Appetite versus Hunger

DFEND 2.0
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Director
Center for Human Nutrition
Objectives

1. Define appetite, hunger, and satiety

2. Identify the differences between appetite and hunger

3. Understand how appetite, hunger, and satiety are regulated

4. Understand energy expenditure and energy balance
Defining Appetite, Hunger, and Satiety

• **Appetite**
  • A desire for food for reasons other than, or in addition to, hunger.

• **Hunger**
  • The biological impulse that drives us to seek out and consume food to meet our energy needs.

• **Satiety**
  • The effect a meal has on our interest in food after and between meals and when we feel hungry again.

• **Satiation**
  • The sense of fullness while eating that leads to the termination of a meal.
Hunger and appetite differ in their origins

• **Hunger**
  • Is a biological impulse

• **Appetite**
  • Is a product of sensory stimuli and perceived pleasure
  • Liking or wanting of food
  • Affected by the “toxic food environment”

Image: https://mindfuleatingforkids.wordpress.com/mefk-blog/page/2/
The Biology of Hunger

• Regulation of hunger involves a constant dialogue between our brains and our gastrointestinal tract.

• Regulated by **2 systems**:
  - **Short-term system**
    - Hormones (e.g. ghrelin)
    - Stomach pressure
    - Triggers hunger and satiety before and after *individual* meals
  - **Long-term system**
    - Regulated by a different set of hormones (e.g. leptin)
    - Adjusts food intake and energy expenditure
    - Maintain adequate fat stores
Food intake is regulated by fullness during meals and by satisfaction between meals

- **Satiation**
  - Sense of fullness
  - Leads to termination of a meal

- **Satiety**
  - Feeling the effect of a meal after and between meals
  - Lacking interest in food

- **Satiation and satiety affected by:**
  - Gastric distention
  - Gut peptide hormones
I need to eat
Hunger tells you to start eating.
Satiation tells you to stop eating.
Satiety is the satisfaction between meals.
I'm getting hungry
Between meals
I'm full
Growing hunger
Eating
HUNGER & SATISFACTION GUIDE
LET YOUR BODY BE YOUR GUIDE

Image:
https://www.surveymonkey.com/r/KOWhungerscale

Individual appetite cues can vary and these are just suggestions. Explore how your body informs you.

Food Intake Regulating Hormones

Table 1.

Principal food intake regulating hormones.

<table>
<thead>
<tr>
<th></th>
<th>Anorexigenic (appetite inhibitors)</th>
<th>Orexigenic (appetite activators)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Peripheral origin</strong></td>
<td>Leptin</td>
<td>Ghrelin</td>
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<tr>
<td></td>
<td>Adiponectin</td>
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<td></td>
<td>Insulin</td>
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<td></td>
<td>Glucose</td>
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<td></td>
<td>Cholecystokinin</td>
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<td>Peptide YY</td>
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<td></td>
<td>Oxyntomodulin</td>
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<td></td>
<td>Glucagon-like peptide-1</td>
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<td></td>
<td>Fatty acids</td>
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<td></td>
<td>Amylin</td>
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<td></td>
<td>Pramlintide</td>
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<tr>
<td><strong>Central origin</strong></td>
<td>Proopiomelanocortin derived peptides</td>
<td>Table-entry</td>
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<tr>
<td></td>
<td>Cocaine-amphetamine related transcriptase</td>
<td>Melanin concentrating hormone</td>
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<td></td>
<td>Corticotropin-releasing hormone</td>
<td>Ghrelin</td>
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<td></td>
<td>Oxytocin</td>
<td>Orexin</td>
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<td></td>
<td>Serotonin</td>
<td>Endocannabinoids</td>
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<td></td>
<td>Norepinephrine</td>
<td>Opioids</td>
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<td></td>
<td>Histamine</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Brain derived neurotrophic factor</td>
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</tbody>
</table>
Fig 1. Gut-brain axis

https://fstjournal.org/features/hunger-and-satiety
Satiety Cascade

https://doi.org/10.1080/10408398.2015.1073140
Daily Pattern of Eating Behaviour

Satiation Cascade

- Sensory & Cognitive
  - Reward and pleasure
  - Changes in palatability and hedonic value
  - within meal

- Pre-Absorptive
  - Physical characteristics
  - Energy / Osmotic load
  - Nutrient composition
  - Ghrelin, CCK, GLP-1 & PYY,
  - Gut motility
  - ("duodenal & ileal brakes")
  - Microbiota?

- Post-Absorptive
  - Metabolites
    - (Glucose & Amino Acids)
  - Oxidation
  - Insulin & leptin
  - Adipose tissue and
  - tonic energy balance

Cognitive
- Prior beliefs and associations
  - from learning and experience

Sensory
- anticipation generated by
  - sight and smell

Preprandial
Prandial
Postprandial

Subjective Experiences of Appetite

Max
Min

HUNGER
(desire, prospective consumption)

FULLNESS
What Motivates Us to Eat?

• Hunger
• Pleasure
  • Bliss point: just the right balance of salt, fat, and sugar that people find nearly irresistible
• Visual cues
  • Advertisements
  • Leads to overconsumption of food that is highly palatable (tasty) and energy-dense (lots of calories compared to nutrients)
• Stress
• Boredom
• Emotions
Hedonic versus Homeostatic Eating

• Hedonic Eating
  • Eating that occurs when there is no need for energy intake
  • Eating that occurs exclusively for its taste and reward properties

• Homeostatic Eating
  • Eating for hunger
  • Eating in response to a perceived energy need by the brain

Psychoneuroendocrinology, 2013-08-01, Volume 38, Issue 8, Pages 1435-1441
Hedonic Eating Decreases Markers of Satiety
Food Type and Food Form Impact Hunger and Satiation

(A)

- 100
- 50
- Water
- Digestible solids <2-3mm
- Indigestible solids >5-7mm

(B)

- 100
- 50
- High-calorie liquids
- Low-calorie liquids
- Solids
- 1-4 Kcal/min
- Water

External cues challenging the internal appetite control

https://doi.org/10.1080/10408398.2015.1073140
Eating Behavior is Learned

Obes Rev. 2010 Mar; 11(3): 251–270.
Appetite, Hunger, and Energy Balance

• **Energy Balance**
  - The amount of energy (also known as calories) we take in equals the amount of energy we use
    - Energy In = Energy Out

• **Positive Energy Balance**
  - The state when energy intake exceeds energy expenditure that leads to weight gain
    - Energy In > Energy Out

• **Negative Energy Balance**
  - The state when energy intake is less than energy expenditure, resulting in weight loss
    - Energy In < Energy Out
Energy Balance and Body Weight

NEGATIVE ENERGY BALANCE

Weight Loss

Energy intake is less than expenditure.


Photo credit: baibaz/Shutterstock

ENERGY BALANCE

Maintain Weight

Intake and expenditure are equal.

POSITIVE ENERGY BALANCE

Weight Gain

Energy intake exceeds expenditure.

Infographic 11.3
Energy Balance is also Hormonally Regulated

• **Ghrelin**
  • Produced in the stomach
  • Stimulates hunger

• **Leptin**
  • Produced by adipose tissue
  • Suppresses hunger

Energy Expenditure = Calorie Burning

Infographic 11.6

Basal metabolism is the largest component of total energy expenditure

- Energy expenditure required to maintain the ongoing functions that sustain life
  - Chemical reactions in cells
  - Active transport of electrolytes and other nutrients
  - Processes within organs—liver, brain, heart
  - Breathing
  - Maintenance of body temperature
  - Renewal and maintenance of muscle and bone tissue
  - Growth
Factors that affect basal metabolic rate (BMR)

- Body composition
  - Fat-free mass
- Age
- Sex
- Growth
- Hormones
- Starvation
- Illness
- Pregnancy
- Lactation
- Ethnicity
- Caffeine
- Smoking
- Sleep

<table>
<thead>
<tr>
<th>Factor</th>
<th>Effect on BMR</th>
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<tbody>
<tr>
<td>Fat-Free Mass</td>
<td>Fat-free mass (FFM) is body weight minus the weight of adipose tissue. FFM is the single most</td>
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<tr>
<td></td>
<td>important factor affecting BMR because adipose tissue is metabolically much less active than</td>
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<td></td>
<td>most other tissues. Our organs have the highest metabolic activity while we are at rest, with</td>
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<td>the liver, brain, heart, and kidneys accounting for about two-thirds of our BMR. Although at-</td>
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<td></td>
<td>rest skeletal muscle is far less metabolically active than our major organs, it is still about</td>
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<td>three times more so than adipose tissue.</td>
</tr>
<tr>
<td>Age</td>
<td>BMR decreases by about 1-2% per decade after young adulthood. The vast majority of this decrease</td>
</tr>
<tr>
<td></td>
<td>is due to the decreased mass of both our organs and skeletal muscle.</td>
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<tr>
<td>Sex</td>
<td>A woman will generally have a lower BMR than a man with the same body weight because FFM</td>
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<td>generally makes up a lower percentage of a woman’s total body weight than a man’s. Women also</td>
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<tr>
<td></td>
<td>tend to be smaller than men.</td>
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<tr>
<td>Growth</td>
<td>The energy demands of growth increase BMR from infancy through adolescence, but only during the</td>
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<tr>
<td></td>
<td>first six months of life do the energy demands of growth cause a significant increase in BMR.</td>
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<tr>
<td>Hormones</td>
<td>Elevated levels of thyroid hormone and epinephrine (released in response to stress) increase</td>
</tr>
<tr>
<td></td>
<td>BMR.</td>
</tr>
<tr>
<td>Starvation</td>
<td>Fasting or low-calorie diets decrease BMR to conserve energy when it is scarce.</td>
</tr>
<tr>
<td>Illness</td>
<td>A fever, burns, and trauma will increase BMR.</td>
</tr>
<tr>
<td>Pregnancy and</td>
<td>During pregnancy, BMR increases because of the increased work required to support the maternal</td>
</tr>
<tr>
<td>Lactation</td>
<td>circulation, respiration, and kidney function, as well as to support the increased tissue mass.</td>
</tr>
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<td></td>
<td>During lactation, BMR increases to meet the energy demands of milk production.</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>The BMR of whites may be 5-10% higher than that of other ethnic groups.</td>
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<tr>
<td>Caffeine</td>
<td>Caffeine consumption increases BMR. The amount of caffeine equal to that of a typical soft drink</td>
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<td>has been shown to raise BMR by about 5%, whereas an amount approximately equivalent to that in</td>
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<td></td>
<td>three to four 8-ounce cups of coffee has been shown to raise BMR by about 10%. Those who regularly</td>
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<td>consume high amounts of caffeine may develop tolerance to its effects.</td>
</tr>
<tr>
<td>Smoking</td>
<td>Nicotine tends to increase BMR.</td>
</tr>
<tr>
<td>Sleep</td>
<td>Sleeping metabolism is about 10% less than basal metabolic rate.</td>
</tr>
</tbody>
</table>
A lean individual expends more energy at rest than someone of the same weight with more body fat

- Skeletal muscle is nearly three times more metabolically active than adipose tissue
- Differences and changes in fat-free mass
  - Accounts for lower BMR in women
  - Contributes to decline in BMR with age
Estimating BMR in normal-weight individuals

- Females: weight (in kg) × 23.2
  - BMR example for 140-pound female:
    - 140/2.2* = 63.6 kg × 23.2 = 1476 calories

- Males: weight (in kg) × 24
  - BMR example for 175-pound male:
    - 175/2.2 = 79.5 kg × 24 = 1908 calories
    * To convert pounds to kilograms, divide weight in pounds by 2.2
Thermic effect of food (TEF) is a component of total energy expenditure

- Energy needed to digest, absorb, and metabolize nutrients in our food
- Generally equivalent to 10% of the energy content of the food ingested
- Does not vary greatly between people
Activity energy expenditure (AEE) is the most variable component of TEE

- Amount of energy expended in physical activity per day
  - Includes intentional “exercise” as well as activities of daily living
  - Includes contraction of skeletal muscles to move and to maintain posture
Intentional “exercise” and NEAT make up our activity-related energy expenditure

• **NEAT = Nonexercise activity thermogenesis**
  - Activities of daily living

![Increase in Energy Expenditure Above Resting Values](image_url)

- Sitting
- Chewing gum while sitting
- Sitting while fidgeting
- Sitting while playing a musical instrument
- Mowing the lawn (riding)
- Standing still
- Standing while fidgeting
- Standing washing dishes
- Vacuuming
- Walking (2 mph)
- Walking (3 mph)
- Mowing the lawn (walking)
- Climbing stairs

The increase in energy expenditure compared to lying down when engaging in various nonexercise activities for one hour is shown (for a 70 kg individual).

*Pope/Nizielski, Nutrition for a Changing World, 2e © 2019 W.H. Freeman and Company*

**Infographic 11.8**
NEAT and its impact on the risk of obesity

Obese individuals spend more time sitting and less time standing and moving than do lean individuals.

W. H. Freeman and Company
Summary

1. Define appetite, hunger, and satiety

2. Identify the differences between appetite and hunger

3. Understand how appetite, hunger, and satiety are regulated

4. Understand energy expenditure and energy balance
Next week...

Intermittent fasting and time restricted feeding

Gastrointestinal (GI) sensing of meal-related stimuli, and effects on GI functions (specifically gut hormone release and slowing of gastric emptying), appetite and energy intake.

Nutrients 2019, 11(6), 1298; https://doi.org/10.3390/nu11061298