Reaching Consensus on a Global Dietary Diversity Indicator for Women
Washington, DC, July 15–16, 2014

Doris Wiesmann
July 15, 2014
Outline

• Criteria for data sets
• Exclusions from the sample
• Food group indicators
• Selected nutrients
• Estimated Average Requirements (EARs)
• Mean Probability of Adequacy (MPA)
• Statistical analysis
• Criteria of indicator performance
Criteria for data sets

- Resource-poor setting
- Women of reproductive age (15-49 years)
- Dietary data from 24-hour recall/direct observation or weighing of food
  - Good standard practice
  - Recipes disaggregated into ingredients
  - Food composition table (FCT) specific to study area
  - Sample size: ≥ 100 women with ≥ 40 repeat records
- Information on age, height, weight, pregnancy and lactation status
Exclusions from the sample

- Extremely low or high energy intakes
  - Ratio of Estimated Energy Intake/Basal Metabolic Rate (BMR): <0.9 (underreporter), >3.0 (overreporter) (Goldberg et al. 1991)
    
    $\text{BMR} = X + Y \times \text{weight}$
    - Age 15 – 18 years: $\text{BMR} = 692.6 \text{ kcal} + 13.384 \text{ kcal/kg} \times \text{weight}$
    - Age 18 – 30 years: $\text{BMR} = 486.6 \text{ kcal} + 14.818 \text{ kcal/kg} \times \text{weight}$
    - Age 30 – 49 years: $\text{BMR} = 845.6 \text{ kcal} + 8.126 \text{ kcal/kg} \times \text{weight}$

  - Personal judgment of principal investigator

- Incomplete or implausible food record

- Age below 15 or above 49 years
Food group indicators

- Disaggregation: 6, 9, 13, and 21 food groups
- Quantity restriction to count:
  - 1 g (FGI)
  - 15 g (FGI-R)
- Vitamin A-rich: > 60 RAE/100g
- Vitamin C-rich: > 9 mg/100g
- Food groups not considered:
  - Fats and oils (except for red palm oil)
  - Sweets and added sugars
  - Alcohol and other beverages (except for 100% juice)
# Food group indicators

<table>
<thead>
<tr>
<th>FGI-6</th>
<th>FGI-9</th>
<th>FGI-13</th>
<th>FGI-21</th>
</tr>
</thead>
<tbody>
<tr>
<td>All starchy staples</td>
<td>All starchy staples</td>
<td>All starchy staples</td>
<td>Grains and grain products</td>
</tr>
<tr>
<td>All legumes and nuts</td>
<td>All legumes and nuts</td>
<td>All legumes and nuts</td>
<td>Cooked dry beans and peas</td>
</tr>
<tr>
<td>All dairy</td>
<td>All dairy</td>
<td>All dairy</td>
<td>Milk/yoghurt</td>
</tr>
<tr>
<td>Other animal source</td>
<td>Organ meat</td>
<td>Organ meat</td>
<td>Eggs</td>
</tr>
<tr>
<td>foods</td>
<td>Eggs</td>
<td>Eggs</td>
<td>Small fish eaten whole with</td>
</tr>
<tr>
<td></td>
<td>Flesh foods and</td>
<td>Small fish eaten whole with all other flesh foods and miscellaneous small animal protein</td>
<td>Large whole fish/dried fish/shellfish and other</td>
</tr>
<tr>
<td></td>
<td>other miscellaneous</td>
<td></td>
<td>Beef, pork, veal, lamb, goat, game meat</td>
</tr>
<tr>
<td></td>
<td>small animal protein</td>
<td></td>
<td>Chicken, duck, turkey, pigeon, guinea hen, game</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Insects, grubs, snakes, rodents and other small</td>
</tr>
<tr>
<td>Vitamin A-rich fruits</td>
<td>Vitamin A-rich dark</td>
<td>Vitamin A-rich dark</td>
<td>Vitamin A-rich dark green leafy vegetables</td>
</tr>
<tr>
<td>and vegetables</td>
<td>green leafy vegetables</td>
<td>green leafy vegetables</td>
<td></td>
</tr>
<tr>
<td>Other vitamin A-rich</td>
<td>Vitamin A-rich deep</td>
<td>Vitamin A-rich deep</td>
<td>Vitamin A-rich deep yellow/orange/red vegetables</td>
</tr>
<tr>
<td>vegetables and fruits</td>
<td>yellow/orange/red</td>
<td>yellow/orange/red</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vitamin A-rich fruits</td>
<td>Vitamin A-rich fruits</td>
<td></td>
</tr>
<tr>
<td>Other fruits and</td>
<td>Other fruits and</td>
<td>Vitamin C-rich</td>
<td>Vitamin C-rich vegetables</td>
</tr>
<tr>
<td>vegetables</td>
<td>vegetables</td>
<td>vegetables</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>All other fruits and</td>
<td>Vitamin C-rich fruits</td>
</tr>
<tr>
<td></td>
<td></td>
<td>vegetables</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>All other fruits</td>
<td>All other fruits</td>
</tr>
<tr>
<td></td>
<td></td>
<td>and vegetables</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>All other vegetables</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>All other vegetables</td>
<td></td>
</tr>
</tbody>
</table>
## Selected nutrients

<table>
<thead>
<tr>
<th>Vitamins</th>
<th>Minerals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thiamin</td>
<td>Calcium</td>
</tr>
<tr>
<td>Riboflavin</td>
<td>Iron</td>
</tr>
<tr>
<td>Niacin</td>
<td>Zinc</td>
</tr>
<tr>
<td>Vitamin B6</td>
<td></td>
</tr>
<tr>
<td>Folate</td>
<td></td>
</tr>
<tr>
<td>Vitamin B12</td>
<td></td>
</tr>
<tr>
<td>Vitamin A</td>
<td></td>
</tr>
<tr>
<td>Vitamin C</td>
<td></td>
</tr>
</tbody>
</table>

- Other nutrients considered, but not selected:
  - Iodine (no reliable FCT data)
  - Vitamin D (no EAR, missing in many FCTs)
Estimated Average Requirements (EARs)

- For adolescent girls and for adult women by physiological status:
  - Non-pregnant non-lactating (NPNL)
  - Pregnant
  - Lactating
- Exceptions
  - Iron: skewed distribution of requirements for NPNL women, tables adapted from IOM (2000)
  - Calcium: method by Foote et al. (2004) using U.S. Adequate Intake
Mean Probability of Adequacy (MPA)

- Probability approach to assess nutrient adequacy (Barr et al. 2002) considers:
  - Intra-individual variation of nutrient intakes
  - Distribution of nutrient requirements
- Stata syntax provided by Maria Joseph and Alicia Carriquiry from Iowa State University
- Probability of adequacy (PA) for each micronutrient
- MPA: average PA across 11 micronutrients for each woman
- Three dichotomous indicators: MPA >50%, >60% and >70%
Mean Probability of Adequacy (MPA)

Probability approach to estimate probability of adequacy at individual and population level

Requirement distribution of nutrient X, defined by mean (EAR) and standard deviation (SD)

Red striped area: Probability of adequate intake (PA) of nutrient X

Estimated Average Requirement (EAR)

Estimated usual intake of nutrient X
Statistical analysis

• Stata software

• Descriptive analysis
  – Dietary patterns and FGIs
  – Energy, macro- and micronutrient intakes
  – PA of each micronutrient, MPA

• Correlation and regression analysis, scatter plots
  – FGIs and energy intakes
  – FGIs and MPA

• Receiver-operating characteristic (ROC) analysis
  – FGI performance in predicting MPA

• Sensitivity-specificity analysis
  – Selection of FGI cutoffs
Statistical analysis: sensitivity + specificity

- Low micronutrient adequacy (MPA≤60%)
- Acceptable micronutrient adequacy (MPA>60%)
**Statistical analysis: sensitivity + specificity**

<table>
<thead>
<tr>
<th>Less than 5 food groups (FGI&lt;5)</th>
<th>At least 5 food groups (FGI≥5)</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Sad face" /> <img src="image" alt="Sad face" /> <img src="image" alt="Sad face" /> <img src="image" alt="Sad face" /> <img src="image" alt="Sad face" /> <img src="image" alt="Sad face" /> <img src="image" alt="Sad face" /> <img src="image" alt="Sad face" /></td>
<td><img src="image" alt="Happy face" /> <img src="image" alt="Happy face" /> <img src="image" alt="Happy face" /> <img src="image" alt="Happy face" /> <img src="image" alt="Happy face" /> <img src="image" alt="Happy face" /> <img src="image" alt="Happy face" /> <img src="image" alt="Happy face" /></td>
</tr>
</tbody>
</table>

- Perfect classification!
  - Sensitivity: 100% *(green smileys in green field/all green smileys)*
  - Specificity: 100% *(red smileys in red field/all red smileys)*
  - Misclassification: 0% *(misclassified smileys/all smileys)*
  - Prevalence above MPA cutoff = prevalence at/above FGI cutoff = 50%
Statistical analysis: sensitivity + specificity

<table>
<thead>
<tr>
<th>Less than 5 food groups (FGI&lt;5)</th>
<th>At least 5 food groups (FGI≥5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>❌ ❌ ❌ ❌ ❌</td>
<td>☀ ☀ ☀ ☀ ☀</td>
</tr>
<tr>
<td>☀ ☀ ☀ ☀ ☀</td>
<td>☀ ☀ ☀ ☀ ☀</td>
</tr>
</tbody>
</table>

- (Almost) acceptable classification
  - Sensitivity: 70% (green smileys in green field/all green smileys)
  - Specificity: 70% (red smileys in red field/all red smileys)
  - Misclassification: 30% (smileys with yellow border/all smileys)
  - Prevalence above MPA cutoff = prevalence at/above FGI cutoff = 50%
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### Statistical analysis: sensitivity + specificity

<table>
<thead>
<tr>
<th>Less than 5 food groups (FGL&lt;5)</th>
<th>At least 5 food groups (FGL≥5)</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="#" alt="Red smileys" /></td>
<td><img src="#" alt="Red smileys" /></td>
</tr>
<tr>
<td><img src="#" alt="Green smileys" /></td>
<td><img src="#" alt="Green smileys" /></td>
</tr>
<tr>
<td><img src="#" alt="Yellow border smileys" /></td>
<td><img src="#" alt="Yellow border smileys" /></td>
</tr>
</tbody>
</table>

- Inacceptable classification (no association)
  - Sensitivity: 50% *(green smileys in green field/all green smileys)*
  - Specificity: 50% *(red smileys in red field/all red smileys)*
  - Misclassification: 50% *(smileys with yellow border/all smileys)*
  - Prevalence above MPA cutoff = prevalence at/above FGI cutoff = 50%
Statistical analysis: sensitivity + specificity

<table>
<thead>
<tr>
<th>(FGI&lt;6)</th>
<th>(FGI≥6)</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="red_smiley_faces.png" alt="Red Smiley Faces" /></td>
<td><img src="yellow_smiley_faces.png" alt="Yellow Smiley Faces" /></td>
</tr>
<tr>
<td><img src="green_smiley_faces.png" alt="Green Smiley Faces" /></td>
<td><img src="green_smiley_faces.png" alt="Green Smiley Faces" /></td>
</tr>
</tbody>
</table>

- Inacceptable classification (no association), higher FGI cutoff
  - Sensitivity: 30% *(green smileys in green field/all green smileys)*
  - Specificity: 70% *(red smileys in red field/all red smileys)*
  - Misclassification: 50% *(smileys with yellow border/all smileys)*
  - Prevalence above MPA cutoff = 50%, prevalence at/above FGI cutoff = 30%
Statistical analysis: ROC analysis

Sensitivity = 50%
Specificity = 60%

Area under ROC curve = 0.5932

FGI-6 versus MPA > 50%, Bangladesh site, WDDP I
Statistical analysis: ROC analysis

FGI-6 and FGI-6R vs. MPA > 50%, Bangladesh site, WDDP-I
Criteria for indicator performance

- Area under the Curve (AUC) from ROC analysis
  - Significantly (p< 0.05) greater than 0.50
  - AUC ≥ 0.70: “reasonable potential”
  - Statistically significant differences (p< 0.05) between AUC of food group indicators

- Sensitivity-specificity analysis
  - Sensitivity > 60%
  - Specificity > 60%
  - Total misclassification < 30%
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