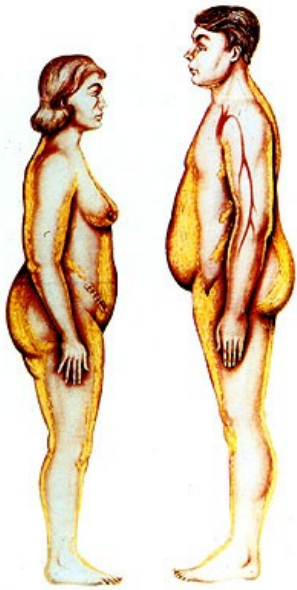




# K536 WHAT IS OVERWEIGHT & OBESITY?

Course	Definitions	Physiology	Pathophysiology	Etiology	Assessment	Treatment	Policy
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- [Is Obesity a Disease?](#)
- [Composition of Lipids](#)
- [Function of Lipids](#)
- [Characteristics of Lipid Deposits](#)
- [Classification Systems of Overweight/Obesity](#)
- [Definitions](#)
- [Prevalence of Overweight/Obesity](#)
- [Economics](#)

*Obesity is excess body fat frequently resulting in a significant impairment of health.*

## Readings

### Articles

- [Olshansky, s.J., D.J. Passaro, R.C. Hershov, J. Layden, B.A. Carnes, J. Brody, L. Hayflick, R.N. Butler, D.B. Allison and D.S. Ludwig. A potential decline in life expectancy in the United States in the 21st century. \*New England Journal of Medicine\* 352:1138-1145, 2005.](#)
- [Mokdad, A.H., J.S. Marks, D.F. Stroup and J.L. Gerberding. Actual cause of death in the United States, 2000. \*JAMA\* 291:1238-1245, 2004](#)
- [Mokdad Update](#)

## IS OBESITY A DISEASE?

If obesity is defined as excess body fat frequently resulting in an impairment of health, does that mean obesity is a disease? Some call obesity a *syndrome*.

- **Disease** is any deviation from or interruption of the normal structure or function of any body part, organ, or system that is manifested by a characteristic set of symptoms and signs and whose etiology, pathology, and prognosis may be known or unknown
  - Criteria for a disease include
    - Impairment of normal functioning
    - Resulting from infection, parasites, nutritional, dietary, environmental, genetic or other causes
    - Characteristic signs & symptoms
    - Resultant harm or morbidity
- **Syndrome** is a set of symptoms occurring together; the sum of signs of any morbid state; a symptom complex.
- **Sign** an indication of the existence of something; any objective evidence of a disease, i.e., such evidence as is perceptible to the examining physician
- **Symptom** is any subjective evidence of disease or of a patient's condition, i.e., such evidence as perceived by the patient; a change in a patient's condition indicative of some bodily or mental state.

The debate over whether obesity is a disease is on-going. Government actions are contradictory in

declaring obesity as a disease.

- World Health Organization, Federal Drug Administration, Internal Revenue Service, and the National Institutes of Health have stated obesity is a disease.
- The Centers for Disease Control, Department of Health and Human Services have not indicted that obesity is a disease.
- Whereas the US House of Representatives in the Oct 29, 2009 health care bill described obesity as a "behavioral risk factor" and not a disease.
- The medical insurance industry does not have codes for billing for obesity

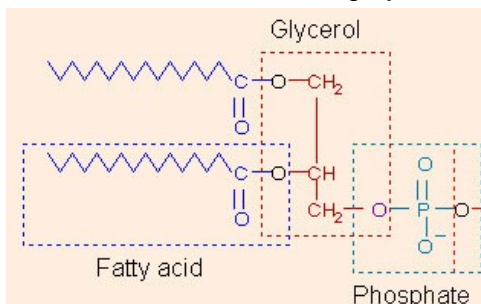
	<b>PRO-DISEASE</b>	<b>CON-DISEASE</b>
<b>Impairment</b>	<ul style="list-style-type: none"> <li>• Does alter physiological systems, not only of adipocyte, but of other organs as well.</li> <li>• Decreased life-expectancy ~ 3 years               <ul style="list-style-type: none"> <li>◦ 10 yrs in morbid obesity</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Does not impair normal functioning in all people               <ul style="list-style-type: none"> <li>• Does not shorten every obese person's life</li> </ul> </li> <li>• Others do not develop comorbidities of obesity</li> </ul>
<b>Cause</b>	<ul style="list-style-type: none"> <li>• May be genetic therefore, not necessarily a disease of "lack of willpower"</li> <li>• Risk factors like hypertension are considered a disease</li> </ul>	<ul style="list-style-type: none"> <li>• Obesity is a result of life-style and personal responsibility, not illness</li> <li>• Obesity is a preventable risk factor like smoking or hypertension</li> </ul>
<b>Signs/Sx</b>	Only sign is excess body fat	No symptoms.
<b>Harm</b>	Leads to atherosclerosis, diabetes, cancer and several other conditions	Obesity can have health benefits. Development of bone growth and prevention of osteoporosis

??????

- [Heshka, S. and D.B. Allison. Is obesity a disease? \*International Journal of Obesity\* 25:1401-1404, 2001](#)

## COMPOSITION OF LIPIDS

Lipids, for the purpose of this class, can be divided into fats & fatty acids and steroids. Triglycerides and phospholipids are included in the fats & fatty acid category whereas hormones and cholesterol are found in the steroid category.

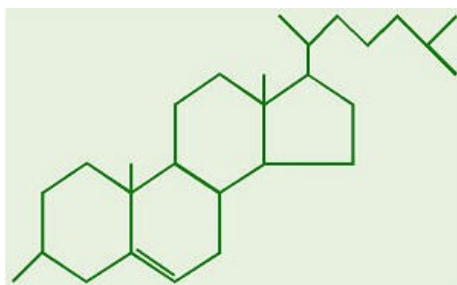


The **phospholipid** is a modification of the triglyceride. Instead of three fatty acids, the phospholipid contains two fatty acids and one phosphate - complex attached to the glycerol molecule. Other molecules are attached to the phosphate molecule forming different types of phospholipids.

Phospholipids are the primary component of cell membranes.

**Steroids** are composed of several six carbon rings.

Reproductive hormones, metabolic & immune substances, and cholesterol are steroids



## FUNCTION OF LIPIDS

Lipid, specifically triglycerides, is stored for fuel as well as a lipid bank for the other the function of

lipids.

- Fuel
- Cell membrane Structure
- Hormones and Other Mediators
- Vitamin Storage
- Insulation
- Organ Protection

As a **fuel**, free fatty acids have the densest caloric content. The caloric value of fats is 9.0 kcal/gram where as carbohydrates and proteins are 4.0 kcal/gram. Approximately 90% of the adipocyte is triglyceride storage. The adipocyte can be found in separate and isolated fat deposits or intra-organ fat deposits.

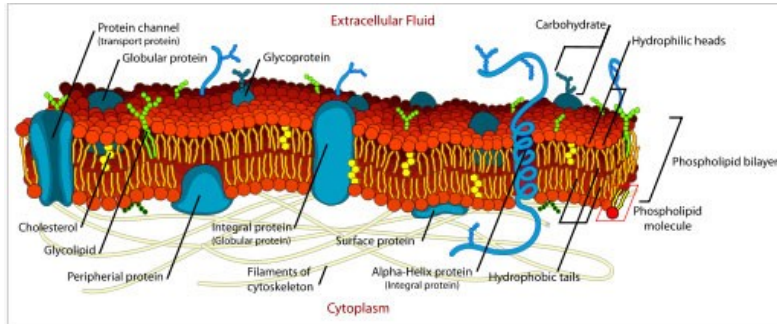


Illustration can be found on [Wikipedia](#)

Phospholipid is the primary lipid in the **cell membrane** of every cell. The phospholipids are arranged in a bi layer with the hydrophilic head facing the extracellular fluid and the cytoplasm. This hydrophilic head is the layer that prevents the cell from being dissolved in fluid.

Cholesterol is also an essential component of the cell membrane. Cholesterol modulates the fluidity of the cell membrane.

**Hormones and other mediators** are comprised mainly of steroids.

Reproductive hormones include

- estrogens
- androgens
- progestins

Other mediators include

- Corticosteroids - stress hormones
- Glucocorticoids - metabolism and immune function
- Mineralocorticoids - fluid and electrolyte balance

**Vitamins** E, D, A & K are stored in the adipocyte.

Although not the primary function of fat deposits, **insulation and organ protection** is secondary.

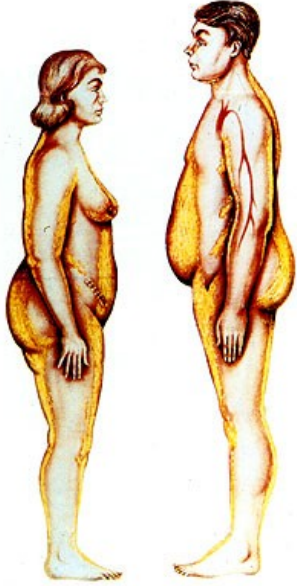
- [Composition of Lipids](#)
- [Function of Lipids](#)
- [Characteristics of Lipid Deposits](#)
- [Classification Systems of Overweight/Obesity](#)
- [Definitions](#)
- [Prevalence of Overweight/Obesity](#)
- [Economics](#)
- [top](#)

## CHARACTERISTICS OF FAT DEPOSITS

Adipocytes, or fat cells are not all the same. Adipocytes can vary in size from 20 to 200 micro m. The smallest adipocyte can be found in the abdominal deposits whereas the largest fat cells can be found in the gluteal deposits. These different adipocytes also exhibit variations in fat metabolism.

Adipose tissue can be described many ways:

Fat can be divided into **brown fat** and **white fat**. Brown fat is thermogenic whereas white fat is primarily for storage. In humans, brown fat is only present in new born infants (5% brown fat).



Fat **deposits** can be

- Intracellular
- Internal
- Subcutaneous

Adipose deposits can be **sex specific**. In general, men deposit fat on the trunk and women deposit fat on limbs. Premenopausal women distribute more on the limbs, but redistribute to abdominal fat after menopause.

Various organs contain **intracellular** fat deposits. For example, muscle and liver tissue have fat deposits within the organs. The marbling found in meat are fat deposits.

**Internal** body fat is found within body compartments or between organs.

This is a CT scan of visceral fat.

**Visceral fat** is internal abdominal fat in contrast to subcutaneous abdominal fat. Visceral fat is located inside the peritoneal cavity, packed in between internal organs.

**Subcutaneous fat** is found under the layer of skin.



## CLASSIFICATION SYSTEMS FOR ADIPOSE DEPOSITION

Classification systems of obesity have been based on phenotype, fat cell morphology, and health status.

- **Phenotype**
  - Type I: Excess body mass or percentage fat
  - Type II: Excess subcutaneous truncal-abdominal fat (android)
  - Type III: Excess abdominal visceral fat
  - Type IV: Excess gluteal-femoral fat (gynoid)
- **Cell Morphology**
  - Hyperplastic obesity
  - Hypertrophic obesity
- **Health Status**
  - Mild obesity
  - Morbid obesity

Hyperplastic Morphology	Hypertrophic Morphology
An increase in fat cell number	An increase in fat cell size
Contributes to juvenile onset obesity	Contributes to adult onset obesity
Critical times for fat cell number to increase are: <ul style="list-style-type: none"> <li>• last trimester of mother's pregnancy</li> <li>• first year of life</li> <li>• puberty</li> </ul>	Fat cell size increases when fat storage exceeds fat release.
80% with hyperplastic obesity have difficulties reducing excess body fat because the fat cells are increased in number rather than in size. The number of fat cells can never be reduced.	Hyperplastic obesity can reduce easily because fat cell size reduces better than fat cell number.

- [Composition of Lipids](#)
- [Function of Lipids](#)
- [Characteristics of Lipid Deposits](#)
- [Classification Systems of Overweight/Obesity](#)
- [Definitions](#)
- [Prevalence of Overweight/Obesity](#)
- [Economics](#)
- [top](#)

## DEFINITION OF OVERWEIGHT AND OBESITY

**Obesity is excess body fat frequently resulting in a significant impairment of health.**

Obesity has been classified many ways. The most common classification systems have been height/weight tables, body mass index (BMI), and body fat percentage. More recently, an estimate of the distribution of body fat have been included in the assessment of body fat.

- **Height/Weight Tables:** People are considered obese when they weigh more than twenty percent of their desirable weight as listed in the tables.
- **Body Mass Index:** Although different BMI standards have been published for increased risk of disease for men [ $>27.8 \text{ kg/m}^2$ ] and women [ $27.3 \text{ kg/m}^2$ ], a combined categorization has been derived from the epidemiological literature:

Category	Range
Acceptable range (low risk)	20.0-25.0 kg/m <sup>2</sup>
Mildly overweight (increased risk)	25.1-27.0 kg/m <sup>2</sup>
Moderately overweight/obese	27.1-30.0 kg/m <sup>2</sup>
Markedly overweight/obese	30.1-40.0 kg/m <sup>2</sup>
Morbidly obese	$>40.0 \text{ kg/m}^2$

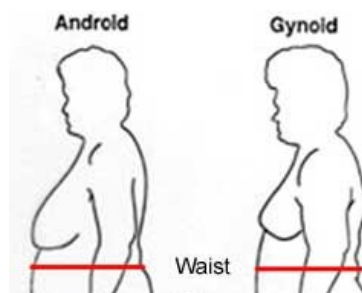
$$\text{BMI} = \text{body weight [kg]} / \text{height [m]}^2$$

### • Body Fat Distribution

The distribution of body fat is probably the most important factor in health and disease. The three types of fat distribution include:

- Upper Body
- Normal
- Lower Body

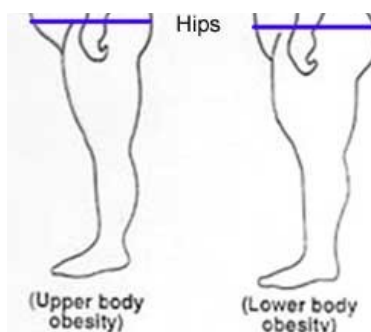
An excess deposition of adipose tissue focused on the trunk



is **Upper Body Obesity** or **Andriod Obesity**. Upper body obesity, more specifically, visceral body fat distribution is related to disease etiologies.

An excess of deposition on the limbs or buttox is **Lower Body Obesity** or **Gynoid Obesity**.

**Waist to Hip Ratio** or **Waist Circumference** are considered simple estimates of upper or lower body fat distribution.



Standards for the method using

Upper Body Obesity	Lower Body Obesity
Men >0.85 Women >0.84	Men <0.80 Women <0.76

- **Waist** - Minimal girth between the sternum & iliac crest
- **Hips** - Maximal girth around the buttox

are summarized to the left.

### • Body Mass Index and Waist Circumference

The federal government has created the following classification system for body fat:

Obesity Class	BMI	Increased Relative Risk to Normal Weight and Waist Circumference	
		Men<102 cm Women<88cm	Men<102 cm Women<88cm
Underweight	<18.5		
Normal	18.5-24.9		
Overweight	25.0 - 29.9	Increased	High
Obesity I	30.0 - 34.9	High	Very High
Obesity II	35.0 - 39.9	Very High	Very High
Extreme Obesity III	>40.0	Extremely High	Extremely High

### • Percent Body Fat

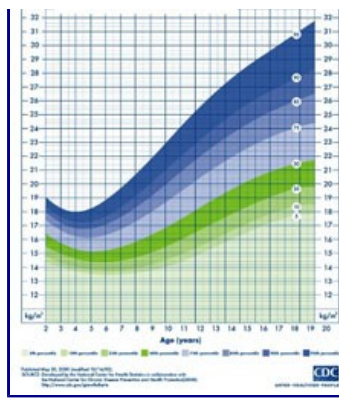
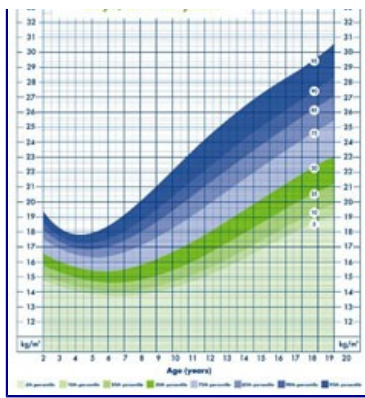
Percent body fat classifications can be based on athletic performance or health. These are based on **health**:

Category	Men	Women
Minimal Fat	5%	8%
Below Average	5-15%	14-32%
Above Average	16-25%	24-32%
At Risk	>25%	>32%

## CHILDREN

Measuring body fat in children is more difficult than in adults. The density of the tissues and organs are not as dense as adults and can too often be confused as adipose tissue. Height and weight are the most often measurement system used for children. The Centers for Disease Control recommend separate BMI charts for boys and girls. Click on the charts below to see a larger version.





Standards for boys are:

- Underweight <5th %ile
- Healthy Weight 5-8th %ile
- At Risk 8.5-9.5th %ile
- Overweight >9.5th %ile

Standards for girls:

- Underweight <5th %ile
- Healthy Weight 5-8th %ile
- At Risk 8.5-9.5th %ile
- Overweight >9.5th %ile

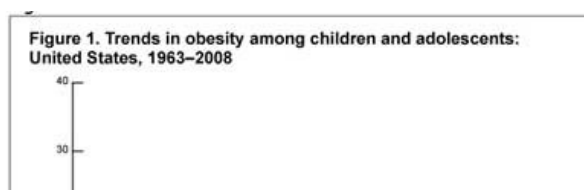
- [Composition of Lipids](#)
- [Function of Lipids](#)
- [Characteristics of Lipid Deposits](#)
- [Classification Systems of Overweight/Obesity](#)
- [Definitions](#)
- [Prevalence of Overweight/Obesity](#)
- [Economics](#)
- [top](#)

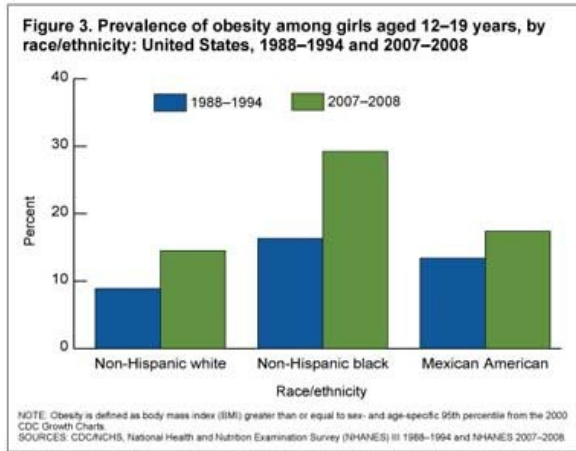
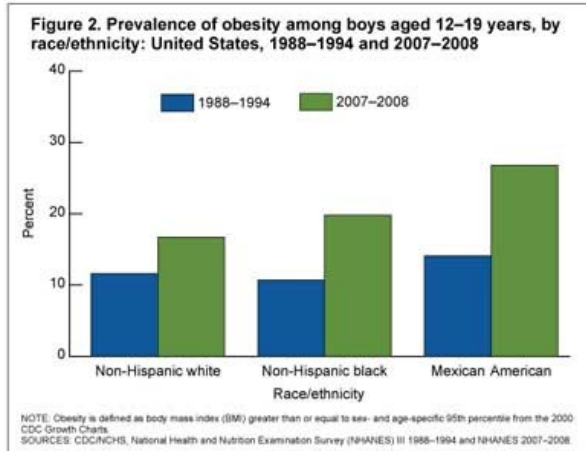
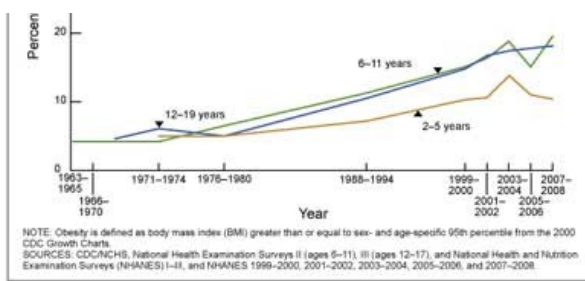
### PREVELANCE OF OVERWEIGHT AND OBESITY

- For the **US**, 62% of the population is either overweight or obese.
- For the state of **Indiana**, 63% of the population is either overweight or obese.

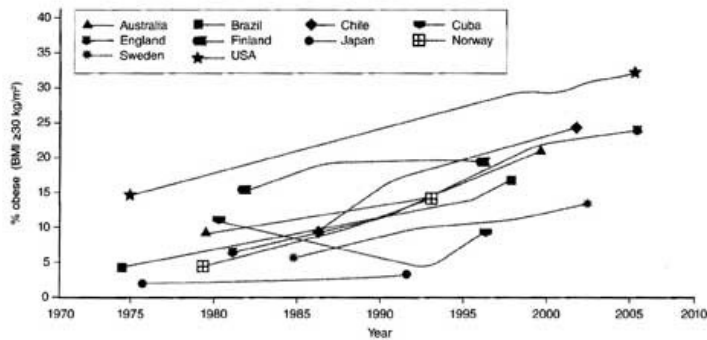
States that have similar prevalence include	States that are have more overweight or obese include
<ul style="list-style-type: none"> <li>• Iowa</li> <li>• Kansas</li> <li>• Louisiana</li> <li>• Minnesota</li> <li>• Missouri</li> <li>• Nebraska</li> <li>• North Carolina</li> <li>• Texas</li> </ul>	<ul style="list-style-type: none"> <li>• Alabama - 65%</li> <li>• Alaska - 64%</li> <li>• Arkansas - 64%</li> <li>• Delaware - 64%</li> <li>• Kentucky - 66%</li> <li>• Michigan - 64%</li> <li>• <b>Mississippi - 67%</b></li> <li>• Nevada - 64%</li> <li>• Oklahoma - 64%</li> <li>• South Carolina - 65%</li> <li>• South Dakota - 64%</li> <li>• Tennessee - 65%</li> <li>• <b>West Virginia - 67%</b></li> </ul>

Overweight in children is not different from adults.





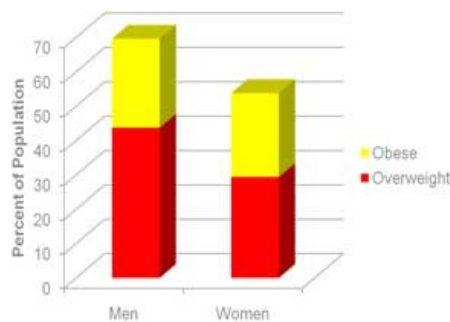
This is not just a US phenomenon. Overweight and obesity is increasing in both children and adults on a global scale, although the US leads the way.



**Figure 11.1** Measured nationally representative (unless otherwise specified) sequential surveys showing the prevalences of obesity in various countries.  
 Data from W.P. James, 2008, "The epidemiology of obesity: the size of the problem," *Journal of Internal Medicine* Apr. 263(4): 336-52.

### Sex Differences in Overweight & Obesity

According to the CDC, men exhibit more overweight and obesity than women.

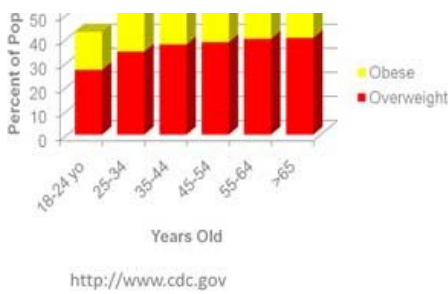


<http://www.cdc.gov>

### Age Differences in Overweight & Obesity



Overweight and obesity increases with age. The peak is in the sixth decade.

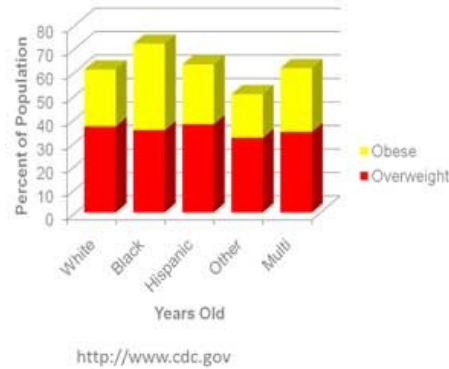


This aging curve is made from cross-sectional data. It does not mean that once people hit 65 years old they become less overweight. It means that the overweight and obese population dies off before the age of 65 years old.

In terms of race/ethnicity, African Americans exhibit the highest prevalence of overweight and obesity in this country.

The question with regard to ethnicity is overweight/obesity truly genetic or environmental?

### Race Differences in Overweight & Obesity



Putting this expansion of overweight and obesity into perspective, we should expect

- More Chronic Disease
- Shorter lifespan
- More Complications in Chronic Disease
- More Orthopedic Problems
- More Complications in Pregnancy
- More Sleep Apnea
- Increased Health Care Costs
- Reduced Productivity

- [Composition of Lipids](#)
- [Function of Lipids](#)
- [Characteristics of Lipid Deposits](#)
- [Classification Systems of Overweight/Obesity](#)
- [Definitions](#)
- [Prevalence of Overweight/Obesity](#)
- [Economics](#)
- [top](#)

### ECONOMICS OF OVERWEIGHT & OBESITY

Costs associated with disease/conditions are divided into direct and indirect. Direct costs have been estimated to be \$51.6 Billion or 5.7% of National medical expenditures. Indirect costs have not been estimated at this time. Using 1994 NHIS data, Wolf and Colditz estimated that nationally

- 39.3 million workdays were lost annually to obesity-related causes
- 239.0 million restricted-activity days
- 89.5 million bed-days
- 62.7 million physician visits.

Compared with the 1988 NHIS data, the number of restricted-activity days increased 36%, bed-days increased 28%, lost work days increased 50%, and physician visits increased by 88%.

Using 1994 NHIS data, Wolf and Colditz estimated that nationally 39.3 million workdays were lost annually to obesity-related causes; in addition, obesity was responsible for 239.0 million restricted-activity days, 89.5 million bed-days, and 62.7 million physician visits. Compared with the 1988 NHIS data, the number of restricted-activity days increased 36%, bed-days increased 28%, lost work days increased 50%, and physician visits increased by 88%.

The [Centers for Disease Control](#) provides different estimates.

**Table 1, Aggregate Medical Spending, in Billions of Dollars, Attributable to Overweight and Obesity, by Insurance Status and Data Source, 1996–1998**

Insurance Category	Overweight and Obesity		Obesity	
	MEPS (1998)	NHA (1998)	MEPS (1998)	NHA (1998)
<b>Out-of-pocket</b>	\$7.1	\$12.8	\$3.8	\$6.9
<b>Private</b>	\$19.8	\$28.1	\$9.5	\$16.1
<b>Medicaid</b>	\$3.7	\$14.1	\$2.7	\$10.7
<b>Medicare</b>	\$20.9	\$23.5	\$10.8	\$13.8
<b>Total</b>	<b>\$51.5</b>	<b>\$78.5</b>	<b>\$26.8</b>	<b>\$47.5</b>

Medical Expenditure Panel Survey (MEPS)  
National Health Accounts (NHA).

Medical costs vary by state (the expenditures appear to be related to population):

**Table 2, Estimated Adult Obesity-Attributable Percentages and Expenditures, by State (BRFSS 1998–2000)**

State	Total population (%)	(Millions \$)	Medicare population (%)	(Millions \$)	Medicaid population (%)	(Millions \$)
Alabama	6.3	\$1320	7.7	\$341	9.9	\$269
Alaska	6.7	\$195	7.7	\$17	8.2	\$29
Arizona	4.0	\$752	3.9	\$154	13.5*	\$242
Arkansas	6.0	\$663	7.0	\$171	11.5	\$180
California	5.5	\$7675	6.1	\$1738	10.0	\$1713
Colorado	5.1	\$874	5.1	\$139	8.7	\$158
Connecticut	4.3	\$856	6.5	\$246	11.0	\$419
Delaware	5.1	\$207	9.8	\$57	13.8	\$66
District of Columbia	6.7	\$372	6.5	\$64	12.5	\$114
Florida	5.1	\$3987	6.1	\$1290	11.6	\$900
Georgia	6.0	\$2133	7.1	\$405	10.1	\$385
Hawaii	4.9	\$290	4.8	\$30	11.2	\$90
Idaho	5.3	\$227	5.6	\$40	12.0	\$69
Illinois	6.1	\$3439	7.8	\$805	12.3	\$1045
Indiana	6.0	\$1637	7.2	\$379	15.7	\$522
Iowa	6.0	\$783	7.5	\$165	9.4	\$198
Kansas	5.5	\$657	6.4	\$138	10.2*	\$143
Kentucky	6.2	\$1163	7.5	\$270	11.4	\$340
Louisiana	6.4	\$1373	7.4	\$402	12.9	\$525
Maine	5.6	\$357	5.7	\$66	10.7	\$137
Maryland	6.0	\$1533	7.7	\$368	12.9	\$391
Massachusetts	4.7	\$1822	5.6	\$446	7.8	\$618
Michigan	6.5	\$2931	7.8	\$748	13.2	\$882
Minnesota	5.0	\$1307	6.6	\$227	8.6	\$325
Mississippi	6.5	\$757	8.1	\$223	11.6	\$221
Missouri	6.1	\$1636	7.1	\$413	11.9	\$454
Montana	4.9	\$175	6.2	\$41	9.8	\$48
Nebraska	5.8	\$454	7.0	\$94	10.3	\$114
Nevada	4.8	\$337	5.0	\$74	10.1*	\$56
New Hampshire	5.0	\$302	5.4	\$46	8.6*	\$79

**Direct costs** include:

- Hospitalization
- Physician Visits
- Hospital Care

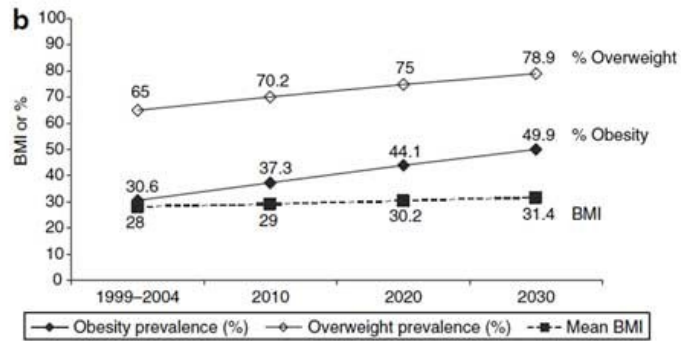
- Nursing Care
- Pharmacology
- Medical Treatment of Obesity
- Associated Diseases
- Psychological Services

**Indirect Costs** include:

- Absenteeism from workplace
- Workplace Productivity
- Premature Mortality
- Disability
- Workers Compensation
- Presenteeism

Wang and colleagues projected the prevalence of overweight & obesity up to 2030.

- [Youfa Wang, May A. Beydoun, Lan Liang, Benjamin Caballero and Shiriki K. Kumanyika. Will All Americans Become Overweight or Obese? Estimating the Progression and Cost of the US Obesity Epidemic Obesity \(2008\) 16 10, 2323-2330](#)

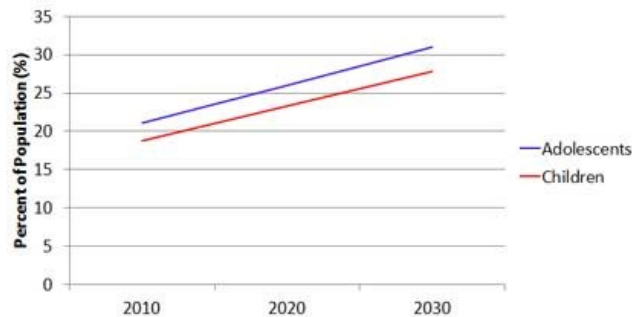


**Figure 3** Current BMI distribution and projected distributions for the years of 2010, 2020, and 2030. (a) BMI Kernel density plots. (b) Mean BMI, obesity, and overweight prevalence.

Similar increases were projected for youth.

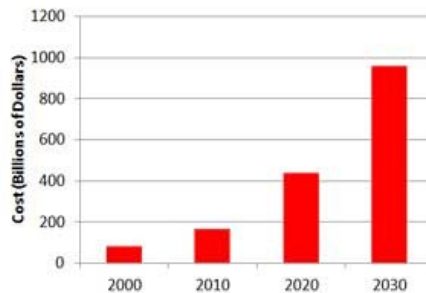
(Adolescents are 12 to 19 year old)

### PROJECTED PREVALENCE OF OVERWEIGHT & OBESITY



Y. Wang, et al. *Obesity* (2008) **16** 10, 2323-2330

### Projected direct health-care costs, in billions of dollars, attributable to overweight and obesity for US adults: 2000-2030



Y. Wang, et al. *Obesity* (2008) **16** 10, 2323-2330

Based on these projections, the costs of overweight & obesity are expected to escalate.

