THE INFLUENCE OF PHYSICAL ACTIVITY AND DIET/FOOD CONSUMPTION ON ENERGY BALANCE

James O. Hill, Ph.D.
Anschutz Professor
University of Colorado
Anschutz Health and Wellness Center
Presenter Disclosures

- **Speaker**: James O. Hill, PhD

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The Energy Balance System

Inherited Factors

- Efficiency
- Adaptive thermogenesis
- Food preferences

Energy Stores

Active Regulation

Environmental Factors

- Food environment
- Physical activity environment

Behavior

- Eating
- Physical activity
- Sleep

Energy Intake

Energy Expenditure

Energy

Active Regulation

Wellness changes everything

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Energy Balance System
Why is it important to study energy balance?

- Understand why we have high rates of obesity
- Help us understand that changing one component effects the others
- Help us interpret research results
- Develop most effective strategies to lower obesity rates
Factors that impact body weight have to work through energy balance

1. Energy balance can be achieved at many different levels of body weight/body fatness
2. How can we help more people achieve energy balance at healthy weights?
If Energy Balance is Regulated, Why are Obesity Rates so High?
Food has never been cheaper, more available and accessible.
Where has all the physical activity gone?
Promotion of Obesity

**Biology**
- Desire to Eat
- Pref for sweet/fat
- No Drive to be active

**Physical Activity**
- Little need for physical activity in daily living
- Attractiveness of sedentary Entertainment
- Car for Transportation

**Sociocultural Forces**

**Economics**
- Consume More
- More for less
- Greater Productivity

**Food**
- Available
- Good tasting
- Energy dense
- Inexpensive
- Large portions

**Obesity**
- Decreased Energy Expenditure
- Increased Energy Intake
Walking: Old Order Amish vs. Current Population

From Bassett et al., Med. And Sci. in Sports and Exer., 2004

Steps per Day

<table>
<thead>
<tr>
<th></th>
<th>Steps per Day</th>
<th>Caloric Expenditure</th>
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<tbody>
<tr>
<td>Amish Men</td>
<td>18000</td>
<td>600 Kcal/d</td>
</tr>
<tr>
<td>Amish Women</td>
<td>14000</td>
<td>5940 Kcal/d</td>
</tr>
<tr>
<td>US Men</td>
<td>5276</td>
<td>440 Kcal/d</td>
</tr>
<tr>
<td>US Women</td>
<td>5940</td>
<td>32%</td>
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</table>

Obesity rate

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Amish Men</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>Amish Women</td>
<td>3%</td>
<td></td>
</tr>
<tr>
<td>US Men</td>
<td>32%</td>
<td></td>
</tr>
<tr>
<td>US Women</td>
<td>35%</td>
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</tbody>
</table>
Daily Occupational Caloric Expenditure

Men
-140 daily kcals

Women
-120 daily kcals

Church et al, PLoS ONE, May 2011
Energy Flux and Energy Balance

At what level of energy “flux” should we attempt to achieve energy balance for a population?

Energy balance at different “flux” levels

1500 Kcal  Sedentary  1500 Kcal

2000  Low Activity  2000

2500  Highly Active  2500
Our biology works best at high level of physical activity

Adapted from Mayer et. al., 1956
Metabolic Changes with Decreased Physical Activity

Muscles
Insulin Sensitivity
Nutrient Metabolism
Fat Cells
Appetite
Brain function
Why Food Restriction is not the Answer

Energy Intake

Energy Expenditure
A very small error in energy balance can explain most weight gain
How big is the “Energy Gap” to prevent primary weight gain?


Assuming 50% storage efficiency

Energy gap = 30 kcal/d

Energy gap = 100 kcal/d

Median 15 kcal/day

90 Percentile 50 kcal/day
An understanding of energy balance can help us develop more effective strategies to reduce obesity rates.
Components of energy balance are interrelated and changes in one component impact all others.
Decrease Energy Intake

- Body weight increases
- Body weight does not change
- Body weight decreases

Usual physical activity
Metabolic Rate
Food Intake
12-month Net Weight Change (kg): Individual Results

Gardner, JAMA, 2007 297:969-77
What happens to body weight when physical activity is increased?

- Body weight increases
- Body weight does not change
- Body weight decreases

Increase Physical Activity

Usual physical activity
Metabolic Rate
Food Intake
Individual and Gender Differences in Response to PA

- Individual differences may be due to compensation from EI, metabolic rate, daily PA, etc.
- Gender differences may be due to method of exercise prescription
- Traditional Rx (duration, freq, intensity) favors men

Donnelly et al, Arch Inter Med, 163:1343-1350, 2003
Impossible to understand body weight regulation without considering both food intake and physical activity
Prevention Should be more Feasible than Treatment
Is weight loss the right strategy?

The Energy Gap

- Energy Gap for prevention of weight gain
- Energy Gap for maintenance for weight loss

Body Weight vs. Time

Natural course of further weight gain
Small Changes for Prevention
Large Changes for Treatment
The “healthy default” approach

• Takes nothing away
• Makes it easier to make better choices
• Allows gradual changes at consumers’ own pace
• Allows consumers to feel empowered & successful, not deprived
Challenges in reducing obesity

Biology
- Desire to Eat
  - Pref for sweet/fat
  - No Drive to be active

Physical Activity
- Little need for physical activity in daily living
  - Increased Energy Intake
  - Car for Transportation

Social Environment of Wellness
- Reason to push back
  - Economics
    - Consume More
      - Different Value Equation
        - Greater Productivity
  - Food
    - Available
      - Good tasting
    - Energy dense
    - Inexpensive
    - Large portions

Obesity
- Decreased Energy Expenditure
- Increased Energy Intake

Make better choices
- Energy Balance
  - Wellness Changes Everything

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Strategies

1. Change the environment
2. Promoting Cognitive Skills
Conclusions
1. Factors that impact body weight work through the energy balance system
2. Both diet and physical activity critical
3. Physical activity more than burning calories – high flux
4. Prevention more feasible than treatment
5. Cognitive skills important
6. Small changes – what people can do
Strategies to Reduce Obesity

1. Increase physical activity to get people into regulated zone
2. Promote smarter eating for individuals
3. Teach energy balance cognitive skills
4. Use small changes approach for changing behavior and environment