Defining Energy Balance

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### Disclosures for: James Hill

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Is Energy Balance the Appropriate Framework to Study Body Weight Regulation and Obesity?
The Energy Balance System

Energy Stores

Active Regulation

- Energy Intake: -3500 kcal
- Energy Expenditure: -7000 kcal
- Energy Expenditure: -1 pound
- Energy Expenditure: <2 pounds

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Energy Balance

Weight Stability

Negative Energy Balance
Weight Loss

Positive Energy Balance
Weight Gain
Concept: Macronutrient Balance

Body Fat Mass

$E_{\text{In}}$  $E_{\text{Out}}$

Prot$_{\text{In}}$  Prot$_{\text{Out}}$

CHO$_{\text{In}}$  CHO$_{\text{Out}}$

Fat$_{\text{In}}$  Fat$_{\text{Out}}$
Is Energy Balance Regulated?
Day-to-Day Intake for A Single Individual

Body Weight

Total Intake (KCal)

Days
Is Energy Balance Regulated?

What is regulated?

- Energy
- Energy stores
- Glucose
- Glycogen
- Fat Stores
- Temperature
Set Point vs Settling Point

Homeostatic Environment

Defended Weight

Conscious Behavior

NON-HOMEOSTATIC REGULATION
Energy Balance

Not just about the addition of diet and exercise. Each affects the other, so that changing one changes the other.
If Energy Balance is Regulated, Why are Obesity Rates so High?
The Energy Balance System

Inherited Factors
- Efficiency
- Adaptive thermogenesis
- Food preferences

Environmental Factors
- Food environment
- Physical activity environment

Energy Stores

Active Regulation

Energy Intake

Energy Expenditure
The Energy Balance System

Inherited Factors
- Efficiency
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Energy Stores

Active Regulation

Energy Intake

Energy Expenditure
The obesity epidemic arose from gradual weight gain over time.
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
Walking: Old Order Amish vs. Current Population

<table>
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<tr>
<th>Steps per Day</th>
<th>Amish Men</th>
<th>Amish Women</th>
<th>US Men</th>
<th>US Women</th>
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<tr>
<td></td>
<td>18000</td>
<td>14000</td>
<td>5940</td>
<td>5276</td>
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<tr>
<td>kcal/day</td>
<td>~600</td>
<td>~440</td>
<td>~600</td>
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Interaction of Diet and Physical Activity

Energy balance (MJ/day)

- Low-fat
- Medium-fat
- High-fat

Sedentary
Active

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What happens to body weight when food intake is decreased?

- 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?

- Increase physical activity
  - Body weight increases
  - Body weight does not change
  - Body weight decreases

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
An understanding of energy balance can help us develop more effective strategies to reduce obesity rates.
Does it Matter how Energy Balance is Achieved?

1500  1500

2300  2300
Our Biology works best at High Levels of Physical Activity

Physical Activity Level

Threshold for Optimal Weight Regulation

Energy Intake

Body Weight

“Unregulated” Zone

“Regulated” Zone

Obesity

Physical Activity Level

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Prevention of weight gain

Modest Weight Loss

Substantial Weight Loss

Natural course of further weight gain

Adapted from Rossner, 1992
How Much Change is Needed?

Defining the *energy gap*
- population estimates
- Individual estimates
How much behavior change is needed for successful weight loss maintenance?

Example for 100 kg person

-10% (10 kg) = 190-200 kcal/day

-15% (15 kg) = 280-300 kcal/day
Energy Gap for Prevention of Weight Gain
(<100 kcal/day)

Body Weight

Energy Gap

Energy Gap

Obese

Overweight

Healthy Weight
Starting a movement...

America on the move™
Quick Start Guide

Simple Ways to Get an Extra 2000 Steps A Day

Achieving an extra 2000 steps a day may take a little extra effort or be a goal you work toward over several weeks. Either way, it means taking each opportunity to increase your walking. Every step you take adds up.

Sign Up for Your FREE On the Move E-Newsletter!

Get the latest America On the Move healthy eating and active living information as well as AOM news from around the nation and in your back yard.

Sign up for On the Move by registering at www.americaonthemove.org.

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What role can small changes play if we need bigger systemic change?

Set the table for bigger change... you have to start somewhere...

Any change requires taking some risk...

There are things we can do NOW that may slip by unnoticed...
A better approach: Healthy Defaults

Disney parks
  Kid’s meals come with low fat milk and fruit

Starbucks
  Drinks made with low fat milk

Portion sizes/energy density
  Would anyone notice a 5% reduction?

School drop offs
  Buses and cars drop kids off 500 steps from school
Teaching Energy Balance Skills

How to determine energy requirements
Influences on energy requirements
How energy in food relates to energy in physical activity
Weight gain and weight loss
Genetic and environmental influence on energy intake and energy expenditure
 Strategies to Reverse Obesity Epidemic

Increase physical activity level of the population
Implement strategies to reduce overeating
Teach our children energy balance skills

Should we consider combining diet and physical activity guidelines?
Conclusions

- Energy balance is a framework that can be used to understand the interplay between energy intake, energy expenditure and energy storage that determines body weight.
- A better understanding of energy balance can help develop more effective strategies for reducing obesity rates in individuals and populations.