Development of a Glycemic Index Database for Dietary Assessment

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What is glycemic index?

- Applies only to carbohydrate foods.
- Ranks foods based on their effect on postprandial glycemia.
- Determined *in vivo*.
- Measures glucose response of a reference food (e.g. glucose or white bread). By definition, GI = 100.
- Measures glucose response of test food.
- Ratio of the area under the curve of the test food to the reference food X 100 = GI.
The two hour blood sugar response of a reference food vs a test food

Reference food

Test food

Glucose, GI score = 100

Lentils, GI score = 40

The amount of carbohydrate (starch & sugars) in the reference and test foods must be the same.
Factors Affecting Glycemic Index

- **Higher GI**
  - Starch gelatinization
  - Moist cooking methods
  - Refined grains
  - Amylopectin starch

- **Lower GI**
  - Amylose starch
  - Resistant starch
  - Intact grains
  - Fermentation
  - Dairy protein
  - Fructose
Classifying Foods

- **High GI = 70 or more**
  - White Bread
  - Processed Cereals
  - Potatoes
  - White Rice (low amylose)

- **Medium GI = 56 to 69**
  - Rye bread
  - Banana
  - White rice (high amylose)
  - Sweet corn

- **Low GI = 55 or less**
  - Milk
  - Apple
  - Legumes
  - Pasta
  - All Bran cereal
Carbohydrate Intake and Chronic Disease

- Diabetes
- Coronary Heart Disease
- Obesity
- Cataracts
- Cancer
Nutrition Data System for Research (NDSR)

- Standardized collection of food intake data
- Database of 18,000+ foods based on 2258 core foods
- Core foods determine nutrient values for other foods
  - Similar foods
  - Recipes
  - Commercial product formulations
Database Preparation for Addition of Glycemic Index

- Added two fields for GI.
  - Glucose reference
  - Bread reference
  - GI (bread) = 1.43 X GI (glucose)

- Added field for available carbohydrate.
  - acho = total carbohydrate – total dietary fiber
Determining GI Values for NDSR Foods

- Match core foods to published GI.
- Estimate GI from a similar food.
- Use a default GI for low carbohydrate foods.
- Assign GI = 0 for foods with no available carbohydrate.
- Calculate GI for multi-component foods from available CHO and GI of ingredients.
Matching to Published GI Values

- Select data sources.
  - International Table of Glycemic Index and Glycemic Load Values: 2002 (Foster-Powell et al)
  - Other current journals

- Match by description, type of carbohydrate, preparation or processing method.

- Select North American foods, healthy subjects, 2 hr glucose response.
Estimating GI from Similar Foods

- Average GI for similar food group
  - Starchy root vegetables
  - Legumes
  - Tropical fruits
  - Berries
  - Nuts
- Cheese = GI of milk
- Refined white flour = GI of white bread
- Luncheon meats with cereal fillers = GI of sausage
Default and Zero Values

- Foods with low carbohydrate content
  - Default GI = 50 (glucose reference)
  - Midway between 0 and 100
  - Diet GI is not affected appreciably by the default value

- Foods with no available carbohydrate
  - GI = 0
## Calculating GI for Multi-component Foods

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>ACHO (g)</th>
<th>Proportion of total ACHO</th>
<th>Ingredient GI</th>
<th>Proportional GI (proportion of total ACHO X ingrd GI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figs, dried</td>
<td>14.12</td>
<td>0.2119</td>
<td>61</td>
<td>12.9</td>
</tr>
<tr>
<td>Flour, white, all-purpose</td>
<td>17.79</td>
<td>0.2670</td>
<td>70</td>
<td>18.7</td>
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<tr>
<td>Corn syrup</td>
<td>12.92</td>
<td>0.1939</td>
<td>105</td>
<td>20.4</td>
</tr>
<tr>
<td>Sugar, white, granulated</td>
<td>16.81</td>
<td>0.2523</td>
<td>61.4</td>
<td>15.5</td>
</tr>
<tr>
<td>High fructose corn syrup</td>
<td>4.95</td>
<td>0.0743</td>
<td>73</td>
<td>5.4</td>
</tr>
<tr>
<td>Shortening, soybean</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Eggs, whole</td>
<td>0.03</td>
<td>0.0005</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Salt</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total for Food</strong></td>
<td><strong>66.62</strong></td>
<td><strong>1.0000</strong></td>
<td><strong>72.9</strong></td>
<td><strong>72.9</strong></td>
</tr>
</tbody>
</table>
The GI Database in

- Carbohydrate-containing foods
  - 22% direct matches
  - 23% similar matches
  - 17% default GI
  - 38% calculated from ingredients

- Major carbohydrate contributors
  - 60% direct matches
  - 19% similar matches
  - 1% default GI
  - 20% calculated from ingredients
Evaluation of Calculation Method

<table>
<thead>
<tr>
<th></th>
<th>Median</th>
<th>Mean</th>
<th>S.D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculated GI</td>
<td>66.0</td>
<td>64.3</td>
<td>9.9</td>
</tr>
<tr>
<td>Analyzed GI</td>
<td>64.5</td>
<td>61.3</td>
<td>16.2</td>
</tr>
</tbody>
</table>
Evaluation of Calculation Method

- Calculation underestimates GI.
  - Unsweetened RTE cereals

- Calculation overestimates GI.
  - Sweetened dairy products
GI Database Limitations

- Limited GI values for U.S. foods.
- Unable to account for variation in cooking times, storage, fruit ripeness.
- Lack of GI values for ingredients used in commercially processed foods.
Future GI Database Modifications

- Addition of more GI values from U.S. foods.
- Addition of “gelatinized cereal grains” for RTE cereal calculations.
- Addition of “low-GI sugars” for use in dairy food calculations.
- Addition of more core foods to increase GI specificity.
Uses of the GI Database

- Determine diet GI.
- Rank high carbohydrate foods.
- Substitute low-GI foods for high-GI foods.
- Couple GI with nutrient density to assess food quality.