a high fat diet. Experiments conducted by Professor Malcolm Parker of Imperial College show that by silencing RIP 140, a nuclear hormone co-repressor which regulates fat accumulation, animal models exhibit a lean profile throughout their life, are resistant to diet-induced obesity, and show an enhanced metabolic rate. CytRx Corporation is developing RNAi therapeutics against this drug target for the treatment of obesity and type 2 diabetes. Similarly, another nuclear hormone receptor co-repressor, SMRT, has demonstrated an opposing effect in genetically engineered mice. Dr. Russell Nofsinger and Dr. Ronald Evans of the Salk Institute showed that disruption of the molecular interaction between SMRT and their nuclear hormone receptor partners leads to increased adiposity and a decreased metabolic rate. These studies suggest that new drugs targeting the molecular interaction between nuclear hormone receptors and their regulatory cofactors could provide a useful new category of therapeutic targets to be developed in an effort to control obesity.

Another approach is to induce a sense of satiety by occupying space in the gastric and intestinal cavities. One clinical trial involves a hydrogel made of indigestible, food-grade materials. Another pilot study uses pseudobezoars.

## Chapter 14

# Bariatric Surgery

**Bariatric surgery**, or weight loss surgery, includes a variety of procedures performed on people who are obese. Weight loss is achieved by reducing the size of the stomach with an implanted medical device (gastric banding) or through removal of a portion of the stomach (sleeve gastrectomy or biliopancreatic diversion with duodenal switch) or by resecting and re-routing the small intestines to a small stomach pouch (gastric bypass surgery).

Long-term studies show the procedures cause significant long-term loss of weight, recovery from diabetes, improvement in cardiovascular risk factors, and a reduction in mortality of 23% from 40%.

The U.S. National Institutes of Health recommends bariatric surgery for obese people with a body mass index (BMI) of at least 40, and for people with BMI 35 and serious coexisting medical conditions such as diabetes. However, research is emerging that suggests bariatric surgery could be appropriate for those with a BMI of 35 to 40 with no comorbidities or a BMI of 30 to 35 with significant comorbidities.

### **Indications**

A medical guideline by the American College of Physicians concluded:

- "Surgery should be considered as a treatment option for patients with a BMI of 40 kg/m<sup>2</sup> or greater who instituted but failed an adequate exercise and diet program (with or without adjunctive drug therapy) and who present with obesity-related comorbid conditions, such as hypertension, impaired glucose tolerance, diabetes mellitus, hyperlipidemia, and obstructive sleep apnea. A doctor-patient discussion of surgical options should include the long-term side effects, such as possible need for reoperation, gallbladder disease, and malabsorption."
- "Patients should be referred to high-volume centers with surgeons experienced in bariatric surgery."

When determining eligibility for bariatric surgery for extremely obese patients, psychiatric screening is critical; it is also critical for determining postoperative success. In patients with a body mass index of  $40 \text{ kg/m}^2$  or greater, there is a 5-fold risk of depression, and half of bariatric surgery candidates are depressed.

### ***Classification of surgical procedures***

Procedures can be grouped in three main categories: Standard of care in the United States and most of the industrialized world in 2009 is for laparoscopic as opposed to open procedures. Future trends are attempting to achieve similar or better results via endoscopic procedures.

### **Predominantly malabsorptive procedures**

Predominantly malabsorptive procedures, although they also reduce stomach size, these operations are based mainly on creating malabsorption.

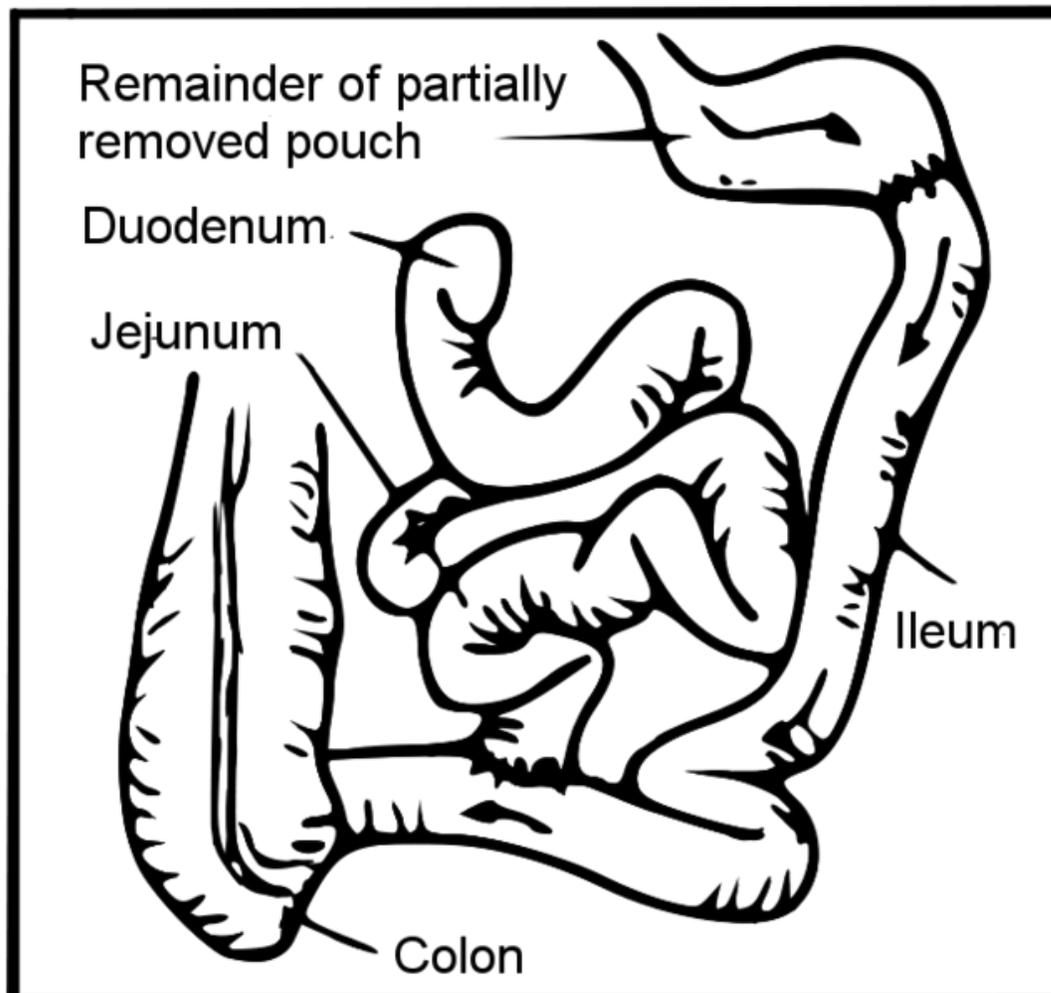


Diagram of a biliopancreatic diversion.

## **Biliopancreatic diversion**

This complex operation is termed *biliopancreatic diversion* (BPD) or the *Scopinaro procedure*. The original form of this procedure is now rarely performed because of problems with malnourishment. It has been replaced with a modification known as duodenal switch (BPD/DS). Part of the stomach is resected, creating a smaller stomach (however the patient can eat a free diet as there is no restrictive component). The distal part of the small intestine is then connected to the pouch, bypassing the duodenum and jejunum.

In around 2% of patients there is severe malabsorption and nutritional deficiency that requires restoration of the normal absorption. The malabsorptive effect of BPD is so potent that those who undergo the procedure must take vitamin and dietary minerals above and beyond that of the normal population. Without these supplements, there is risk of serious deficiency diseases such as anemia and osteoporosis.

Because gallstones are a common complication of the rapid weight loss following any type of bariatric surgery, some surgeons remove the gallbladder as a preventive measure during BPD. Others prefer to prescribe medications to reduce the risk of post-operative gallstones.

Far fewer surgeons perform BPD compared to other weight loss surgeries, in part because of the need for long-term nutritional follow-up and monitoring of BPD patients.

## **Jejunioileal bypass**

This procedure is no longer performed.

## **Endoluminal sleeve**

A trial study performed on rats involved placing a 10 cm long impermeable sleeve into the rat's intestine to block absorption of food in the duodenum and upper jejunum. A study at Massachusetts General Hospital Weight Center and Gastrointestinal Unit found that rats who had the surgery ate 30% less food and lost 20% more weight than counterpart rats, while blood glucose levels returned to normal levels in all mice who had the surgery.

A study on humans was done in Chile using the same technique however the results were not conclusive and the device had issues with migration and slipping.

## **Predominantly restrictive procedures**

Procedures that are solely restrictive, act to reduce oral intake by limiting gastric volume, produces early satiety, and leave the alimentary canal in continuity, minimizing the risks of metabolic complications.

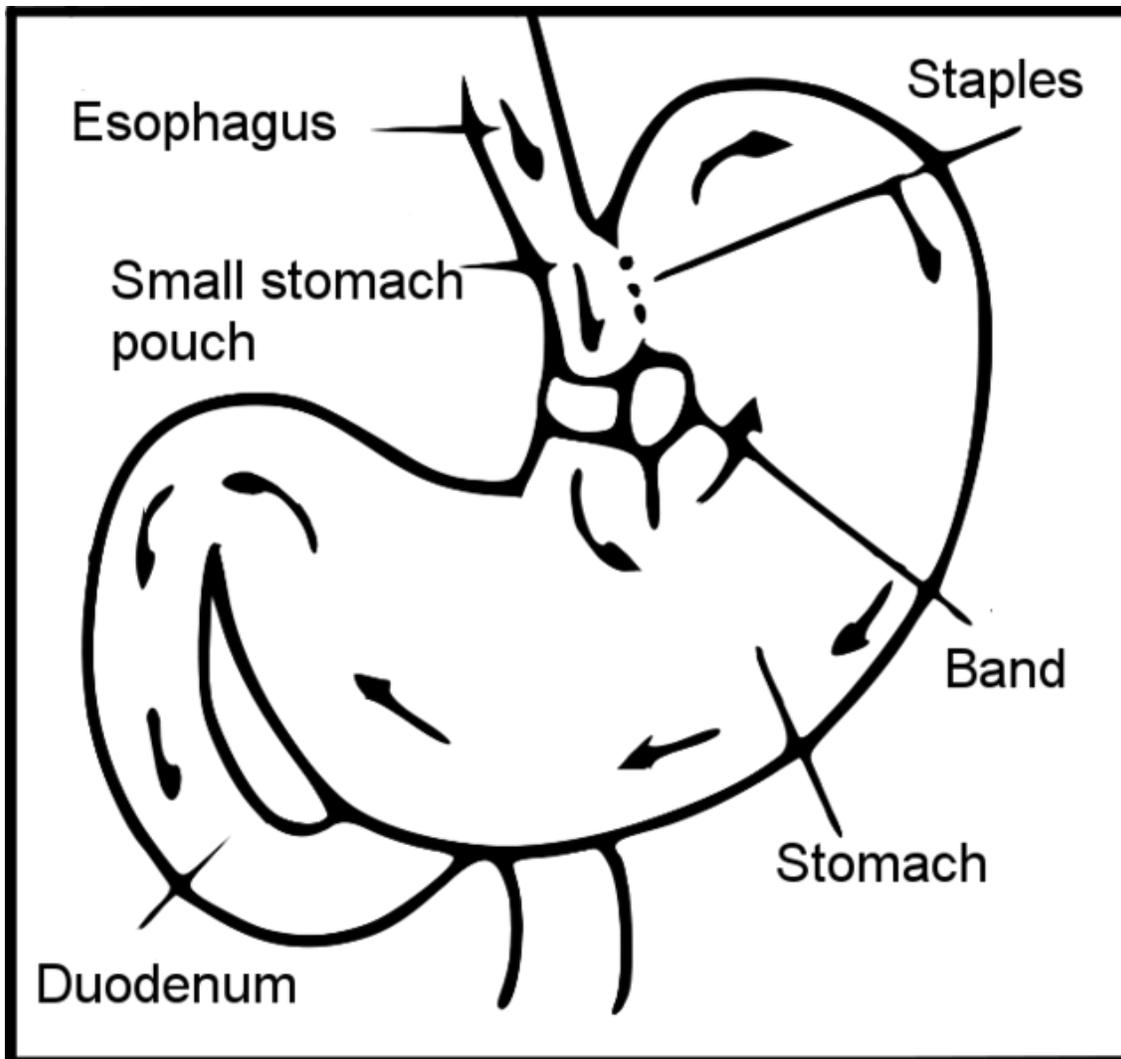


Diagram of a vertical banded gastroplasty.

### **Vertical banded gastroplasty**

In the vertical banded gastroplasty, also called the Mason procedure or stomach stapling, a part of the stomach is permanently stapled to create a smaller pre-stomach pouch, which serves as the new stomach.

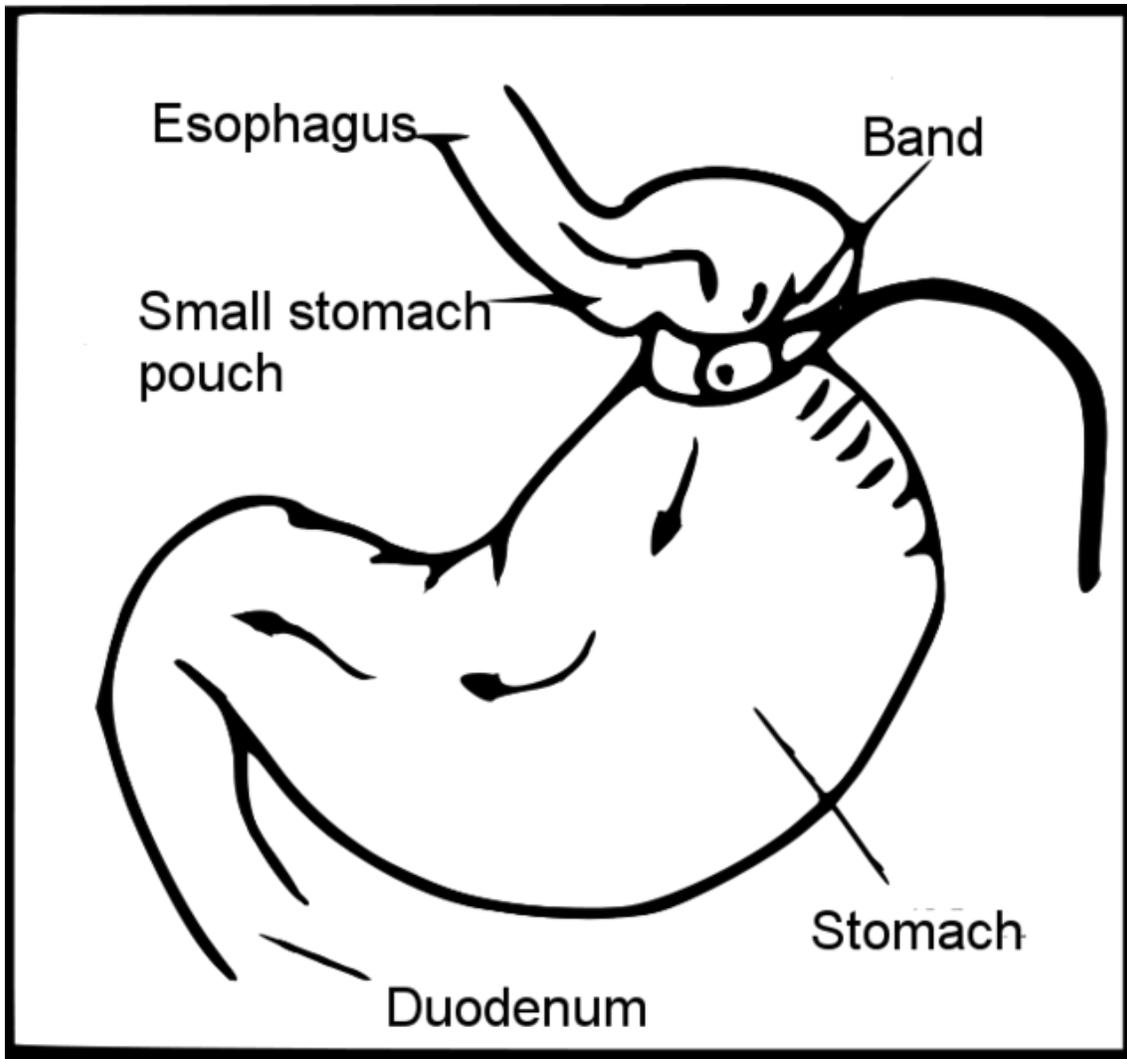


Diagram of an adjustable gastric banding.

### **Adjustable gastric band**

The restriction of the stomach also can be created using a silicone band, which can be adjusted by addition or removal of saline through a port placed just under the skin. This operation can be performed laparoscopically, and is commonly referred to as a "lap band." Weight loss is predominantly due to the restriction of nutrient intake that is created by the small gastric pouch and the narrow outlet. It is considered one of the safest procedures performed today with a mortality rate of 0.05%.

### **Sleeve gastrectomy**

Sleeve gastrectomy, or gastric sleeve, is a surgical weight-loss procedure in which the stomach is reduced to about 15% of its original size, by surgical removal of a large portion of the stomach, following the major curve. The open edges are then attached

together (often with surgical staples) to leave the stomach shaped more like a tube, or a sleeve, with a banana shape. The procedure permanently reduces the size of the stomach. The procedure is performed laparoscopically and is not reversible.

This combined approach has tremendously decreased the risk of weight loss surgery for specific groups of patients, even when the risk of the two surgeries is added. Most patients can expect to lose 30 to 50% of their excess body weight over a 6 - 12 month period with the sleeve gastrectomy alone. The timing of the second procedure will vary according to the degree of weight loss, typically 6 – 18 months.

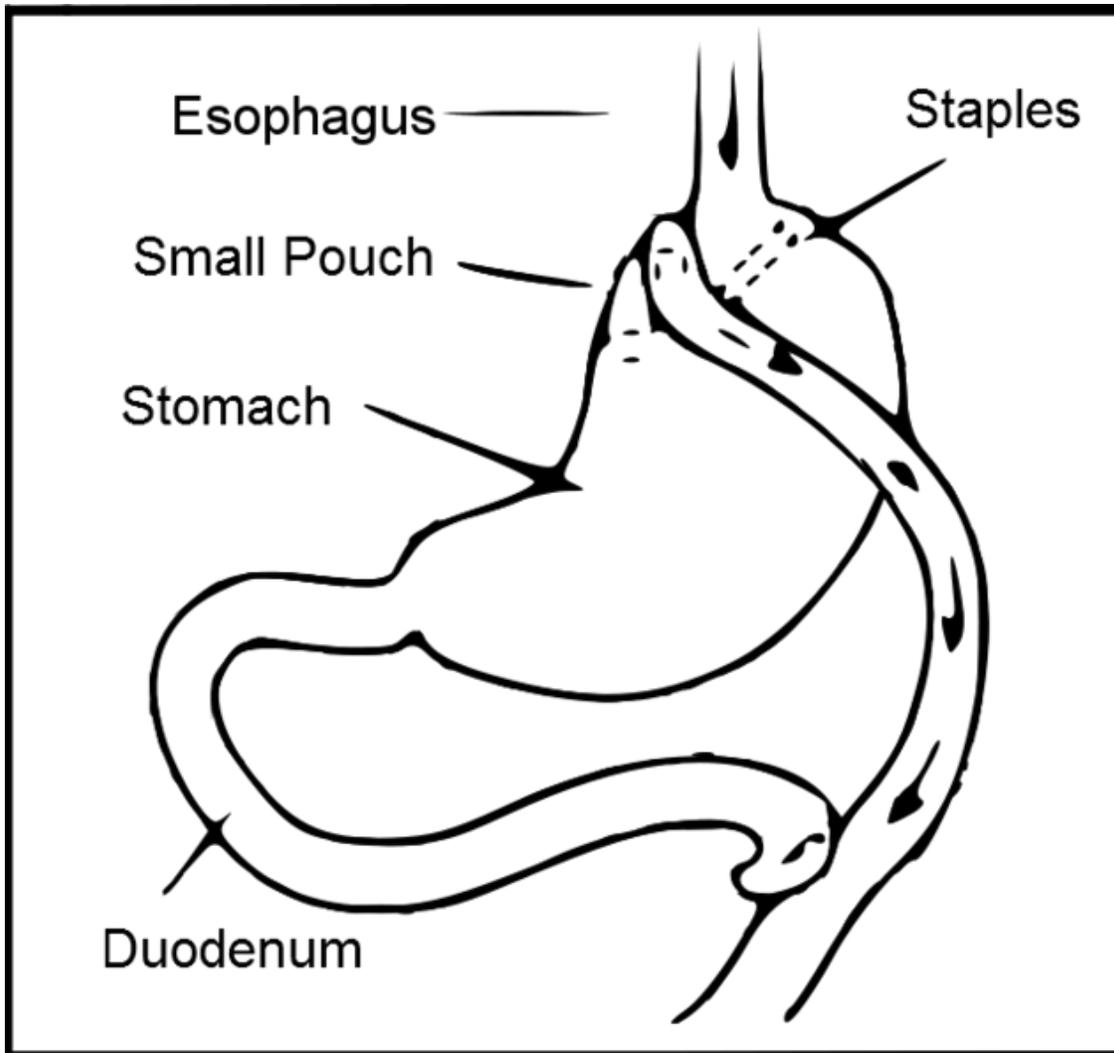
- Stomach volume is reduced, but it tends to function normally so most food items can be consumed in small amounts.
- Removes the portion of the stomach that produces the hormones that stimulates hunger (Ghrelin), although the durability of this removal has yet to be confirmed.
- No dumping syndrome because the pylorus is preserved.
- Minimizes the chance of an ulcer occurring.
- By avoiding the intestinal bypass, the chance of intestinal obstruction (blockage), anemia, osteoporosis, protein deficiency and vitamin deficiency are significantly reduced.
- Very effective as a first stage procedure for high BMI patients (BMI >55 kg/m<sup>2</sup>).
- Limited results appear promising as a single stage procedure for low BMI patients (BMI 35–45 kg/m<sup>2</sup>).
- Appealing option for people with existing anemia, Crohn's disease and numerous other conditions that make them too high risk for intestinal bypass procedures.

### **Intragastric balloon (Gastric balloon)**

Intragastric balloon involves placing a deflated balloon into the stomach, and then filling it to decrease the amount of gastric space. The balloon can be left in the stomach for a maximum of 6 months and results in an average weight loss of 5-9BMI over half a year. While not yet approved by the FDA the Intragastric balloon is approved in Australia, Canada, Mexico, India and several European and South American countries. The Intragastric balloon may be used prior to another bariatric surgery in order to assist the patient to reach a weight which is suitable for surgery, further it can also be used on several occasions if necessary.

### **Mixed procedures**

Mixed procedures apply both techniques simultaneously.



Roux-en-Y gastric bypass.

### **Gastric bypass surgery**

A common form of gastric bypass surgery is the Roux-en-Y gastric bypass. Here, a small stomach pouch is created with a stapler device, and connected to the distal small intestine. The upper part of the small intestine is then reattached in a Y-shaped configuration.

The gastric bypass had been the most commonly performed operation for weight loss in the United States, and approximately 140,000 gastric bypass procedures were performed in 2005, dwarfing the number of Lap-Band, duodenal switch and vertical banded gastroplasty procedures. The gastric bypass operation is considered the "gold standard" in the U.S. A factor in the success of any bariatric surgery is strict post-surgical adherence to a healthier pattern of eating.

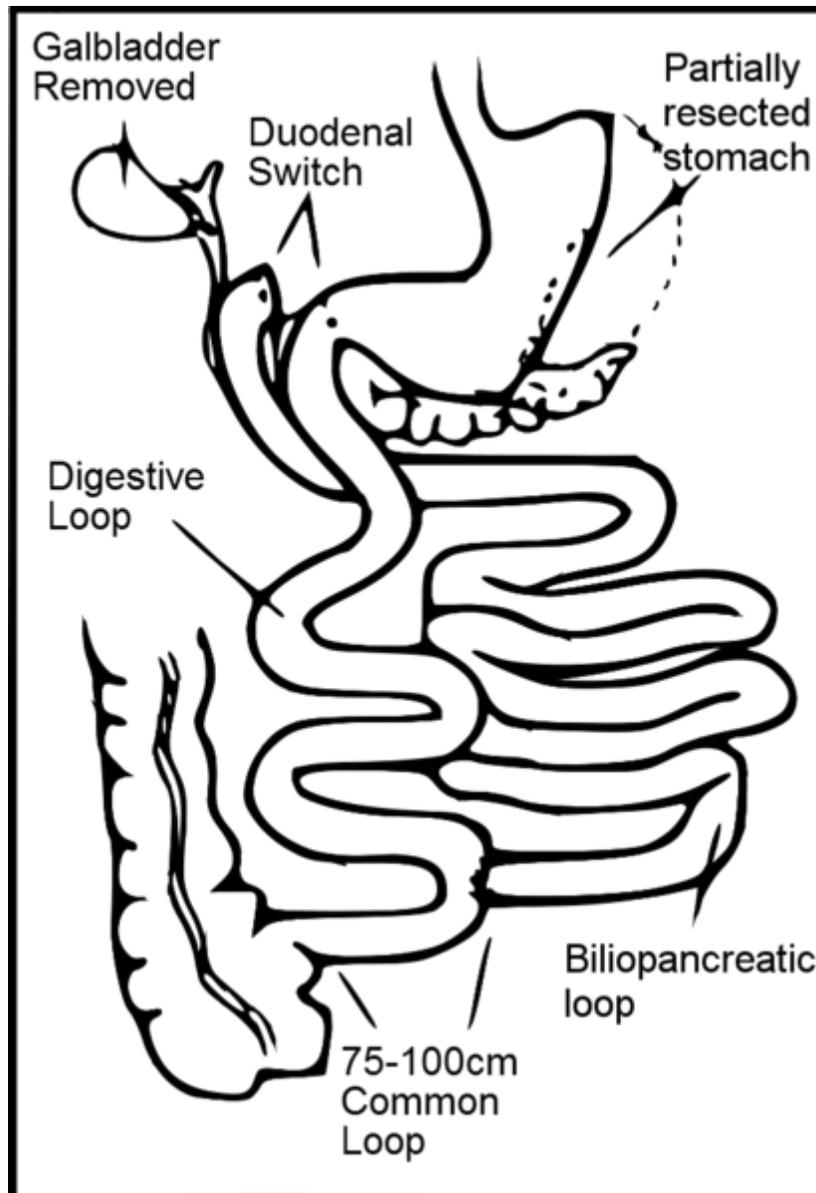


Diagram of a sleeve gastrectomy with duodenal switch.

### **Sleeve gastrectomy with duodenal switch**

A variation of the biliopancreatic diversion includes a Duodenal switch. The part of the stomach along its greater curve is resected. The stomach is "tubulized" with a residual volume of about 150 ml. This volume reduction provides the food intake restriction component of this operation. This type of gastric resection is anatomically and functionally irreversible. The stomach is then disconnected from the duodenum and connected to the distal part of the small intestine. The duodenum and the upper part of the small intestine are reattached to the rest at about 75–100 cm from the colon.

## **Implantable gastric stimulation**

This procedure where a device similar to a heart pacemaker is implanted by a surgeon, with the electrical leads stimulating the external surface of the stomach, is being studied in the USA. Electrical stimulation is thought to modify the activity of the enteric nervous system of the stomach, which is interpreted by the brain to give a sense of satiety, or fullness. Early evidence suggests that it is less effective than other forms of Bariatric Surgery.

## ***Eating after bariatric surgery***

Immediately after bariatric surgery, the patient is restricted to a clear liquid diet, which includes foods such as clear broth, diluted fruit juices or sugar-free gelatin desserts. This diet is continued until the gastrointestinal tract has recovered somewhat from the surgery. The next stage provides a blended or pureed sugar-free diet for at least two weeks. This may consist of skimmed milk, cream of wheat, a small pat of margarine, protein drinks, cream soup, pureed fruit and mashed potatoes with gravy.<

Post-surgery, overeating is curbed because exceeding the capacity of the stomach causes nausea and vomiting. Diet restrictions after recovery from surgery depend in part on the type of surgery. Many patients will need to take a daily multivitamin pill for life to compensate for reduced absorption of essential nutrients. Because patients cannot eat a large quantity of food, physicians typically recommend a diet that is relatively high in protein and low in fats and alcohol.

## **Fluid Recommendations**

It is very common, within the first month post-surgery, for a patient to undergo volume depletion and dehydration. Patients have difficulty drinking the appropriate amount of fluids as they adapt to their new gastric volume. Limitations on oral fluid intake, reduced calorie intake, and a higher incidence of vomiting and diarrhea are all factors that have a significant contribution to dehydration. In order to prevent fluid volume depletion and dehydration, a minimum of 48-64 fl oz should be consumed by repetitive small sips all day.

## ***Effectiveness of surgery***

### **Weight loss**

In general, the malabsorptive procedures lead to more weight loss than the restrictive procedures however, have a higher risk profile. A meta-analysis from University of California, Los Angeles reports the following weight loss at 36 months:

- Biliopancreatic diversion - 53 kg
- Roux-en-Y gastric bypass (RYGB) - 41 kg
  - Open - 42 kg

- Laparoscopic - 38 kg
- Adjustable gastric banding - 35 kg
- Vertical banded gastroplasty - 32 kg

More recent studies have demonstrated that the medium (3–8 years) and long term (>10 years) weight loss results for RYGB and LAGB become very similar. However, the range of excess weight loss for LAGB patients (25% to 80%) is much broader than that of RYGB patients (50% to 70%). Data (beyond 5 years) for Sleeve Gastrectomy is not yet available (as of 12/09).

## **Reduced mortality and morbidity**

Several recent studies report decrease in mortality and severity of medical conditions after bariatric surgery. But long term effects are not clear. In the Swedish prospective matched controlled trial, patients with a body mass index (BMI) of 34 or more for men and 38 or more for women underwent various types of bariatric surgery and were followed for an average of 11 years. Surgery patients had a 23.7% reduction in mortality (5.0% vs. 6.3% control, adjusted hazard ratio 0.71). This means 75 patients must be treated to avoid one death after 11 years (number needed to treat is 77).

In a Utah retrospective cohort study that followed patients for an average of 7 years after various types of gastric bypass, surgery patients had 0.4% mortality while control patients had 0.6% mortality. Death rates were lower in the gastric bypass patients for all diseases combined, as well as for diabetes, heart disease and cancer. Deaths from accident and suicide were 58% higher in the surgery group.

A randomized, controlled trial in Australia compared laparoscopic adjustable gastric banding ("lap banding") with non-surgical therapy in 80 moderately obese adults (BMI 30-35). At 2 years, the surgically-treated group lost more weight (21.6% of initial weight vs. 5.5%) and had statistically significant improvement in blood pressure, measures of diabetic control, and high-density lipoprotein cholesterol. Post surgical complications included 1 patient with an infected surgical site, 4 with lap band malpositioning requiring laparoscopic revision, and 1 patient with cholecystitis. In the non-surgical group, 12 patients declined or did not tolerate orlistat or diet restrictions, and 4 patients developed acute cholecystitis.

Bariatric surgery in older patients has also been a topic of debate, centered on concerns for safety in this population. One study of elderly patients undergoing laparoscopic bariatric surgery at Mount Sinai Medical Center, however, reported 0% conversion to open surgery, 0% 30-day mortality, 7.3% complication rate, and average hospital stay of 2.8 days. post operative mortality from 0.1 - 2 %

Given the remarkable rate of diabetes remission with bariatric surgery, there is considerable interest in offering this intervention to type 2 diabetes patients with a BMI of <35 kg/m<sup>2</sup>. Until high-quality, controlled trials are completed, appropriateness criteria (based on age, BMI, and the severity of eight obesity-related comorbidities) may be used

to guide the careful selection of diabetes patients who may potentially benefit from bariatric surgery.

Laparoscopic bariatric surgery requires a hospital stay of only one or two days. Short-term complications from laparoscopic adjustable gastric banding are reported to be lower than laparoscopic Roux-en-Y surgery, and complications from laparoscopic Roux-en-Y surgery are lower than conventional (open) Roux-en-Y surgery.

### ***Adverse effects***

Complications from weight loss surgery are frequent. A study of insurance claims of 2522 who had undergone bariatric surgery showed 21.9% complications during the initial hospital stay and a total of 40% risk of complications in the subsequent six months. This was more common in those over 40 and led to increased health care expenditure. Common problems were gastric dumping syndrome in about 20% (bloating and diarrhoea after eating, necessitating small meals or medication), leaks at the surgical site (12%), incisional hernia (7%), infections (6%) and pneumonia (4%). Mortality was 0.2%. As the rate of complications appears to be reduced when the procedure is performed by an experienced surgeon, guidelines recommend that surgery is performed in dedicated or experienced units.

## Chapter 15

# Weight Loss

**Weight loss**, in the context of medicine, health or physical fitness, is a reduction of the total body mass, due to a mean loss of fluid, body fat or adipose tissue and/or lean mass, namely bone mineral deposits, muscle, tendon and other connective tissue. It can occur unintentionally due to an underlying disease or can arise from a conscious effort to improve an actual or perceived overweight or obese state.

### ***Unintentional weight loss***

Unintentional weight loss occurs in many diseases and conditions, including some very serious diseases such as cancer, AIDS, and a variety of other diseases.

Poor management of type 1 diabetes mellitus, also known as insulin-dependent diabetes mellitus (IDDM), leads to an excessive amount of glucose and an insufficient amount of insulin in the bloodstream. This triggers the release of triglycerides from adipose (fat) tissue and catabolism (breakdown) of amino acids in muscle tissue. This results in a loss of both fat and lean mass, leading to a significant reduction in total body weight. Untreated type 1 diabetes mellitus will usually not produce weight loss, as these patients get acutely ill before they have time to lose weight.

In addition to weight loss due to a reduction in fat and lean mass, fluid loss can be triggered by illnesses such as diabetes, certain medications, lack of fluid intake or other factors. Fluid loss in addition to reduction in fat and lean mass exacerbates the risk for cachexia.

Infections such as HIV may alter metabolism, leading to weight loss.

Hormonal disruptions, such as an overactive thyroid (hyperthyroidism), may also exhibit as weight loss.

Recent research has shown fidgeting to result in significant weight loss.

## **Causes of unintentional weight loss**

- Starvation, a state of extreme hunger resulting from lack of essential nutrients over a prolonged period.
- Cancer, a very common and sometimes fatal cause of unexplained (idiopathic) weight loss. About one-third of unintentional weight loss cases are secondary to malignancy. Cancers to suspect in patients with unexplained weight loss include gastrointestinal, prostate, hepatobiliary (hepatocellular carcinoma, pancreatic cancer), ovarian, hematologic or lung malignancies should be considered in any patient presenting with unexplained weight loss.
- AIDS can cause weight loss and should be suspected in high-risk individuals presenting with weight loss.
- Gastrointestinal disorders are another common cause of unexplained weight loss - in fact they are the most common non-cancerous cause of idiopathic weight loss. Possible gastrointestinal etiologies of unexplained weight loss are celiac disease, peptic ulcer, inflammatory bowel disease (crohns disease and ulcerative colitis), pancreatitis, gastritis, diarrhea and many other GI conditions can cause weight loss.
- Infection. Some infectious diseases can cause weight loss. These include fungal illness, endocarditis, many parasitic diseases, AIDS, and some other sub-acute or occult infections may cause weight loss.
- Renal disease. Patients who have uremia often have poor or absent appetite, emesis and nausea. This can cause weight loss.
- Cardiac disease. Cardiovascular disease, especially congestive heart failure, may cause unexplained weight loss.
- Pulmonary disease.
- Connective tissue disease
- Neurologic disease, including dementia

## ***Intentional weight loss***

Intentional weight loss refers to the loss of total body mass in an effort to improve fitness and health, and to change appearance.

Therapeutic weight loss, in individuals who are overweight or obese, can decrease the likelihood of developing diseases such as diabetes, heart disease, high blood pressure, stroke, osteoarthritis, and certain types of cancer.

Attention to diet in particular can be beneficial in reducing the impact of diabetes and other health risks of an overweight or obese individual.

Weight loss occurs when an individual is in a state of negative energy balance: when the body is exerting more energy (i.e. in work and metabolism) than it is consuming (i.e. from food or other nutritional supplements), it will use stored reserves from fat or muscle, gradually leading to weight loss.

It is not uncommon for some people who are currently at their ideal body weight to seek additional weight loss in order to improve athletic performance, and/or meet required weight classification for participation in a sport. However, others may be driven by achieving a more attractive body image. Notably, being underweight is associated with health risks such as difficulty fighting off infection, osteoporosis, decreased muscle strength, trouble regulating body temperature and even increased risk of death.

There are many diet plans and recipes that can be helpful for weight loss. While some are classified as unhealthy and potentially harmful to one's general health, others are recommended by specialists. Diet plans are generally designed according to the recommended caloric intake but it is important to note that the most successful diets are those that simultaneously promote physical activity. There are many dietary programs that claim to be efficient in helping overweight individuals to lose weight with no effort. However, the long-term efficacy of these plans is questionable.

Intentional weight loss is, in most cases, achieved with the help of diets since dietary restriction is generally more manageable than making a significant change in one's lifestyle (although weight loss is generally associated with some degree of change in lifestyle habits) or beginning to practice a sport. In that regard, a wide variety of dietary strategies have been designed to meet the needs of individuals seeking to lose excess weight. Calorie-restriction strategies are one of the most common dietary plans. Notably, daily calorie consumption for dietary purposes vary depending on a number of factors including, age, gender, weight loss goals, and many more. For instance, nutritionists suggest that a minimum of 1,200 daily calories should be consumed by women in order to maintain health. The daily calorie consumption by men, on the other hand, could approach 1,500. It is important to note that these recommendations primarily target relatively healthy individuals who seek weight loss for a better body tonus. However, individuals whose obesity places them at an increased risk for diabetes, heart disease, or other conditions, may follow a more strict diet, but only under the close monitoring of a physician and/or specialist. In some cases, obese individuals may need to restrict their daily calorie intake to 800 or even 500. According to the U.S. Food and Drug Administration (FDA), healthy individuals seeking to maintain their weight, should consume 2,000 calories per day.

According to the Dietary Guidelines for Americans, 2010 Executive Summary, which was released on January 31, 2011, those that achieve and manage a healthy weight do so most successfully by being continuously vigilant in taking in only the amount of calories that meet their needs and with physical activity.

Low-calorie regimen diets are also referred to as balanced percentage diets. Due to their minimal detrimental effects, these types of diets are most commonly recommended by nutritionists. In addition to restricting calorie intake, a balanced diet also regulates macronutrient consumption. Therefore, from the total number of allotted daily calories, 55% should come from carbohydrates, 15% from protein, and 30% from fats with no more than 10% of total fat coming from saturated forms. For instance, a 1,200 calorie diet would consist of no more than 660 calories from carbohydrates, 180 from protein, and

360 from fat. Although counting calories seems difficult altogether, the long term benefits of calorie restriction are many. After reaching the desired body weight, the amount of calories consumed per day may be increased gradually, without exceeding 2,000 net (i.e. derived by subtracting calories burned by physical activity from calories consumed). Combined with increased physical activity, low-calorie diets are thought to be most effective long term, unlike crash diets which can achieve short term results, at best. Physical activity could greatly enhance the efficiency of a diet. The healthiest weight loss regimen, therefore, is one that consists of a balanced diet and moderate physical activity.

The golden rule in weight loss is to avoid foods that are high in fats and sugars, both of which contribute to increased body mass and are detrimental to the overall health. Further, weight gain has been associated with excessive alcohol consumption. Depression, stress or boredom may also contribute to weight increase, and in these cases, individuals are advised to seek medical help. A 2010 study found that dieters who got a full night's sleep more than doubled the amount of fat loss compared to sleep-deprived dieters.

### **Therapeutic weight loss techniques**

The least intrusive weight loss methods, and those most often recommended, are adjustments to eating patterns and increased physical activity, generally in the form of exercise. Physicians will usually recommend that their overweight patients combine a reduction of processed foods and caloric content of the diet with an increase in physical activity.

An increase in fiber intake is also recommended for regulating bowel movements.

Other methods of weight loss include use of drugs and supplements that decrease appetite, block fat absorption, or reduce stomach volume. Application of such medications, however, should only be performed under the strict supervision of a physician and/or specialist.

Finally, surgery (i.e. bariatric surgery) may be used in more severe cases to artificially reduce the size of the stomach, thus limiting the intake of food energy.

Dietary supplements, though widely used, are not considered a healthy option for weight loss. Even though a wide array of these products is available to the public, very few are effective long term.

Bariatric surgery is usually considered a last resort in treating severe obesity and it consists of two main procedures: gastric bypass and gastric banding.

Virtual gastric band uses hypnosis to make the brain think the stomach is smaller than it really is and hence lower the amount of food ingested. This brings as a consequence weight reduction. This method is complemented with psychological treatment for anxiety

management and with hypnopedic. In 1996 a study revealed that hypnosis reinforced with cognitive-behavioral therapy was more effective than just CBT for weight reduction.

## **Crash dieting**

A crash diet refers to willful nutritional restriction (except water) for more than 12 waking hours. The desired result is to have the body burn fat for energy with the goal of losing a significant amount of weight in a short time. There is a possibility of muscle loss, depending on the approach used. Crash dieting can be dangerous to health and this method of weight loss is not recommended by medical doctors.

Crash dieting is not the same as intermittent fasting, in which the individual periodically abstains from food (e.g., every other day).

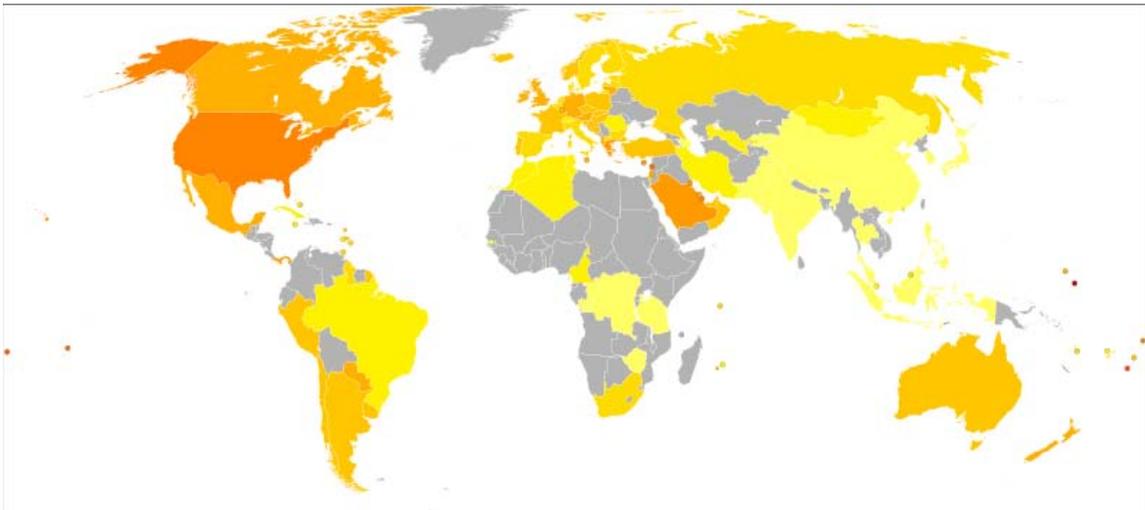
## **Weight loss industry**

There is a substantial market for products which promise to make weight loss easier, quicker, cheaper, more reliable, or less painful. These include books, CDs, cremes, lotions, pills, rings and earrings, body wraps, body belts and other materials, not to mention fitness centers, personal coaches, weight loss groups, and food products and supplements. US residents in 1992 spent an estimated \$30 billion a year on all types of diet programs and products, including diet foods and drinks.

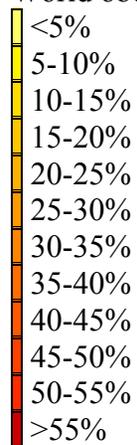
Between \$33 billion and \$55 billion is spent annually on weight loss products and services, including medical procedures and pharmaceuticals, with weight loss centers garnering between 6 percent and 12 percent of total annual expenditure. About 70 percent of Americans' dieting attempts are of a self-help nature. Although often short-lived, these diet fads are a positive trend for this sector as Americans ultimately turn to professionals to help them meet their weight loss goals.

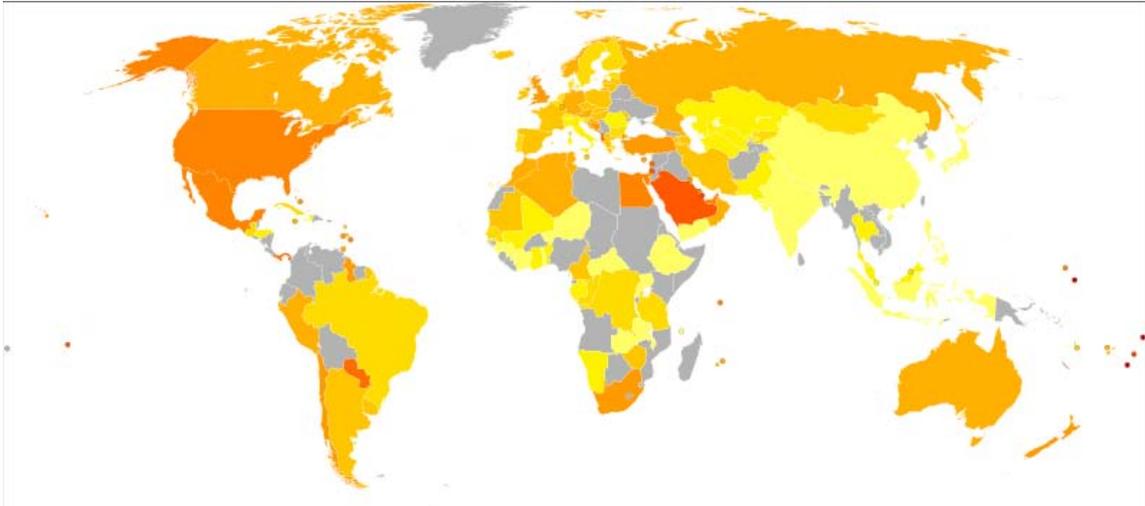
## Chapter 16

# Epidemiology of Obesity

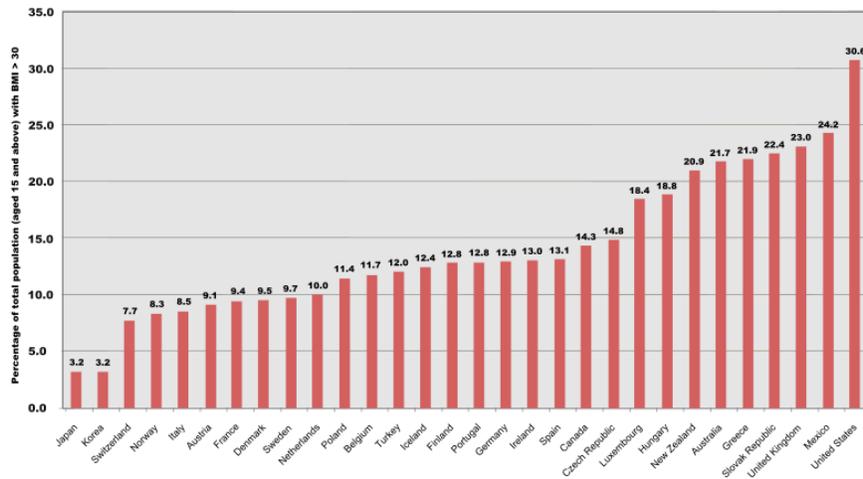
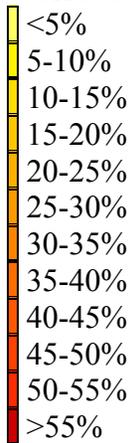


World obesity prevalence among males.





World obesity prevalence among females.



Obesity rates as a percentages of total population in OECD member countries in the years 1996-2003.

For thousands of years obesity was rarely seen. It was not until the 20th century that it became common, so much so that in 1997 the World Health Organization (WHO) formally recognized obesity as a global epidemic. As of 2005 the WHO estimates that at least 400 million adults (9.8%) are obese, with higher rates among women than men. The rate of obesity also increases with age at least up to 50 or 60 years old. Once considered a problem only of high-income countries, obesity rates are rising worldwide. These increases have been felt most dramatically in urban settings. The only remaining region of the world where obesity is not common is sub-Saharan Africa.

## ***Australia***

Studies conducted in 2006 found that close to 52% of Australian women and up to 67% of Australian men aged 25 or over are overweight or obese.

## ***Canada***

The number of Canadians who are obese has risen dramatically in recent years. In 2004, direct measurements of height and weight found 23.1% of Canadians older than 18 had a BMI greater than 30. When broken down into degrees of obesity, 15.2% were class I (BMI 30–34.9), 5.1% were class II (BMI 35–39.9), and 2.7%, class III (BMI > 40). This is in contrast to self-reported data the previous year of 15.2% and in 1978/1979 of 13.8%. The greatest increases occurred among the more severe degrees of obesity; class III obesity increased from 0.9% to 2.7% from 1978/1979 to 2004. Obesity in Canada varies by ethnicity; people of Aboriginal origin have a significantly higher rate of obesity (37.6%) than the national average.

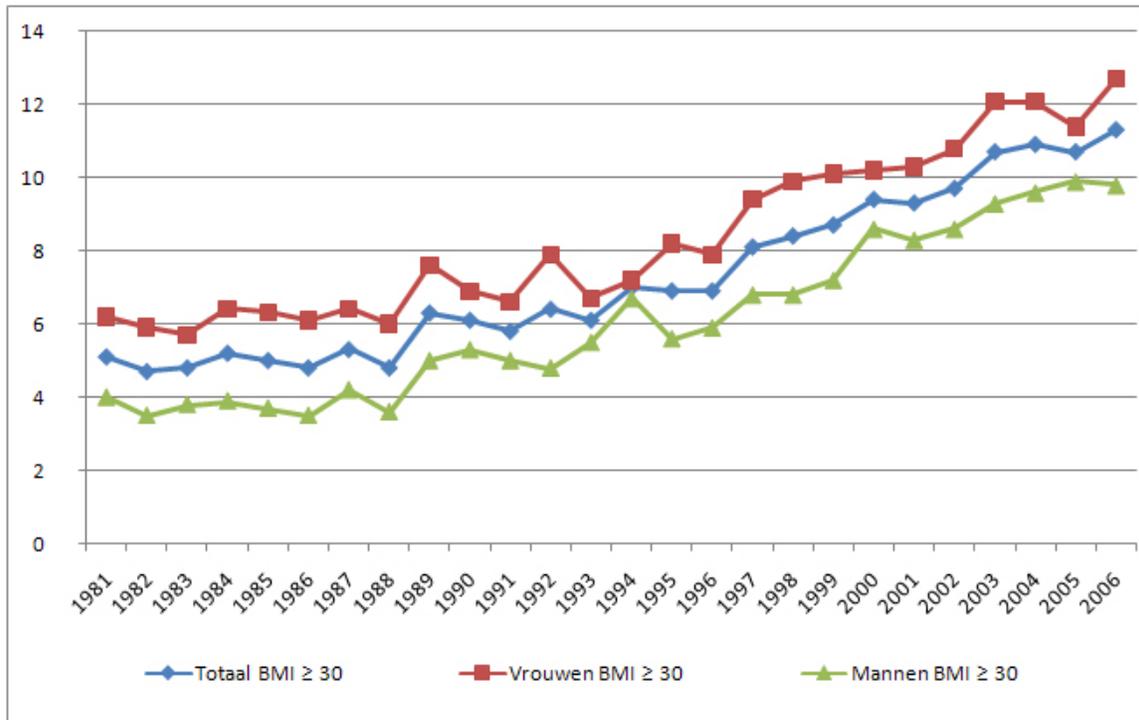
In children obesity has substantially increased between 1989 and 2004 with rates in boys increasing from 2% to 10% and rates among girls increasing from 2% to 9%.

## ***China***

China is currently facing challenges of overnutrition. This is believed to be primarily due to the rapid declines in physical activity and changing dietary habits which has occurred between the 1980s and the 2000s. The decline in physical activity is attributed to increasing technology in the workplace and changing leisure activities. In 1989 65% of Chinese had jobs that required heavy labor. This decreased to 51% in the year 2000. Combined with this has been a change to a diet higher in meat and oil, and an increase in overall available calories. Available calories per person increased from 2330 kcal/day in 1980 to 2940 kcal/day in 2002. Rates of overweight and obese adults increased 12.9% in 1991 to 27.3% in 2004.

Overall rates of obesity are below 5% in China as a whole but are greater than 20% in some cities.

## European Union



Rates of obesity in the Netherlands between 1981 and 2006.

Between the 1970s and the 2000s, rates of obesity in most European countries have increased. During the 1990s and 2000s the 27 countries making up the EU reported rates of obesity from 10–27% in men and from 10–38% in women.

## India

In India urbanization and modernization has been associated with obesity. In Northern India obesity was most prevalent in urban populations (male = 5.5%, female = 12.6%), followed by the urban slums (male = 1.9%, female = 7.2%). Obesity rates were the lowest in rural populations (male = 1.6%, female = 3.8%). Socioeconomic class also had an effect on the rate of obesity. Women of high socioeconomic class had rates of 10.4% as opposed to 0.9% in women of low socioeconomic class. With people moving into urban centers and wealth increasing, concerns about an obesity epidemic in India are growing.

## Iran

In Iran, as of 2008, 26.3% of the population is obese. Obesity was more among women (39.5%) than men (14.5%).

## ***Japan***

Using the WHO criteria Japan has the lowest rate of obesity among the OECD member countries at 3.2%. However, as Asian populations are particularly susceptible to the health risks of excess adipose tissue the Japanese have redefined obesity as any BMI greater than 25. Using this cut off value the prevalence of obesity in Japan would be 20%, a threefold increase from 1962 to 2002. A 2008 report stated that 28.6% of men and 20.6% of women in Japan were considered to be obese.

## ***Mexico***

Mexico has the second-highest rate of obesity among OECD members, at 24.2% of the population.

## ***New Zealand***

Obesity in New Zealand has become an important national health concern in recent years, with high numbers of people afflicted in every age and ethnic group. As of June 2008, 26.5% of New Zealanders are obese, a number only surpassed in the Anglosphere by the United States.

## ***South Pacific***

Many of the island nations of the South Pacific have very high rates of obesity. Nauru has the highest rates of obesity in the world (80%) followed by Tonga, the Federated States of Micronesia, and the Cook Islands. Being big has traditionally been associated with health, beauty, and status and many of these beliefs remain prevalent today.

## ***Taiwan***

In 2002, 15% of children range from 6 to 12 years of age were overweight, by gender, 15.5% of male and 14.4% of female were overweight. In the same age range, 12% of children were obese, by gender, 14.7% of male and 9.1% of female were categorized as obese. In 2005, 14.9% children range from 6 to 12 years of age were overweight, where by gender, 15.85% of male and 14.02% of female were overweight. 10.3% were categorized as obese, where by gender, 10.92% of male and 9.73% were categorized as obese.

Base on these reports done, the trends were inconclusive, although with more than 10% of the age group being obese, the problem of overweight and obesity does appear to be a problem.

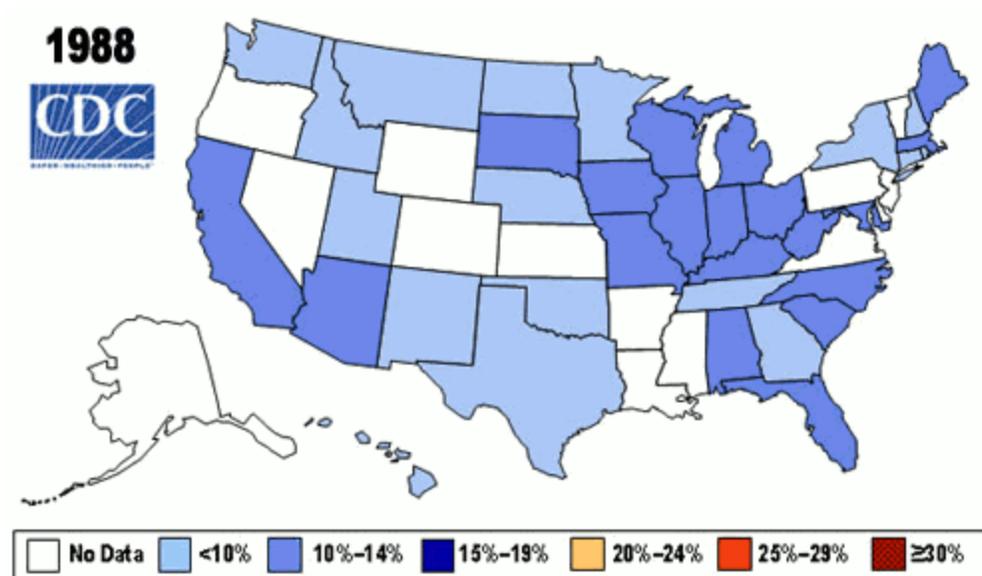
## ***United Kingdom***

In the UK the rate of obesity has increased about fourfold over the last 25 years, reaching current levels of 22%.

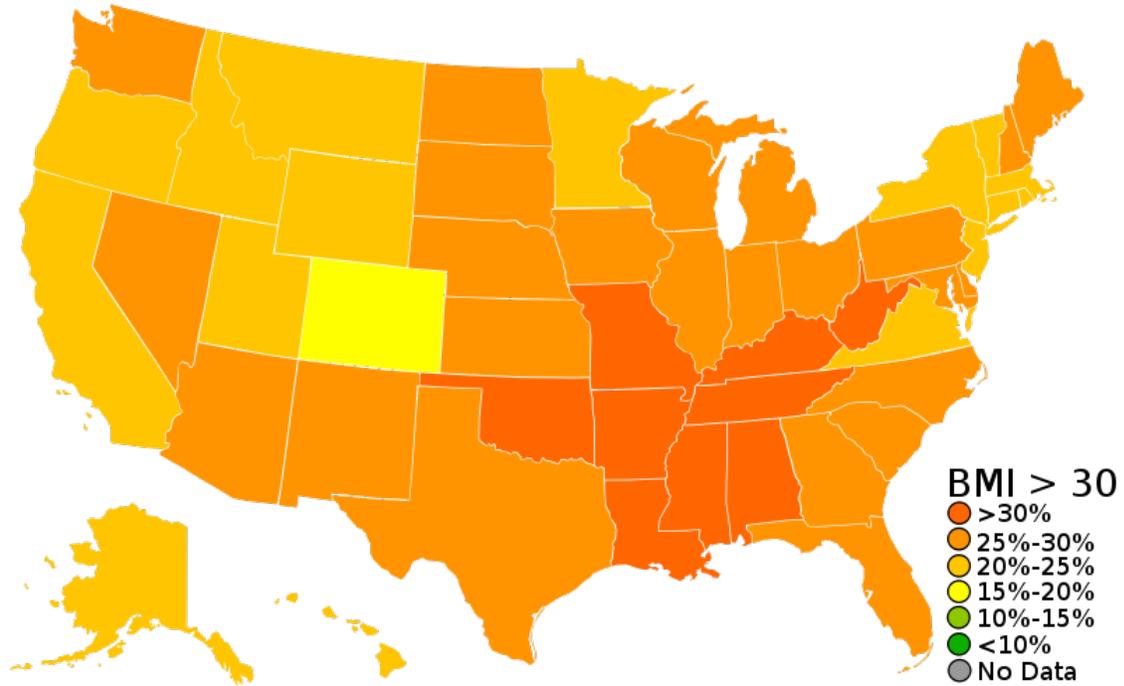
**Year Percent males obese Percent females obese**

1980	6%	8%
1993	13%	16%
2000	21%	21%
2002	22%	23%

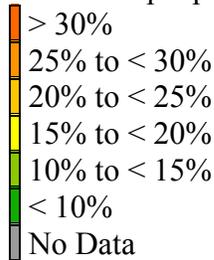
**United States**



U.S. Obesity Trends by State 1985–2008

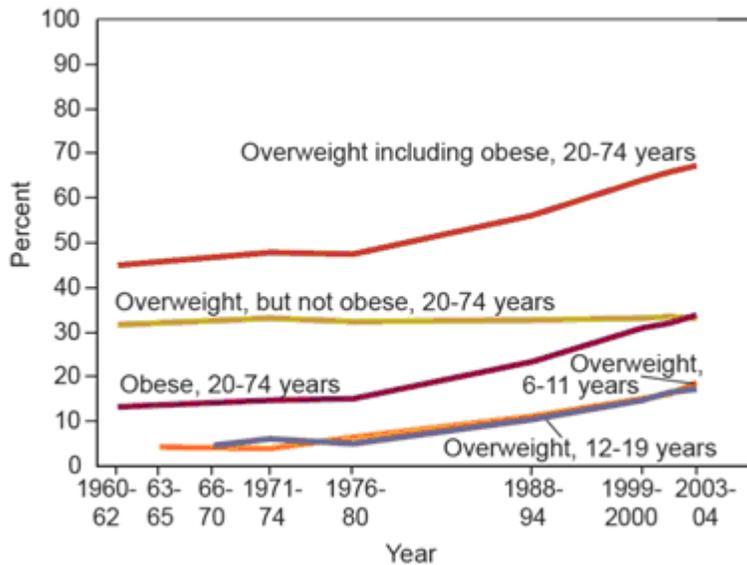


Percent of people per state with a BMI greater than 30 from 2009.



The United States has the highest obesity rates in the developed world. From 1980 to 2002, obesity rates have doubled, reaching the current rate of 32% of the adult population. Rates of obesity vary by ethnicity and gender. In the US, as of 2007, 33% of men and 35% of women are obese. The rates however are as high as 50% among African American women. The prevalence of class III obesity (BMI  $\geq 40$ ) has increased the most dramatically from 0.78 percent in 1990 to 2.2 percent in 2000. The overall rate of obesity began to plateau in the '00s, but severe obesity and obesity in children continued to rise. In January 2010, a study published in the *Journal of the American Medical Association* found that the obesity rate for American women has remained constant over the last decade, with only small rises amongst men and children.

## Overweight and obesity



SOURCES: Centers for Disease Control and Prevention, National Center for Health Statistics, Health, United States, 2006, Figure 13. Data from the National Health and Nutrition Examination Survey.

Prevalence of obesity between 1960 and 2004 in the USA.

Obesity is one of the leading health issues in US society, resulting in about 300,000 deaths per year in the United States. About 65 percent of Americans are now considered either overweight or obese. According to National Health and Nutrition Examination Study collected between 1970s and 2004, overweight and obesity prevalence have increased steadily among all groups of Americans over the past three decades.

### **Africa**

Obesity rates in Western Africa are estimated to be 10%. Rates of obesity among women are three times those found in men. In urban West Africa rates of obesity have more than doubled in the last 15 years.