Beyond Carb Counting: The Relationship Between Glycemic Variability and Carbohydrates

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Objectives
- Define glycemic variability
- Nutrition goals for people with diabetes
- Understand differences between type and amount of carbs
- Define different types and benefits of dietary fiber
- Define Glycemic Index (GI) and Glycemic Load (GL)
- Explain how to incorporate GI and GL into diet

What is Glycemic Variability?
Spikes in glucose levels from pre-meal to post-meal
- Post-meal blood glucose checks 3 hours after start of meal
Questions to Ask....
- How long does the blood glucose stay high?
- How high does the blood glucose spike?
Both impact A1c-approximately 1% and contribute to diabetes complications

Managing Blood Glucose-Balancing Act!

What Effects Glycemic Variability?
- Sensitivity to Insulin
- Carbohydrate Counting: Underestimating GI
- Compliance: Forgetting to Bolus

How to Measure Glycemic Variability
- CGMS (Continuous Glucose Monitoring System)
  - Real-time Sensor
- SMBG (Self-monitoring Blood Glucose)
  - Post meal BG should be 50 points within the pre-meal BG
  - Test 3 hours after starting the meal
Timing of Insulin and Carbohydrates

Carbohydrate Metabolism
- After first bite, BG levels increase within 10-15 minutes
- Peak within 60-90 minutes
- Takes 2-4 hours for BG to return to pre-meal level

Timing of Insulin
- Pre-meal vs. Post-meal
- Lag Time - Realistic?
  - Inject insulin 10 minutes before meal (BG ~100)
  - Inject insulin 20 minutes before meal (BG ~200)
  - Inject insulin 30 minutes before meal (BG ~300)

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Issues with Post Meal Dosing

Effect of Different Nutrients on Blood Glucose

Protein
- Minimal effect on blood glucose
- Eating large portions may require insulin

Fat
- Delays food digestion
- May result in delayed hyperglycemia

Carbohydrates
- Greatest impact on blood glucose
- High fiber, glycemic index and resistant starch may improve blood glucose

Goals of Nutrition Therapy for Adults With Diabetes

1. To promote and support healthful eating patterns, emphasizing a variety of nutrient-dense foods in appropriate portion sizes, in order to improve overall health and specifically to:
   - Achieve and maintain body weight goals
   - Attain individualized glycemic, blood pressure, and lipid goals
   - Delay or prevent the complications of diabetes
2. To address individual nutrition needs based on personal and cultural preferences, health literacy and numeracy, access to healthful foods, willingness and ability to make behavioral changes, and barriers to change
3. To maintain the pleasure of eating by providing nonjudgmental messages about food choices
4. To provide an individual with diabetes the practical tools for developing healthful eating patterns rather than focusing on individual macronutrients, micronutrients, or...
Accuracy of Carb Counting Effects Glycemic Variability
- Weighing Carbs
- Measuring Carbs
- Carbohydrate Factors

Can’t Always Measure Carbs?
- Average adult’s fist = 1 cup
- Baseball = 1 cup
- Child’s fist = 1/2 cup
- Cupped hand = 1/2 cup
- Deck of cards = 3 ounces meat
- Half-pint of milk = 1 cup
- Tennis ball = ¾ cup

Not All Carbs Are the Same!
Types of Carbs

Refined/Simple
- Milk
- Fruit
- Desserts
- Sweets
- Juice
- Enriched Wheat, Unbleached Flour
- Pretzels, chips, white bread/pasta/rice

Whole Grain
- 100% whole grain bread, pasta, cereal, crackers
- Brown rice
- Popcorn
- Quinoa
- Barley/Buckwheat
- Rye
- Oatmeal and whole oats

Benefits to Eating Fiber Rich Foods
- Research shows eating 44-50 g dietary fiber/day improves BG compared to less than 24 g/day
- Not digested and absorbed
- Lower calories
- Improves fullness/weight management

How Much Fiber Do We Need?
DRI Fiber Recommendations

- 1-3 years: 19 g
- 4-8 years: 25 g
- 9-13 years: 26-31 g
- 14-18 years: 26-38 g
- 19-50: 25-30 g
- 50+: 21-30 g

Fiber Grams

- 1 medium apple with skin: 3 g
- 1 medium banana: 3 g
- 1 cup cooked broccoli: 2 g
- 1 whole wheat tortilla: 2.5 g
- 1 cup almonds: 3 g
- 1 cup Fiber One cereal: 14 g
Reading Food Labels

• Choose whole-grain products with 3 grams of fiber or more per serving

Are All Fibers Alike?

- Beta glucan (barley and oats) guargum, psyllium, resistant starch, maltodextrin, inulin (chicory root, Jerusalem artichoke)

Blood Glucose Lowering

- Beta glucan (barley and oats), guar gum, pectin (citrus fruits), psyllium (Metamucil)

Improve Cholesterol and Reduce Inflammation

- Beta glucan (barley and oats), inulin (chicory root, Jerusalem artichoke), agave, pectin (fruit fiber), psyllium

Improve GI Health (Prebiotic)

White Whole Grain?

• Same nutritional advantages of traditional whole wheat, but with lighter color and milder taste

• Contains WHOLE flour – including the bran, germ and endosperm – made from WHITE wheat

Compare White Whole Grain vs. Whole Wheat

Nutrition Facts/2 oz dry

- Total Carbs: 43 g
- Dietary Fiber: 6 g
- Ingredients: Semolina (Wheat), Durum Wheat Flour, Whole Durum Wheat Flour, Corn Starch, Niacin, Iron (Ferrous Sulfate), Thiamine Mononitrate, Riboflavin, Folic Acid.

Nutrition Facts/2 oz dry

- Total Carbs: 41 g
- Dietary Fiber: 6 g
- Ingredients: Whole Grain Durum Wheat Flour, Semolina (Wheat), Durum Wheat Flour, Oat Fiber

Ways to Add Fiber

Homemade trail mix with dried fruit
Add fresh fruit to breakfast and dinner
Mix bran or whole grain cereals with your favorite cereal
Eat oatmeal for breakfast
Mix Kaashi into yogurt
Add salad or raw vegetables before dinner
Try whole wheat pasta or brown rice

What is the Glycemic Index or Glycemic Load?

Glycemic Index (GI)

- Introduced in 1981
- Blood glucose response of a 50 g carb portion of a food compared to glucose or white bread

Statement from the ADA:
“Low-glycemic index diets can produce a modest benefit in controlling postprandial hyperglycemia”

Glycemic Load (GL)

- The effect of a portion of food has on blood glucose
- GI x carbohydrate grams/100
What Affects a Food’s GI?

- **Botanical**
  - Different Variety of Foods (Rice/Potatoes)

- **Processing of Food**
  - Instant vs. Steel-Cut Oats
  - More finely ground grain (Higher GI)

- **Fiber**
  - Oats, barley and legumes (Lower GI)

- **Preparation of Food**
  - Al dente vs Fully Cooked pasta

- **External Factors**
  - Prior food intake
  - Blood glucose level at the time of meal
  - Exercise

GI and GL Ranges

- **Glycemic Index**
  - Low GI= ≤55
  - Moderate GI= 56-69
  - High GI= 70+

- **Glycemic Load**
  - Low GL= ≤10
  - Moderate GL=11-19
  - High GL=20+

How to Calculate GL

\[
\text{Glycemic Load} = \frac{\text{Glycemic Index} \times \text{grams of carbohydrate}}{100}
\]

Example:

- Watermelon GI: 72
- 1 ¼ cup: 14 g

\[
\text{Calculate GL} = \frac{14 \times 72}{100} = 10.08
\]

Take Home Message

- Watermelon has a HIGH GI but a LOW GL depending on portion size

Food Values: Glycemic Index/Glycemic Load

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<thead>
<tr>
<th></th>
<th>Low GL</th>
<th>Med GL</th>
<th>High GI</th>
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<tbody>
<tr>
<td><strong>Low GI</strong></td>
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<td>Alkalai cereal (8.4)</td>
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<td>Apples (6.3)</td>
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<td>Carrots (5.7)</td>
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<td>Peanuts (1.14)</td>
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<td>Strawberries (2.48)</td>
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<td>Sweet Corn (1.54)</td>
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<td><strong>Med GI</strong></td>
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<td>Apple juice (11.4)</td>
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<td>Bar-lean (11.5)</td>
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<td>Butternut (10.4)</td>
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<td>Orange juice (10.6)</td>
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<td>Bread/hard wheat bread (15.5)</td>
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<td>Life cereal (16.00)</td>
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<td>New potatoes (13.43)</td>
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<td>Rice (16.54)</td>
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<td>Oatmeal (15.71)</td>
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<td><strong>High GI</strong></td>
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<td>Linguine (23.02)</td>
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<td>Macaroni (22.17)</td>
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<td>Spaghetti (20.42)</td>
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<td>Couscous (22.65)</td>
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<td>White rice (23.56)</td>
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<tr>
<td>Baked Sweet potatoes (32.75)</td>
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<tr>
<td>Cornflakes (21.41)</td>
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Source: Revised International Table of Glycemic Index (GI) and Glycemic Load

The Effect of a Low-Glycemic Diet vs. a Standard Diet on Blood Glucose Levels and Macronutrient Intake in Children with Type 1 Diabetes (Journal of American Dietetic Assoc. 2006;109:333-307)
Effects of meals with different glycaemic index on postprandial blood glucose response in patients with Type 1 diabetes treated with continuous subcutaneous insulin infusion (Diabetic Medicine. 2001. 28, 227-229)

Study in Adults with Type 1 DM
- Fat, Carbs, Fiber and Calories were similar
- Low GI Diet: 59
  - Legumes, pasta, olive oil, apple, tuna fish
- High GI Diet: 90
  - Rice, tuna fish, white bread, olive oil, banana

Lower GI Diet: High fiber diet
- Average BS: 124
- A1C: 6.3%
- Less Glycemic Variability

High GI: Low fiber diet
- Average BS: 173
- A1C: 7.8%

Pros and Cons of GI

Pros
- Minimizes blood glucose peak
- Increases dietary fiber intake if choosing more whole grains
- May improve lipid levels if high fiber, low GI foods are eaten

Cons
- Not accurate when eating a mixed meal
- Unreliable (variable responses among test subjects)
- Limited food choices
- May increase fat intake
- No long-term studies in children with T1DM

When should your patient eat high GI foods?

Sports
- To increase BG levels quickly
- Sports drinks, gels and carb chews

Hypoglycemia
- Protein and fat with carbs delays high BG
- 100% glucose best choice to raise BG quickly
Substituting High GI for Low GI

**High GI Food**
- White bread
- Puffed and flaked breakfast cereals
- Plain crackers
- White Potatoes
- White Rice

**Low GI Food**
- Whole grain bread
- Whole grain cereals (steel-cut oats)
- Whole grain crackers
- Sweet potatoes
- Brown rice, quinoa, white grain pasta

How to Lower Glycemic Variability...
- Check blood glucose 3 hours after meals; look for patterns
- Eat more dietary fiber
- Consider GI and/or GL
- Bolus insulin before meals/snacks
- Consider dual-wave bolus for low GI foods
- Eat lower fat

What Does this ALL Mean?
- Most fruits and vegetables
- Whole grains
- Legumes
- Eat foods high in sugar in moderation
- Don’t completely avoid sugar to prevent overeating
- Eat in smaller portions
- Don’t carb restrict to control glucose levels
- About half of your calories should come from carbs
- Unexplained highs? Measure carbs
- Try Carbohydrate Factors, carb apps, books/websites

MNT delivered by a registered dietitian is associated with A1C decreases of 0.3–1% for people with type 1 diabetes and 0.5–2% for people with type 2 diabetes.