Energy Balance and Body Composition



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Energy Balance



- Body weight is stable when energy consumed is equal to energy expended.
- When energy consumed is greater than expended, weight increases.
- When energy consumed is less than expended, weight decreases.

 One pound of body fat is equal to 3,500 kcalories.

Energy In: The kCalories Foods Provide

- Eating behaviors respond to different signals.
- Hunger and appetite encourage eating, while satiation and satiety stop eating.
- Messages are sent from the hormonal and nervous system.
- Other aspects of human behavior affect eating habits.

Energy In: The kCalories Foods Provide

- Food Intake
 - Appetite initiates eating through the sight, smell, thought or taste of food. Hunger is the feeling that motivates us to eat and is controlled by the hypothalamus.
 - Satiation is the feeling of satisfaction and fullness that causes us to stop eating.
 - Satiety reminds us not to eat again until the body needs food.



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Energy In: The kCalories Foods Provide

- Food Intake
 - Overriding Hunger and Satiety
 - Stress eating is eating in response to arousal.
 - Cognitive influences such as perceptions, memories, intellect, and social interactions
 - Sustaining Hunger and Satiety
 - Protein is the most satiating.
 - Complex carbohydrates are satiating.
 - High-fat foods stimulate and entice people to eat more.



For the same size portion, peanuts deliver more than 15 times the kcalories and 20 times the fat of popcorn.



For the same number of kcalories, a person can have a few high-fat peanuts or almost 2 cups of high-fiber popcorn. (This comparison used oil-based popcorn; using air-popped popcorn would double the amount of popcorn in this example.)

Energy In: The kCalories Foods Provide

- Food Intake
 - Message Central—The Hypothalamus
 - Integrates messages about energy intake, expenditure, and storage
 - Neuropeptide Y initiates eating, decreases energy expenditure, increases fat storage and causes carbohydrate cravings.

- Energy expenditure includes basal metabolic activities, physical activity, thermic effect of food and adaptive thermogenesis.
- These energy requirements differ from person to person and are affected by age, gender, weight, and height.
- The intensity and duration of physical activity also make a difference.

30-50% Physical activities

10% Thermic effect of food

50-65% Basal metabolism

- Components of Energy Expenditure
 - [I] Basal Metabolism (basal metabolic rate, BMR)
 - 2/3 of energy expenditure
 - Supports the basic processes of life
 - Resting metabolic rate (RMR) is a measure of energy slightly higher than BMR.

- Components of Energy Expenditure
 - [I] Basal Metabolism Factors affecting BMR
 - Aging slows BMR
 - Height the taller, the higher the BMR
 - Growth increases BMR
 - Body composition (lean body mass increases BMR)
 - Fever increases BMR.
 - Stress increases BMR.
 - Environmental temperature both heat and cold raise BMR

- Components of Energy Expenditure
 - [I] Basal Metabolism Factors affecting BMR
 - Fasting/starvation slows BMR.
 - Malnutrition slows BMR.
 - Hormones
 - Thyroid hormones can increase or decrease BMR.
 - Premenstrual hormones can increase BMR.
 - Smoking increases BMR.
 - Caffeine increases BMR.
 - Sleep slows BMR.

Factor	Effect on BMR
Age	Lean body mass diminishes with age, slowing the BMR. ^a
Height	In tall, thin people, the BMR is higher. ^b
Growth	In children, adolescents, and pregnant women, the BMR is higher.
Body composition (gender)	The more lean tissue, the higher the BMR (which is why males usually have a higher BMR than females). The more fat tissue, the lower the BMR.
Fever	Fever raises the BMR. ^c
Stresses	Stresses (including many diseases and certain drugs) raise the BMR.
Environmental temperature	Both heat and cold raise the BMR.
Fasting/starvation	Fasting/starvation lowers the BMR. ^d
Malnutrition	Malnutrition lowers the BMR.
Hormones (gender)	The thyroid hormone thyroxin, for example, can speed up or slow down the BMR. ^e Premenstrual hormones slightly raise the BMR.
Smoking	Nicotine increases energy expenditure.
Caffeine	Caffeine increases energy expenditure.
Sleep	BMR is lowest when sleeping.

- Components of Energy Expenditure
 - [2] Physical activity
 - Most variable and changeable
 - Voluntary
 - It can be significant in weight loss and weight gain.
 - Duration, frequency and intensity influence energy expenditure.

- Components of Energy Expenditure
 - [3] Thermic effect of food (TEF) is estimated at 10% of total energy intake and involves digestion and absorption.
 - Carbohydrate 5-10%
 - Fat 0-5%
 - Protein 20-30%
 - Alcohol 15-20%
 - Adaptive thermogenesis is the adjustment in energy expenditure related to environmental changes.

- Estimating energy requirements is affected by many factors.
 - Gender men generally have a higher BMR
 - Growth BMR is high in people who are growing
 - Age BMR declines as lean body mass decreases
 - Physical activity Activities are clustered by intensity and vary considerably
 - Body composition and body size taller people have more surface area and heavier people have higher BMRs





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- Current weight standards use height and weight data and do not take body composition into consideration.
- These may be misleading.

- Defining Healthy Body Weight
 - The Criterion of Fashion
 - Society values change over time.
 - Perceived body images
 - The Criterion of Health
 - Good health supercedes appearance.
 - Longevity is a criterion.



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- Defining Healthy Body Weight
 - Body mass index (BMI) measures relative weight for height.
 - Underweight is a BMI below 18.5.
 - Overweight is a BMI above 25.
 - Obese is a BMI above 30.



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- Body Fat and Its Distribution
 - Some People Need Less Body Fat
 - Fat for fuel
 - Fat for insulation and protection
 - Fat to assist in nerve impulse transmissions
 - Fat to support normal hormone activity
 - Some People Need More Body Fat
 - Thresholds differ among individuals
 - Thresholds differ for each function



- Body Fat and Its Distribution
 - Fat Distribution
 - Intra-abdominal fat around abdominal organs may be critical.
 - Central obesity is excess fat around the trunk of the body. It is also called abdominal fat or upperbody fat.
 - Associated with increased risks





In healthy weight people, some fat is stored around the organs of the abdomen. © 2007 Thomson Higher Education In overweight people, excess abdominal fat increases the risks of diseases.

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Upper-body fat is more common in men than in women and is closely associated with heart disease, stroke, diabetes, hypertension, and some types of cancer.

Lower body fat is more common in women than in men and is not usually associated with chronic diseases.

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- Body Fat and Its Distribution
 - Waist Circumference
 - Practical indicator of fat distribution and abdominal fat
 - \geq 35' is considered high risk for women.
 - \geq 40' is considered high risk for men.

- Body Fat and Its Distribution
 - Other Measures of Body Composition
 - Monitoring changes over time is important.
 - Fatfold measures
 - Hydrodensitometry
 - Bioelectrical impedance
 - Air displacement plethysmography
 - Dual energy X-ray absorptiometry (DEXA)



Skinfold measures estimate body fat by using a caliper to gauge the thickness of a fold of skin on the back of the arm (over the triceps), below the shoulder blade (subscapular), and in other places (including lower-body sites) and then comparing these measurements with standards.







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Hydrodensitometry measures body density by weighing the person first on land and then again while submerged in water. The difference between the person's actual weight and underwater weight provides a measure of the body's volume. A mathematical equation using the two measurements (volume and actual weight) determines body density, from which the percentage of body fat can be estimated.

Bioelectrical impedance

measures body fat by using a low-intensity electrical current. Because electrolyte-containing fluids, which readily conduct an electrical current, are found primarily in lean body tissues, the leaner the person, the less resistance to the current. The measurement of electrical resistance is then used in a mathematical equation to estimate the percentage of body fat.



Air displacement

plethysmography estimates body composition by having a person sit inside a chamber while computerized sensors determine the amount of air displaced by the person's body.

Dual energy X-ray absorptiometry (DEXA) uses

two low-dose X-rays that differentiate among fat-free soft tissue (lean body mass), fat tissue, and bone tissue, providing a precise measurement of total fat and its distribution in all but extremely obese subjects.

- Health Risks Associated with Body Weight and Body Fat
 - An appropriate weight for an individual depends on many factors which include body fat distribution, health history and current state of health.
 - Health Risks of Underweight
 - Cannot handle medical stresses
 - Menstrual irregularities and infertility
 - Pregnancy problems
 - Osteoporosis and bone fractures



- Health Risks Associated with Body Weight and Body Fat
- Health Risks of Overweight
 - Diabetes
 - Hypertension
 - Cardiovascular disease
 - Sleep apnea
 - Osteoarthritis

- Some cancers
- Gallbladder disease
- Kidney disease
- Respiratory problems
- Complications in pregnancy and surgery

- Health Risks Associated with Body Weight and Body Fat
 - Cardiovascular disease and obesity have a strong relationship.
 - Diabetes and obesity have a strong relationship.
 - Insulin resistance and obesity have a strong relationship.

- Health Risks Associated with Body Weight and Body Fat
 - Inflammation and the Metabolic Syndrome
 - High blood pressure
 - High blood glucose
 - High blood triglycerides
 - Low HDL cholesterol
 - High waist circumference

- Health Risks Associated with Body Weight and Body Fat
 - Cancer risk increases with weight gain but the relationship is unclear.
 - Fit and Fat versus Sedentary and Slim
 - Healthy weight is important.
 - Cardiorespiratory fitness is important.



Reference

Whitney E, Rolfes SR. 2011. Energy balance & body composition, in Understanding Nutrition 12th ed. Int'l student ed. Thomson Learning Inc., USA, pp. 240 – 260.