MEASURING DIET (DIETARY ASSESSMENT)

Chapter 3

Dietary Assessment

- The most widely used indirect indicator of nutritional status.

- Weaknesses associated with the dietary assessment

Limitations of dietary Assessment

1. Weakness of data gathering techniques
2. Human behaviors
3. Natural tendency of individual's nutrient intake to vary considerably from day to day

4. Limitations of nutritional composition tables and databases

   – **Conversion of dietary intake data to nutrient intake data requires information on the nutrient content of foods**

Why do we measure diet?

TO IMPROVE HUMAN HEALTH

- Investigate the relationship between the diet and diet-related diseases
- Identifying groups at risk of nutritional deficiencies
- Formulation food and nutrition policies for disease prevention and health promotion

BOX 3.1

Uses of Dietary Evaluation

1. Assessing and monitoring food and nutrient intake

- Insure adequacy of food supply
  - Surveys, disappearance studies
- Estimate the adequacy of food intakes of individuals and groups
  - Surveillance, NHANES
- Monitoring trends in food and nutrient composition
  - % of energy from what nutrient
- Estimating exposure of food additives and contaminants
  - FDA: 800 contaminants and nutrients

Uses of Dietary Evaluation

2. Formulating and evaluating government health and agricultural policies
   - Planning food production and distribution
     - Exports ,imports , priorities for food aid
   - Establishing food and nutrition regulation
     - Labels, enrichment, fortification
   - Establishing programs for nutrition education and diseases risk reduction (CVDs)
   - Evaluating the success and cost effectiveness of nutrition education and disease risk reduction programs

Uses of Dietary Evaluation

3. Conducting epidemiologic research

-Studying the relationship between diet and health

-Identifying groups at risk of developing diseases because if their diet and /or nutrient intake

Folic acid and NTDs

4. Commercial purposes

Advertising campaigns

Selection of Dietary Assessment Methods in Research

- **Depends on such considerations: but there is no best method**
  - **Research design**
    - Type of study conducted
  - **Characteristics of participants**
    - Literacy, commitment, memory, age, culture
  - **Available resources**
    - Time and budget
      - 24-hr and food record for ??
      - FFQ for ????

Research Design Considerations

1. Correlational Studies (ecological):

- compare the level of some factor with the level of another factor on the same population

  - **Show no cause and effect** (only suggest further investigation)
  - Useful in generating new hypothesis
  - Typical of epidemiological studies

2. Cross-sectional Studies (surveys)

- May measure various health & dietary parameters from a sample of the population at only one point in time.

- Sample surveys are cross-sectional studies whose samples are drawn in such a way as to be representative of a specific population.

- The 24 hour recall is the most common used

Design of **Cross-sectional Study**

- Select a sample
- Ask the subject about exposure and disease at that point of time
  - Researches gather the data one point in time
- Disease rate in exposure group to disease rate in unexposure group.

3. Case-control Studies

- Select a group of people with disease and a similar group of people without the disease.
- Ask both groups about their exposures in the past.
- Determine how the past exposure relates to a currently existing disease
- Then measure level of exposure to the factor

Case-control Studies

- Epidemiologist is involved after disease has occurred and relies on subjects' memories to gather information about exposure **(retrospective)**

- We need to asses dietary habits in the "past"
  - 24 hr and food records are not suitable !!!!

Cohort studies (longitudinal)

- Select a healthy study sample.
- Observe who is exposed and who is not exposed.
- Follow through time and compare rate of disease in exposed group to rate of disease in unexposed group

- Also known as prospective studies

Cohort studies (longitudinal)

- Requires methods that measure current diet or dietary habits in the immediate past
  - 24 hr recall
  - Food records
  - FFQ

Techniques in Measuring Diet

- 24-Hour Recall
- Food Record or Diary
- Food Frequency Questionnaires
- Diet History
- Duplicate Food collections
- Food Accounts
- Food balance sheet
- Telephone interviews
- Photographic
- and Video records
- Computerized Techniques

What are the basis for selection such method?

- Research design considerations
- Characteristics of the study participants
- Available resources
- Whether the intent is to estimate average group intake or estimate an individual's usual intake

24-hour Recall

- A trained interviewer asks the respondent to remember all food and beverages consumed in preceding 24-hours
  - The interviewer helps the respondent remember all that was consumed during the past 24-hour and assists the respondent in estimating portion sizes of foods consumed and the method of preparation
  - Respondents are shown models of food or household measures to help them estimate serving sizes.
  - Must ask probing questions

24-hour Recall

- The interviewer records all information for later analysis
- After the interview, the recall is checked for omission and/or mistakes
  - Respondent may have to be contact later by telephone or mail
- Analyze the recalls using a computerized diet analysis program

Strengths of Dietary Recall

- Easy to obtain
  - Can be done in 20 minutes or less
  - more acceptable to respondents
- Since fewer refuse, it is easier to get a large, representative sample.
- Relatively inexpensive
- Respondents literacy level not a factor
- Low burden for the respondent
- Does not alter usual diet
- Can provide detailed information on types of food consumed
- Useful in clinical setting
- Can be used to estimate nutrient intake of groups
- Multiple recalls can be used to estimate nutrient intake of individuals

Weaknesses of Dietary Recall

- One recall is **seldom representative** of person's usual intake
- Inaccurate reporting
  - Falling memory
  - Interview situation
    - Interviewer's judgment and ways questions were asked (leading or suggestions)
- Respondent biases
  - Embarrassment about what they ate
  - Wanting to please or impress the interviewer
  - Binge eating, alcohol, and unhealthy foods tend to get **UNDER-REPORTED** (missing foods)
  - Brand name foods, expensive cuts of meat and healthy foods tend to get **OVER-REPORTED**
  - **Light eaters over-report, heavy eaters under report**
  - **Missing food vs. phantom food**
- Analysis may be labor intense

Multiple pass 24-hr

- Underreporting can be limited by using a multiple pass 24-hr recall
  - By reviewing the food consumed several times to obtain detailed and accurate information

    - Quick list of foods
    - Detailed description (preparation method)
    - Review (probing for additional eating occasions, clarify portion sizes)

Technological advancement in obtaining 24-hr recall

- The USDA Automated Multiple Pass Method **(AMPM)**
  - Computer assisted interview

- **Automated self administered 24-hr (ASA24)**

ASA24 WEBSITE: Epi.grants.cancer.gov/asa24

Example : https://youtu.be/QcXZWmzUWws

Validity of Dietary Recalls

- Group mean from reported appear to be similar to group average observed intakes.
  - Respondents with lower observed tended to over report and respondents with higher observed tended to underreported past intakes.

Is a single day's intake valid?

- It is a poor description of your usual intake because the diet varies from day to day
- Even if repeated on several days, it will miss foods that are rarely eaten
- However, repeated recalls reasonably well characterize food intake **FOR A GROUP**
- They need to include week days and weekend days and each season of the year

How many replicates to use?

- The number of replicates needed depends on:
  - sample size
  - the nutrient of interest
  - how varied and changing people's diets tend to be

- **3** replicates may work for macronutrients
- **6** are needed for micronutrients

Dietary Records/Diary

- Foods/Beverages/Amounts over 1-7 days.
- More detailed information is maintained.

- See the example of a form on appendices

- Requires a **trained respondent/recorder**
  - food record form is given to the respondent
  - Food and beverage consumption can be quantified by:
    - portion sizes using household measures such as cups, tablespoons, teaspoons
    - weighing the food or beverage consumption
      - but requires respondent cooperation and may be more likely to influence the diet

Strength of Dietary Records

- Non-dependent on memory
  - Minimizes omission
  - More accurate in portion sizes
- Better description of food consumed
  - Can provide detailed intake data
    - Can provide more accurate data on when, where, and with whom foods are eaten; even on the respondent's mood when eating

- **More reflect of eating habits and usual intake**
- Multiple day data more representative of usual intake
  - **Reasonably valid up to 5 days**
  - but multiple 24-hr recalls spread over seasons is more complete

Weaknesses of Dietary Records

- High respondent burden
  - Require high degree of cooperation
  - Tedious and time consuming
  - Response burden can results in **low response rates** when used in large national surveys
- Subject must be literate
- Time consuming
  - Take more time to obtain data
- Acts of recording may alter diet
  - Distortion of typical way of eating
- Analysis: labor intensive and expensive

Validity of Dietary Records

- Decreases with the length of recording!!!!
  - The longer is kept the less consistent the recording
    - More dependent on memory
    - Less cooperative
- Underreporting
  - Incomplete recording/impact on dietary choices
  - More common in obese respondents

Food Frequency Questionnaire

- Assess nutrient intake by determining the frequency of consumption of a limited number of foods **known to be major sources of the dietary components of interest**.

- Respondents indicate how many times a day, week, month or year the foods usually are consumed

Food Frequency Questionnaires

- Relatively high-quality data can be gathered on large groups of respondents

- **Data may be more representative of usual intake than a few days of diet records**

- Respondent must be able to describe their diets
- Foods and portion sizes included in questionnaires must be carefully chosen

Types of Food Frequency Questionnaires

- Simple or non-quantitative food frequency questionnaires format
- The semi-quantitative food frequency questionnaires format
- Quantitative food frequency questionnaires

Food item	Average use During Past Year				
	1 month	1-3 month	1-4 week	5-7 week	2-4 day
Coffee					
Dark bread					
Ice cream					

Simple or non-quantitative food frequency questionnaires format

answers : how many times ?

Food item	Average use During Past Year							
	1 month	1-3 month	1 week	2-4 week	5- 6 week	1 day	2-3 day	6+ day
Coffee (1 cup)								
Dark bread (1 slice)								
Ice cream (1/2 cup)								

Semi-quantitative food frequency questionnaires format

Food item	Medium Serving	Average use During Past Year							
		Your Serving size			How often?				
		S	M	L	Day	Week	Month	Year	Never
Coffee	(1 cup)						6		
Dark bread	(1 slice)								
Ice cream	(1/2 cup)								

Quantitative food frequency questionnaires format

Screener

- Targeted FFQ, to asses intake of certain nutrients
- Used when we don’t want to assess the total diet , limited resources
- The foods in each questionnaire are selected because they are the most important predictors of variability in intake of certain nutrient.

- There are a variety of screeners :
  - Fruits, veges
  - Dairy products
  - Processed meats
  - Fiber and whole grain
  - Added sugars
  - Red meats
  - Calcium
  - % of energy from total fats

- Look for screener example p76

  *fruits, veges screener p355

  * ***MEDIFICTS dietary assessment*** questionnaire : (meats, eggs, dairy, fried foods, in baked goods, convenience foods, table fats, snacks)

    to assess a person's intake of total fat, sat.fat, and dietary cholesterol

Willett questionnaire

- A self-administered, machine-readable, semi-quantitative questionnaire **used to link diet to risk of chronic disease**

- Some information is written in and has to be examined and coded by researchers

- It has been adapted for use with older children
- Used in the nurses' health study (170,000 participant)

Block questionnaire

- A self-administered, scannable quantitative food frequency questionnaire used for linking diet to cancer risk
- Reduced the 4312 NHANES food codes to 200 that group similar foods
- **Includes other lifestyle factors like smoking and physical activity**

Diet History Questionnaire

- A self-administered, scannable food frequency questionnaire also used for linking diet to cancer risk; contains 124 food items

- Designed to improve on the Block questionnaire:
  - Overcomes conceptual problems in filling it in
  - Updated to include recent American foods
  - Uses an improved method to convert food frequency into nutrient intake estimates

Diet History Questionnaire

- The questionnaire and the software for analyzing it can be downloaded for free from the National Cancer Institute website
- It seems to do the best job overall among the FFQs in measuring energy intakes and at least as well measuring intakes of nearly 70 other nutrients
- Nutrients analyzed page 78
- Multiple versions see p77
- On p 361 are the first few pages of the questionnaire

Food propensity questionnaire (NHANES FFQ)

- This is a combination of a 24-hour recall and a questionnaire on food propensity, that is, how often a person consumes each food and beverage (a kind of FFQ)
- It does not ask about quantities consumed except for the past 24 hours
- The NHANES now uses this with its two 24-hour recalls and gets reasonable data with good response rates

Strengths of Food Frequency Questionnaire

- Can be self-administered
- Easy to complete, code or scan
  - (Block 30 min; DHQ 60 min)
- Relatively inexpensive
- May be more representative of usual intake than a few days of diet records
- Modest respondent burden
- Ideal to study diet-disease relationship

Weakness of Food Frequency Questionnaire

- Fails to measure **details** of dietary intake.
- Quantification of intake is not very accurate (Not appropriate for determining absolute nutrient intake)
  - Incomplete listing of all possible foods
  - Errors in estimation of usual serving sizes
  - Problem in reporting foods in mixtures
- Grouping of food may limit interpretation of food intake
- Depend on ability of subject to describe diet

Validity of Food Frequency

- Food frequency with long lists of foods tend to yield higher estimates (**unrealistic**) of food and nutrient intake than quantitative methods.
- **Not** appropriate for determining **absolute nutrient intake**

Diet History

1. Ask general questions about person's health
2. Questions about his/her usual eating pattern

- Report about past diet
  - Assess usual intake patterns with details about characteristics of food consumed, as well as type, frequency and amount of foods intake.

3. May include ways to cross-check report
   - Recall, preferences, habits, diary
4. Complete 3 day food record (less helpful)

Strengths of Diet History

- Assess usual meal patterns and details of food intake and preparation
- May reflect more accurately long-term food intake.
  - Can detect seasonal changes
- Can obtain data on all nutrients

Weaknesses of Diet History

- Lengthy interview process
  - Time consuming
  - It takes 1-2 hours to administer, coding is difficult
- Require highly trained interviewers
  - Dietitian
- High respondent burden
  - Asked to make many **judgments** about usual food and amount of food intake
  - Requires high cooperative of respondent

Validity of Diet History

- Tend to overestimate nutrient intakes

Duplicate Food Collection

- Collection of duplicate food portions is a more direct method of assessing nutrient intake

- Avoids some of the problems associated with coding and entering data
- Avoids the limitations of food composition tables, such as nutrient losses during food storage and preparation

Duplicate Food Collection

- Respondents collect identical portions of all foods and beverages consumed during a specified period which are then analyzed for nutrient content
- Respondents concern about the expense of duplicate portions can alter eating habits, resulting in underestimates of nutrient intake

Strengths of Duplicate Food Collections

- Can provide **more accurate** measurements of actual nutrient intake than calculations based on food composition tables

Limitations of Duplicate Food Collection

- Expense and effort of preparing more food
- Effort and time to collect duplicate sample
- May underestimate usual intake

Food Accounts

- Food accounts are used to measure dietary intake within households and institutions where congregate feeding is practiced such as nursing homes
- The method accounts for:
  1. All food on hand in home or institutions at the beginning of the survey period
  2. All that is purchased or grown throughout the period
  3. all that remains by the ends of the survey
- Trained personnel make site visits at the beginning and ending of the survey period

Food Accounts

- The "daily mean consumption per person" is calculated for each food item from the total amount of food consumed during the period of the survey.

Strength of Food Accounts

- Suitable for use with large sample sizes
- Can be used over relatively long periods
- Gives data on dietary patterns and habits of families and other groups
- Less likely to lead to alterations in diet than some other methods
- Relatively economical

Limitations of Food Accounts Method

- Does not account for food losses
- Respondent literacy and cooperation necessary
- Not appropriate for measuring individual food consumption

Food balance sheets

- Provides data on food “disappearance” or “availability” rather than actual food consumption
- Mean per capita annual amounts are calculated by **dividing total food disappearance by the country’s population**
- It detects trends in food availability within a country over time and generates data that are useful in epidemiologic research across countries

Strengths of Food Balance Sheets

- Can give a total view of a country's food supplies
- Indicates food habits and dietary trends
- Used to plan international nutrition policies and food programs
- May be the only data available on a country's food consumption practices

Limitations of Food Balance Sheets

- Accuracy of data may be questionable
- Only represents food available for consumption
- Does not represent food actually consumed
- Does not indicate how food was distributed
- Does not account for wasted food

Telephone Interviews

- Become an accepted and widely used method for collecting dietary intake data
- Investigators have used the technique to administer 24-hour recalls and food frequency questionnaires

Strengths of Telephone Interviews

- One-quarter to one-half the costs of comparable personal interview
- Fewer time, and personnel constraints
- Lower respondent burden
- Gives respondent more personal security

Limitations of Telephone Interviews

- Subject to many of the same disadvantages of collecting 24-hour recall and food record data
- Estimating portion sizes in recalls may be difficult unless steps are taken to address the problem

Photographic and Video Records

- Several investigators have developed photographic and video methods to record dietary intake
  - To reduce respondent burden
  - To Increase validity of dietary intake data.
- Respondents were provided with an easily operated camera with a built-in electronic flash

Photographic and Video Records

- Participants photographed all their food before eating it and what was left after eating
- They recoded descriptions of their food and preparation method

- The exposed slid film was returned to the investigators for development and evaluation
- The slides were projected into a screen and estimates were made of each food.

Strengths of Photographic and Video Records

- Photographic method has good validity
- Video method has good validity and reproducibility
- Recording food intakes takes less time than 24-hour recalls or food records
- Respondent burden is less

Limitations of Photographic and Video Records

- Large initial expense is involved
- Periodic revaluations are recommended
- Unable to distinguish visually similar foods
- Subject to technical problems

Nutrition evaluation scale system

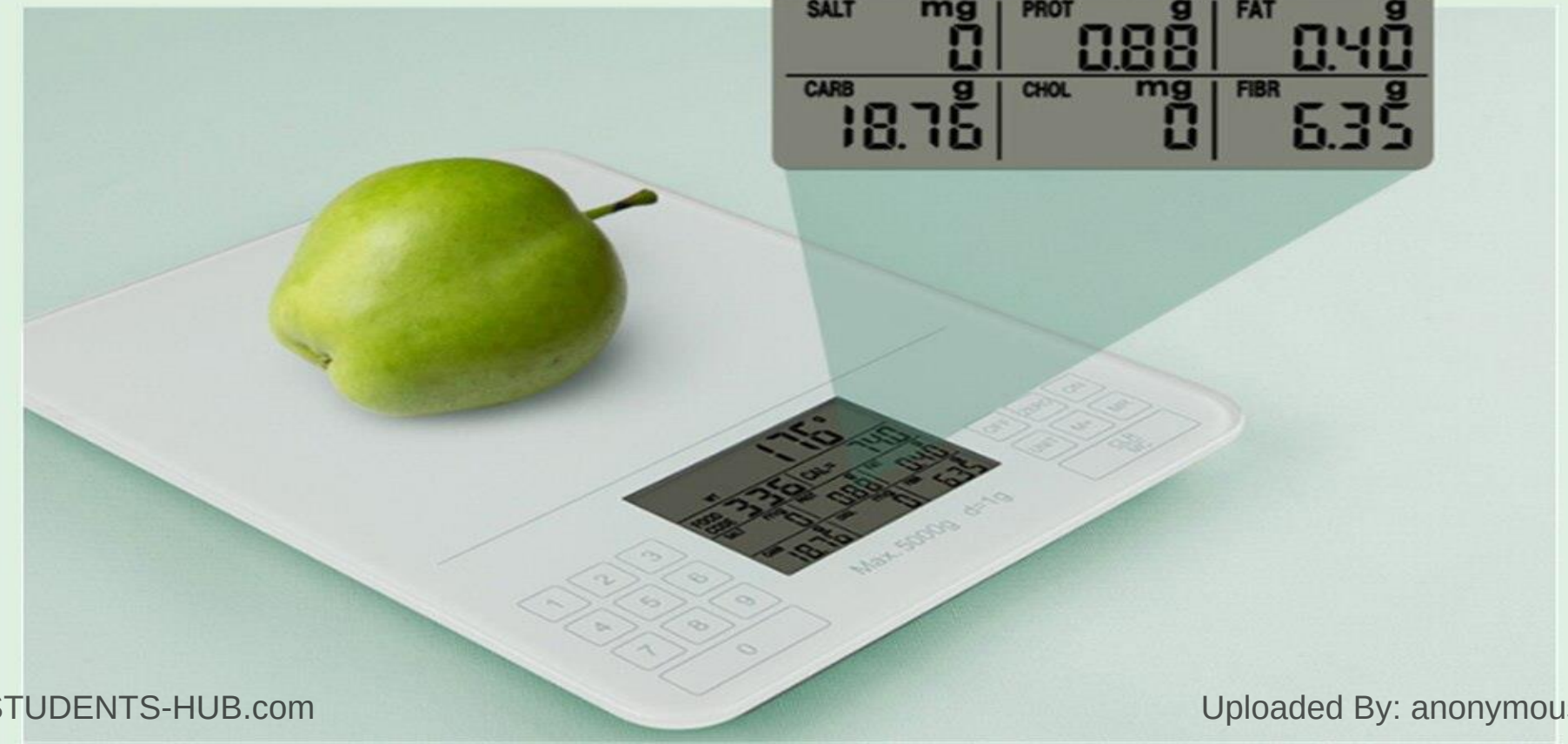
- An electronic scale interfaced with a handheld computer
- Before eating, the respondent enters the type of food into the computer and then weighs it. Weight of the plate and leftovers need to be weighed and the computer can subtract them.
- The respondent only needs to be able to respond to simple instructions
- Saves 80% of time and labor costs

Analysis 7 Kinds of Food Ingredients

SALT: 0mg PROT: 0.88g FAT: 0.40g

CARB:18.76g CHOL: 0g FIBR:6.35g

CAL: 74.0



Computer-assisted self-interviewing

- Respondents are led through a dietary intake interview at their own space
- The computer program standardizes data collection with appropriate levels of probing, makes certain all responses are complete, and finds inconsistent entries and encourages respondents to review and correct them
- Uses **colorful images** to help respondents remember foods, preparation methods and serving sizes

Computer-assisted self-interviewing

- Use of images and sound is motivational, thus getting high respondent rates
- Can be set up to work for people who are hearing impaired and for those with a low literacy level

Surrogate sources

- Respondents may be too young to respond or have problems with hearing, speech or memory loss or may be known to give incorrect or biased dietary information

- Others close to the respondent may then act as surrogates to provide some or all the needed information, especially if they prepare or share meals for the respondent

- Women do this better than men but surrogates can easily make mistakes

Considerations for certain groups

- For children who have had their 8th birthday (or less), interview them with a parent
- For younger children, you must obtain dietary information from a parent AND the kindergarten, school or daycare center
- For old people (especially males) or others with impaired memory, surrogates can help
- For visually impaired people, use large-print materials, oral methods

Considerations for certain groups

- For the hearing impaired, use self-explanatory print or computer-based materials. Use of sign language can help.
- For those who cannot read well, rely more on oral approaches or print materials designed for low reading levels
- For obese people, we know they tend to under-report food intakes. Carefully **getting help from a surrogate** may be useful

Estimating portion size

- Simple geometric shapes of various sizes may help and **can be as accurate as three-dimensional models**:
  - Use circles for round foods like oranges, hamburger patties, and cookies
  - Use square or rectangle for bread, cake, meat or cheese
  - Use pie-shaped models for pie, pizza, watermelon, etc

Estimating portion size

- Use household measures such as glasses, bowls, cups of various sizes, measuring spoons, measuring cups

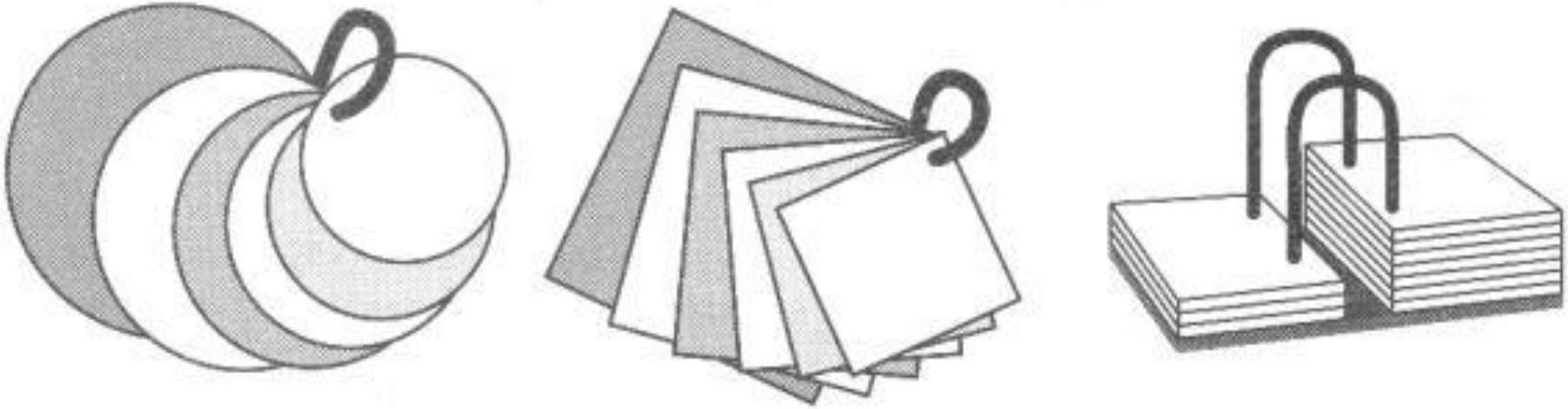


Figure 3.7
Simple geometric shapes representing foods are sometimes used to help survey participants estimate food portion size. Each piece has a known dimension (surface area or thickness) and is made from poster board or other materials.

Rating of Nutritional Assessment Techniques

- Validity
- Precision (Reproducibility or Reliability)

Validity

Ability of an instrument to actually measure what is intended to measure

- To accomplish that → we should compare estimate of intake from certain instrument with the person's usual intake (difficult!!!)

Relative validity

- Comparison of new instrument with another instrument **(gold standard),** which has a greater degree of demonstrated validity

- **Ex**: we can validate FFQ by comparing estimates of food and nutrient intake with estimate obtained from multiple food records or 24 hr recalls

Relative validity

- OR : compare intake data with certain biological markers associated with dietary intake (from urine, blood,…)
- Independent of respondent's accuracy and truthfulness
- Examples: urinary nitrogen, sodium, potassium, energy expenditure ,…
- Problem → many factors other than dietary intake can affect nutrient concentration in tissues

Reliability

- The ability of the method to produce the same estimate on two or more occasions

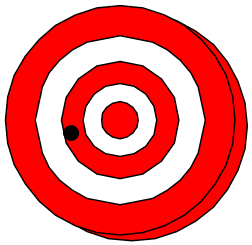
- Providing the same or similar answer two or more times
- and DOES NOT necessarily indicate whether the answer is correct

How Do We Evaluate Observer Measurement Reliability?

- **Test-retest method :**
  - Compare measurements made by the same observer/rater at two points in time
  - Time frame should be short enough that the construct itself hasn't changed
  - Calculating Cronbach's Alpha
    - ≥ 0.70 = adequate reliability for group comparisons
    - ≥ 0.90 = adequate reliability for individual monitoring

Reliability & Validity

- Reliability =consistency
- Validity = measuring what is intended



Unreliable
Invalid

Reliable
Invalid

reliable
valid

Relationship between Reliability and Validity

- They are closely inter-dependent
- There can not be validity without reliability
- There can be reliability without validity