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Lecture 3: Digestion and Dieting Physiology

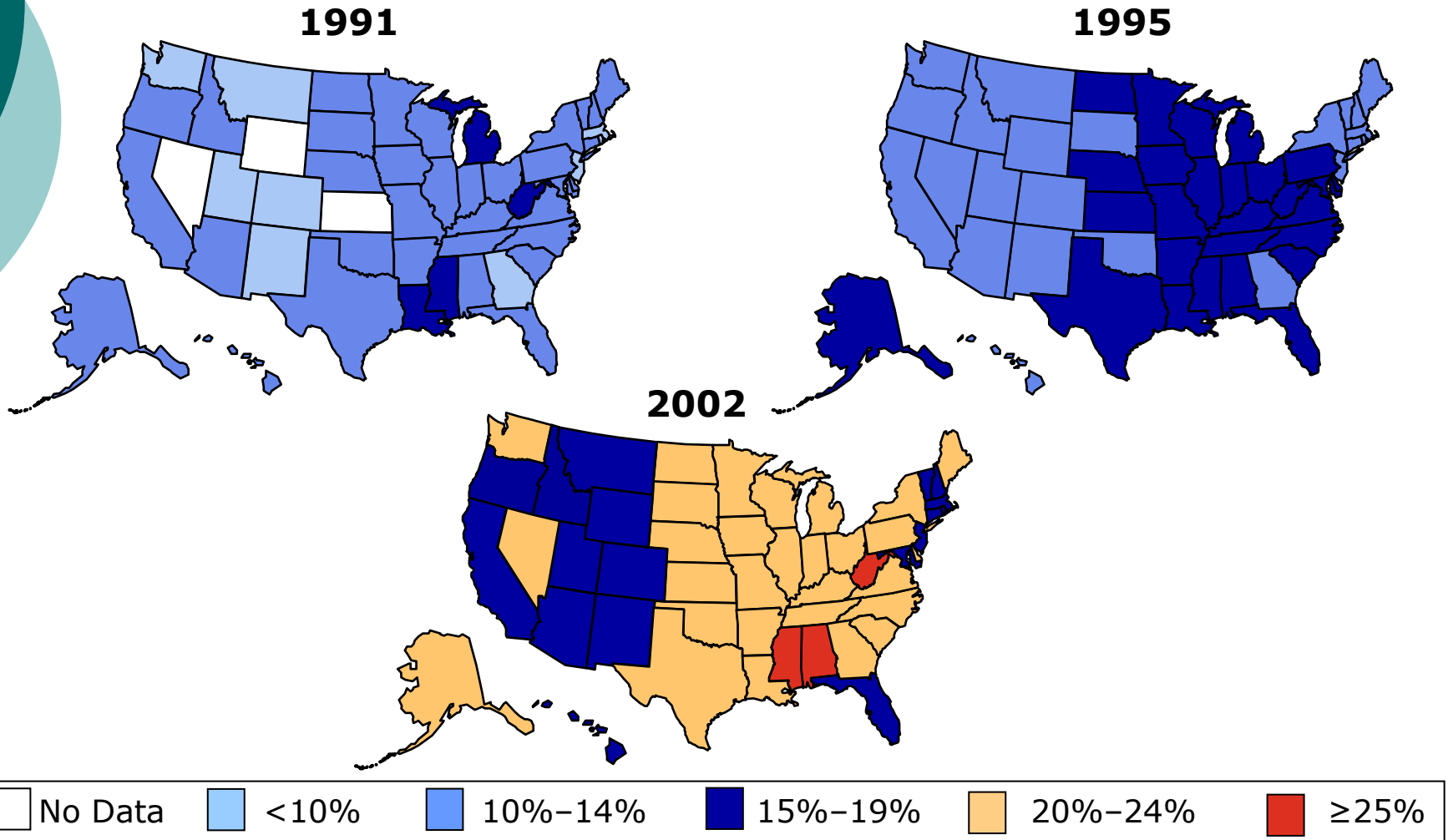
Critical Analysis of Popular Diets and Supplements

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Obesity Trends* Among U.S. Adults

BRFSS, 1991-2002

(*BMI ≥ 30 , or ~ 30 lbs overweight for 5' 4" woman)



Source: CDC, 2003

Digestion

The food path in animals:

- Hungry animal efficiently searches out food
- Food is compared to past taste, smell
- If ok, eaten, swallowed, stimulates stretch, chemoreceptors, which signal CNS, regulate meal
- Bolus passes to small bowel, inhibits gastric emptying rate; food is digested by enzymes in SB
- Glucose is now absorbed: ghrelin, CCK, other hormones released that end meal.
- Insulin released: transports glucose into tissues; glucagon opposes
- Rest of nutrients are stored; control long-term intake

Digestion

- The food path in humans:
Same physiology, different outcome...

Why?

- Hungry human is now vastly more efficient than animals at searching out food
- Food supply is very high in energy density
- Humans can downplay/ignore physiologic signals: “What’s hunger got to do with it?”



Dieting Basics

1. Evaluate energy needs (separate lecture)
2. Set degree of energy deficit/ rate of weight loss desired
3. Calculate energy intake needed
4. Decide on macronutrient composition
5. Decide on meal/snack frequency
6. Decide on variety
7. Design weekly menus
8. Monitor and adjust as needed during weight loss

1. Evaluate Energy Needs

- Your choices:
 1. Prediction equations based on weight, gender, age; simplest is 16 kcal/lb
 2. Indirect calorimetry
 - Adjust both for activity level

2. Set Degree of Energy Deficit/ Rate of Weight Loss Desired

- Your choices:
 - Low calorie diet- > 800 kcal/day
 - Very low calorie diet- < 800 kcal/d
 - Weight maintenance diet- based on current EE
 - Rate of weight loss depends on EE:
 - $7(EE - EI \text{ on diet}) / 3500 =$ predicted weekly loss, lbs
 - Each 500 kcal/d deficit = 1 lb/wk loss
 - $3500 \times \text{lbs per week loss desired} / 7 \text{ d} =$ daily diet deficit needed

3. Calculate Energy Intake Needed

- EE – daily diet deficit in kcal = daily kcal allowed on diet
- Example: I weigh 160 lbs, wish to lose 1 lb/wk:
 - $EE = 160 \times 16 = 2360$ kcal/d
 - Deficit needed = $3500/7 = 500$ kcal/d
 - $2360 - 500 = 1860$ kcal/d is the prescribed diet

4. Decide on Macronutrient Composition

- Your choices:
 - Balanced deficit
 - Fat restricted
 - Carbohydrate restricted (ketogenic?)
 - High or normal protein
 - Others

5. Decide on Meal/Snack Frequency

- Generally, large, infrequent meals cause greater weight gain than small, frequent snacks
- If total daily EI is held constant, this effect disappears
- Thus, total daily EI is *not* being held constant when meal frequency changes
- Small, frequent meals generally satisfy dieters better
- Epidemiologic data: small, freq meals → low BMI



6. Decide on Variety

- Sensory variety promotes overconsumption
- Limited menu limits consumption
- This is how it may be possible to lose weight on certain monotonous fad diets (cabbage soup, Hagen-Dags)



7. Design Weekly Menus

- Dietitians are best at this
- Books
- Pamphlets from ADA, etc
- Take into account dieters food preferences

8. Monitor and Adjust as Needed During Weight Loss

- Weekly weights at a minimum
- Daily weights at a maximum
- Recognize the phases of weight loss
 - Initial diuresis
 - Predictable weight loss
 - Slowing of weight loss (deficit narrows)
 - Honeymoon ends- diet must be changed
 - Maintenance

Dieting Techniques and Tools: Fat Mimetics

- ***Olestra***: fatty acid side chains linked to a sucrose (cf glycerol) molecule, and 7-9 instead of 3 fatty acid side chains
- Olestra is indigestible by lipases and by bacterial fermentation
- Potentially useful tool to separate the sensory from the energy effects of foods
- Just as palatable as regular fat to most people

Dieting Techniques and Tools: Degree of Compensation

- The utility of a fat mimetic hinges on the degree of compensation for fat and calories it elicits
- Compensation formula:

$$\%C = 1 - \frac{(\text{EI unsubstituted} - \text{EI substituted})}{(m \text{ kcal} - u \text{ kcal})} \times 100$$

Where:

m = calories of substituted food consumed

u = calories consumed at baseline of unsubstituted food

EI = total energy intake in kcal consumed *ad libitum* during each measurement period (includes the calories of the substituted or unsubstituted food).

Studies of Degree of Compensation-I

○ Olestra:

- Substituting 55g of dietary fat with olestra (potential energy savings=500 kcal) is only about 1/3 compensated the next day, especially when substitution is covert (Miller et al, 1998)
- Olestra is minimally compensated in terms of *fat grams* consumed in studies of up to 14 days (Hill 1998)

Studies of Degree of Compensation-II

- **Aspartame** (Nutrisweet):
 - Energy compensation is nearly complete in the majority of studies
- Differences in %C by age, gender, BMI:
 - Young males exhibit more complete compensation than females and older adults (Rolls 1998)
 - Obese individuals generally have been found to compensate more poorly than lean (Rolls 1994, Roe 1999)