

# Methods for Calculating Energy Density

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## What is energy density and how do we calculate it?

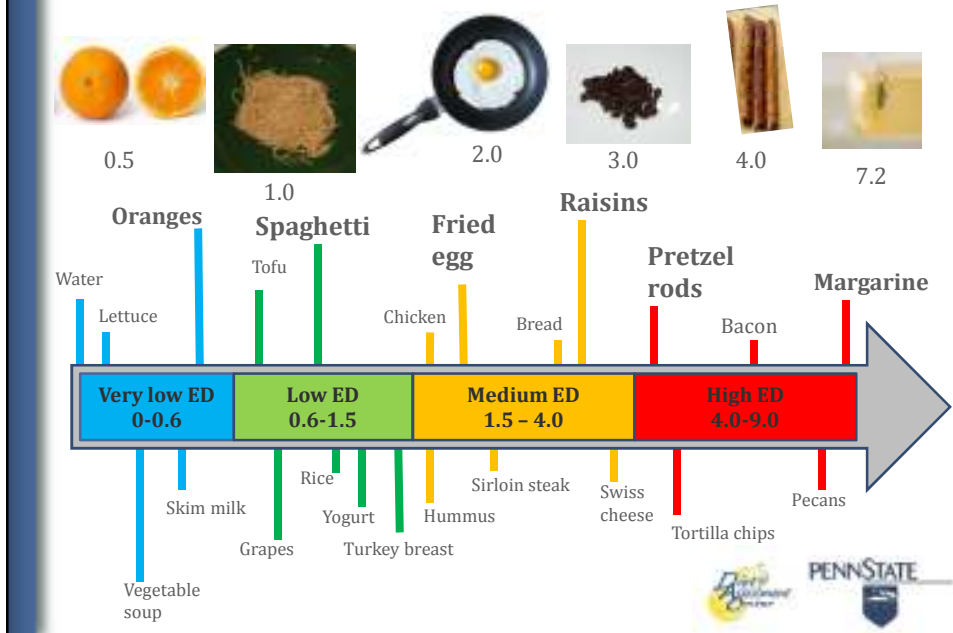
- Ratio of energy per weight of food
- Several factors influence energy density (ED)
  - Water = 0kcal/g
  - Fat = 9kcal/g
  - Protein, Carbohydrate = 4kcal/g
  - Fiber = 2kcal/g

Apple: 65 kcal, 125 g

ED=0.52



## The Energy Density Spectrum



## Energy Density: Recommendations



- WHO 2006 report indicated that consumption of high ED foods is associated with obesity



- CDC: "limit portion size of foods high in energy density"; "Eat More, Weight Less"



- 2010 USDA Dietary Guidelines for Americans Executive Summary indicated that diets low in energy density are associated with beneficial body weight status



- AICR/WRCF: "Limit consumption of energy dense foods..." and "consume a diet low in energy density"



## Dietary Energy Density is Associated With Increased Risk for Disease

Obesity



Type II Diabetes



Various Cancers



## Portion Size and Energy Density



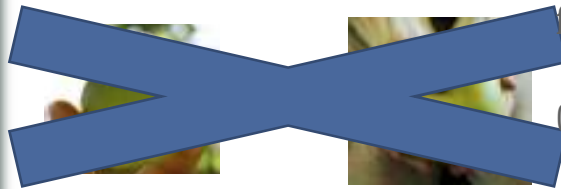
1992  
500 kcal



2012  
850kcal

Rise in obesity among US adults has corresponded with an increase in portion size of **energy dense foods.**

(Nestle, 2002)



Adapted from NHLBI "Portion Distortion" Quiz



## Properties of individual foods can be used to alter ED of mixed dishes

Example:

220g of macaroni and cheese

**Eat More,  
Weigh Less?**



Made with whole milk, butter, full-fat cheese

ED = 2.45



Made with skim milk, light cream cheese, spinach, tomatoes

ED=1.43

*Adapted from the CDC*



## Dietary Energy Density: Beyond single foods

- Meal energy density
  - Total calories consumed / total grams consumed



- Same caloric content, different amounts of food
- Lab setting vs. free-living population



## Comparing a high vs. low ED diet



Full day of food for an average woman consuming a high-ED vs. low-ED diet

Matched for energy and macronutrient distribution.



## Measuring ED in free-living individuals using the NHANES

- National Health and Nutrition Examination Survey
- Cross-sectional survey designed to monitor the health and nutritional status of US residents
- Began in the 1960s (NHES) with a focus on chronic disease



- » Nutrition component added in 1970
- » Single 24-hour recall
- » 2<sup>nd</sup> 24hr recall added in 2003





# DIETARY INTAKE DATA

## What We Eat in America

NHANES 2007-2008

### Food and Nutrient-Related Variables

- For each food and beverage, including water, consumed by a survey participant:
  - Name, identified by a USDA food code and description
  - Amount consumed, in grams
  - Amounts of food energy and 64 nutrients/food components provided by each food
  - Identification of foods eaten in combination (e.g., cereal with milk added)
  - Separate ingredients coded for many salads and sandwiches
  - Day of week
  - Eating occasion – time and name (breakfast, lunch, etc.)
  - Source of food (where obtained)
  - Whether the food was eaten at home or not
- For each survey participant:
  - Daily aggregates of food energy and 64 nutrients/food components
  - Whether the amount of food consumed was usual, much more than usual, or much less than usual
  - Salt type and use in food preparation and at the table
  - Whether on a special diet and type of diet
  - Frequency of fish/shellfish consumption in past 30 days (participants age 1 year or older)

Individual food file

Total food file

### Sample and Data Collection

- Nationally representative
- Oversampled persons 60+ years, African-Americans, Hispanics, and low-income persons
- Day 1 dietary recalls for 9,255 individuals; Day 2 recalls for 7,838 individuals
- Two nonconsecutive days of dietary intake using 24-hour recalls
  - Day 1 in-person at the Mobile Exam Center
  - Day 2 from central NHANES telephone center



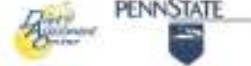
## The Individual Food File

Respond sequence number	Food/Indivi component number	Dietary day one sample weight	Dietary two-day sample weight	Dietary recall status	Number of days of intake	Combina food number	Combina food type	Time of eating occasion (HH:MM)	Name of eating occasion	Source of food	Did you eat this meal at home?	USDA food code	Grams	Energy (kcal)	Protein (g)	Carbohy (g)
35478	1	5520.3113377	6317.5159049	1	2	0	0	8:15	1	1	2	53540200	37	139	1.63	26.1
35478	2	5520.3113377	6317.5159049	1	2	0	0	8:15	1	1	2	63107010	118	105	1.29	26.1
35478	3	5520.3113377	6317.5159049	1	2	0	0	8:15	9	1	2	61210250	496	208	2.92	48.1
35478	4	5520.3113377	6317.5159049	1	2	0	0	10:00	9	1	2	94100100	355.5	0	0	0.0
35478	5	5520.3113377	6317.5159049	1	2	0	0	10:00	1	1	2	63107010	59	53	0.64	13.1
35478	6	5520.3113377	6317.5159049	1	2	0	0	10:30	6	1	2	91708030	15	55	0.08	12.1
35478	7	5520.3113377	6317.5159049	1	2	0	0	11:00	6	16	2	71201010	9	49	0.59	4.1
35478	8	5520.3113377	6317.5159049	1	2	0	0	11:00	6	1	2	94100100	118.5	0	0	0.0
35478	9	5520.3113377	6317.5159049	1	2	1	5	11:30	2	16	2	25210110	57	171	7.76	21.1
35478	10	5520.3113377	6317.5159049	1	2	1	5	11:30	2	16	2	51320010	43	117	3.7	19.1
35478	11	5520.3113377	6317.5159049	1	2	0	0	11:30	2	16	2	22701020	2.79	6	0.79	0.0
35478	12	5520.3113377	6317.5159049	1	2	0	0	11:30	2	16	2	58148500	88.5	125	2.92	17.1
35478	13	5520.3113377	6317.5159049	1	2	0	0	11:30	2	1	2	92510610	167.2	76	0.06	19.1
35478	14	5520.3113377	6317.5159049	1	2	0	0	13:30	6	16	2	63141110	28.2	17	0.12	4.1
35478	15	5520.3113377	6317.5159049	1	2	0	0	13:30	6	16	2	63109010	54	18	0.45	4.1
35478	16	5520.3113377	6317.5159049	1	2	0	0	13:30	6	16	2	63123000	25	17	0.18	4.1
35478	17	5520.3113377	6317.5159049	1	2	2	9	13:30	6	16	2	73101010	35	14	0.33	3.1
35478	18	5520.3113377	6317.5159049	1	2	2	9	13:30	6	16	2	12350000	7.59	17	0.27	0.1
35478	19	5520.3113377	6317.5159049	1	2	3	9	13:30	6	16	2	75109000	8	1	0.06	0.1
35478	20	5520.3113377	6317.5159049	1	2	3	9	13:30	6	16	2	12350000	7.59	17	0.27	0.1
35478	21	5520.3113377	6317.5159049	1	2	0	0	13:30	6	1	2	92510610	167.2	76	0.06	19.1
35478	22	5520.3113377	6317.5159049	1	2	0	0	18:30	3	1	1	41208030	134.41	126	6.92	25.1
35478	23	5520.3113377	6317.5159049	1	2	0	0	18:30	3	1	1	92510610	62	28	0.02	7.1
35478	24	5520.3113377	6317.5159049	1	2	0	0	19:30	6	1	1	13110100	22	44	0.77	5.1
35479	1	1636.396549	1761.027158	4	2	0	0	3:00	8	.	.	11000000	.	.	.	.



## Calculating dietary ED in NHANES

- Energy density is NOT included in NHANES
- Use the **total food file** to calculate **overall** dietary ED (food + all beverages)
- Use the **individual food file** to calculate **food-only** ED, meal ED, etc.
- Critical components of the individual food file
  - Codes to identify beverages
  - Codes to identify foods that were consumed in combination
  - Codes to identify type / name of meal



...Food-only ED?

...Meal ED?

**WHY SHOULD WE CALCULATE THOSE?**





## Dietary Energy Density is Associated With Increased Risk for Disease

Obes

Associations found with "food-only" ED!

Various Cancers

Mixed results



## Calculating food-only ED: How do you define a "food"?

- Beverages with / without additions
- Smoothies
- Meal replacements
- 100% juice and fruit nectars





## Calculating Food-Only ED: Meal codes and combination foods

USDA Food Code	Combination Food Type	Name of Meal
51302010	2	1
11112110	2	1
61210220	1	1



- Granola, reduced fat milk, orange juice
  - Using only USDA food codes:  
**breakfast ED = 3.81**
  - Using combination food type + USDA food code:  
**breakfast ED = 1.13**



## Food preparation method influences energy density: Oatmeal ≠ Oatmeal

### Oatmeal with whole milk

- ½ c oats (45g, 150 kcal)
- ½ c milk (125g, 73 kcal)
- 1Tbsp butter (14g, 102 kcal)



ED = 1.3 kcal/g

### Oatmeal with water

- ½ c oats (45g, 150 kcal)
- 1 c water (236g, 0 kcal)



ED = 0.53 kcal/g



## Calculating Dietary ED: Recommendations for a standardized method

### Food-Only ED

- Include all solid foods
- Carefully identify all combination foods
- Include meal replacement shakes when used as a true meal replacement
- Smoothies composed of entirely blended fruit are considered foods

### Food + Beverage ED

- Include all foods and beverages consumed

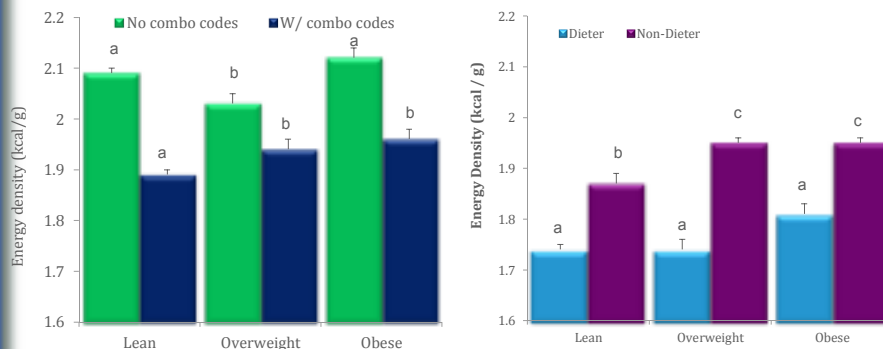
### Beverage- Only ED

- All beverages
- Milk, juice, or yogurt based smoothies consumed as beverages or snacks
- Meal replacement shakes included when consumed as a beverage



## Standardized ED Method: Implications for mixed findings

Dietary Energy Density in US Adults: NHANES 2005-2008



- The relationship between ED and body weight status differs by dieting status in US Adults: NHANES 2005-2008
- Combination food codes dramatically influence dietary ED

Vernarelli, et. al. under revision, JADA.



## Summary and Conclusions

- Dietary energy density is not included in the NHANES dietary data
- Using USDA food codes, a standardized method for calculating dietary ED can be derived.
- This method can then be universally used by future researchers.



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