Treatment of Obesity Through Dietary Modification

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Conflict of Interest Disclosure
I disclose that:
• I anticipate referencing the unlabeled / unapproved use of 3 medications for the treatment of obesity
• I have an affiliation with:
  • Medifast
  • Obesity Medicine Association

Learning Objectives
• Recognize the metabolic response of different macronutrients
• Compare and contrast different dietary interventions
• Understand the role of adaptive thermogenesis in weight management
“All diets work,  
All diets fail”

First Law of Thermodynamics

- Conservation of energy
- In a closed system, energy is neither created or destroyed.

Thermodynamics

- Energy_in vs. Energy_out
Is a Calorie a Calorie?

Measuring Calories

• Are all calories equal?
  • Do all calories have the same nutrient value?
  • Are all calories digested at the same rate?
  • Do all calories make you feel equally full?
  • Do all calories have the same health effects?

Hormonal Regulation of Appetite
Macronutrients

Carbohydrates

- Carbohydrates (4 kcal/gm)
  - Digestible Carbohydrates
    - Initial End Products
      - Glucose
      - Fructose
      - Galactose
    - Liver
  - Indigestible Carbohydrates
    - Dietary Fiber
      - No impact on calories
      - Net carbs

Carbohydrate Metabolism

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Carbohydrates

- Carbohydrates (4 kcal/gm)
  - Simple
    - Monosaccharides – glucose, fructose, galactose
  - Disaccharides – sucrose, lactose, maltose
  - Complex – polymers of monosaccharides
    - Starch – amylose and amylopectin
Carbohydrates

- Carbohydrates (4 kcal/gm)
  - Glycemic Index
    - Rate at which foods are converted to glucose
    - High GI → Rapid Conversion; Low GI → Slow Conversion
  - Fiber – CHO not bioavailable
    - Net carbs = Total Carbs – Fiber
  - Sugar alcohols
    - Mannitol, sorbitol, xylitol, erythritol
    - 60% conversion to glucose

- Sugar sweetened Beverages are High GI
- Sugar intake
  - 1800 – 5 lbs/person/year
  - 2015 – 128 lbs/person/year
- Starches – wide range of GI
  - Low – Quinoa, Rye Bread, WW Pasta
  - Med – Sourdough, Oatmeal (not instant)
  - High – White Bread, Bagels, Rolls

- Vegetables – Glycemic Index
  - Low – Zucchini, Asparagus, Broccoli
  - Med – Raw Carrots, Green Beans
  - High – Peas, Corn, Cooked Carrots

- Fruit – Glycemic Index
  - Low – Lemons, Raspberries, Cherries
  - Med – Apples, Pears, Strawberries
  - High – Grapes, Bananas, Melon, Blueberries
Carbohydrate Metabolism

• Digestible Carbohydrates
  • Glucose
    • Stimulates Insulin – central satiety
    • Suppresses Glucagon – decreases HGP
    • Stimulates Leptin – central satiety
    • Suppresses Ghrelin – reduces hunger

Carbohydrate Metabolism

• Glucose verses Fructose
  • Fructose has 4 kcal/gm but it:
    • Does not stimulate insulin or leptin – no satiety effect
    • Does not suppress glucagon – HGP continues
    • Does not suppress ghrelin – appetite not suppressed
    • Hunger is not reduced by consumption
    • No barriers to excess calorie load

Carbohydrate Metabolism

• Glucose verses Fructose
  • Fructose has 4 kcal/gm but:
    • Fructose is metabolized in the liver
    • Excess fructose is converted to fat and uric acid
    • Steatosis and gout
    • Is fruit bad for you?
Soda verses Fruit

Fruit Nutrition Chart

<table>
<thead>
<tr>
<th>Fruit</th>
<th>Serving Size</th>
<th>Calories</th>
<th>Fat</th>
<th>Fiber</th>
<th>Sugar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apples</td>
<td>1 medium apple</td>
<td>90</td>
<td>0.5g</td>
<td>2g</td>
<td>17g</td>
</tr>
<tr>
<td>Bananas</td>
<td>2 medium bananas</td>
<td>115</td>
<td>1g</td>
<td>2g</td>
<td>13g</td>
</tr>
<tr>
<td>Dates</td>
<td>1 medium dates</td>
<td>95</td>
<td>0.4g</td>
<td>1g</td>
<td>18g</td>
</tr>
<tr>
<td>Nectarines</td>
<td>1 medium nectarine</td>
<td>115</td>
<td>1g</td>
<td>2g</td>
<td>13g</td>
</tr>
<tr>
<td>Pearls</td>
<td>1 medium pears</td>
<td>105</td>
<td>1g</td>
<td>2g</td>
<td>14g</td>
</tr>
<tr>
<td>Prunes</td>
<td>10 medium prunes</td>
<td>70</td>
<td>0.5g</td>
<td>0.5g</td>
<td>1g</td>
</tr>
<tr>
<td>Strawberries</td>
<td>10 medium strawberries</td>
<td>70</td>
<td>0.5g</td>
<td>0.5g</td>
<td>1g</td>
</tr>
<tr>
<td>Blueberries</td>
<td>1 cup m. blueberries</td>
<td>126</td>
<td>2g</td>
<td>1g</td>
<td>13g</td>
</tr>
<tr>
<td>Grapes</td>
<td>10 medium grapes</td>
<td>70</td>
<td>0.5g</td>
<td>0.5g</td>
<td>1g</td>
</tr>
</tbody>
</table>

69 g of sugar

Fat Digestion

- GI Absorption TAG → Lymph → Chylomicron → Blood → Adipose
- No impact on insulin
- More satiating than carbohydrates
- Medium chain FA's most satiating

Fats

- Fats (9 kcal/gm)
  - Play Important Structural and Functional Roles in Cells and Tissues
  - Essential Fats
    - Linoleic (Omega-6)
    - α – Linolenic (Omega-3)
Fats

• Healthier Fats
  • Monounsaturated and Polyunsaturated
  • Olive, Avocado, Flaxseed
  • Peanut, sesame, grapeseed

• Less Healthy Fats
  • Trans-fats - Partially Hydrogenated Vegetable Oil
  • Saturated Fat
  • Coconut – medium chain fatty acids

Saturated vs. Unsaturated Fats

• Saturated Fats (9 kcal/gm)
  • ↑ LDL
  • ↑ VLDL

• Monounsaturated & Polyunsaturated Fats (9 kcal/gm)
  • ↓ LDL
  • ↑ HDL
  • Have antioxidant capabilities

Protein Digestion

• Oxidation of protein yields 4 kcal/gm
  • Actual caloric value is 5.63 kcal/gm
  • High TEF
  • Broken down into amino acids
    • Stored as protein
    • Excess converted to glucose
Protein Digestion

• Most satiating macronutrient
  • Suppresses ghrelin
  • Stimulates leptin
  • Limited impact on insulin except in with excess consumption

Protein

• Healthy Protein Sources
  • Fish – great source of Omega 3
  • Legumes – soy, chickpea, lentils
  • Nuts & Seeds – high in fat as well
  • Eggs

Question

Compared to glucose, fructose
1. Has less suppression of ghrelin
2. Has a greater effect on leptin
3. Stimulates a greater insulin response
4. Stimulates a greater glucagon response
5. Is readily metabolized in the muscle
Energy Balance

All calories are not equal
Principles of Dietary Regulation

- How often should you weigh yourself?

Dietary Intervention

Goals of Dietary Intervention
- Improve patient health
- Improve quality of life
- Improve body weight and composition
Dietary Intervention

• Long-term process
• Comprehensive lifestyle change
  • Nutrition
  • Physical Activity
  • Behavioral Change

Simple Calorie Restriction Myth

• There are 3500 calories in a pound
• If you reduce calorie consumption by 500 kcal/d you will lose 1 lb/wk

Rapid Weight Loss Myth

• If you lose weight quickly you are more likely to gain it back

Myths, Presumptions, and Facts about Obesity


Nutrition History

Meals and Snacks
- Timing
- Frequency (via questionnaire)
- Nutritional content
- Preparer of food
- Access to foods
- Location of home food consumption (i.e., eating area, television, computer, etc.)
- Location of away food consumption (i.e., workplace restaurants, fast food, etc.)

Behavior
- Triggers (hunger, cravings, anxiety, boredom, reward, etc.)
- Emotions (anger, emotional eating, stress)
- Emotional eating
- Family/cultural influences
- Community influences
- Readiness for change

Records
- Food and beverage diary, including type of food or beverage consumed and amount consumed
- 72-hour recall
- Keep food and beverage record for a week and return for evaluation
- Electronic application tools

Healthy Diet Principles

• Calories + Nutrients
  • Minimizing total calories
  • Maximizing Nutrients
    • Macronutrients (2015 Dietary Guidelines)
      • ↑ Variety of vegetables
      • ↑ Whole fruits
      • ↑ Whole grain
      • ↑ Low-fat dairy
      • ↓ Sugars, saturated fats and sodium
    • Micronutrients
Principles of Dietary Intervention

- Protein - 1.5 gm/kg to prevent muscle loss
- Fat – essential fatty acids
  - linoleic & α-linolenic
  - Gallbladder disease
- Carbohydrates
  - Net carbs
  - Total carbohydrates – fiber = net carbs
  - Sugar alcohols x 60% = net carbs
- Vitamins and Minerals

Dietary Treatment

- Nutritional Therapy
  - Energy consumption intended to cause negative caloric balance and fat weight loss

Restricted Calorie Diet
- Restricted Dietary Fat
- Restricted Dietary Carbohydrate
- Other Dietary Strategies

Dietary Treatment Options

- Restricted Calorie Diets
  - Calorie Deficit (1200-1800 kcal/d)
  - LCD (800-1200 kcal/d)
  - VLCD (400-800 kcal/d)
Simple Calorie-restricted Diets

• No emphasis placed on macronutrient composition
• Protein intake should be adequate
• Portion control needed
• Strengths: many food choices
• Weakness: hunger

Examples: Weight Watchers and many commercial weight programs

Portion Control

• 9 inch verses 12 inch plates
  • 9 inch plate 63 sq. inches
  • 12 inch plate 113 sq. inches
  • 77% larger!

Very Low Calorie Diets (VLCD)

• Often defined as 400-800 kcal/day; often implemented by use of commercially prepared formulas
• By nature this diet is both low carb and low fat
• Protein needs must be met - 1.2-1.5 g/kg of IBW
• Vitamin and mineral supplementation essential
• Commercial products approved for VLCD will meet needs; real food may also be used but is challenging

Weight Loss Effects: weight loss > than standard carbohydrate or fat-restricted dietary intake

Adapted from Obesity Algorithm®, Obesity Medicine Association®
Very Low Calorie Diets

**Metabolic Effects:**

<table>
<thead>
<tr>
<th></th>
<th>Fasting Glucose</th>
<th>Fasting Insulin</th>
<th>Triglycerides</th>
<th>HDL</th>
<th>LDL</th>
<th>Blood Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decrease</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
<td>↑</td>
<td>↓</td>
<td>↓</td>
</tr>
</tbody>
</table>

**Average Weight Loss**

- 4 weeks: 15-22 lbs.
- 12 weeks: 44 lbs.
- 20 weeks: 68-90 lbs.

**Risks**

- Fatigue
- Nausea
- Diarrhea
- Hair loss
- Brittle nails
- Cold intolerance
- Dysmenorrhea
- Gall stones
- Kidney stones
- Gout

**Insufficient mineral intake, may predispose**

- Palpitations
- Cardiac dysrhythmias
- Muscle cramps
- Possible ↑ risk of osteoporosis
- Tooth decay

Should not be done without medical monitoring!

Fat-restricted Diets

Often defined as 10-35% of calories from fat

**Weight-loss Effects:**

- After six months, fat-restricted low calorie nutritional interventions generally produce the same amount of weight loss as a low-carbohydrate diet
Fat-restricted Diets

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<td>↓</td>
</tr>
</tbody>
</table>

Risks:
- Hunger control may produce challenges
- If fat is replaced by carbohydrates →
  - Hyperglycemia
  - Hyperinsulinemia
  - Hypertriglyceridemia
  - Reduced levels of HDL cholesterol
  - Weight loss may not occur

Examples:
- Ornish®
- American Heart Association diet
Carbohydrate-restricted Diets

- Often defined as less than 150 grams of carbohydrate/day, but sometimes less
- Ketogenic diet defined as 15-50 grams of carbohydrate/day
- Weight-loss Effects:
  - May produce slightly greater weight loss compared to fat-restricted dietary intake in the first six months
  - After six months, the net weight loss may be similar to other nutritional interventions
  - May produce less cravings than other interventions

Metabolic Effects:

- Fasting Glucose: ↓
- Fasting Insulin: ↓
- Triglycerides: ↓
- HDL: ↑
- LDL: ↓
- Blood Pressure: ↓
Carbohydrate-restricted Diets

• Metabolic Effects:
  • Energy source shifts from glucose to fat
  • Fat metabolism leads to ketone formation
  • Low-carbohydrate diets may improve glucose control in diabetes
  • In patients with epilepsy, low-carb ketogenic diets may reduce seizures

• Risks:
  • First few days
    • Headache
    • Fatigue
    • Constipation
    • Carbohydrate cravings
    • Gout
    • Hair loss

• Examples:
  • Atkins
  • Paleo
  • Keto

Question
Which macronutrient suppress appetite the most?
1. Alcohol
2. Carbohydrates
3. Fats
4. Protein
Other Dietary Strategies

• **DASH: Dietary Approaches to Stop Hypertension:**
  Balanced macronutrient diet; low in sugar, salt, alcohol and saturated fat, with moderate levels of total fat, and a high level of mono-unsaturated fats; with minerals and antioxidants that may lower blood pressure.

• **Mediterranean:**
  40% C, 17% P, 43% F; high amount of mono-unsaturated fats. The diet contains vegetables, fruits, cereals, diary products, meats and poultry, fish, wine, legumes, and olive oil – in that order – plus red wine.

• **South Beach Diet:**
  28% C, 33%P, 39% F; emphasizes healthy carbs, such as whole grains and certain fruits and vegetables; mono-unsaturated fats, such as olive and canola oil and nuts; and lean sources of protein.

Other Dietary Strategies

• **Vegetarian Diet:**
  Diet may vary: strictly vegan, variance of "lacto" or "ovo.”

• **American Diabetes Association (ADA):**
  60% C, 20% P, 20% F; based on “exchange units”. For a 1600 calorie diet, it includes: 9 starch, 4 fruit, 4 vegetable, 5 meat, 2 milk, and 6 fat exchanges.

• **Intermittent Fasting**
  Fasting periods range from alternate day to prolonged fasts
  Claim muscle sparing occurs after the 2nd day
  Limited data on safety and long-term efficacy

Adherence > Type

Dansinger Annals of Internal Medicine 2007
Dietary Prescription

Nutrition Do's for Better Health

Weight Loss Challenges

• Less than 20% of Individuals who lose 10% or more weight are able to maintain that weight loss > 1 yr.
  • Multiple Factors
    • Cultural
    • Social habits
    • Food environment
    • Food economics
    • Adaptive Thermogenesis

Kraschnewski et al. Int J Obesity 2010
Weight Homeostasis

• Adaptive Thermogenesis
  • When energy stores are low feedback mechanisms trigger energy consumption
  • When energy stores are high feedback mechanisms suppress energy consumption
  • Normally the body seeks to minimize weight change

Original Article

Long-Term Persistence of Hormonal Adaptations to Weight Loss

October 27, 2011
DOI: 10.1056/NEJAm1110808

Mean (±SE) Fasting and Postprandial Levels of Ghrelin, Peptide YY, Amylin, and Cholecystokinin (CCK) at Baseline, 10 Weeks, and 62 Weeks.

Mean (±SE) Fasting and Postprandial Ratings of Hunger and Desire to Eat at Baseline, 10 Weeks, and 62 Weeks.

Adaptive Response to Calorie Restriction

• Take Home Message
  • Negative energy balance triggers a physiologic increase in hunger and decrease in satiety

↑ Hunger
↓ Satiety

Summary

• Diets can be categorized by either nutrient composition or calorie content
• Different calorie sources have different metabolic responses
• Meeting essential nutrient needs is vital with any dietary intervention
• Weight loss results in ↑ hunger and metabolic adaptation
References


References