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Methods: Mind the Gap

Webinar Series

Issues in Dietary Assessment Methodology for Assessing Risk of Chronic Disease

Presented by:

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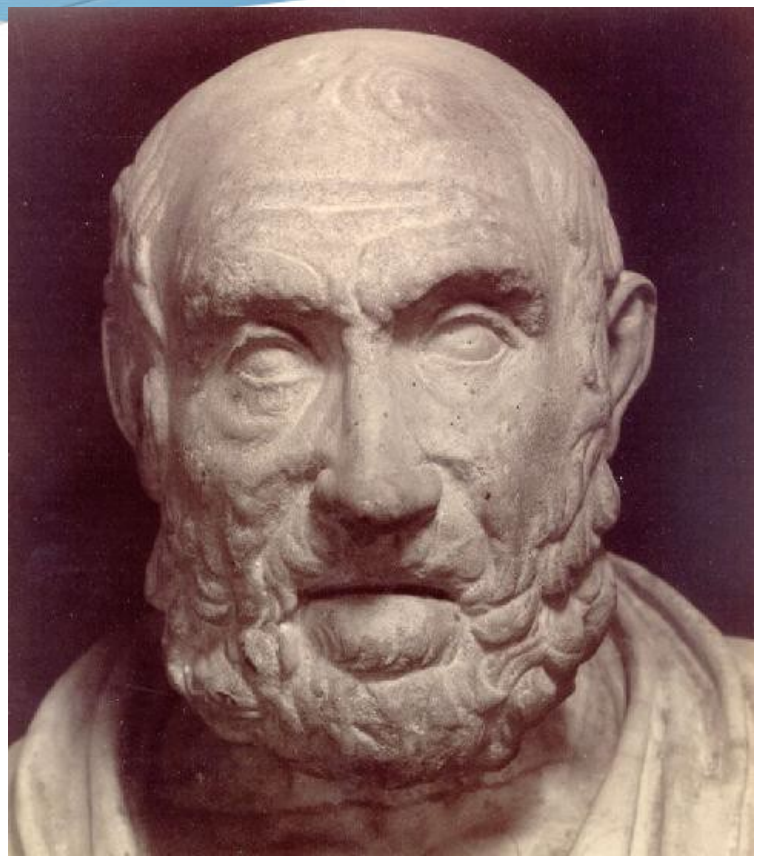
Office of Disease Prevention

"If we could give every individual the right amount of nourishment and exercise, not too little and not too much, we would have found the safest way to health."

Hippocrates (460–377 BC)

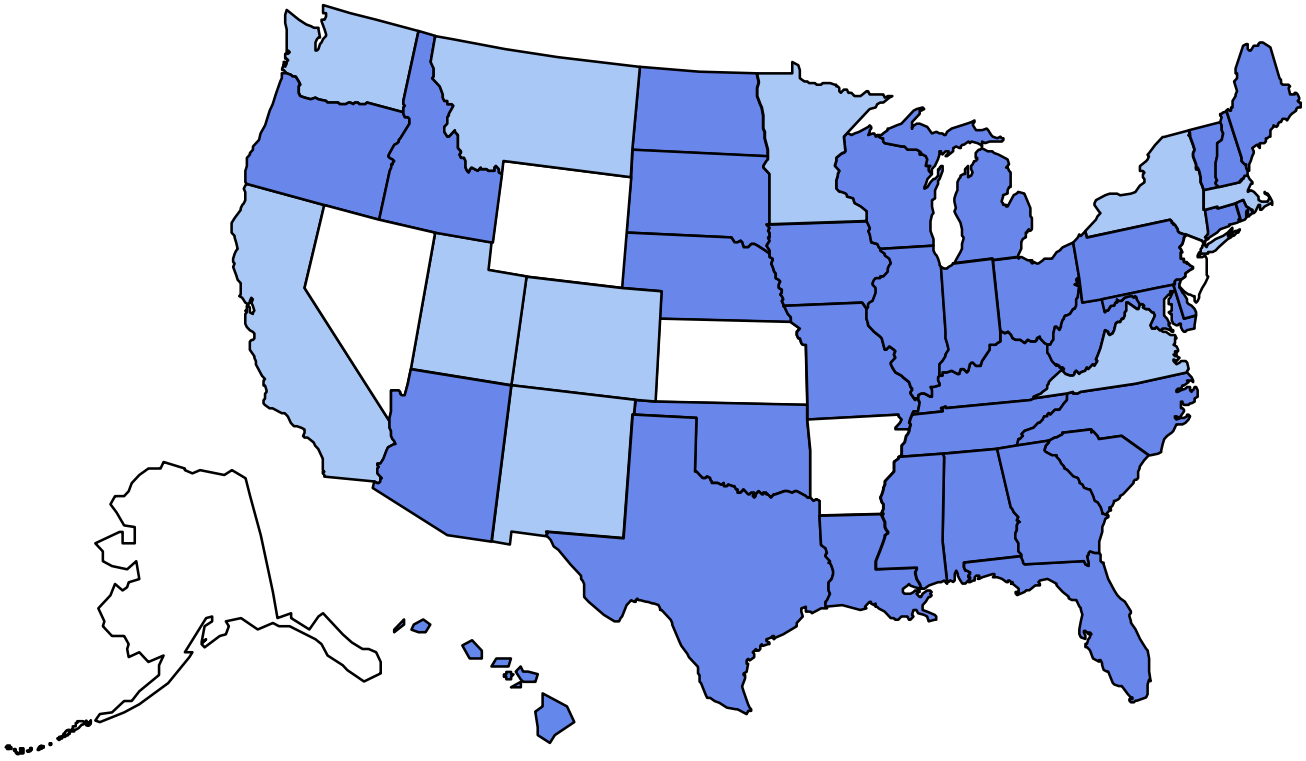


Why measure diet?

- Self report dietary data provide information on food intake and dietary patterns that is not possible to obtain any other way.
- To inform nutrition policy and guidance on diet to the population, it is critical to understand current dietary behavior.
- Linking dietary intake of nutrients, foods and dietary patterns with chronic disease is needed to improve behavior to reduce health risk and improve the food supply.

Obesity Trends* Among U.S. Adults
BRFSS, 1990

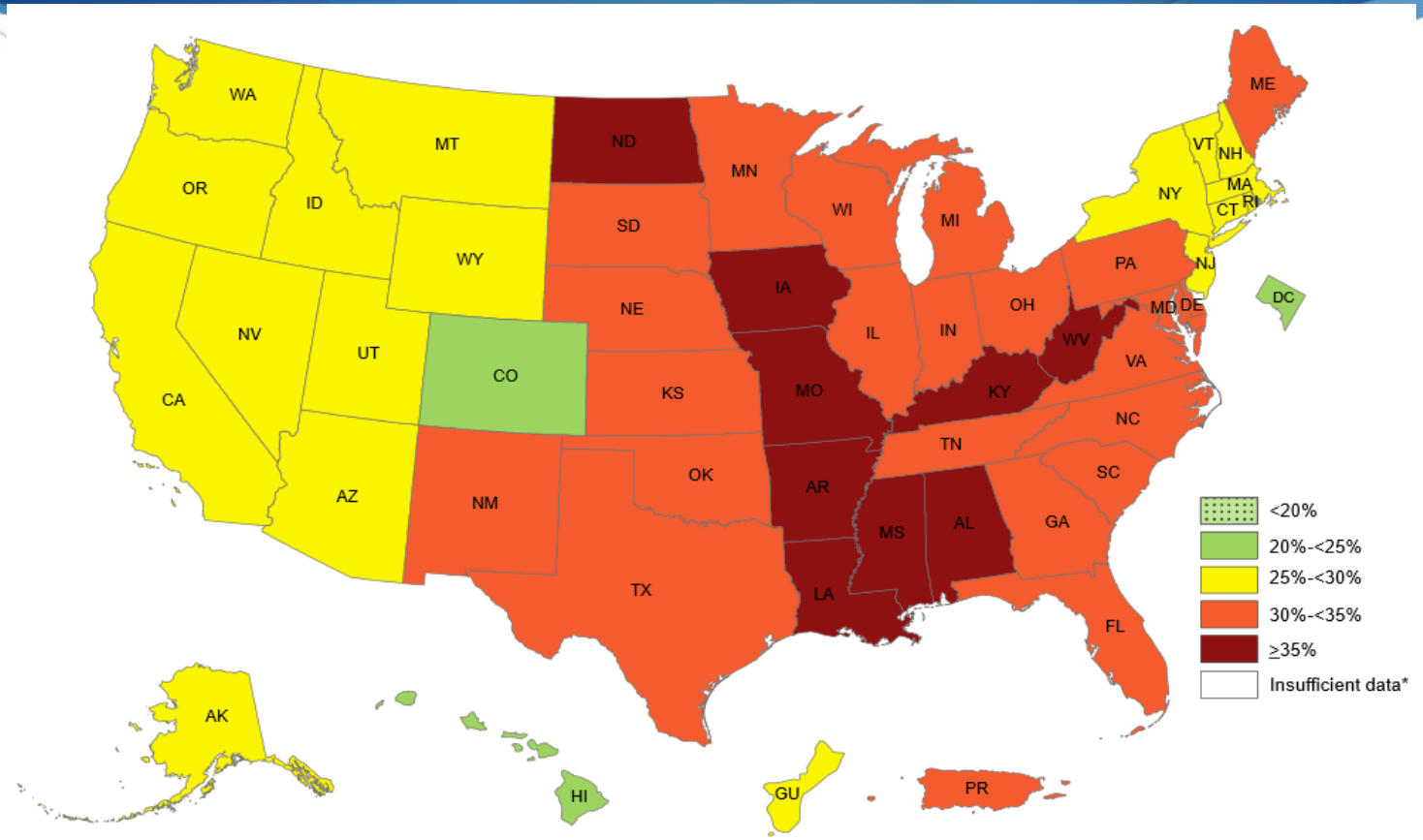
(*BMI ≥30, or ~ 30 lbs. overweight for 5’ 4” person)



No Data | <10% | 10%–14%

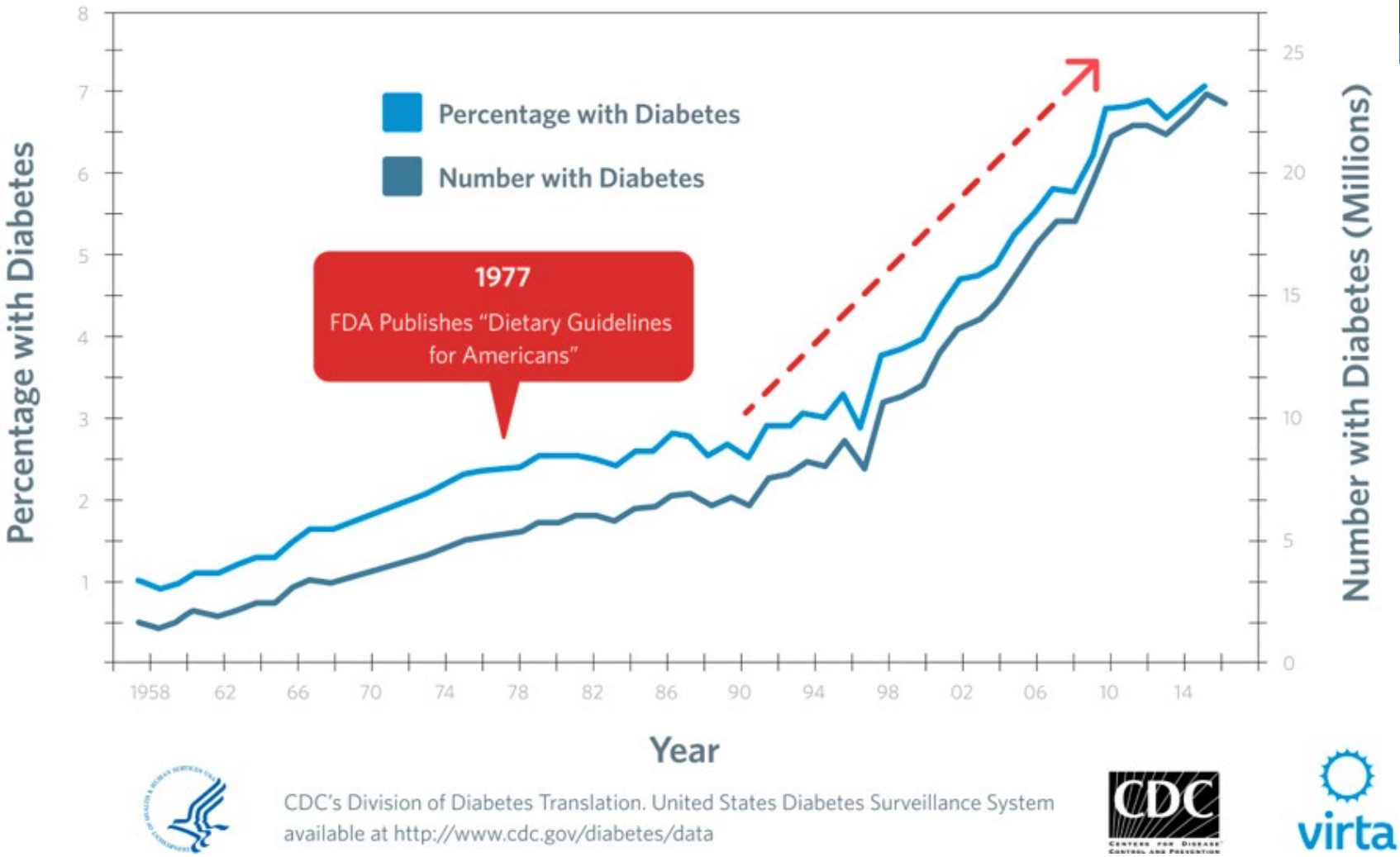
Prevalence¶ of Self-Reported Obesity Among U.S. Adults by State and Territory, BRFSS, 2018

¶ Prevalence estimates reflect BRFSS methodological changes started in 2011. These estimates should not be compared to prevalence estimates before 2011.



***Sample size <50 or the relative standard error (dividing the standard error by the prevalence) ≥ 30%.**

Type 2 Diabetes Prevalence: 1958-2014



CDC's Division of Diabetes Translation. United States Diabetes Surveillance System available at http://www.cdc.gov/diabetes/data

CDC

virta

Rothman's Conceptual Scheme

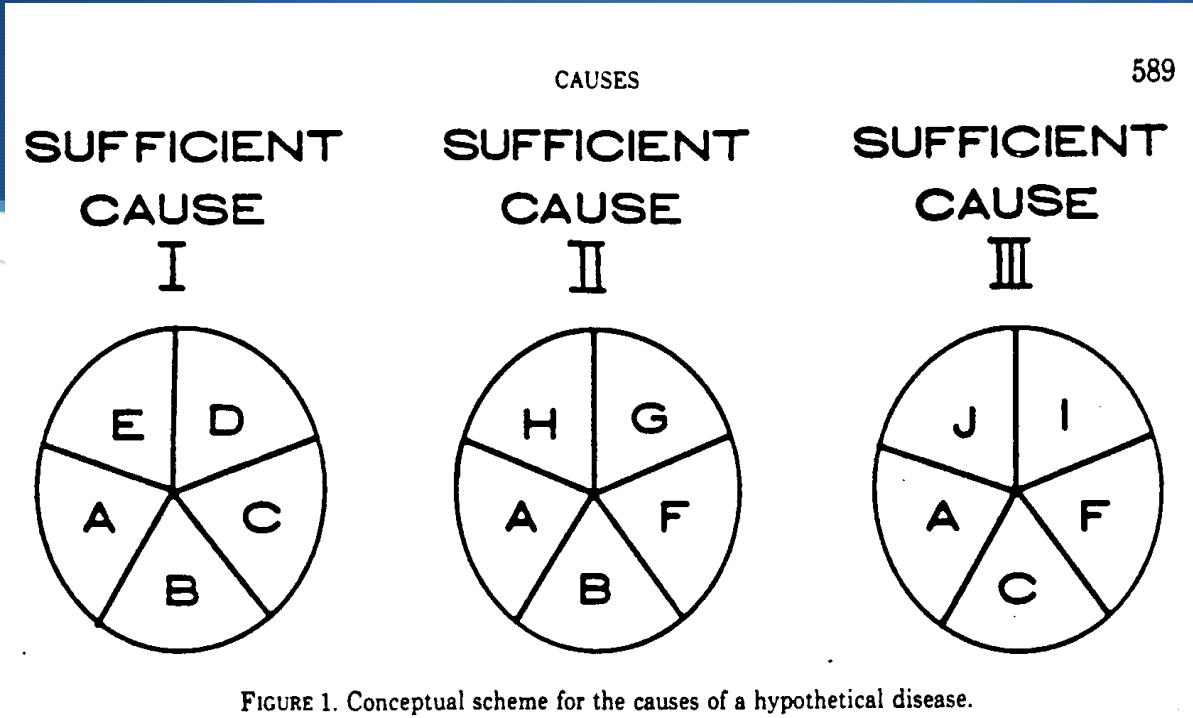


FIGURE 1. Conceptual scheme for the causes of a hypothetical disease.

- "What is required is much more than the application of a list of criteria. Instead, one must apply thorough criticism, with the goal of obtaining a quantified evaluation of the total error that afflicts the study. This type of assessment is not one that can be done easily by someone who lacks the skills and training of a scientist familiar with the subject matter and the scientific methods that were employed. Neither can it be applied readily by judges in court, nor by scientists who either lack the requisite knowledge or who do not take the time to penetrate the work".

Rothman 2005 Am J Pub Health

Hill's criteria for causality in cohort studies

- Strength of the association
- Consistency of findings
- Biological plausibility
- Dose-response
- Time-sequence

Hypothetical Dose-Response Curve

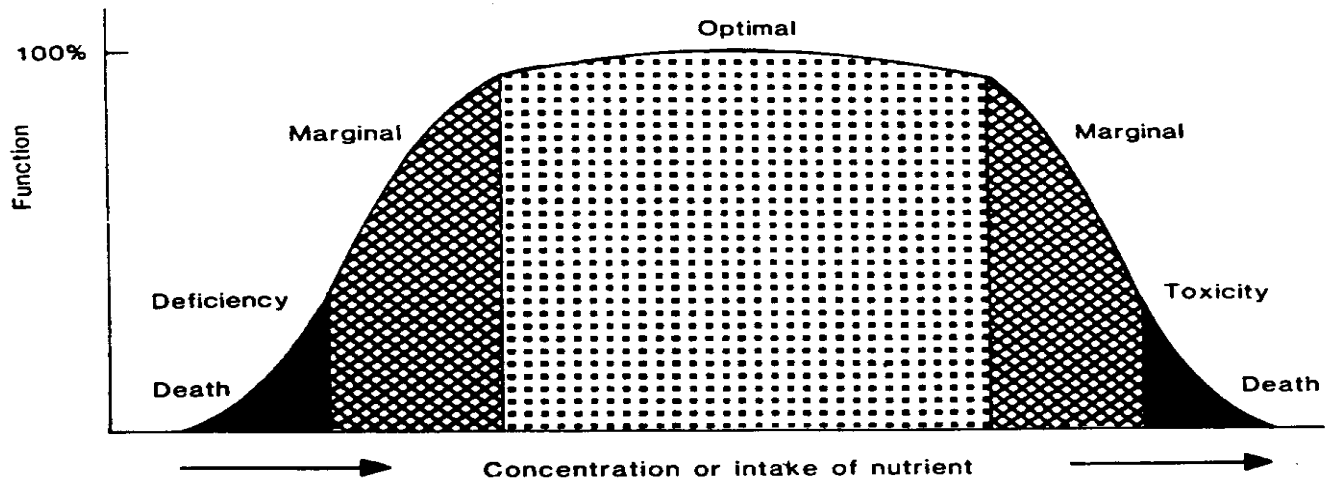


Figure 1–2. Hypothetical relationship between intake of an essential dietary factor and health. If two points on the ascending part of the curve are compared, it might be concluded that the nutrient was beneficial; if points on the horizontal portion were compared, it might be concluded that the nutrient had no effect; if points on the descending segment were contrasted, it might be reported that the nutrient was deleterious. The health effects of the nutrient can only be fully appreciated by an examination of the dose–response relationship over the full range of exposures, which may not be possible within any single study. (From Mertz, 1981; reproduced with permission.)

Traditional Assessment Methods

Dietary records

- Participant records own intake as consumed

24-hr recalls

- Detailed intake measured for the previous day

Food frequency questionnaire

- Long term measure of usual intake
- Uses preset food list

Recalls

Advantages:

- Doesn't require literacy or highly motivated participants
- Relatively low respondent burden
- Open ended for diverse intake patterns and analytical detail
- Excellent for surveys, group means

Disadvantages:

- Reliance on memory
- Requires repeated measures
- Day to day variability limits ability to assess usual intake

DIETARY INTAKE FORM

Participant ID: *Place sticker here* Date of Intake: _____

Participant Name: _____ Gender: _____

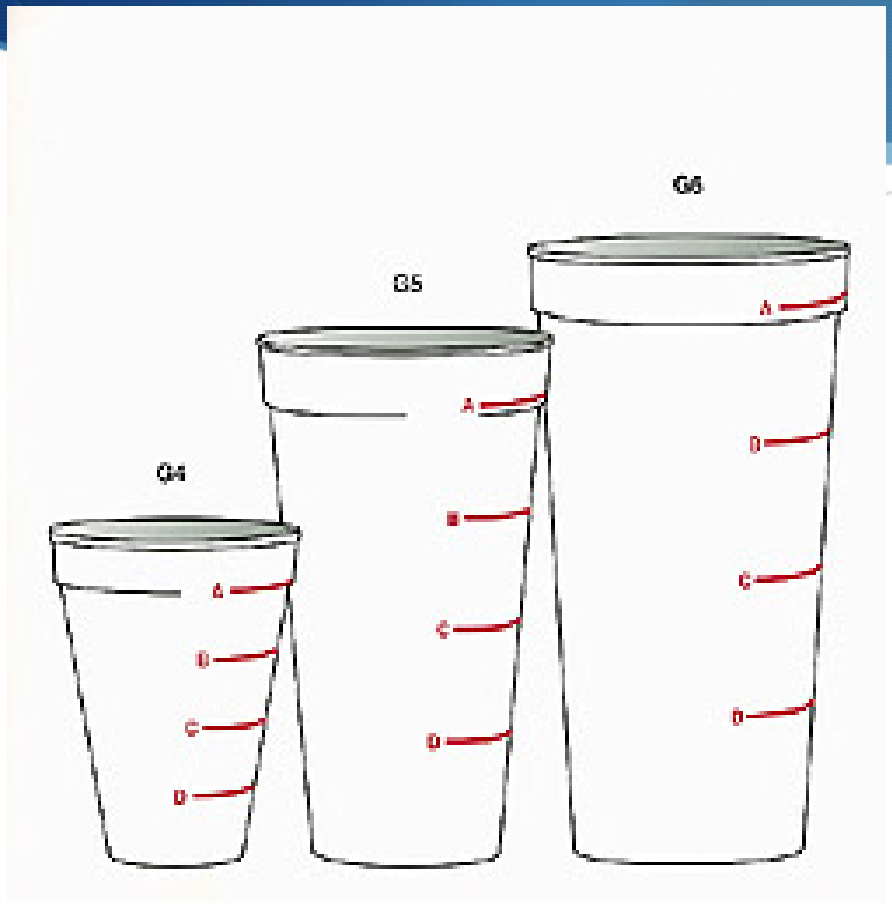
Date of Birth: _____

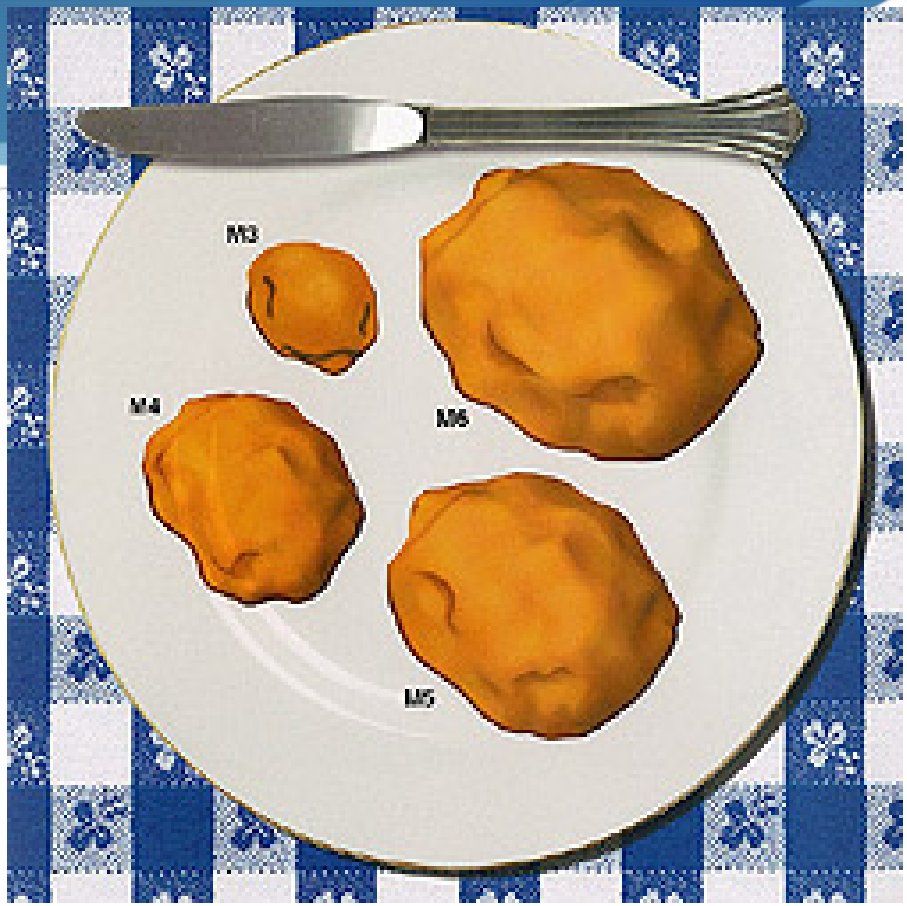
Collection Method Recall Record (circle one)

Intake Day: Sun Mon Tue Wed Thu Fri Sat (circle one)

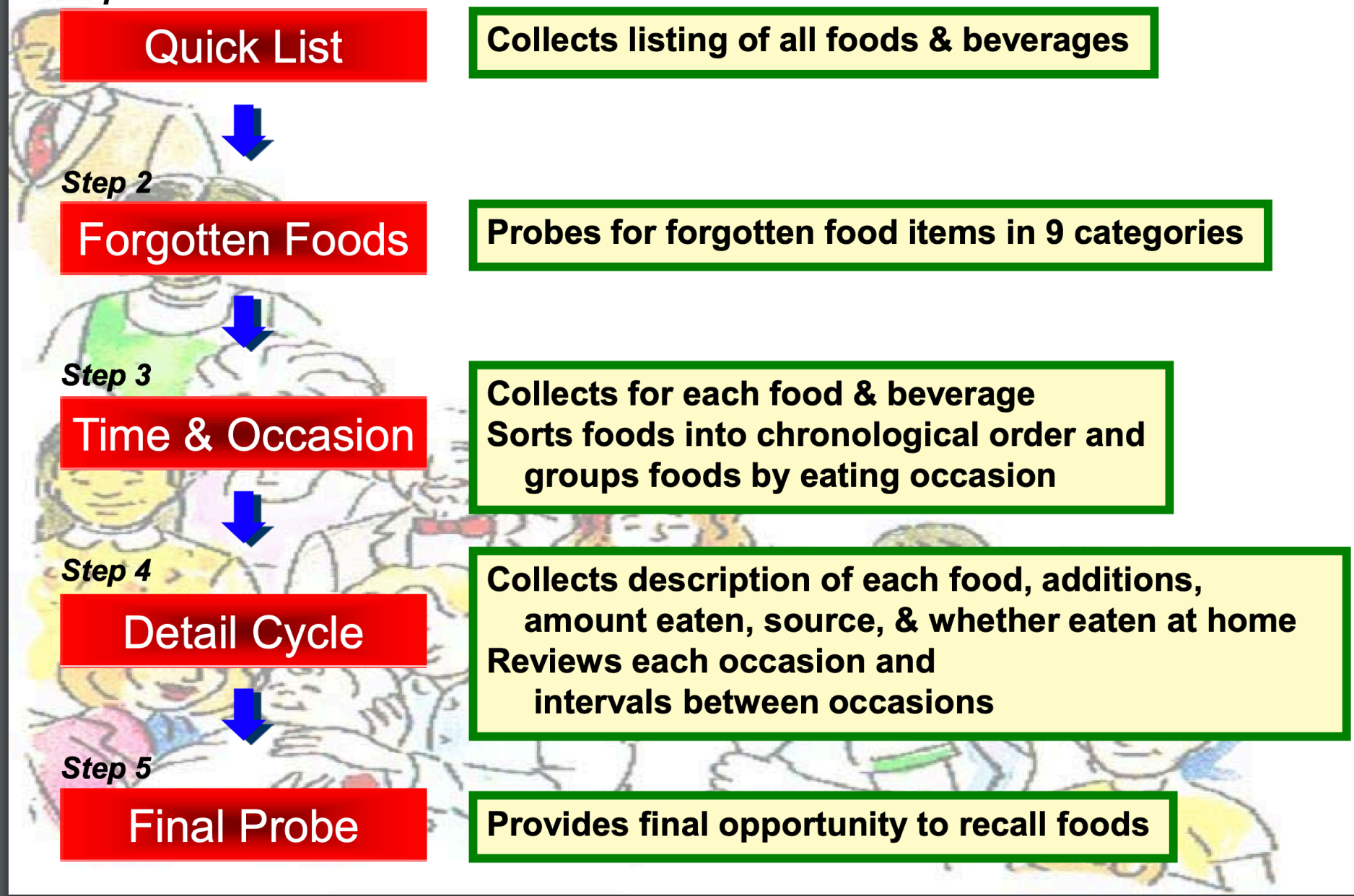
Line #	Time Eaten A=a.m. P=p.m. Hrs	Min		Food and Beverages	Amount Eaten	Complete Description (Include the brand name, preparation method and type of fat used and at table additions.)
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						

USDA Food Model Booklet





USDA Automated Multiple Pass Method



Step 1

Quick List

Collects listing of all foods & beverages

Step 2

Forgotten Foods

Probes for forgotten food items in 9 categories

Step 3

Time & Occasion

Collects for each food & beverage
Sorts foods into chronological order and groups foods by eating occasion

Step 4

Detail Cycle

Collects description of each food, additions, amount eaten, source, & whether eaten at home
Reviews each occasion and intervals between occasions

Step 5

Final Probe

Provides final opportunity to recall foods

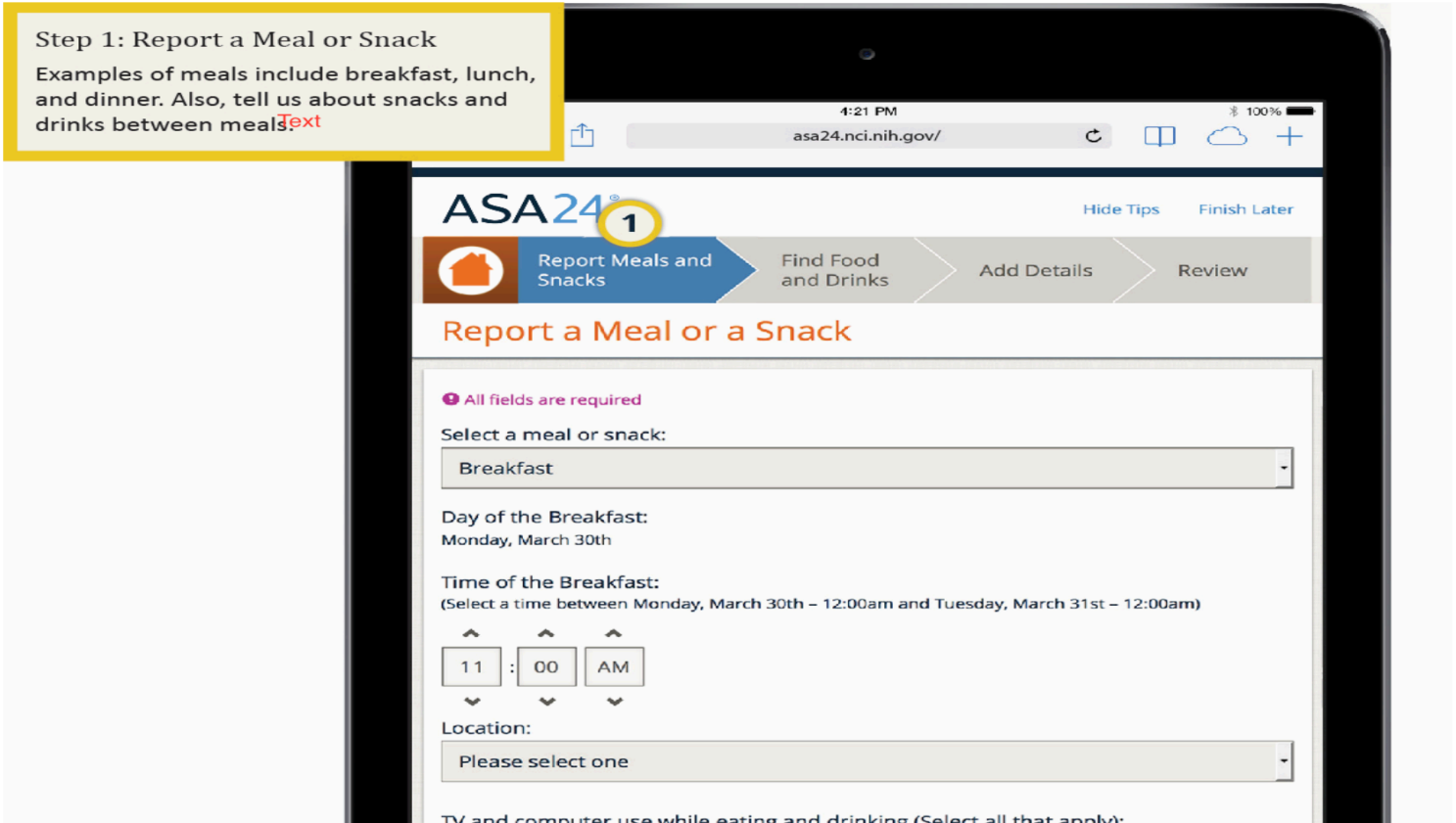
ASA24

Automated Self-Administered 24-Hour Dietary Assessment Tool

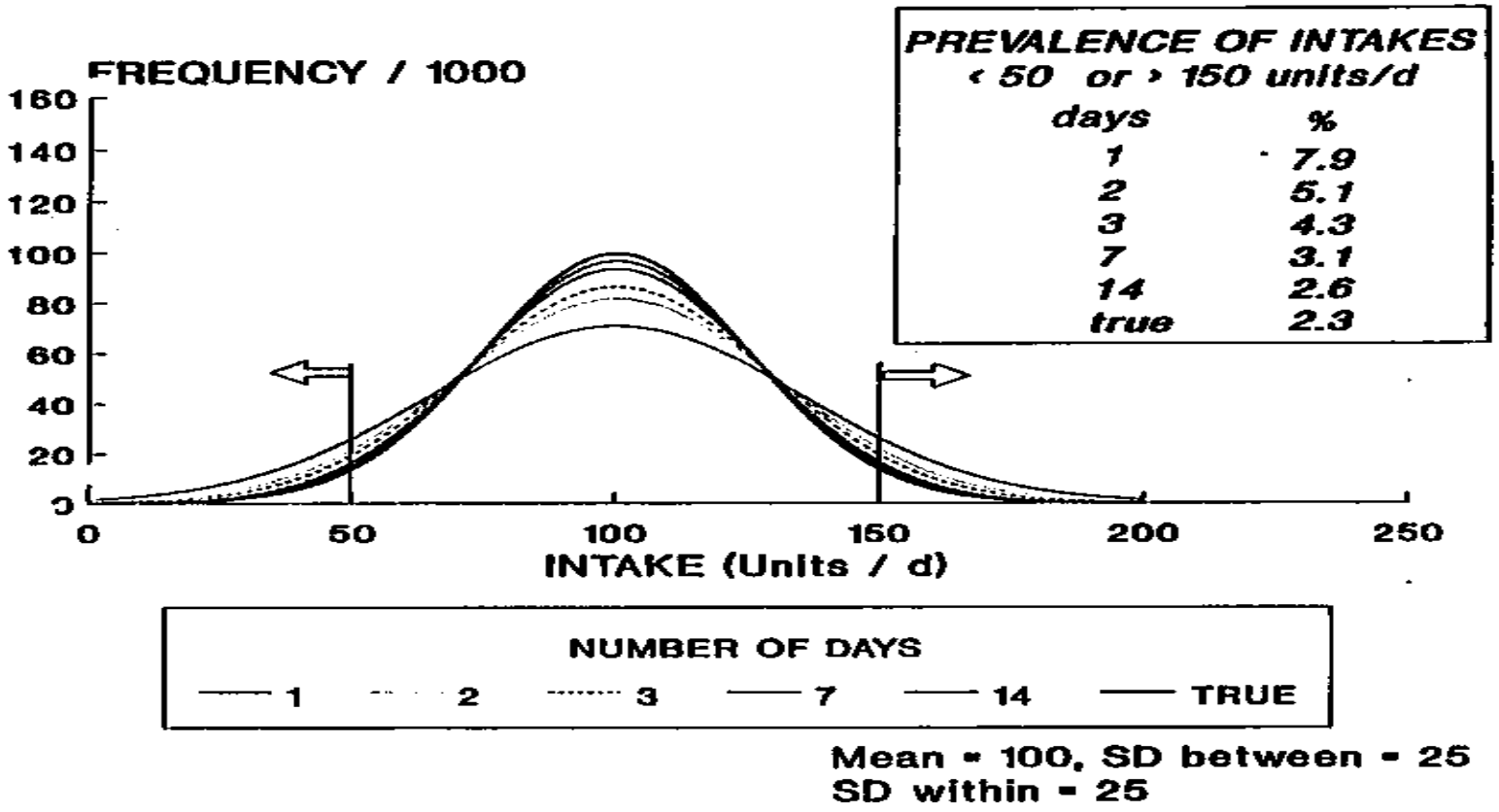
Question: How do I complete a 24-hour dietary recall using the ASA24 system?

Answer: To complete a dietary recall, you will be asked to report everything you had to eat and drink from midnight to midnight yesterday, or during the past 24 hours, depending on the instructions you were given. The first step is to report an eating occasion such as a meal or snack, or when you had just a drink or just a supplement. You will then search for foods, drinks, and dietary supplements (vitamins, minerals, herbals, etc.) you consumed to add to your meal or snack. Finally, you will add the details about your foods, drinks, and dietary supplements, such as how they were prepared, the amount you ate or drank, and anything added (such as butter on potatoes, milk to cereal). For dietary supplements, you will be asked about dosage.

Image:

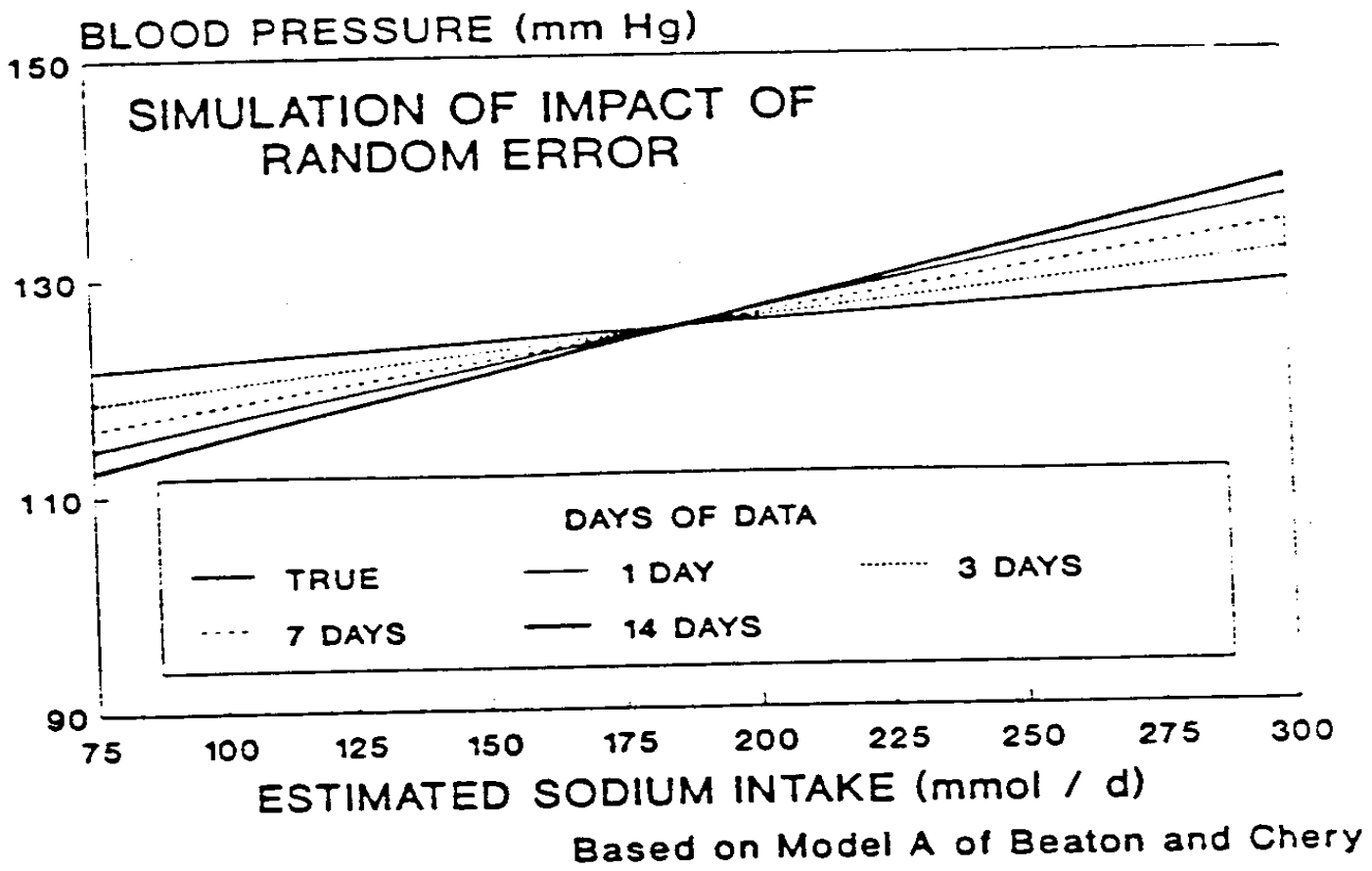


Effect of Multiple vs. One Day



Beaton AJCN 1994

Impact of Random Error on Regression Analyses



Beaton AJCN 1994

Intra/inter Individual Variance Ratios

Within- to between-person variance ratios and 95 percent confidence intervals (CI) for dietary components and food groups based on 24 days of food recording (n = 162): Helsinki Diet Methodology Study, 1984

Dietary component	Variance ratio	95% CI	Food group	Variance ratio	95% CI
Energy	1.5	1.2–1.9	Cereals	1.5	1.2–1.9
Protein	2.2	1.7–2.8	Potatoes	5.0	3.8–6.6
Total fat	1.9	1.5–2.4	Vegetables	2.5	1.9–3.2
Saturated fat	1.4	1.1–1.8	Roots	5.4	4.1–7.1
Monounsaturated fat	2.6	2.0–3.3	Legumes*,†	6.4	4.9–8.5
Polyunsaturated fat	1.5	1.2–1.9	Other	3.1	2.4–4.0
Cholesterol	3.2	2.5–4.1	Fruits*	2.7	2.1–3.5
Carbohydrates	1.1	0.9–1.4	Berries	4.8	3.7–6.3
Dietary fiber	1.1	0.9–1.4	Milk products	0.9	0.7–1.1
Vitamin A*	4.6	3.6–6.1	Meat	4.5	3.4–5.8
Thiamin	2.9	2.3–3.8	Beef, pork, and poultry	9.5	7.0–13.0
Riboflavin	2.0	1.5–2.5	Sausages*	3.3	2.5–4.2
Niacin	2.8	2.2–3.6	Organ meats*,†	11.8	8.4–16.6
Vitamin C	2.9	2.3–3.7	Fish	5.7	4.3–7.5
Vitamin E	1.6	1.3–2.0	Eggs*	5.2	4.0–6.9
Calcium	1.5	1.2–1.9	Coffee	0.5	0.4–0.6
Sodium	2.2	1.7–2.8	Alcohol (ethanol)†	2.4	1.8–3.0
Selenium	4.0	3.1–5.1			
P:S ratio‡	1.0	0.8–1.3			
Fat as % of energy	2.5	1.9–3.2			

Hartman Am J Epidemiol 1990

Deattenuation methods

- If random variation is assumed, can use a formula with at least 2 recalls or records to adjust for day to day variability with straightforward correlation or regression measures.

Variance component	Estimate
inter person Var (id)	74.5
intra person Var (error)	103

- $r_t = r_o$SqRt (1+intra/intervar$_x$/n_x)
- Gives a better idea of likely true association
- But: Unclear how this works with complex interactions or diverse populations

Food Frequency Questionnaire (FFQ)

Advantages:

- Measures usual intake in a single administration
- Uses pattern memory which may be more reliable than episodic memory for some

Disadvantages:

- Defined food list
  - Simplified to prevent response fatigue
- Portion size assumptions limit assessment of true variation
- Assumptions for recipes limit true variation
- Underestimates intake for those with unusual eating patterns

FRUIT

For seasonal fruits, answer with which frequency you eat them during the Summer. For all other fruits, with which frequency you consider you eat them year-round.	Never	Less than 1x per month	1x per month	2-3x per month	1x per week	2x per week	3-4x per week	5-6x per week	1x per day	2+x per day
Apples, applesauce, pears	○	○	○	○	○	○	○	○	○	○
Bananas	○	○	○	○	○	○	○	○	○	○
Oranges, tangerines	○	○	○	○	○	○	○	○	○	○
Grapefruit (white or pink)	○	○	○	○	○	○	○	○	○	○
Peaches, nectarines, apricots, plums (fresh, canned, or frozen)	○	○	○	○	○	○	○	○	○	○
Grapes	○	○	○	○	○	○	○	○	○	○
Avocado, fresh (including guacamole)	○	○	○	○	○	○	○	○	○	○
Kiwi, or Acerola	○	○	○	○	○	○	○	○	○	○
Papaya/ mango	○	○	○	○	○	○	○	○	○	○
Dried fruit (e.g. raisins, prunes, apricots, dried cranberries)	○	○	○	○	○	○	○	○	○	○
Cantaloupe, honeydew melon	○	○	○	○	○	○	○	○	○	○
Watermelon	○	○	○	○	○	○	○	○	○	○
Strawberries	○	○	○	○	○	○	○	○	○	○
Other berries (e.g. blackberries, blueberries and raspberries)	○	○	○	○	○	○	○	○	○	○
Any other fruit (e.g. pineapple, cherries, lychee, canned mixed fruit, fruit cocktail)	○	○	○	○	○	○	○	○	○	○

If you eat dried fruit, your portion is usually closest to . . .

○ 1/8 cup ○ 1/4 cup ○ 3/8 cup ○ 1/2 cup or more

If you eat cantaloupe or honeydew, your portion is usually closest to *(1 wedge = 1/4 melon)* **. . .**

○ 1/2 wedge or 1/2 cup ○ 1 wedge or 3/4 cup ○ 1 1/2 wedges or 1 cup ○ 2 or more wedges or 1 1/2 cups or more

If you eat watermelon, your portion is usually closest to *(1 med. slice watermelon = 7 1/2" dia. x 1" thick)* **. . .**

○ 1 sm. slice or 1/2 wedge ○ 1 med. slice/wedge ○ 1 lg. slice/wedge ○ more than 1 lg. slice/wedge

If you eat strawberries, cherries and/or other berries, your portion is usually closest to . . .

○ 1/2 cup ○ 1 cup ○ 1 1/2 cups ○ 2 cups or more

If you eat any other cut up or canned fruit, pineapple, cherries, or fruit cocktail, your portion is usually closest to . . .

○ 1/2 cup ○ 1 cup ○ 1 1/2 cups ○ 2 cups or more

SUMMARY QUESTIONS

	Never	Less than 1x per month	1x per month	2-3x per month	1x per week	2x per week	3-4x per week	5-6x per week	1x per day	2+x per day
How often do you usually eat fruit of any kind?	○	○	○	○	○	○	○	○	○	○

Major FFQs

- Willett
  - Foods were selected to explain the greatest amount of variance in intakes
  - Does not include portion sizes, but specifies size
    - “How often do you drink skim milk (8 oz. glass)?”
    - “How often do you eat dark bread (slice)?”
- Block/NCI
  - Foods were those that contributed the most to the nutrients of interest for the US population
  - Includes S/M/L portion sizes
- NCI
  - Considers cognitive interview results

Food Frequency Validity

- Comparison with independent measure
  - Errors in diet recalls are not highly correlated
- Comparison with biochemical indicator
  - Homeostasis, absorption, metabolism;
  - Variability and random lab error
- Correlation with expected physiologic response or disease outcome
  - Eg. Showing an association between high potassium intake and incident hypertension

Willett FFQ Validation

Table 6–11. Correlations between the 1986 questionnaire and nutrients calculated from the 1980 diet records and from 1980 plus 1986 diet records among 92 NHS participants[a]

Nutrients	1986 FFQ[b] vs. 1986 diet records		1986 FFQ vs. 1980 diet records		1986 FFQ vs. 1980 + 1986 diet records	
	r	De-attenuated *r*	*r*	De-attenuated *r*	*r*	De-attenuated *r*
Total fat	0.51	0.57	0.49	0.53	0.62	0.67
Saturated fat	0.59	0.68	0.42	0.46	0.64	0.70
Polyunsaturated fat	0.41	0.48	0.45	0.50	0.58	0.64
Monounsaturated fat	0.51	0.58	0.51	0.56	0.63	0.69
Cholesterol	0.62	0.73	0.38	0.42	0.58	0.65
Carbohydrates	0.59	0.64	0.61	0.65	0.69	0.73
Protein	0.42	0.50	0.40	0.44	0.50	0.56
Total vitamin A	0.56	0.79	0.33	0.38	0.57	0.65
Vitamin B_6	0.55	0.64	0.42	0.46	0.60	0.65
Vitamin C	0.63	0.76	0.36	0.38	0.47	0.50
Calcium	0.64	0.75	0.40	0.43	0.49	0.53
Iron	0.47	0.60	0.23	0.25	0.37	0.40

[a] All nutrients adjusted for total energy intakes and do not include supplements.
[b] FFQ, food-frequency questionnaire.

FFQ vs. 1 y Diet Record

Table 6–1. Comparison of mean nutrient intakes measured among 27 men and women using a 116-item food-frequency questionnaire, and 1-year diet record[a]

Nutrient	Diet record mean	Questionnaire mean
Total energy (kcal)	2,229 ± 706.9[b]	2,114 ± 1,012
Protein (g)	82.0 ± 24.8	87.0 ± 40.0
Total fat (g)	89.9 ± 30.1	81.9 ± 45.8
Saturated fat (g)	33.5 ± 13.1	31.9 ± 18.0
Linoleic acid (g)	14.0 ± 4.1	13.9 ± 7.8
Total carbohydrate (g)	258 ± 96	263 ± 116
Crude fiber (g)	4.4 ± 1.6	5.1 ± 2.8
Cholesterol (mg)	362 ± 122	332 ± 151
Oleic acid (g)	30.9 ± 9.85	29.4 ± 17.0
Vitamin A (IU)	6,434 ± 2,679	10,553 ± 6,194[c]
Niacin (mg)	21.9 ± 6.41	27.0 ± 12.2
Vitamin C (mg)	125 ± 87	146 ± 88
Calcium (mg)	894 ± 446	917 ± 586
Phosphorus (mg)	1,384 ± 504	1,420 ± 717
Thiamin (mg)	1.50 ± 0.55	1.30 ± 0.63
Riboflavin (mg)	1.91 ± 0.86	2.19 ± 1.31
Potassium (mg)	2,778 ± 1,045	3,076 ± 1,559
Iron (mg)	14.6 ± 5.92	13.6 ± 5.89

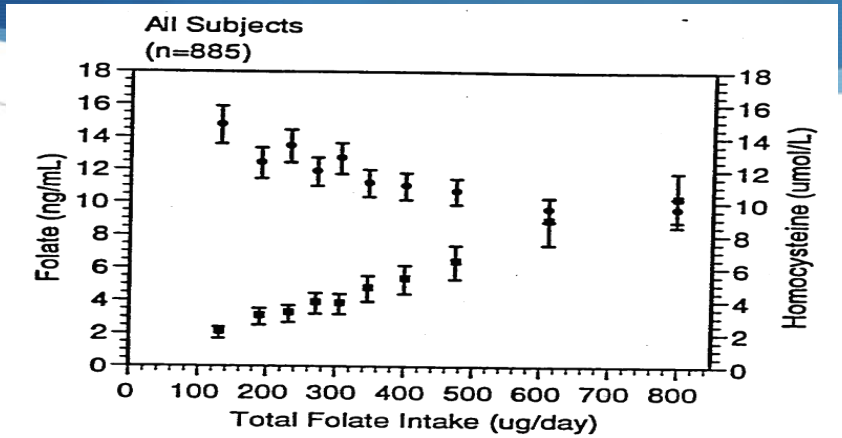
[a]Data were provided by 27 men and women aged 20 to 54.

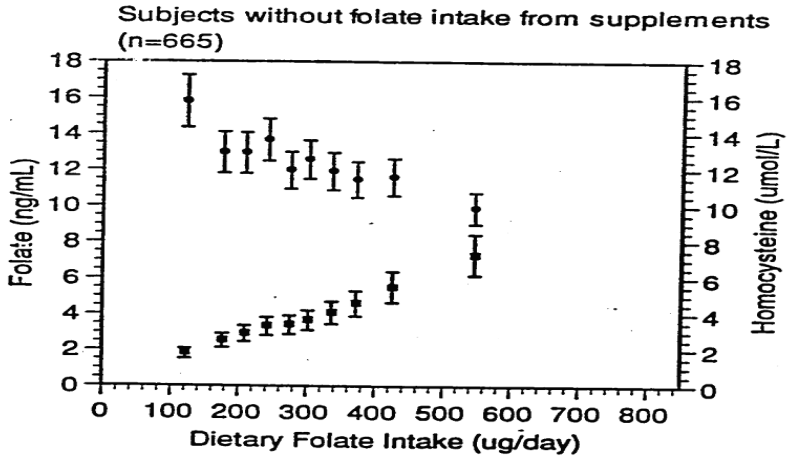
[b]Mean ± standard deviation.

[c]Discrepancy for vitamin A is in part due to use of new USDA tables, which have dramatically changed vitamin A values for several vegetables. Use of older USDA values reduced this value to 8,511 IU.

From Willett et al., 1987.

FFQ Folate and Homocysteine





Tucker J Nutr 1994

Carotenoid diet-blood Validation

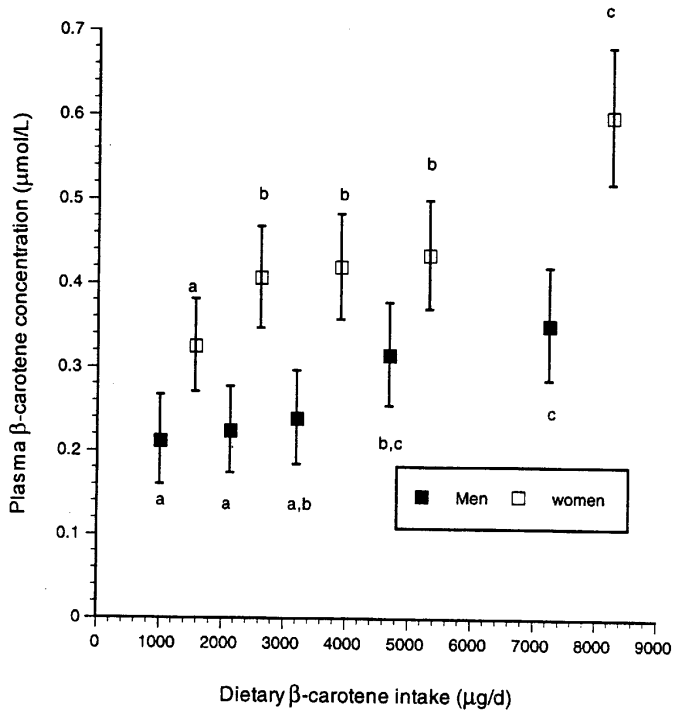


FIGURE 2 Plasma β-carotene concentration (μg/d) in elderly men (■, n = 201) and women (□, n = 346) plotted against median daily β-carotene intake (μmol/L) by quintile, adjusted for age, energy intake, body mass index, plasma cholesterol concentrations and smoking status.Values are means ± 95% confidence interval. Within gender, means with no common letters differ, $P < 0.05$.

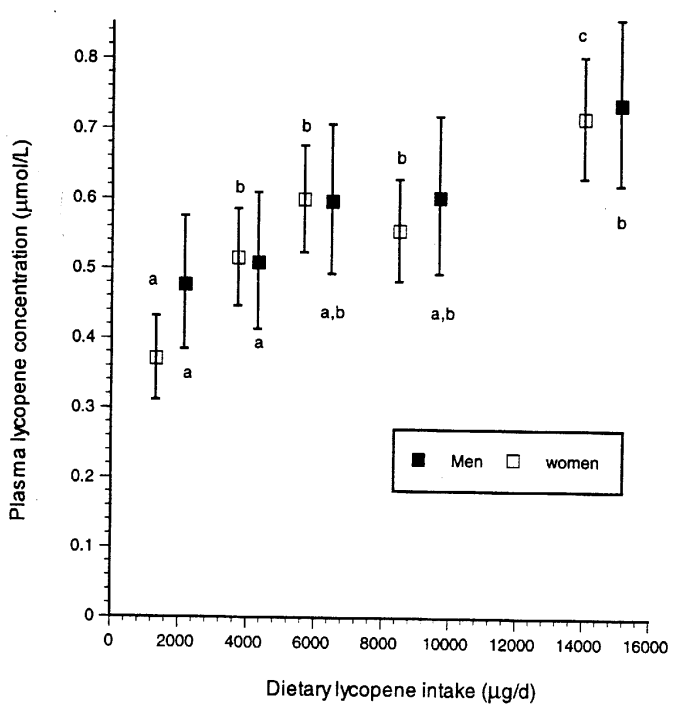


FIGURE 4 Plasma lycopene concentration (μg/d) in elderly men (■, n = 201) and women (□, n = 346) plotted against median daily lycopene intake (μmol/L) by quintile, adjusted for age, energy intake, body mass index, plasma cholesterol concentrations and smoking status.Values are means ± 95% confidence interval. Within gender, means with no common letters differ, $P < 0.05$.

Tucker J Nutr 1999

Findings from Cognitive Interviewing

- Aggregation
  - Had difficulty with aggregate portion size (e.g. 1 apple OR ½ c applesauce)
- Units
  - Confused number of eggs with frequency of consumption and small, medium and large serving with egg size
- Order of foods was important
  - E.g. Include orange juice before oranges

Subar JAND 1995

NATIONAL INSTITUTES OF HEALTH

Diet History Questionnaire

1. Over the past 12 months, how often did you drink **tomato juice** or **vegetable juice**?

☐ NEVER (GO TO QUESTION 2)

☐ 1 time per month or less
☐ 2–3 times per month
☐ 1–2 times per week
☐ 3–4 times per week
☐ 5–6 times per week
☐ 1 time per day
☐ 2–3 times per day
☐ 4–5 times per day
☐ 6 or more times per day

1a. Each time you drank **tomato juice** or **vegetable juice**, how much did you usually drink?

☐ Less than ¾ cup (6 ounces)
☐ ¾ to 1¼ cups (6 to 10 ounces)
☐ More than 1¼ cups (10 ounces)

2. Over the past 12 months, how often did you drink **orange juice** or **grapefruit juice**?

☐ NEVER (GO TO QUESTION 3)

☐ 1 time per month or less
☐ 2–3 times per month
☐ 1–2 times per week
☐ 3–4 times per week
☐ 5–6 times per week
☐ 1 time per day
☐ 2–3 times per day
☐ 4–5 times per day
☐ 6 or more times per day

2a. Each time you drank **orange juice** or **grapefruit juice**, how much did you usually drink?

☐ Less than ¾ cup (6 ounces)
☐ ¾ to 1¼ cups (6 to 10 ounces)
☐ More than 1¼ cups (10 ounces)

3. Over the past 12 months, how often did you drink **other 100% fruit juice** or **100% fruit juice mixtures** (such as apple, grape, pineapple, or others)?

Over the past 12 months...

4. How often did you drink other **fruit drinks** (such as cranberry cocktail, Hi-C, lemonade, or Kool-Aid, diet or regular)?

☐ NEVER (GO TO QUESTION 5)

☐ 1 time per month or less
☐ 2–3 times per month
☐ 1–2 times per week
☐ 3–4 times per week
☐ 5–6 times per week
☐ 1 time per day
☐ 2–3 times per day
☐ 4–5 times per day
☐ 6 or more times per day

4a. Each time you drank **fruit drinks**, how much did you usually drink?

☐ Less than 1 cup (8 ounces)
☐ 1 to 2 cups (8 to 16 ounces)
☐ More than 2 cups (16 ounces)

4b. How often were your fruit drinks **diet** or **sugar-free drinks**?

☐ Almost never or never
☐ About ¼ of the time
☐ About ½ of the time
☐ About ¾ of the time
☐ Almost always or always

5. How often did you drink **milk as a beverage** (NOT in coffee, NOT in cereal)? (Please include chocolate milk and hot chocolate.)

☐ NEVER (GO TO QUESTION 6)

☐ 1 time per month or less
☐ 2–3 times per month
☐ 1–2 times per week
☐ 3–4 times per week
☐ 5–6 times per week
☐ 1 time per day
☐ 2–3 times per day
☐ 4–5 times per day
☐ 6 or more times per day

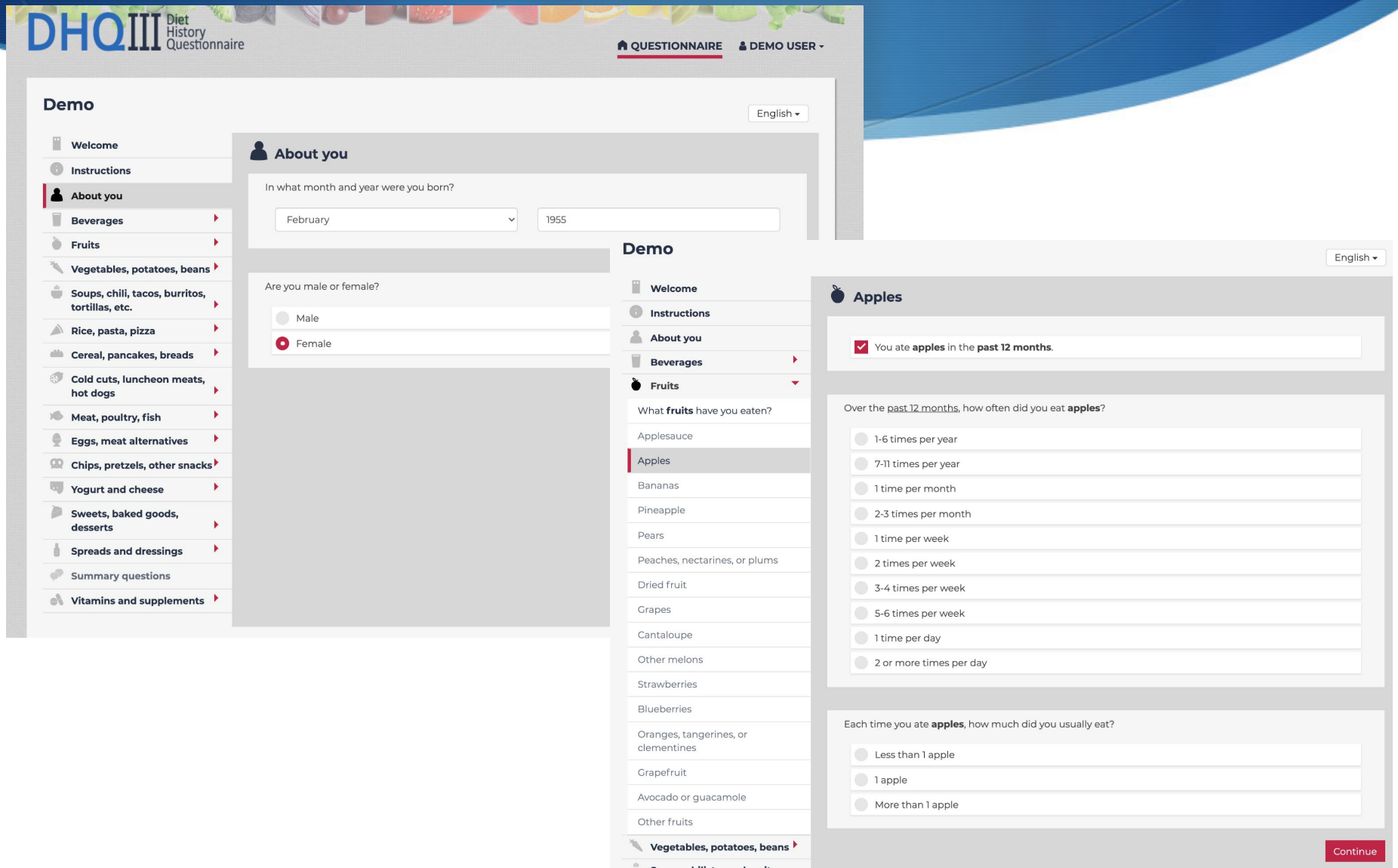
https://epi.grants.cancer.gov/dhq/forms/

Correlations vs. 4 24 Hr Recalls

Nutrient	Men			Women		
	NCI	Block	Willett	NCI	Block	Willett
Energy	.48	.45	.18	.49	.45	.20
Fat	.55	.53	.30	.52	.53	.25
Fat adj kcal	.66	.67	.65	.62	.55	.60
% fat	.67	.66	.64	.66	.60	.65
Vitamin E	.43	.28	.17	.55	.39	.23
Vit E adj kcal	.51	.19	.46	.57	.24	.48

Subar Am J Epidemiol 2001

DHQIII


DHQIII Diet History Questionnaire
QUESTIONNAIRE
DEMO USER
Demo
English
Welcome
Instructions
About you
Beverages
Fruits
Vegetables, potatoes, beans
Soups, chili, tacos, burritos, tortillas, etc.
Rice, pasta, pizza
Cereal, pancakes, breads
Cold cuts, luncheon meats, hot dogs
Meat, poultry, fish
Eggs, meat alternatives
Chips, pretzels, other snacks
Yogurt and cheese
Sweets, baked goods, desserts
Spreads and dressings
Summary questions
Vitamins and supplements
About you
In what month and year were you born?
February
1955
Are you male or female?
Male
Female
Demo
English
Welcome
Instructions
About you
Beverages
Fruits
What fruits have you eaten?
Applesauce
Apples
Bananas
Pineapple
Pears
Peaches, nectarines, or plums
Dried fruit
Grapes
Cantaloupe
Other melons
Strawberries
Blueberries
Oranges, tangerines, or clementines
Grapefruit
Avocado or guacamole
Other fruits
Vegetables, potatoes, beans
Apples
You ate apples in the past 12 months.
Over the past 12 months, how often did you eat apples?
1-6 times per year
7-11 times per year
1 time per month
2-3 times per month
1 time per week
2 times per week
3-4 times per week
5-6 times per week
1 time per day
2 or more times per day
Each time you ate apples, how much did you usually eat?
Less than 1 apple
1 apple
More than 1 apple
Continue

Nutritional Biomarkers

- Direct markers of dietary intake (recovery biomarker)

  eg: urinary nitrogen, doubly labeled water

- Surrogate markers of dietary intake (concentration marker)

  eg: serum vitamin C, carotenoids, folate

- Integrated markers of nutritional status

  eg: red blood cell fatty acids, adipose tissue fatty acids

Potischman J Nutr 2003

Biomarkers: variation in nutritional physiology and metabolism

- Absorption
  - Feedback control by tissue load
  - Effect of transit time
  - Intraluminal concentration
- Tissue distribution of uptake
  - Across various body pools
- Turnover
  - Variation in conversion to metabolites
  - Presence of cofactors
- Excretion
  - Variation in degradative pathways
  - Effects of medications, medical conditions
- Effects of the microbiome!

Potischman J Nutr 2003

Biomarker Calibration

- Assess relation of biomarker with measured intake in feeding study
- Method using biomarkers to calibrate intake with a subsample
- Regress biomarker values on self report along with other study subject characteristics (like BMI)
- Use adjusted values to extrapolate to the full sample
- Limitation: it is sample dependent and not generalizable

Prentice Curr Atheroscler Rep 2013

US Population 2019

Non-Hispanic white	60.1
Hispanic	18.5
African American	13.4
Asian	5.9
American Indian	1.3
Pacific Islander	0.2

Limitations of FFQ validity for diverse populations

- Existing FFQs are designed to capture diet for the majority
- Compromises by grouping foods and assuming relative exposures
  - "other fruits" (other than apples, pears, banana, citrus, melon or berries)
    - Weighted average of grapes, plums, peaches, pineapple, mango, kiwi…
  - This removes important variation!
    - Amplified with diverse cultural diets leading to confounding!
- Assume standard recipes
  - Eg "soup"
    - Weighted averaged of canned chicken soup, beef noodle soup, vegetable soup…
    - Ethnic differences are tremendous, can lead to bias!
- Assume standard portions
  - Again can remove variation and lead to bias!

Validity coefficients for Block and Harvard FFQs in the WIC Dietary Assessment Validation Study

	Ethnicity	Energy	Protein	Vit A	Vit C	Iron	Calcium
Harvard	African American	0.18	0.22	0.00	-0.36	0.02	0.27
	Hispanic	0.19	0.13	0.40	0.28	0.28	0.18
	White	0.27	0.33	0.28	0.33	0.27	0.40
Block	African American	0.53	0.46	0.28	0.32	0.40	0.46
	Hispanic	0.14	0.09	0.15	0.17	-0.01	0.15
	White	0.44	0.53	0.62	0.20	0.47	0.56

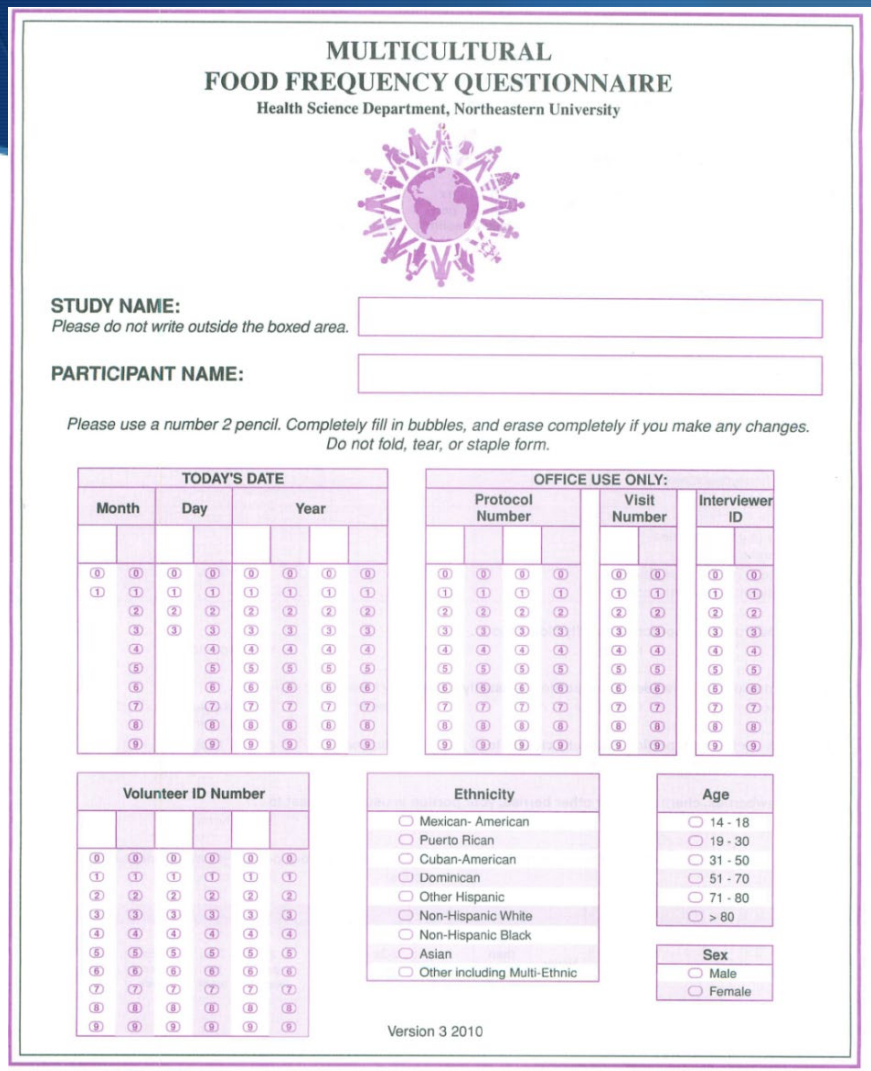
WIC Dietary Assessment Validation Study
Final Report -- September 22, 1994

Validity coefficients for the Multiethnic Cohort in Hawaii and Los Angeles FFQ

Women	Energy	Protein	Tot Fat	Fiber	Vit C	Calcium
African Americans	0.17	0.22	0.24	0.34	0.38	0.33
Japanese Americans	0.19	0.25	0.32	0.56	0.55	0.59
Latinos	0.40	0.35	0.57	0.40	0.30	0.34
Whites	0.28	0.38	0.39	0.46	0.66	0.49

Stram *Am J Epidemiol 2000*

Need more inclusive FFQ



MULTICULTURAL
FOOD FREQUENCY QUESTIONNAIRE
Health Science Department, Northeastern University

STUDY NAME:
Please do not write outside the boxed area.

PARTICIPANT NAME:

Please use a number 2 pencil. Completely fill in bubbles, and erase completely if you make any changes. Do not fold, tear, or staple form.

TODAY'S DATE: Month, Day, Year

OFFICE USE ONLY: Protocol Number, Visit Number, Interviewer ID

Volunteer ID Number

Ethnicity
- Mexican- American
- Puerto Rican
- Cuban-American
- Dominican
- Other Hispanic
- Non-Hispanic White
- Non-Hispanic Black
- Asian
- Other including Multi-Ethnic

Age
- 14 - 18
- 19 - 30
- 31 - 50
- 51 - 70
- 71 - 80
- > 80

Sex
- Male
- Female

Version 3 2010

- Use of FFQs for multicultural-populations are currently inadequate and may lead to bias
- Need more detail on cultural ways of eating
  - Ethnic foods
  - Portion sizes
  - Recipes and preparation
  - Fortified foods

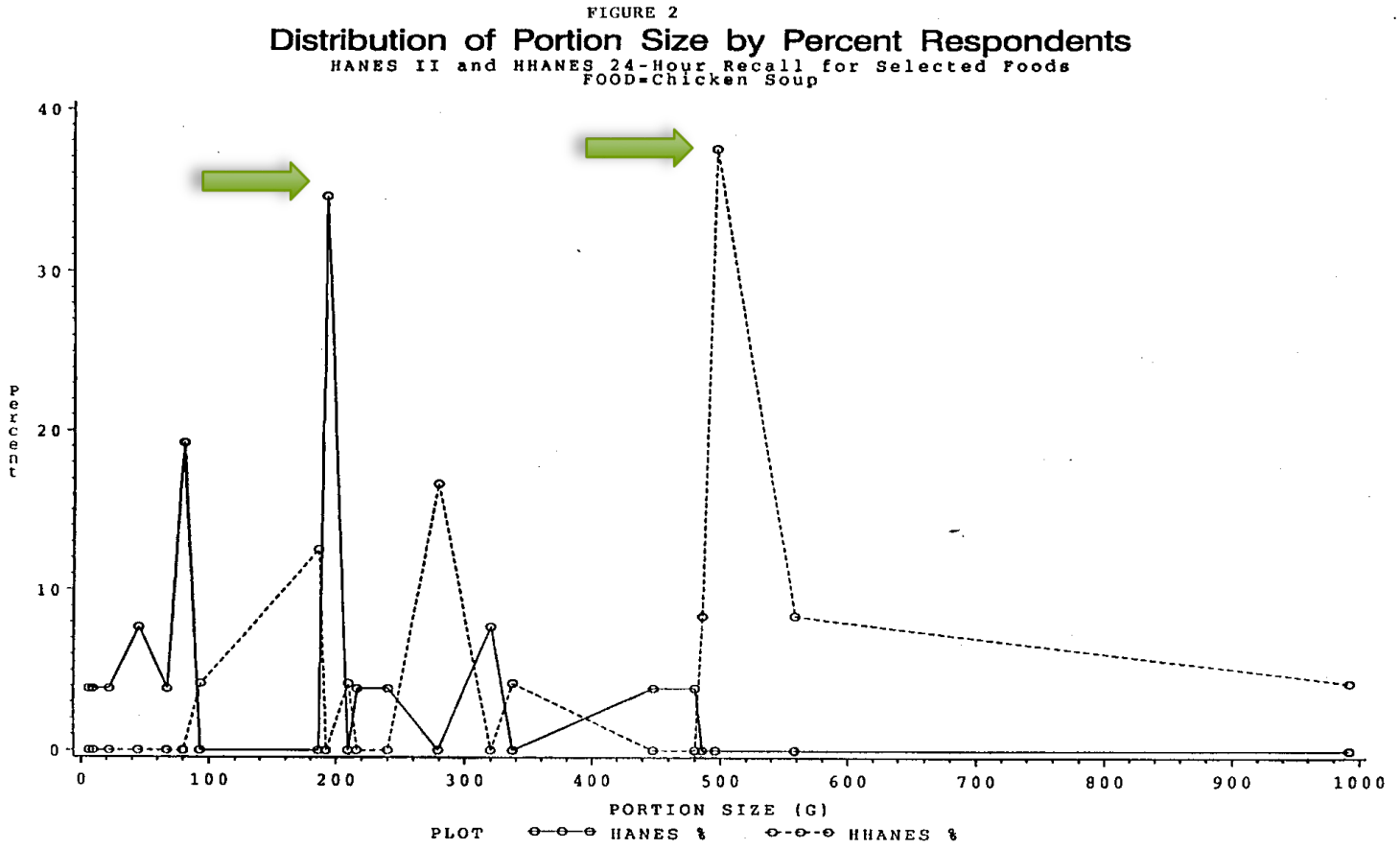
Puerto Rican Health Study FFQ

- Based on 24-hour recall data from Hispanic HANES Puerto Rican subset with updating from more recent studies and community input
- Using Block method of ranking food contribution to nutrients
- Comparing portion sizes
- Recipes!!!

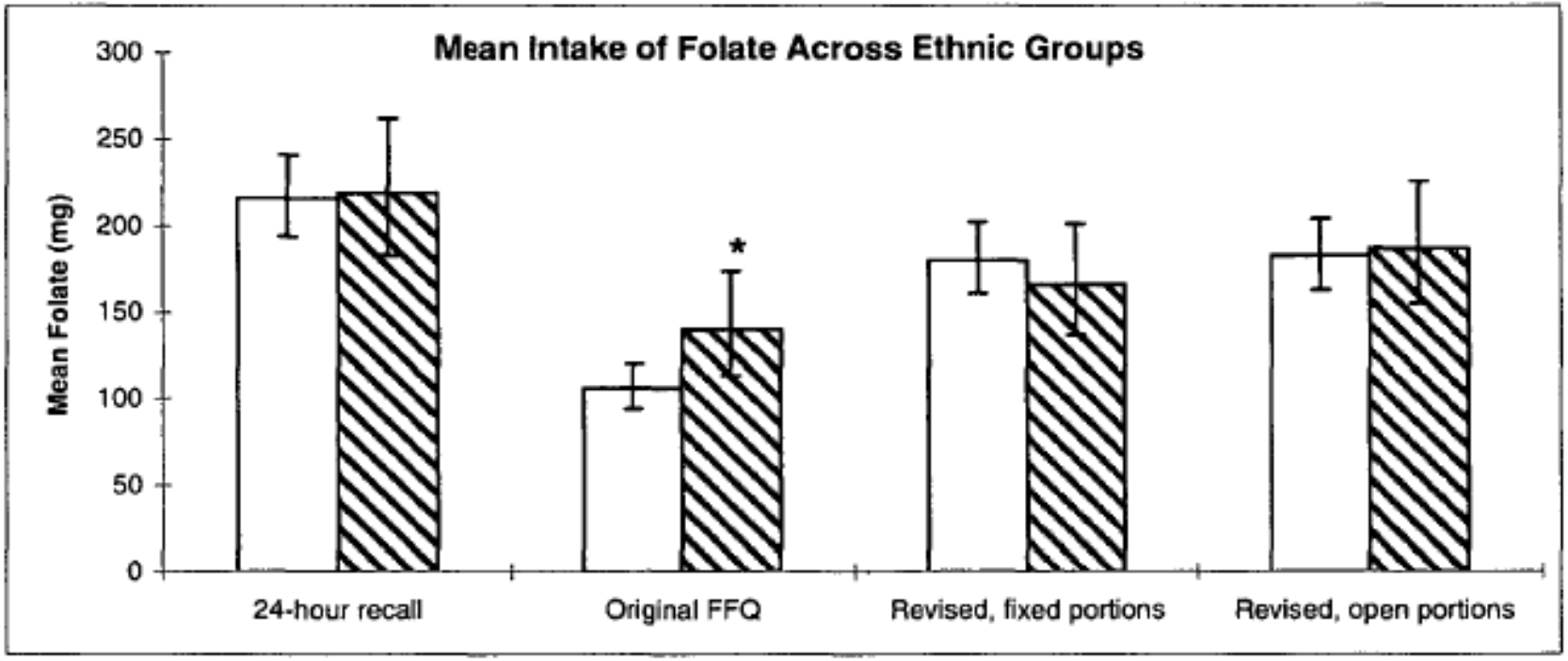
Foods Used by Boston area Latinos added to the FFQ

- Mango
- Fruit nectar
- Avocado
- Cassava
- Green plantain
- Ripe plantain
- Meat pie, fritter
- Rice with chicken
- Rice with pigeon peas
- Rice with beans
- Rice with meat
- Custard-Flan
- Homemade soup

Portion Size: Chicken Soup



Mean Folate Estimates of Intake for Hispanic and non-Hispanic White Elders



Tucker *Am J Epidemiol* 1998

Comparison of mean intakes by differing methods in Hispanic elders

Mean ± SE	24-hr recall	Original FFQ	Revised FFQ	Revised FFQ open portions
Energy (kcal)	1464 ± 64	1163 ± 45****	1202 ± 44****	1409 ± 64
Protein (g)	60.0 ± 3.0	14.6 ± 2.4****	53.5 ± 2.5***	62.0 ± 3.4*
Fat (g)	52.5 ± 2.9	48.7 ± 2.4	43.3 ± 2.1****	51.4 ± 2.9
Carbohydrate (g)	191 ± 8.7	134 ± 5.6****	151 ± 5.6****	176 ± 8.2**
Vitamin A (µg RAE)	732 ± 120	330 ± 44****	454 ± 75****	487 ± 76*
Calcium (mg)	573 ± 31	454 ± 32****	431 ± 26****	549 ± 31**

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$; **** $P < 0.0001$, by paired f-test statistics for Ho: mean from food frequency = mean from 24-hour recall. For differences with non-normal distributions, significance levels were determined with the non-parametric sign test.

Tucker *Am J Epidemiol* 1998

Delta NIRI Need for region-specific FFQ

- Widely used FFQs capture foods commonly consumed in the United States but not in all sub-areas

- Foods of Our Delta Study (FOODS 2000)
  - Dietary survey of residents of the Delta region
  - USDA funded

Tucker Pub Health Nutr 1995

Foods added to Delta FFQ

Table 6 Regional foods added to the Lower Mississippi Delta Nutrition Intervention Research Initiative Food Frequency Questionnaire for Adults*

Food	Note
Biscuits	Made with white flour, frequently served with gravy
Broccoli and rice casserole	Popular casserole that also contains processed cheese
Cheese dip	Commercially processed
Chicken and dumplings, pot pie	Chicken in gravy with flour dumplings or pie crust
Cracklings	Deep fried pork skin
Fried beef (chicken fried steak)	Beef loin, flattened, battered and fried
Fried catfish, fish sandwich	Usually deep fried
Fried potatoes: potato logs	Large pieces of potato, deep fried
Fruit drinks: orangeade, lemonade	Usually commercially prepared, condensed or powdered
Game: venison, squirrel	From local hunters
Gravy (on meat or biscuits)	Usually prepared from a commercial mix
Greens: mustard, turnip, collards, poke salat	Locally popular green vegetables
Grits	Corn-based cereal, cooked like rice
Home-made soup: gumbo	Usually contains okra, rice, sausage and special seasonings
Jambalaya, dirty rice	Rice recipe with meat or fish and special seasonings
Neck bones, ham hock, pig's feet	May be smoked or pickled
Okra	Locally popular vegetable
Organ meats: chitterlings	Fried intestines
Peas: field, black-eyed, purple hull	Locally popular peas
Powdered drink mixes	Mostly sugar with artificial flavour
Root crops: turnips, rutabaga	Locally popular root vegetables
Shellfish: crawfish	River crustacean
Sweet potato pie	Sweet pie made with sweet potatoes, milk and sugar
Sweet tea	Iced tea prepared with sugar

Tucker Pub Health Nutr 1995

Jackson Heart Study

- Noted in the ARIC study that FFQ data (based on the Willett questionnaire) seemed less valid in Jackson MS than in other sites
- Developed shortened version (158 items) of the DELTA NIRI FFQ for use in the JHS

Carithers Ethn Dis 2005

JHS validation study vs 4 24HR*

Nutrient	Men, n=163		Women, n=273	
	JHS FFQ	DELTA NIRI	JHS FFQ	DELTA NIRI
Energy	0.41	0.38	0.33	0.33
Protein	0.39	0.45	0.37	0.50
Carbohydrate	0.70	0.67	0.44	0.53
Vitamin C	0.55	0.56	0.49	0.65
Vitamin B6	0.49	0.70	0.40	0.59
Iron	0.57	0.73	0.37	0.49
Calcium	0.48	0.57	0.49	0.56

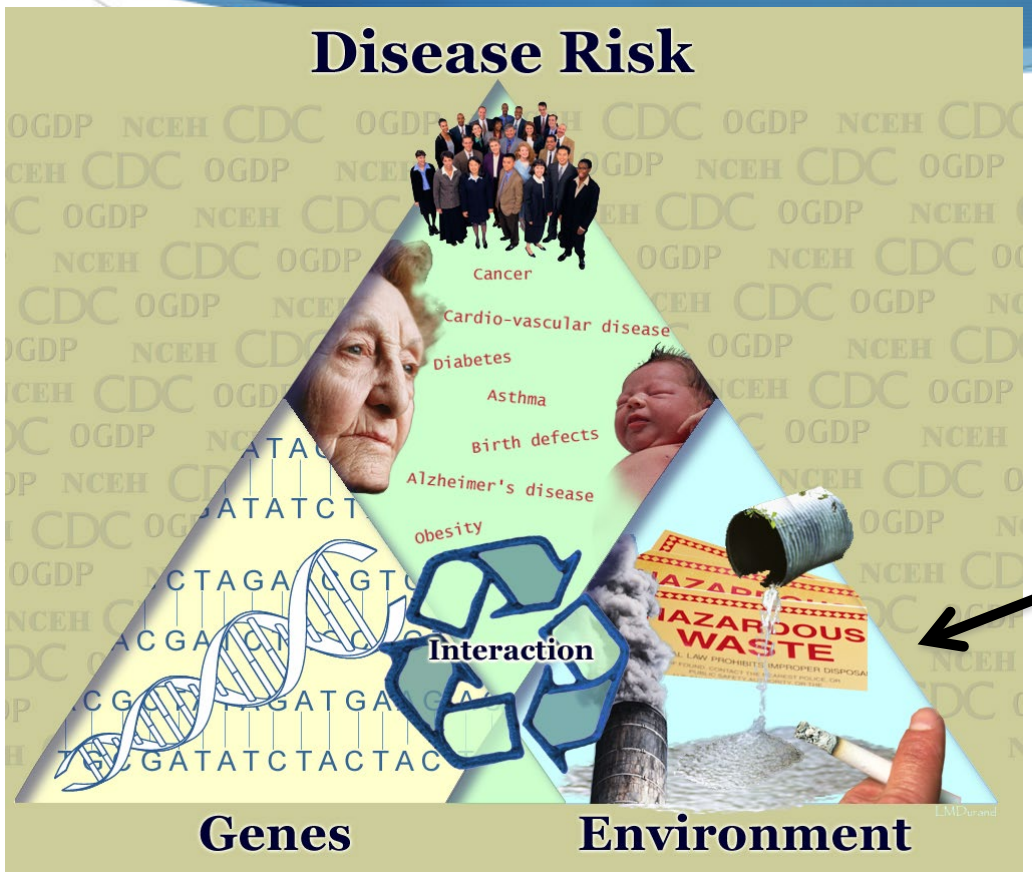
*Energy adjusted and deattenuated correlations

Carithers J Am Diet Assoc 2009

Personalized Nutrition

- Important to be sure we are using the right tools for each specific population
- Some existing cohorts are fairly homogeneous and diet*gene interactions are valid there, but also need to expand to other populations.
- Ethnic variation exists in diet and in genetic polymorphisms
- Precision becomes even more important in multiethnic cohorts

Genes, Environment & Disease

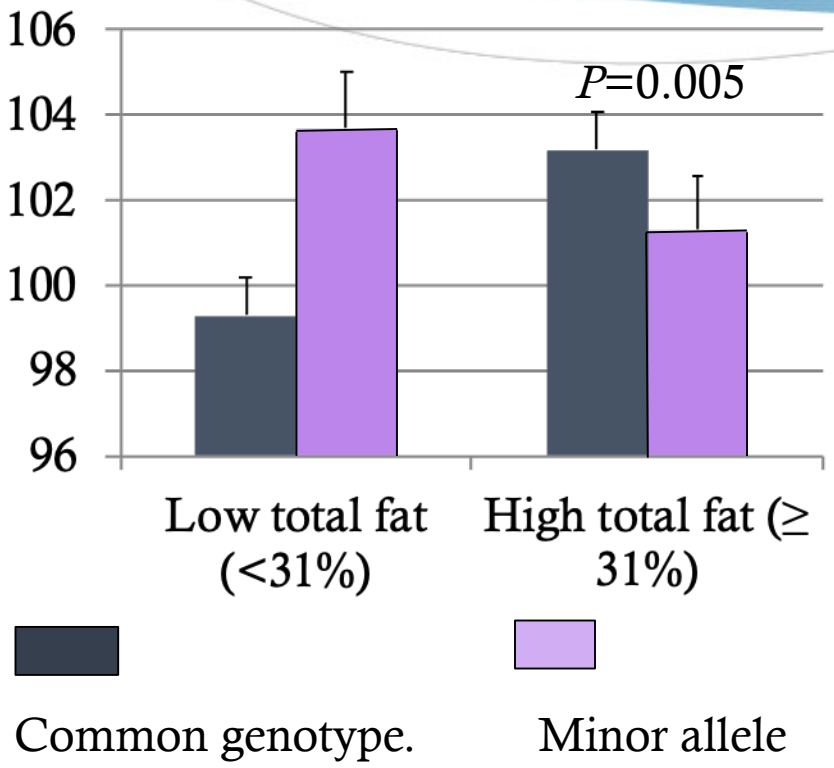


"An individual's phenotype is the result of a complex interaction between their genotype and environmental exposure"

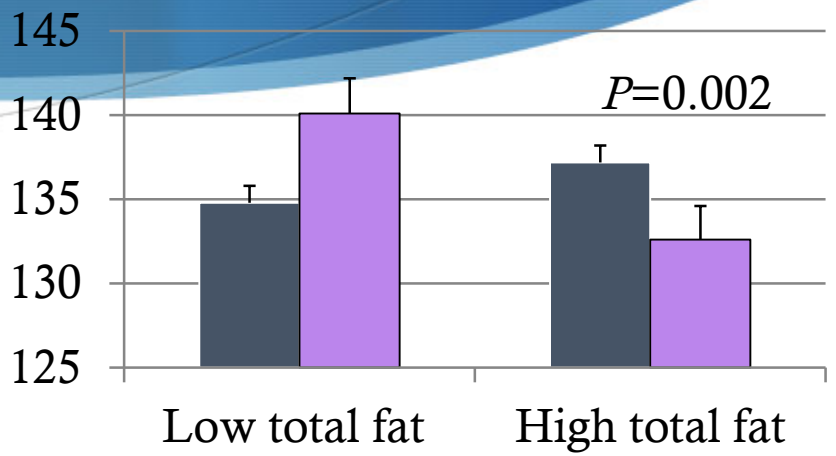
Penn et al. *Genes Nutr* 2010;5:205-13

Apolipoprotein genes and dietary fat intake

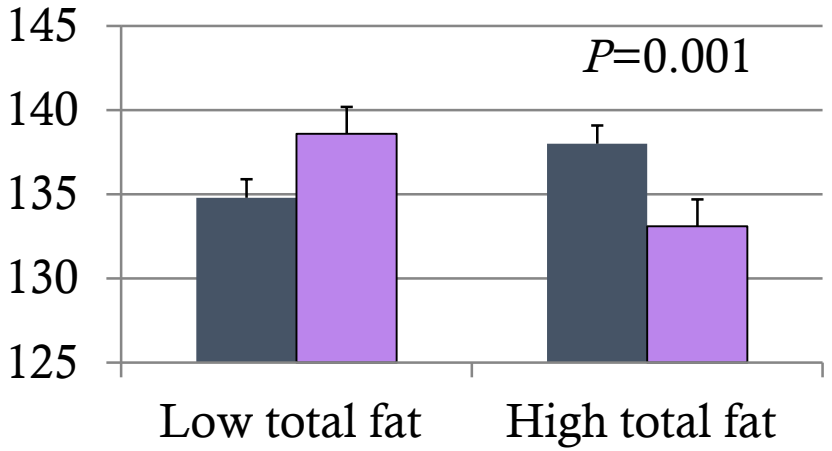
APOA1 -75 and waist (cm)



APOA5 S19W and systolic BP (mmHg)



APOA4 N147S and systolic BP (mmHg)



Mattei Nutr Metab Cardiovasc Dis. 2010
Mattei J Nutr. 2009

Next Steps

- Using technology to improve measurement
- Combining methods to improve estimates
- Improved statistical modeling for correction of measurement error
- Using biomarkers to enhance estimates of association with outcomes
- Improve precision for personalized nutrition, including differences in dietary quality within food groups
- Using complex data approaches to approach to personalized nutrition with consideration of genomics, metabolomics, etc.

Conclusions

- Chronic diseases are of extreme importance in this country and the world
- Diet is of major importance for the health of the nation
- We must invest in optimal dietary assessment and in understanding its contribution to health and disease in diverse populations