Selecting a Measure of Dietary Intake for Children

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I want to measure 3rd grade students’ fruit and vegetable intake as the primary outcome for my study. I only have a couple of minutes, so I need to do it with one or two questions. What do you have?

(but impossible)
Diet Assessment

- Every measure has error
- Diet measures are fraught with error
- How much error can you tolerate?
  - Can you afford not to detect a true difference?
  - Can you afford not to detect a true relationship?

(For review of studies see: T Baranowski et al, Preventive Medicine 2004, 38: S1-S13)
Issues in Selecting a Method

- SPECIFIC TO YOUR STUDY -

- Prior Assessment
  - Validity
  - Reliability
  - Sensitivity to change

- Precision
  - Level of detail
  - Habitual behavior
  - Reactivity

- Appropriateness
  - Developmental
  - Ethnic
  - Regional

- Implementation
  - Procedures
  - Conversions
  - Respondent burden
  - Staff burden

- Costs
  - Financial

Developmental Considerations

- **0-7 years**
  - Probably need a proxy reporter or observer

- **8-10 years**
  - May need assistance (national surveys)

- **11-13 years**
  - Cognitive capabilities not clear

- **14 years +**
  - Answer like adults?
Characteristics of diet among adolescents

- Rapidly changing eating habits
- Unstructured eating (snacks, meal skipping)
- Eating away from home (31% foods)
- High levels of restrained eating
Characteristics related to diet assessment

- Increased under reporting with age
- Difficulty with time reference
- Greater under reporting among obese (high levels of overweight)
- Data collection in schools - challenging
Most of method research done in adults

- Methods usually work less well in children
Common Methods of Assessing Validity of Diet Assess

Compare against

- Observation of consumption - quantitative
  - At the food level
  - Reactive?
- Doubly labeled water - quantitative
  - Energy expenditure/intake
  - 2 weeks: urine/saliva
- Biomarkers – non quantitative
  - Nutrient specific
  - Blood sample
What do we usually want to do with dietary intake

- **Dependent measure**
  - Diet intervention work? (attenuation)

- **Classification**
  - Is this person in a high/low consuming group? (misclassification error)

- **Correlation with other variables**
  - Do children with this psychosocial characteristic eat more/less? (attenuation)
In outcome studies, unreliability reduces effective sample size.

Effective sample size can be calculated as: $\text{Effective sample} = n \times R$.
Misclassification Error

Identification of the errors of assignment of a single cut point when the true values are known

Observed intake

$x_o$

True intake

$x_T$

false negative  true negative

true positives  false positives

select cut point

(de Moor C et al Public Health Nutrition 2003, 6(4); 393-399)
Misclassification Error

Accuracy (AC) for four percentile cut points as the correlation between true and observed values increases.

(De Moor C et al Public Health Nutrition 2003, 6(4); 393-399)
Correction for attenuation

\[ r_T \sqrt{R_x R_y} = r_{xy} \]
Most common tools for measuring intake

- Food Frequency Questionnaire (FFQ)
- 24 hour dietary recall
- Food Record
- Innovative Methods
## Food Frequency Questionnaire (FFQ)

<table>
<thead>
<tr>
<th>Time covered</th>
<th>Diet assessed</th>
<th>Age group</th>
</tr>
</thead>
<tbody>
<tr>
<td>life long</td>
<td>whole diet</td>
<td>all adults</td>
</tr>
<tr>
<td>long ago</td>
<td>FV/fiber</td>
<td>children specific</td>
</tr>
<tr>
<td>last year</td>
<td>dietary fat</td>
<td>seniors specific</td>
</tr>
<tr>
<td>last month</td>
<td>specific micronutrients</td>
<td>ethnic specific</td>
</tr>
<tr>
<td>last week</td>
<td>portion size?</td>
<td>proxies for young children</td>
</tr>
</tbody>
</table>
Strengths of the FFQ

- Assesses entire diet re: specific nutrients or food groups
- Averages across time interval (<day to day var)
- Done in a short time interval (<1hr?)
- Requires no special expertise to administer
- Straight forward conversion to foods/nutrients
- Infrequent updating of nutrient data base or foods needed
Major Method Issues

Food Frequency Questionnaire

Adults:
- Supposed to cover long time, but test retest rel is low
- Error structure
  - Correlated errors
- Longer q’naires – higher over estimation
- Requires year long memory
  - Season effects?
- Requires averaging across irregular consumption
- Portion size est. adds little
- Identify under/over reporters & modify
Correlations backward in time between a retrospective estimate of minutes of aerobic activity per day from self-monitoring forms

- Indicates significance $a \leq 0.10$
- Indicates $r$ significance $\leq 0.05$
- Indicates $r$ is not significantly different from zero

Experimental Adults ($n=12$)
Control Children ($n=13$)
Experimental Children ($n=9$)
Control Adults ($n=12$)

Usual Method of FFQ Validation

FFQ vs multiple 24hdr

- Problem: Common self report errors

OPEN (Observing Protein and Energy Nutrition) Study
(among mostly middle class adults)

<table>
<thead>
<tr>
<th>Correlations</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td>24hdr</td>
<td>0.39</td>
</tr>
<tr>
<td></td>
<td>FFQs</td>
<td>0.19</td>
</tr>
<tr>
<td>Protein</td>
<td>24hdr</td>
<td>0.41</td>
</tr>
<tr>
<td></td>
<td>FFQs</td>
<td>0.33</td>
</tr>
</tbody>
</table>

(Subar et al Am J Epid 2003, 158; 1-13)
## OPEN Study (Subar et al)

<table>
<thead>
<tr>
<th>% Under reporting against biomarker</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy 24hdr</td>
<td>12-14%</td>
<td>16-20%</td>
</tr>
<tr>
<td>FFQs</td>
<td>31-36%</td>
<td>34-38%</td>
</tr>
<tr>
<td>Protein 24hdr</td>
<td>11-12%</td>
<td>11-15%</td>
</tr>
<tr>
<td>FFQs</td>
<td>30-34%</td>
<td>27-32%</td>
</tr>
</tbody>
</table>

- Under reporting increased with level of intake
When is FFQ appropriate

- Only need to determine a person’s relative position in a distribution on a particular food/nutrient
  - Better for group differences
  - Will use large samples
- Time & resource limited
- An instrument has been validated for the variable of interest in the target population under similar circumstances

(See J Cade et al Public Health Nutrition 2002,5: 567-587)
24 Hour Dietary Recall

Time covered
- yesterday
- last 24 hrs
- multiple recent days
- one meal/ lunch
- food recognition form

Diet assessed
- everything
- foods
- portion sizes
- add ons

Age groups

Variables possible
- foods/beverages consumed
- nutrients consumed
- meals/snacks pattern
- who was there
- when occurred
- duration of meal
- was TV on?
- where consumed
- from where did food come?
Strengths of the 24hdr

- Assesses one day with some accuracy
- Provides a more detailed data set
  - Food groups
  - By day, meal, snack
  - Nutrients
    - By day, meal, snack
  - Times eaten/duration
  - Who present
  - TV on?
  - Location of eating
  - Source of foods
  - Food practices/add ons
  - Food prep methods
Major Method Issues

24 Hour Dietary Recall

Adults:

- Need multiple days of assessment to overcome day to day variability
  - How many days?
Error is a function of time

S. Domel Baxter  (JADA 1997, 97:1293-8)

4th grade students

Design:

<table>
<thead>
<tr>
<th>Thursday</th>
<th></th>
<th>Friday</th>
<th></th>
<th>Monday</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observe</td>
<td>24hdr</td>
<td>(“next day”)</td>
<td>24hdr</td>
<td>(“after weekend”)</td>
</tr>
<tr>
<td>School</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lunch</td>
<td>24hdr</td>
<td>(“same day”)</td>
<td>(within 90 min)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Same Day</td>
<td>Next Day</td>
<td>After Weekend</td>
<td></td>
</tr>
<tr>
<td>--------------------------</td>
<td>----------</td>
<td>----------</td>
<td>---------------</td>
<td></td>
</tr>
<tr>
<td><strong>Match Rate</strong></td>
<td>84%</td>
<td>68%</td>
<td>38%</td>
<td></td>
</tr>
<tr>
<td><strong>Phantom Rate</strong></td>
<td>5%</td>
<td>13%</td>
<td>48%</td>
<td></td>
</tr>
<tr>
<td><strong>(Intrusions)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Omitted Rate</strong></td>
<td>16%</td>
<td>32%</td>
<td>63%</td>
<td></td>
</tr>
<tr>
<td><strong>(Forgotten)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(JADA 1997, 97:1293-8)
Can parents accurately report for their children?

**Procedure Design:**

<table>
<thead>
<tr>
<th>Procedure Design:</th>
<th>Sample Design:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Day 1</strong></td>
<td><strong>Day 2</strong></td>
</tr>
<tr>
<td>All day</td>
<td>Mother</td>
</tr>
<tr>
<td>observation</td>
<td>proxy</td>
</tr>
<tr>
<td>of child</td>
<td>24hdr</td>
</tr>
<tr>
<td>(7am–7pm)</td>
<td></td>
</tr>
</tbody>
</table>

 SES

<table>
<thead>
<tr>
<th>Low</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>At home ≤ 4.5hr</td>
<td></td>
</tr>
<tr>
<td>Not at home &gt; 4.5hr</td>
<td></td>
</tr>
</tbody>
</table>

(Baranowski et al JADA 1991, 91: 669-674)
Can parents accurately report for their children?

At home group: 27 of 29 could report
- Not at home group: 13 of 27 could report
- No difference by SES

(Baranowski et al JADA 1991, 91: 669-674)
## Agreement & Errors of Mothers against Observation

<table>
<thead>
<tr>
<th></th>
<th>All mothers</th>
<th>At home mothers</th>
<th>Not at home mothers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agreement</td>
<td>65%</td>
<td>67%</td>
<td>62%</td>
</tr>
<tr>
<td>Over reporting</td>
<td>10%</td>
<td>9%</td>
<td>12%</td>
</tr>
<tr>
<td>Under reporting</td>
<td>18%</td>
<td>19%</td>
<td>16%</td>
</tr>
<tr>
<td>Partial Agreement</td>
<td>7%</td>
<td>5%</td>
<td>10%</td>
</tr>
</tbody>
</table>

(Baranowski et al JADA 1991, 91: 669-674)
Limitations of the 24hdr

- Complicated to administer
  - Require RD, NDS cert?
- Multiple QC reviews
- Multiple non-contiguous days of assess
- Social desirability of response
- Substantial under reporting
- Takes 20-45 min/day to administer
- Benefits from NDS to prompt
- Portion size estimation problems
- Behav vs Epid Coding: What to Count?
- Complex program to est nutrients
- Regularly update program to est nutrients (20-30,000 new foods each year)
- Different software provide different nutrient estimates
Food Recognition Form

- List of foods
- Had yesterday? (yes/no)
  - by meal/snack

+++’s easy for children to complete
- - - ’s limited # of foods
  only one day
  no portion size

(Simons-Morton, Baranowski et al AJPM 1990, 6: 218-27)
Food Records

**Time covered**
- multiple random days
- multiple sequential days
- one day

**Diet assessed**
- everything
- weighed or not?
- portion sizes
- add ons

**Age groups**
- “9 yot?”

**Variables Possible**
- Same as 24hdr
Major Method Issues

Food Records

Children:
- Requires training
- Spelling problems (olivnacoqtal)
- Portion size problems – units/no referents
- Recall problems – if not done right after meal (fill out week’s record in front of center)
- Needs daily supervision/prompting/review
- Substantial coding time
- Need multiple days
- If weighed – need equipment
  - takes special people
Financial Costs

- Paper copies
- Software
- Portable hardware
- Scales
- Staff time administrator
  - Dietitian
  - RA
- Staff time QC
- Data entry staff time
Biomarker solutions

- Blood sample
  - Carotenoids
- DLW – saliva
  - Total energy
- Transdermal infrared technology
  - Iron, carotenoids (machine can be trained), glucose

Surrogate Variables

- Home food availability
- Grocery store purchases receipts
- Store food availability
Statistical Manipulation

- Post adjust distributions of intake from existing methods
  - Propensity to be missing adjustment
    (Carriquiry, *J Nutr* 2003, 133: 601S-8S)
  - Moment reconstruction
Innovations in Dietary Assessment

Technological solutions – minimal respondent burden

- Foods on trays with numbers
  - Take pictures before and after meal
    - Not catch spills/trades

- Point of purchase/service sales data
  - Supermarkets/groceries
  - Schools
    - Not consumption
    - Not who consumes
Innovations in Dietary Assessment

Technological solutions – more participant effort

- **Use cell phone with video**
  - Take and transmit pictures before and after meals
  - Use visual pattern recognition technique to identify foods and portions

- **Use USP bar codes to identify foods**
  - Queries for how much (also can be bar coded)

- **Diet Self Monitoring PDA**
  - Audio enhanced for children

- **Prompted Momentary Time Sampling with PDA or Cell Phone**
Innovations in Dietary Assessment

Technological solutions – substantial participant effort

- Computerized 24 hour dietary recall
  - Food Intake Recording Software System (FIRSSSt) (Baranowski et al JADA 2002, 102: 380-5)
  - ASA24 (Subar et al, 2006 abstract)
  - Teresita Hernandez
  - Zoellner et al (J Extension 2006, 44: 1-17)
Conclusions

- All measures have error
- Measures of diet have substantial error
  - Measures with children – even more error
- Tom’s order or preference
  - 24hdr
  - FFQ (only if have to)
- Gadgets & widgets offer some promise for the future, but no hope now