The Obesity Epidemic

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FIG. 1. Effects of recombinant human leptin treatment in a child with leptin deficiency.
Outline for today

1. Overview of factors that influence body weight
2. Analyzing the energy budget.
4. Clinical definitions of obesity and the metabolic syndrome
5. Obesity as a primary cause of chronic disease
6. Our tool box: Practical advice, medications and the last resort: bariatric surgery
Pressures that influence steady-state weight

Maclean et al; Am. J. Physiol. 301: R581, 2011
Metabolism Adapts, But at a Higher Weight

Maclean et al; Am. J. Physiol. 301: R581, 2011
Evidence for regulation of energy balance: Changes in energy expenditure in response to weight gain or loss (Mark AL; Clin Exp Pharm. Physiol 33: 857-62, 2006)

Fig. 2  This figure, which is adapted from a study by Leibel et al., demonstrates that, with 10% weight gain from forced feeding in healthy humans, there is a compensatory increase in energy expenditure that would limit weight gain. Conversely, with a 10% weight loss from caloric restriction, there is a compensatory decrease in energy expenditure. This latter response would protect against starvation during famine, but it helps explain why weight maintenance is more difficult than weight loss during dieting.
Metabolism Adapts to Dieting

Genetics → Homeostatic → Behavior → Environment → steady state weight

Maclean et al; Am. J. Physiol. 301: R581, 2011
Relapse: Biology Promotes Weight Regain

- Homeostatic
- Behavior
- Environment
- Genetics

steady state weight

Maclean et al; Am. J. Physiol. 301: R581, 2011
1. Energy enters an organism as food or drink and exits as heat or work.

2. Energy can also be mobilized from adipose stores (3500 kcal/lb).

3. Total energy expenditure can be subdivided into 3 components:
   4. **Obligatory energy expenditure**: required for normal functioning of cells and organs (1 kcal/min)
   5. **Physical activity** (~100 kcal/mile)
   6. **Adaptive thermogenesis**: heat production in response to environmental temperature or diet.
Actual and predicted weight loss ([http://bwsimulator.niddk.nih.gov/](http://bwsimulator.niddk.nih.gov/)) in response to: A) 25% caloric restriction; B) 12.5% caloric restriction plus exercise; C) 880 kcal/d for 3 mo followed by “weight maintenance”

Hall; Lancet 378:826, 2011
Bodyweight time course of a 100 kg (220 lb) following a decrease in energy intake of 2 MJ/day (480 calories). The variability is due to error in estimation of energy expenditure and biologic variability in response to dieting.

(Hall; Lancet 378:826, 2011)
Study: Eat an extra 1000 kcals for 8 wks?

Baseline values: Subject weighed 68 kgs and ate about 2800 kcals; resting EE was about 1700 kcals and total EE was also about 2800 kcals. (Levine, Science 283, 212, 1999).

Fig. 1. The relation of the change in (A) basal metabolic rate, (B) postprandial thermogenesis, and (C) activity thermogenesis with fat gain after overfeeding (27–33). Exercise levels and the thermic efficiency of exercise were unchanged with overfeeding, so that changes in activity thermogenesis represent changes in NEAT.
Homeostatic regulation of energy balance-I
The brain integrates energy balance multiple energy balance signals

1. Vagal afferents signal stomach distention and hormonal milieu in the upper small bowel to the NTS within the DVC.

2. Hormones released by the gut have incretin- (insulin secretory), hunger-, and satiety stimulating actions. The incretin hormones GLP-1, GIP, and potentially oxyntomodulin (OXM) improve the response of the endocrine pancreas to absorbed nutrients.

3. GLP-1 and OXM also reduce food intake.

4. Amylin is co-secreted with and compliments insulin. Suppresses glucagon release and inhibits gastric emptying. Synthetic amylin (Pramlintide) is treatment for T2DM and has bonus effect of decreasing food intake and producing weight loss.

Obesity is common, serious and costly

• About one-third of U.S. adults (33.8%) are obese.
• No state has met the nation's Health People 2010 goal to lower obesity prevalence to 15%. The number of states with an obesity prevalence of 30% or more has increased to 12 states in 2010.
• Obesity-related conditions include heart disease, stroke, type 2 diabetes and certain cancers, some of the leading causes of death.
• In 2008, medical costs associated with obesity were estimated at $147 billion; the medical costs paid by third-party payors for people who are obese were $1,429 higher than those of normal weight.
• Non-Hispanic blacks have the highest rates of obesity (44.1%) compared with Mexican Americans (39.3%), all Hispanics (37.9%) and non-Hispanic whites (32.6%).
Obesity Trends Among U.S. Adults Between 1985 and 2010

Source of the data:
• The data was collected through CDC’s Behavioral Risk Factor Surveillance System (BRFSS). Each year, state health departments use standard procedures to collect data through a series of telephone interviews with U.S. adults. Height and weight data are self-reported.
Obesity Trends* Among U.S. Adults
BRFSS, 1985
(*BMI ≥30, or ~ 30 lbs. overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults

BRFSS, 1990

(*BMI ≥30, or ~ 30 lbs. overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults
BRFSS, 1995

(*BMI ≥30, or ~ 30 lbs. overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults
BRFSS, 2000
(*BMI ≥30, or ~ 30 lbs. overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults
BRFSS, 2005

(*BMI ≥30, or ~ 30 lbs. overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults

BRFSS, 2010

(*BMI ≥30, or ~ 30 lbs. overweight for 5’ 4” person)
In 1990
- 10 states had a prevalence of obesity less than 10% and
- No state had prevalence equal to or greater than 15%.

By 2000
- No state had a prevalence of obesity less than 10%,
- 23 states had a prevalence between 20–24%, and
- No state had prevalence equal to or greater than 25%.

In 2010,
- No state had a prevalence of obesity less than 20%.
- Thirty-six states had a prevalence ≥ 25%;
- 12 of these states (Alabama, Arkansas, Kentucky, Louisiana, Michigan, Mississippi, Missouri, Oklahoma, South Carolina, Tennessee, Texas, and West Virginia) were ≥ 30%.
Obesity Trends* Among U.S. Adults
BRFSS, 1990, 2000, 2010

(*BMI ≥30, or about 30 lbs. overweight for 5’4” person)
Clinicians use the Body Mass Index (BMI) as a measure of obesity

\[ \text{BMI} = \frac{\text{mass (kg)}}{\text{height (m}^2)} \]

**BMI** | **Weight Status**
--- | ---
Below 18.5 | Underweight
18.5 – 24.9 | Normal
25.0 – 29.9 | Overweight
30.0 and Above | Obese
Metabolic Syndrome

Definition
• The name for a group of risk factors that occur together and increase the risk for coronary artery disease, stroke and type II diabetes

Causes, incidence, and risk factors
• Is becoming more and more common in the United States. Researchers are not sure whether the syndrome is due to one single cause, but all of the risks for the syndrome are related to obesity.
Metabolic Syndrome

The two most important risk factors are:

• Extra weight around the middle and upper parts of the body (central obesity) - "apple-shaped."

• Insulin resistance, in which the body cannot use insulin effectively.

Other risk factors include:

• Aging / hormones (post-menopausal)

• Genetics

• Lack of exercise
Metabolic Syndrome

According to the American Heart Association and the National Heart, Lung, and Blood Institute, metabolic syndrome is present if you have three or more of the following signs:

- Blood pressure equal to or higher than 130/85 mmHg
- Fasting blood sugar (glucose) equal to or higher than 100 mg/dL
- Large waist circumference (length around the waist):
  - Men - 40 inches or more
  - Women - 35 inches or more
- Low HDL cholesterol:
  - Men - under 40 mg/dL
  - Women - under 50 mg/dL
- Triglycerides equal to or higher than 150 mg/dL
Childhood obesity

- **Cause**? - childhood obesity is the result of eating too many calories and not getting enough physical activity

- American society has become characterized by environments that promote *increased consumption of less healthy food* and *physical inactivity*. It can be difficult for children to make healthy food choices and get enough physical activity when they are exposed to environments in their home, child care center, school, or community
Childhood Obesity Factors

- **Sugar drinks and less healthy foods on school campuses.** About 55 million school-aged children are enrolled in schools across the United States, and many eat and drink meals and snacks there.
- **Advertising of less healthy foods.** Both in schools and in the media.
- **More children in child care.** More than 12 million children regularly spend time in child care arrangements outside the home.
- **Lack of daily, quality physical activity in all schools.** Most adolescents fall short of the 2008 Physical Activity Guidelines for Americans recommendation (60 minutes of aerobic physical activity each day) In 2009 only 33% attended daily physical education classes.\(^7\)
- **No safe / appealing place, in many communities, to play or be active.**
Childhood Obesity Factors

- Limited access to healthy affordable foods.
- Greater availability of high-energy-dense foods and sugar drinks. Each day, 80% of youth drink sugar drinks.
- Increasing portion sizes. Portion sizes have increased over time. “Super-size” it
- Lack of breastfeeding support. Breastfeeding protects against childhood overweight and obesity. However, in the United States, while 75% of mothers start out breastfeeding, only 13% of babies are exclusively breastfed at the end of 6 months.
Risk Factors for Obesity

Television and media.

– Children 8—18 years of age spend an average of 7.5 hours a day using entertainment media, including TV, computers, video games, cell phones, and movies.

– Of those 7.5 hours, ~4.5 hours is dedicated to TV.

– 83% of children (6 mos to <6 years) view TV/videos ~ 2 hrs./day

– TV viewing
  • Takes away from the time spent in physical activities
  • Leads to increased energy intake through snacking and eating meals in front of the TV
  • Influences children to make unhealthy food choices through exposure to food advertisements
Obesity and Disease

• Obesity causes hypertension and can lead to heart failure

• Obesity causes sleep / breathing abnormalities
  – Increased obstructive sleep apnea
  – Increased lung problems after surgery

• Obesity leads to development of diabetes
  – insulin resistance
  – increases glucose production by the liver
  – inhibits glucose uptake by muscle
  – ultimately impairs insulin secretion by the pancreas
Percentage of some chronic disease that is potentially preventable by life-style modifications (Willett; Science 296: 695, 2002)

For stroke and coronary heart disease (CHD), the low-risk definition includes nonsmoking, a good diet (incorporating low intake of saturated and trans fat and glycemic load and adequate intake of polyunsaturated fat, omega-3 fatty acids, cereal fiber, and folic acid), body mass index < 25 kg/m², physical activity equivalent to > 30 min/day of brisk walking, and moderate alcohol consumption.
Management of Obesity

• Medication
• Diet
• Exercise
• Lifestyle changes
• Surgery
Treatment of obesity – Historical strategies

- Thyroid Hormones – tachycardia, cardiac hypertrophy, thyroid atrophy and muscle wasting
- Amphetamines – dependence, habituation and rebound depression
- Di-nitrophenol (DNP) – used extensively in diet pills from 1933 to 1938 after reports on the drug's ability to greatly increase metabolic rate. Pulled from market due to lethal hyperthermia and development of cataracts
History of Diet Drugs

• Fen-Phen
  – is a prescription diet drug combo that was used for many years to control appetite.
  – The two drugs that make up the combination are fenfluramine (Pondimin) and phentermine (Ionamin).
  – Combination produced effective weight loss but was linked in 1997 to increased risk of cardiac valve disease

• Ephedra / Ephedrine
  – Ephedrine has three actions: 1) direct alpha and beta agonist, 2) a CNS stimulant, and 3) increases NE release from adrenergic neurons.
  – Ephedrine may be used clinically as a pressor agent or bronchodilator
  – Banned by FDA due to deaths associated with severe hypertension and psychosis.
There are very few current selective and effective therapies for obesity

- **Current therapeutic targets:**
  - **Sibutramine (Meridia):** Serotonin reuptake inhibitor - A class of medications called appetite suppressants - works by acting on appetite control centers in the brain – associated with increased cardiovascular events and strokes and voluntarily removed from market in 2010.
  - **Orlistat (Xenical, ALLI):** Its primary function is preventing the absorption of fats from the human diet thereby reducing caloric intake
  - **Rimonabant:** an anorectic anti-obesity drug that has been withdrawn from the market. It is an inverse agonist for the cannabinoid receptor CB1. Its main effect is reduction in appetite.
7 Habits of Highly Effective Dieters

1. Expect failure, but keep trying.
2. Don’t deny yourself.
3. Weigh yourself often.
4. 90% of successful dieters exercise for 1 hour/day (25% of these are walkers).
5. Find ways to add little bits of activity each day.
6. Eat high carbohydrate, low fat meals.
7. Eat 5 meals/day.
Habits of Highly Effective Dieters
(From 225 to 175 lbs. for 10 years)

1. Used commercial weight-loss program to track calorie and fat intake (1800 kcals; less than 30% fat)
2. Ate breakfast
3. Dine out less than 3 times/week
4. Eater similar foods regular and avoid splurging
5. Walk an hour per day
6. Watch less than 10 hours TV per week
7. Weigh themselves at least once/week
Exercise Recommendations

• Children and adolescents should do 60 minutes or more of physical activity each day (aerobic, muscle strengthening, bone strengthening)

• Adults need 2.5 hours (150 minutes) of moderate-intensity aerobic (i.e., brisk walking) every week and muscle strengthening activities on 2 or more days a week that work all major muscle groups

• Same for older adults

• 10 minutes at a time is fine
Have you done 30 minutes of exercise today?

Just 10 minutes three times a day. Set yourself a time to exercise.
Gastric by-pass surgery / Banding

The Roux-en-Y gastric bypass

Usually reserved for those with BMI > 40, at least 100# > IBW or BMI >35 with other health problems (Diabetes or Heart Disease)

The Lap Band

Usually reserved for those with BMI > 40, at least 100# > IBW or BMI >35 with other health problems (Diabetes or Heart Disease)
Summary

• The term "metabolic syndrome" is a way of identifying individuals at high risk for the development of heart disease and diabetes.

• Patients at risk should receive education and counseling on lifestyle modification, and all risk factors for heart disease should be treated aggressively.

• It is important to treat the risk factors as bad things, before worse things happen.
Summary

• Some changes will be addressed by your doctor
  – Smoking cessation, treat HBP, high lipids and diabetes..
• Most change will occur by the individual
  – Choosing healthier food options
  – Walk / exercise regularly
  – Evaluate what you feed your kids
  – Urge children to go outside and play
• It all adds up. Preventing metabolic syndrome really means choosing a healthy lifestyle.