

The Body's Energy Budget

-energy is measured in units called kcals = **Calories**

-we take in & burn energy continuously; optimal body conditions when **energy input = energy output**

Energy Input (Food Calories)

-the amount of energy taken in varies by proportion of **Carbohydrates, Fats & Protein** in the food

-the primary source of energy in food is in **Carbohydrates**; but Fats and Proteins can also be used as energy sources

Energy Output

-in our cells, energy is extracted from food and used as ATP molecules

→ the body converts the energy in food to ATP at ~50% efficiency

→ when ATP is used again to do work (movement, heartbeat, nerve impulses, active transport, etc) again ~50% is lost

= overall **efficiency** of converting food to work ~25%; the other 75% is lost as heat

Energy Balance

-There is a tremendous variation in daily caloric requirements; 1300 - 5000 Cal/day

[**average male = 2900 Cal; average female = 2100 Cal**]

-the speed at which we burn energy each day = **metabolic rate**

-metabolic rate depends on many factors, including:

1. **age**; eg. 2 yr old burns 2x's Calories/lb as an adult; for adults, declines ~5%/decade

2. **weight**; the more a person weighs, the more total energy is required but less energy/lb

3. **exercise**; strenuous exercise can increase metabolism up to 40 x's for a short period

4. **stress**; severe stress can increase metabolism over 160 x's over short time

5. **metabolic hormones**; eg pituitary, thyroid, GH; eg. GH can raise BMR 15-20%

6. **body temperature**; 1° C → 10% increase in MR; high fever may double the metabolic rate

7. **pregnancy**; 20% increase last trimester; 60% increase during lactation

-over 2/3rds of body daily energy use is used for 'maintenance'; maintain body temperature, nerve impulses, heart beat, posture, kidney filtration, etc

eg. normally, brain and nerve cells consume 20% of all energy used in body/day

-only ~1/3 is used in voluntary muscle activity

Fasting and Energy Shifts

1. when we eat, excess organic molecules are converted to glycogen and fat

2. later (hrs to ~1 day) glycogen and fat are used for energy

3. continued fast (or starvation) proteins and fats are used for energy

low bld glucose → liver begins to make glucose from lactic acid and amino acids

4. body protein in muscles and liver breakdown to some extent during fasting

in 1st few days of a fast: body protein provides ~90% of glucose; fats provides ~10%

(if protein loss were to continue at this rate death would occur in ~3 weeks regardless of the quantity of stored fat)

5. as fast continues, fat breakdown also increases (almost doubles), nerve cells shift to using waste of fat metabolism called **ketones** for energy; but some cells still rely exclusively on glucose that must be made from the breakdown of proteins

6. body goes into acidosis: appetite is reduced **BUT** loss of body fat is greatly reduced ((less than what would be lost on a 'healthy' low cal diet) & acidosis has harmful and potentially lethal side effects

Excess Energy Storage

- average person takes in ~1 Million Calories per year and expends 99% of them
- of the various energy pathways, **Fats** provides the most energy for its weight; most **excess energy** is stored in the body as **fat**; 1 lb of body fat stores ~3500 Calories
- People seem to gain more body fat when they eat extra fat calories than when they eat extra carbohydrate calories

Body Weight, Body Fat & Health

- Normal Fat Values: normal wt male: 10-25% body fat; normal wt female: 18-32% body fat
athletes generally lower: males: 5-10%; females: 15-20%
some need more fat than others; eg. Alaskan fishermen eg. starting pregnancy
- research has shown that health problems develop when fat exceeds:
22% in men <40 yrs old 25% in men >40 yrs old
32% in women <40 yrs old 35% in women >40 yrs old
- Fat Distribution may be more important than % fat alone; 2 major fat distribution patterns:

a. lower body fat

- fat around hips and thighs
- is most common in women in reproductive years
- is not associated with any health risks (except children!)

b. upper body fat (=central obesity, = intra abdominal fat)

- fat is stored around abdomen
- abdominal fat is more common in men and in women after menopause
- presents a greater risk than fat elsewhere in body
- increases risk of premature death due to: heart disease, stroke, diabetes, hypertension, cancers
- also, people with central obesity smoke more and drink more than average
- exercise reduces central obesity

Health Risks of Underweight

- 1st to die during famine
- in greater danger when fighting a wasting disease like cancer (many people with cancer die not from cancer but from malnutrition)
- reduced hormone synthesis
- depression
- underweight women more likely to be infertile
- pregnancy may result in unhealthy infant
- inability to keep warm

Health Risks of Overweight

- over 1 Billion overweight adults; 300 M are obese vs 800 M undernourished worldwide (2006)
- 65% of American adults are **overweight**; about half of those are **obese** (2011)
- obesity related illnesses in US cost \$147 Billion/yr (2008)
 - obesity has been declared a “disease” because so many health risks are associated with it:

diabetes	cardiovascular disease	flat feet
hypertension	sleep apnea	gall bladder disease
osteoarthritis	abdominal hernias	liver malfunction
some cancers	varicose veins	complications in surgery
gout	respiratory problems	complications during pregnancy
arthritis	greater rate of accidents	

eg. Cardiovascular Disease: central obesity is as important risk factor as high blood cholesterol, hypertension and smoking

eg. Diabetes: Adult Onset (Noninsulin dependent) diabetes is 3x's more likely to develop in obese than nonobese person. Central body fat cells appear to be larger and more insulin resistant than lower body fat cells

eg. Cancer: risk of cancer increases with body fat; not sure why – may be correlated with greater levels of some hormones eg. estrogen in women

Obesity

- overweight people now outnumber the undernourished of the world

-US spend over \$60 Billion/yr on diets (2011)

-95% of all dieters end up weighing more than when they started; most who keep weight off are those who don't follow any fixed/fad diet plan

some popular kinds of diets:

eg. **Low Carbohydrate Diets**

-similar to fasting; glycogen reserves are spent; protein is metabolized to make glucose; eventually get onset of ketosis

-hype: brings dramatic wt loss in 1st few days

-but: much of this loss is glycogen and protein and large amounts of water and minerals (eg. 7 lb loss in 2 days: 1 or 2 lbs of fat; 5-6 lbs of protein, water, minerals)

-after diet, weight quickly rebounds

eg. **Protein Sparing Diets**

-ingesting only protein; but this protein must be used to supply glucose for the brain

-carries serious health risks: ketosis, vitamin and mineral deficiencies, fluid loss

-poor long term record of success; people generally regain weight

-now sold only to doctors or hospitals and must carry a "Protein Diet Warning"