

# Obesity, Starvation, and Eating Disorders



Most people have a rough idea of what is good to eat, how much is appropriate, and what is not. And yet humans manage to go to extremes.

# Obesity

There are several ways to measure “appropriate” body fat. One method that is often used is the BMI (body mass index), which is a quick weight/height proportionality.

- BMI 25 – 30 = overweight (there is argument about how much risk this really poses)
- BMI > 30 = obese (higher risk – and researchers agree on this)
- BMI >40 = morbid obesity (dangerous)

The body mass index is a very rough way of calculating appropriate height/weight relationships. It was designed to measure the risk of a **group** of people (such as a state or region), not individuals. It does not work well for very muscular people, and different ethnic groups may actually show the risk factors of obesity at different BMIs. However, it is still useful for discussing obesity as it occurs in populations.

Obesity increases the risk for heart disease, diabetes, stroke, etc.

Developed nations are currently in the middle of an obesity epidemic.

In the U.S., it is particularly serious for children and adolescents.

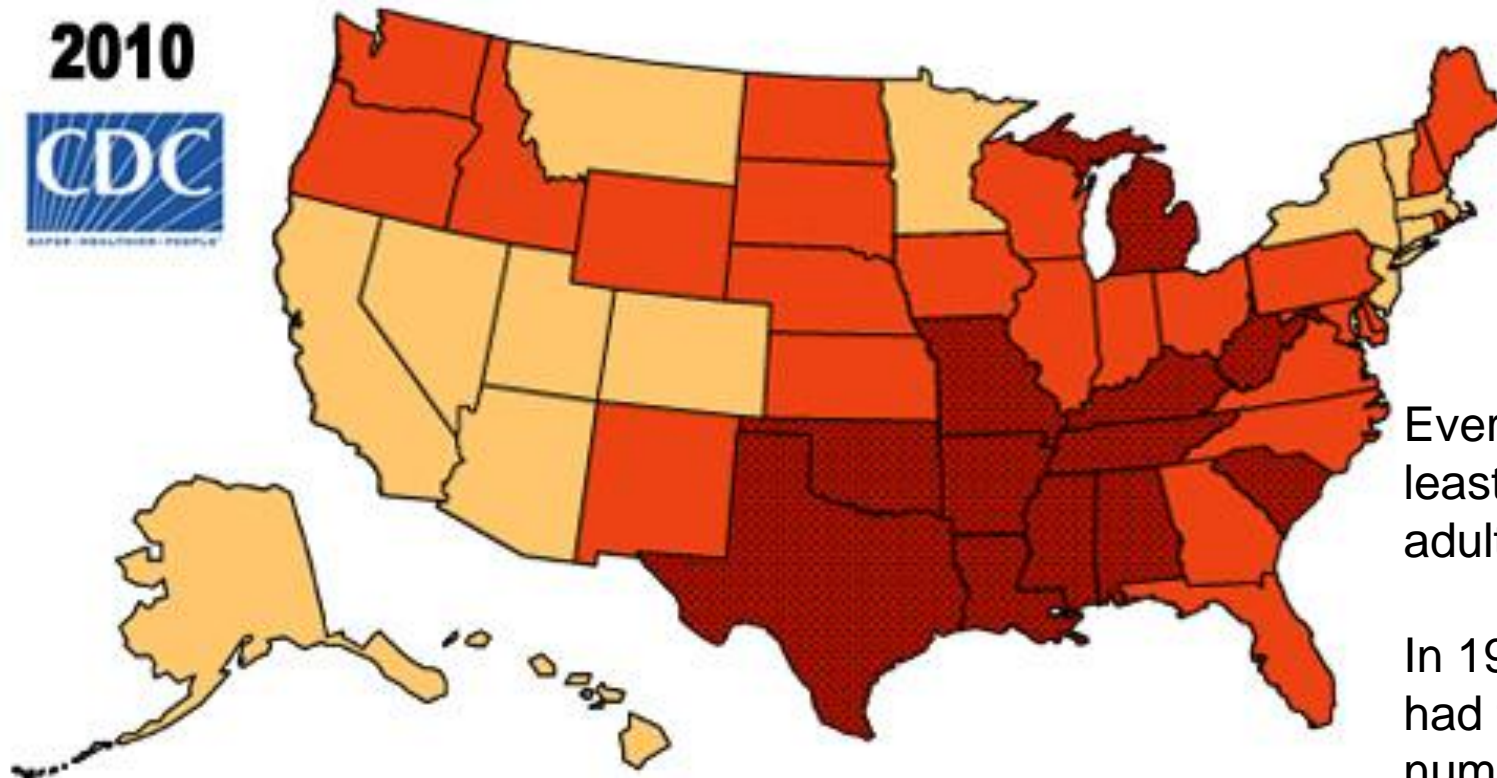
US: 65% of adults >25 BMI

35.7% are obese

*Although it's fair to say that BMI does not measure every person's risk well, it is still clear that a BMI over 30 carries substantial health risk, especially for diabetes, heart disease, stroke, and certain cancers. There is some research that links obesity to Alzheimers disease, as well.*

# Percent of Obese (BMI $\geq 30$ ) in U.S. Adults

2010

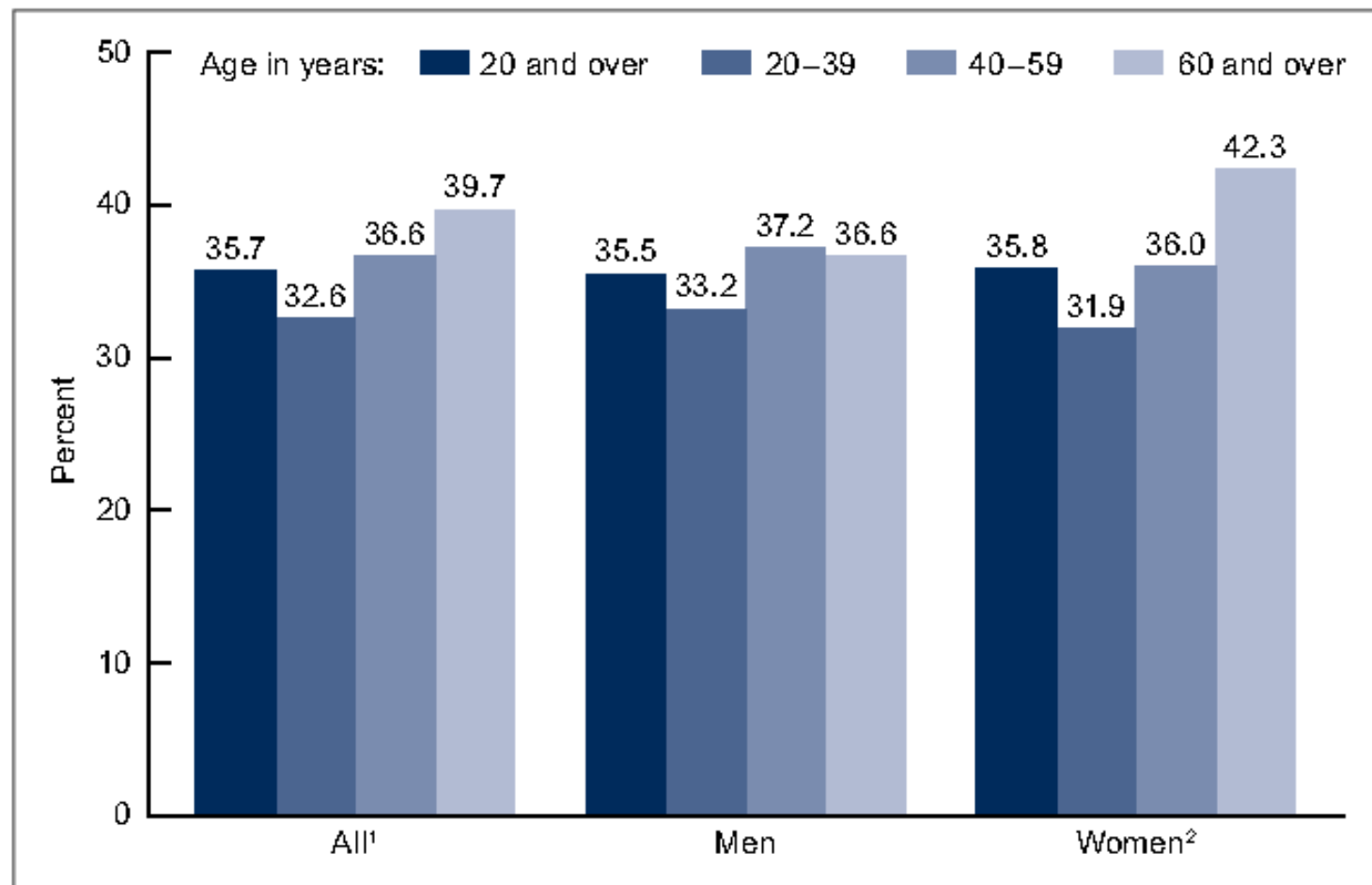


Every state has at least 20% of adults obese.

In 1991, no state had that high a number.

## In 2009–2010, 35.7% of U.S. adults were obese.

Figure 1. Prevalence of obesity among adults aged 20 and over, by sex and age: United States, 2009–2010



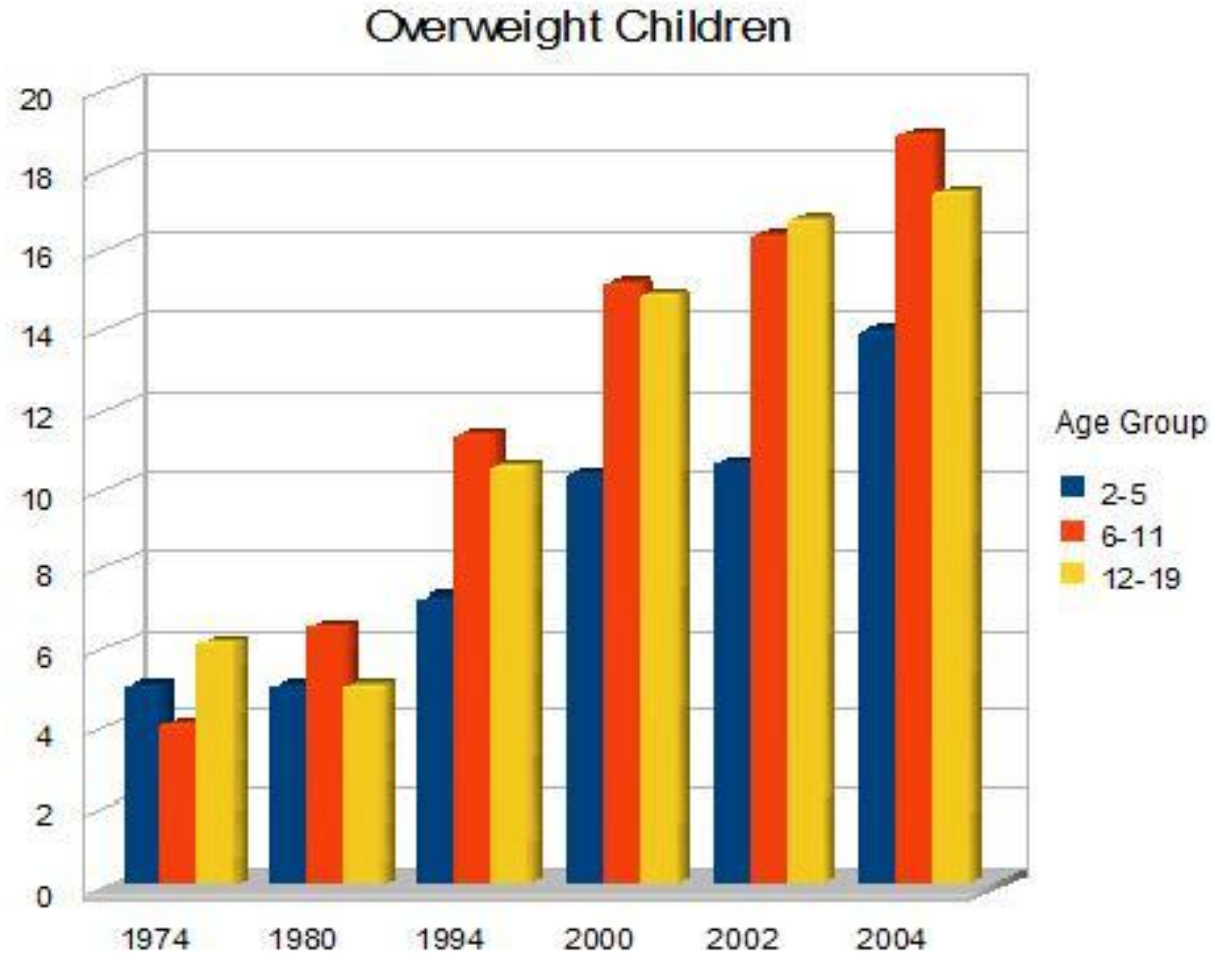
<sup>1</sup>Significant increasing linear trend by age ( $p < 0.01$ ).

<sup>2</sup>Significant increasing linear trend by age ( $p < 0.001$ ).

NOTE: Estimates were age adjusted by the direct method to the 2000 U.S. Census population using the age groups 20–39, 40–59, and 60 and over.

SOURCE: CDC/NCHS, National Health and Nutrition Examination Survey, 2009–2010.

And while adult weights are up, the increase in overweight and obese children is more worrying. We are starting to see the health problems of obesity in younger and younger kids.



# Factors leading to obesity

**Environment** creates the conditions for obesity;

**Genetics** picks out the susceptible

- **Cheap foods** are high in fat and sugar – and young families often can't afford better quality food
- Young children are incapable of informed choice – they will pick the foods that taste good. Food companies know this, and start marketing early.
- School environment (cheap lunches, low activity) – *and the food you eat as a child becomes the adult comfort food*
- Food labeling is misleading (serving size)
- Fast-food: supersizing, no substitutions, lots of fat and salt
- Major marketing manipulates food preference
- Long work hours and commuting time – leads to **convenience foods**, which tend to be high in fat, salt and sugar



*What other factors can you come up with?*





1978 – The Federal Trade Commission concludes that advertising candy and other sugary products to children is “unfair and deceptive” since children do not have the developmental capability to evaluate the purpose of advertising, and that this type of advertising should be limited or banned.

1981 – The FTC issues a statement that such a ban could not be implemented “as a practical matter.”

2006 - more than \$10 billion a year is spent on marketing food and beverages to children and youth.



# Dieting

Ever since there have been fat people, there have been others urging them to diet. It makes sense, but in reality, few diets work on a long-term basis.

- Food restriction
  - Based on calories in – calories out
- Does not take into consideration:
  - Metabolism changes
  - Hormone levels
  - Ethnic/cultural issues
  - Placement of fat

Most good studies of diets have focused on specific medical conditions (such as controlling blood pressure or diabetes.) Only recently have good, controlled studies been done on diets for weight loss.

A lot of what we know about weight loss comes from the 1940s Minnesota Starvation Study – one of the projects that made Dr. Keys famous.



# Minnesota Starvation Study

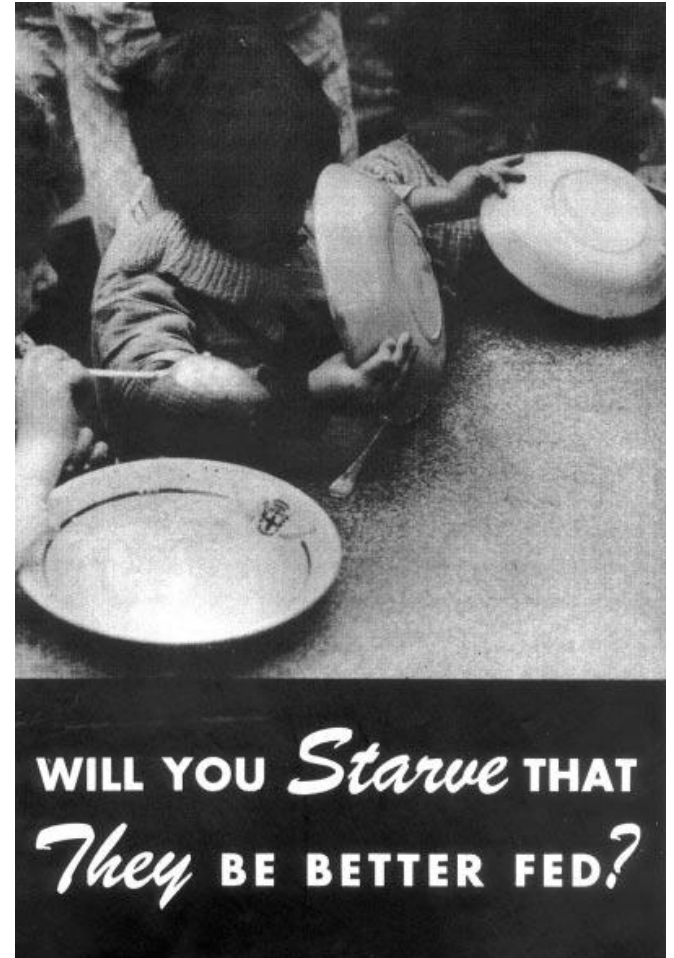
World War II (1944) – as the war was ending, the government knew that they would be dealing with thousands of refugees, many of whom had been near starvation for many years. No one knew how to treat these people, or what coming off starvation conditions meant.

36 conscientious objectors volunteered as subjects to study starvation at the University of Minnesota.

For 6 months these young men ate 1800 calories/day plus did exercise. Their conditions were trying to imitate what the people in Europe would be exposed to. Their diet was potatoes, turnips, rutabagas, dark bread, and macaroni.

They walked 22 miles/week plus held jobs and/or attended classes.

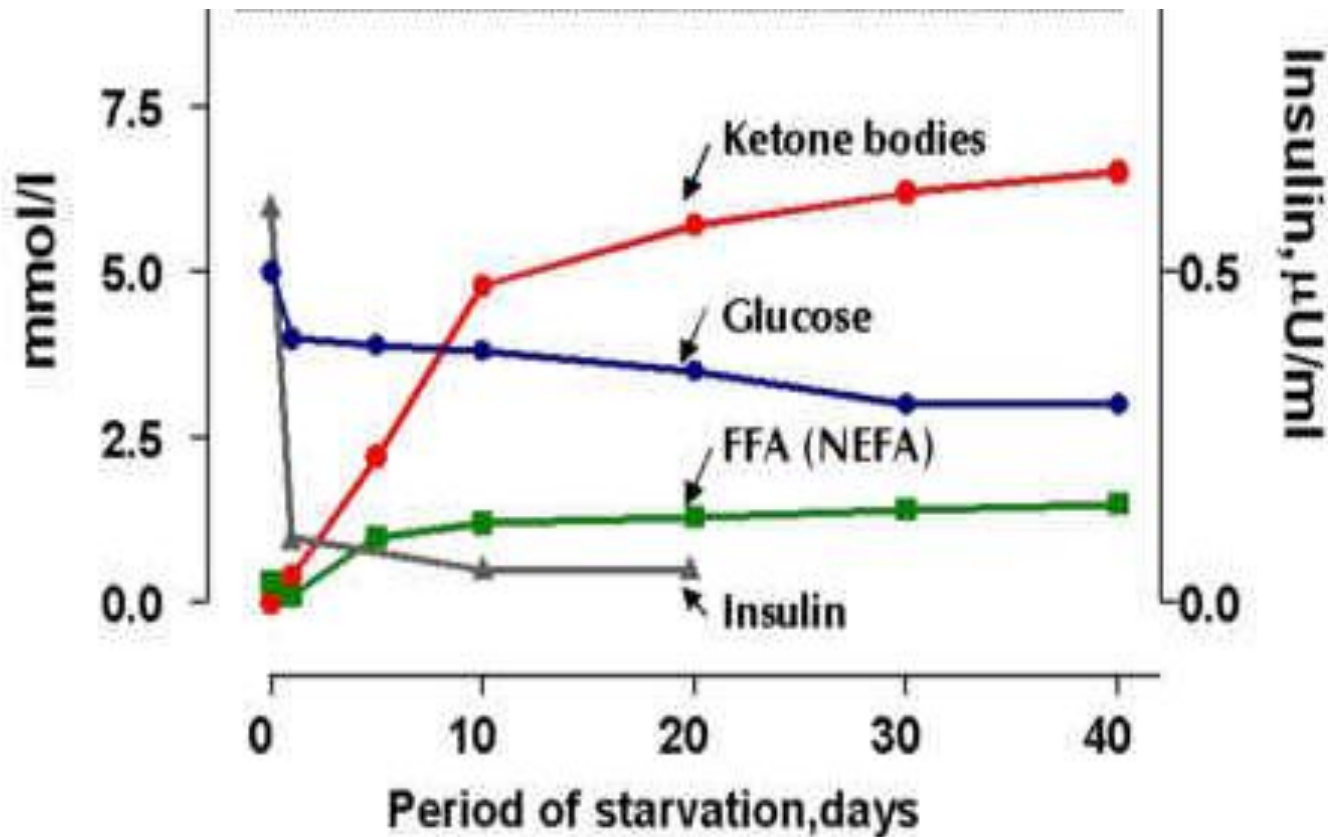
2003: Marshall Sutton: *“Our friends and colleagues in other places were putting their lives on the line, and you know, we wanted to do the same.”*



**Prolonged Fasting** – stored glycogen (sugar) and fat is used up quickly, then metabolism changes.

- The **liver** breaks down fat to generate free fatty acids (FFA) and the waste ketones . Muscles and liver begin to use fatty acids for energy, saving the glucose for the brain and blood.
- Blood glucose stays surprisingly steady, but insulin production drops quickly.

Blood Levels of Energy Substances

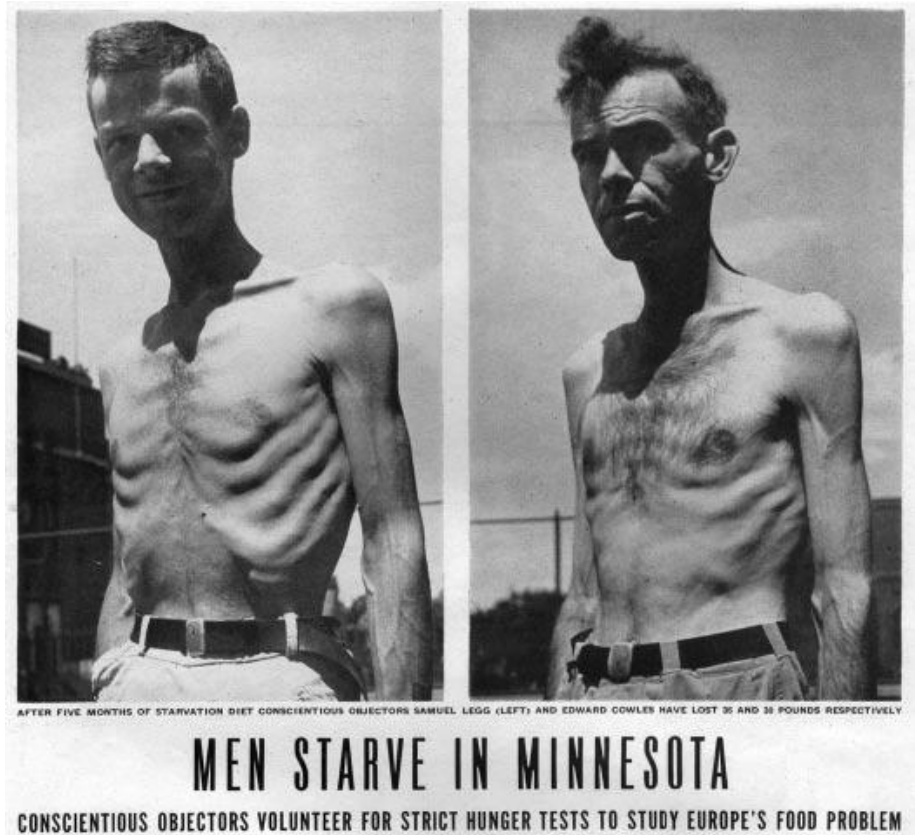


# Starvation Experiment – what the men experienced

- Irritability
- Impatience
- Feeling cold
- Dizziness
- Extreme tiredness
- Loss of sex drive
- **Obsession with food**
- Muscle soreness
- Hair loss
- Reduced coordination
- Ringing in the ears

Several withdrew from university classes because they didn't have the energy or motivation to attend and concentrate.

There were changes in mental ability and personality, as well as strength, as the men lost weight.



**“It made food the most important thing in one’s life.”**

## Lessons – and questions

What we learned from the starvation study was that the body is very adaptable. When food is not available, it will conserve resources, and lower the metabolism to save energy. When food is available again, the body will put fat on again – the men in the study recovered their original weight fairly quickly. They did not stay thin, and some complained of putting on a lot of “flab”, because the weight came back before the muscles did. One man reported he “... couldn’t satisfy [his] craving for food by filling up [his] stomach.”

This all applies to weight-loss diets. Although some people have been able to lose weight on diets, the vast majority gain it back within 2 years. Often, there is an increase in fat, which replaces muscle weight loss. We still don’t understand how the body “knows” how much to weigh.

Most people get to a steady weight at some point, and stay there (plus about half a pound added each year as metabolism slows with age.)

So why do some people become obese? Why do others not? It isn’t a question of “willpower” – why do some people feel hungry when they have eaten a huge amount of food and are overweight? Why are others satisfied with a cigarette and a Tic-tac?

We will look at a few disorders to see if we can find clues to this.

# Eating and Metabolism Disorders

- Prader-Willi syndrome
- Anorexia nervosa
- Bulimia (binging plus purging)

Traditionally, eating disorders have been considered psychological problems, and are still listed in the psychiatric diagnostic manual. There is some evidence that they may **not** be entirely “in the head”.

They frequently involve distorted body image.

Some research suggests that they may have some biological causes.

# Prader-Willi Syndrome

This is a known genetic mutation disorder, which results in mild mental retardation and a severe eating disorder.

Prevalence: 1 in 12,000- 15,000 people (both sexes, all races)

The syndrome involves:

- A deletion mutation in chromosome 15 – this affects several genes.
- Uncontrollable hunger, which develops between ages 2 and 3.
- Other medical issues, including cognitive impairment
- **Ghrelin** hormone levels are very high. Ghrelin is a recently-discovered hormone (chemical signal) given by the stomach. It affects appetite and how much and where the body stores fat. This high hormone level apparently keeps the people hungry all the time, no matter how much is eaten.



The discovery of ghrelin in 1999 led to some questions about other eating disorders – were they really psychological, or were there disorders in the brain that affected hunger and appetite?



# Anorexia Nervosa and Bulimia

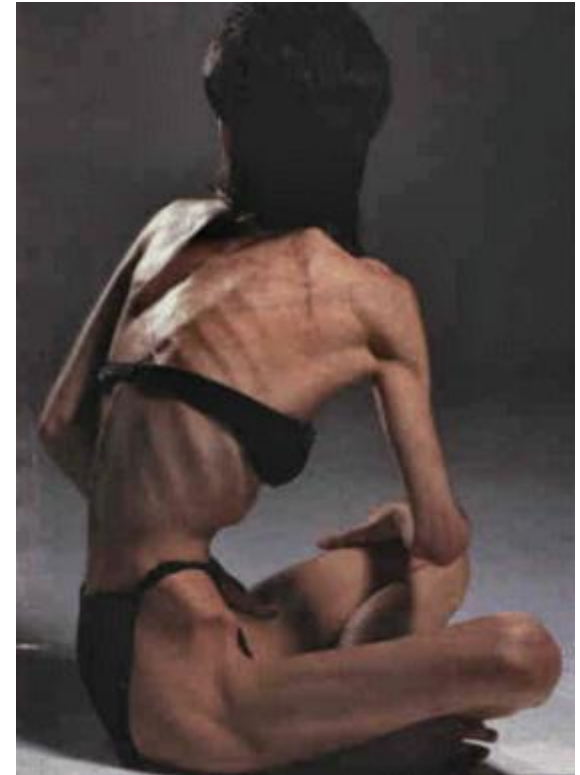
These conditions typically develop in late childhood or adolescence. They involve

- Excessive diet/exercise to maintain minimal weight
- Fear of gaining weight
- Altered body image

The cause of these disorders is not completely known. For years, they were considered psychological problems that were caused by poor family dynamics and stress, along with media images that emphasized thinness as beauty.

New research implicates:

- Genetics – twin studies show it is partially heritable
- Disorders that affect
  - Neurotransmitter production (signals in the brain)
  - Hormone secretion (which may include ghrelin or other newly discovered hormones)



<http://fathersforlife.org/images/skeleton7.jpg>

# Eating Disorders – Possible Biological Causes

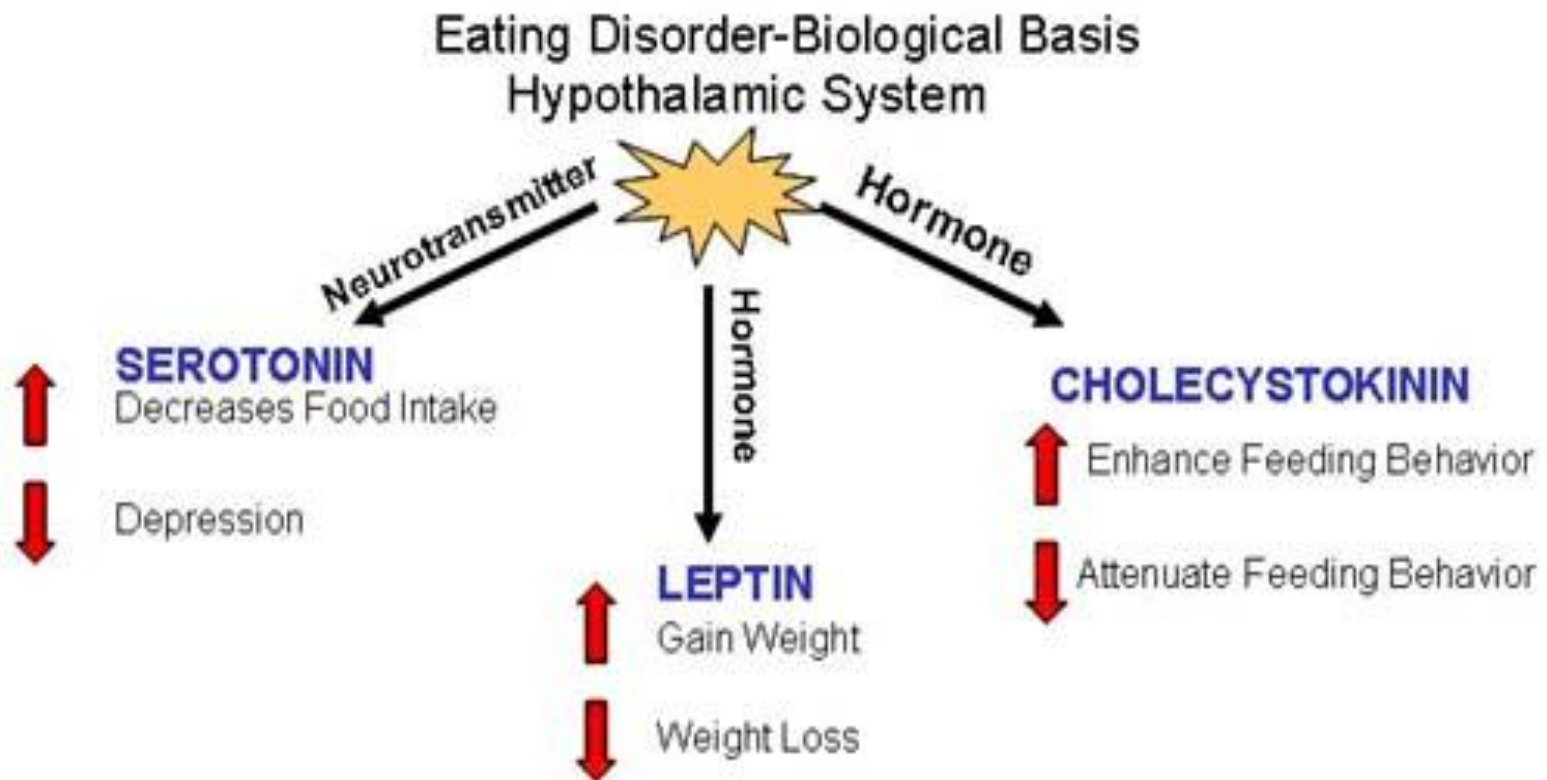
- Some recent research at the University of California San Diego has linked severe eating disorders with genetic mutations that affect the neurotransmitter GABA in the brain. (A neurotransmitter is a chemical that nerve cells use to communicate with each other.) These changes in GABA production may also cause anxiety disorders, which may be why anorexia and bulimia are often associated with anxiety.
- A case study of identical twins with anorexia showed that treatment with the anti-psychotic medication olanzapine (which binds to several different neurotransmitter receptors in the brain, though not GABA) corrected the disorder in one twin. An identical twin who got fluoxetine (which increases serotonin only) did not get the same results.
- In an autoimmune disorder, the immune system attacks normal body structures. Some researchers believe that immune system attacks on the brain chemicals that signal hunger (or maybe body weight) could be one cause of this disorder.

**Hypothalamus** – an area of the brain that controls hormone production, appetite, and fat usage (among other things)

**Neurotransmitter** – chemical signal between nerve cells

**Hormone** – chemical signal between other body organs

If the hypothalamus becomes dysfunctional, it can cause other dysfunctions in hormones, nerve signals, and other communication systems in the body, causing an endless loop of problems.



# Other Hormones Associated with Eating

- **New Intestinal hormones** - We are still identifying new hormones in the body. Glucose-dependent insulinotropic polypeptide (GIP), xenin, GLP-1, GLP-2, and others are made in the gut, and may have strong influence on appetite and satiety (sense of fullness).
  - Mouse study – killing the GIP cells reduced obesity & diabetes, even on a high-fat diet. This has not yet been tried on humans.
- **Growth Hormone** causes more muscle tissue to form, rather than fat. Some people are experimenting with it.
- **Androgens** (such as testosterone) may also direct body energy toward muscle production instead of fat. There are many side effects with these, though, so they have not been approved for this use.
- **Insulin** is known to regulate blood sugar in the body, and loss of insulin receptors causes Type 2 diabetes. Recent research on insulin receptors in the brains of mice seems to indicate that the same problem with receptors that causes diabetes may also cause appetite to increase strongly – and thus result in obesity. This has not yet been investigated in humans.

# Gut Microbiota

The intestines have a large population of natural bacteria in them (the gut microbiota), which seem to be vital to health. It turns out that thin people and fat people may have different types of bacteria in their guts. Certain types may make a person more efficient at extracting calories from the same foods, resulting in more calories coming in.

A 2012 review article in the American Journal of Gastroenterology summarized:

*“The preponderance of the evidence demonstrates that germ-free mice are protected against obesity and that the transfer of gut microbes from conventionally raised animals results in dramatic increases in body fat content and insulin resistance.*

*“Moreover, the composition of the gut microbiota has been shown to differ in lean and obese humans and animals and to change rapidly in response to dietary factors. The gut microbiota may also influence the development of conditions characterized by low-level inflammation, such as obesity and type 2 diabetes, through systemic exposure to bacterial lipopolysaccharide derived from the intestinal microbiota.*

*“Together, these data suggest that modification of the gut microbiota may be a relevant therapeutic avenue for obesity and other metabolic disorders.”*



[http://cache.boston.com/resize/bonzai-fba/Globe\\_Photo/2007/09/30/1191191326\\_0386/410w.jpg](http://cache.boston.com/resize/bonzai-fba/Globe_Photo/2007/09/30/1191191326_0386/410w.jpg)

In short, we know less than we thought about managing weight.  
But if just cutting calories is not effective in managing weight, what is?



# Exercise



- **More important than diet for health**
- Decreases CRP and LDL

In a 2005 study of people in cardiac rehabilitation (after a heart attack), exercise was more effective in lowering CRP (the inflammation marker) than drugs (statins).

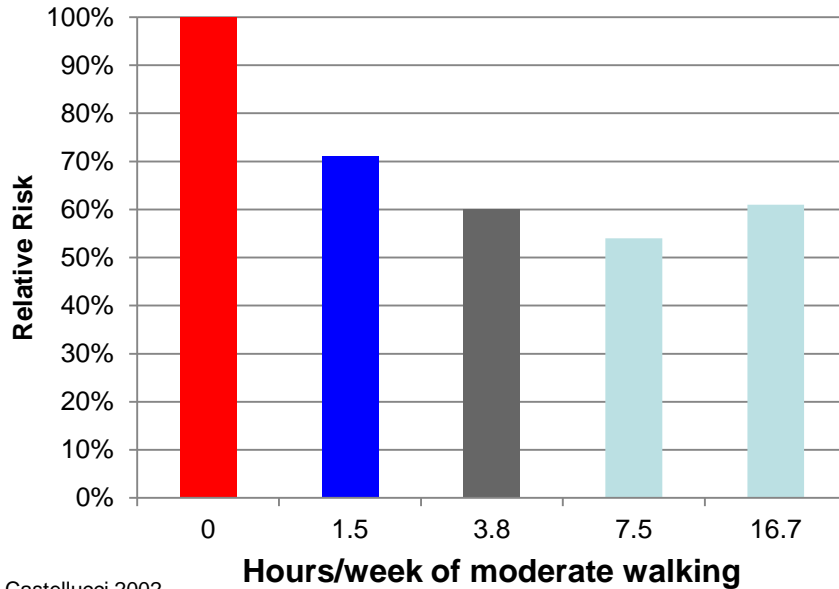
Exercising 3 – 4 days per week for 40 – 80 minutes lowered CRP levels within 2 months. This was independent of the person's weight. So – regardless of weight, exercise improved health.

Diet does matter – but exercise seems to matter more.

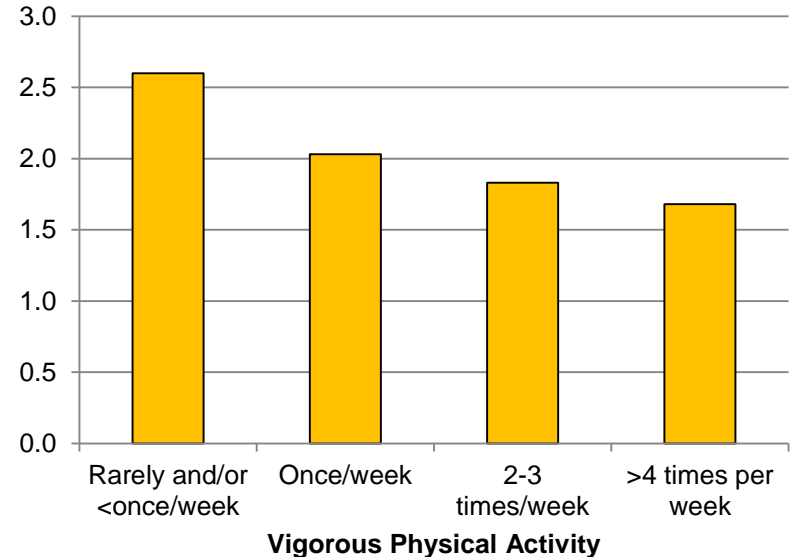
Studies to date show that if a person is trying for better health, then more exercise is a better choice than dieting. (At least until we understand metabolism better.)

# Exercise

**Risk of Coronary Heart Disease  
Women age 50-79**



**Median CRP concentration (mg/L)**



We have not yet really identified what exercise does to the body chemically. At very high levels, it might cause stress, due to wear on the joints. But within regular levels, it appears to improve all measures of health, including lowering blood pressure, CRP, and other risk markers.

According to a 2013 study, even a short-term (12-week) aerobic training program reduced CRP in young women with metabolic syndrome.