# Glycemic Index:
## *from Research to Practice*

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# Outline

- Selection of Topic and CFDR
- Background of Glycemic Index
- Rationale for CFDR-Funded Study
- Presentation of CFDR-Funded Study
- Impact of Study
- Future Directions

# Selection of Topic

- **Personal interest in GI since undergrad**
- **Growing evidence base in prevention and management of *diabetes, obesity and CVD***
- **Recommended by *Canadian Diabetes Association* (CDA) for use in clinical practice**

# Selection of CFDR

- **Support practice-based research by dietitians**
- **Topic in line with criteria for funding**

  ***emerging concept with important health implications for Canadians***
- **Relevant to the practice of dietitians**

# Glycemic Response vs. Glycemic Index

- **Glycemic response to food refers to the *extent* to which blood glucose (BG) *rises* with food ingestion**

# Glycemic Response vs. Glycemic Index

- **Glycemic Index (GI)** was developed in 1981, by Dr. David Jenkins of the University of Toronto, as a way to ***standardize*** the ***glycemic response*** to carbohydrates (i.e., sugars and starch) and carbohydrate-containing foods (grain products, fruits, vegetables, milk products)

# Glycemic Index: Definition

- **The GI describes the *glycemic response* to ingestion of 25g or 50g **available carbohydrate* in a test food compared to 25g or 50g available carbohydrate in a reference food**

***Reference food= glucose or white bread***

****available carbohydrate (excludes fibre)***

# Glycemic Index: Definition

- **Ranks the *postprandial glycemic response* to different sources of carbohydrate, *reflecting the rate of conversion of carbohydrates into glucose***

- **Expressed as the *incremental area* under the BG response curve, above baseline, over a period of 2 to 3 hours**

# Glycemic Index: Definition

- **Quickly converted carbs (High GI)**

  ⇒ *greater rise in BG and insulin secretion*

- **Slowly converted carbs (Low GI)**

  ⇒ *lower BG concentrations and lower insulin responses*

# Glycemic Index: Methodology

- **Individuals, similar health status, consume 25g or 50g available carb in test food and 25g or 50g available carb in reference food in *random order***
- **BG measured every 15-30 minutes over 2-3 hours**
- **The reference food (glucose or white bread) assigned value of 100, against which test foods are compared**
- **Mean GI from 8-10 individuals is used as the GI rating for a particular food**

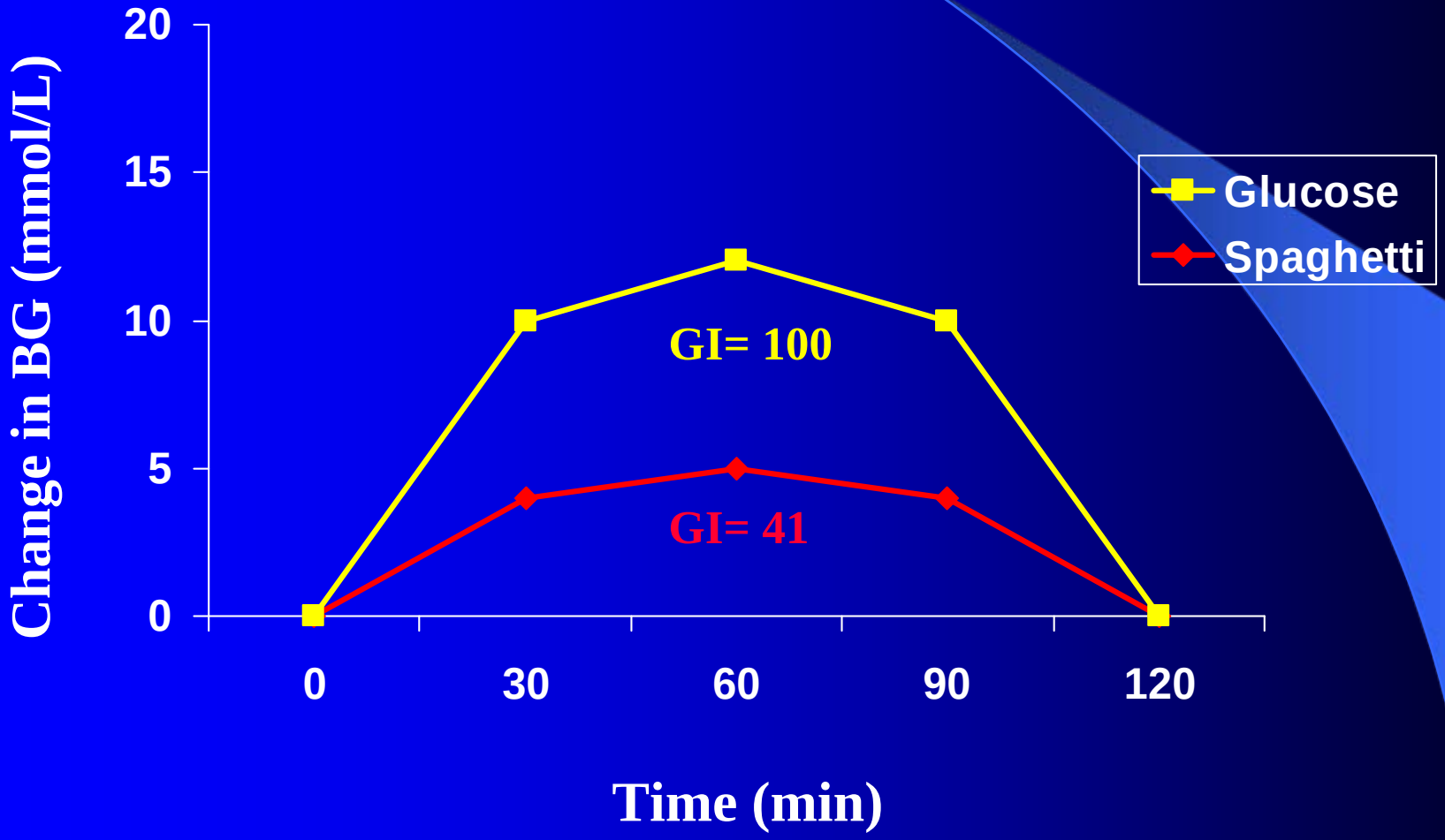
# Glycemic Index: Calculation

$$GI = \frac{\text{Incremental BG area of 25g or 50g carbohydrate in test food}}{\text{Incremental BG area of 25g or 50g carbohydrate in reference food}} \times 100\%$$

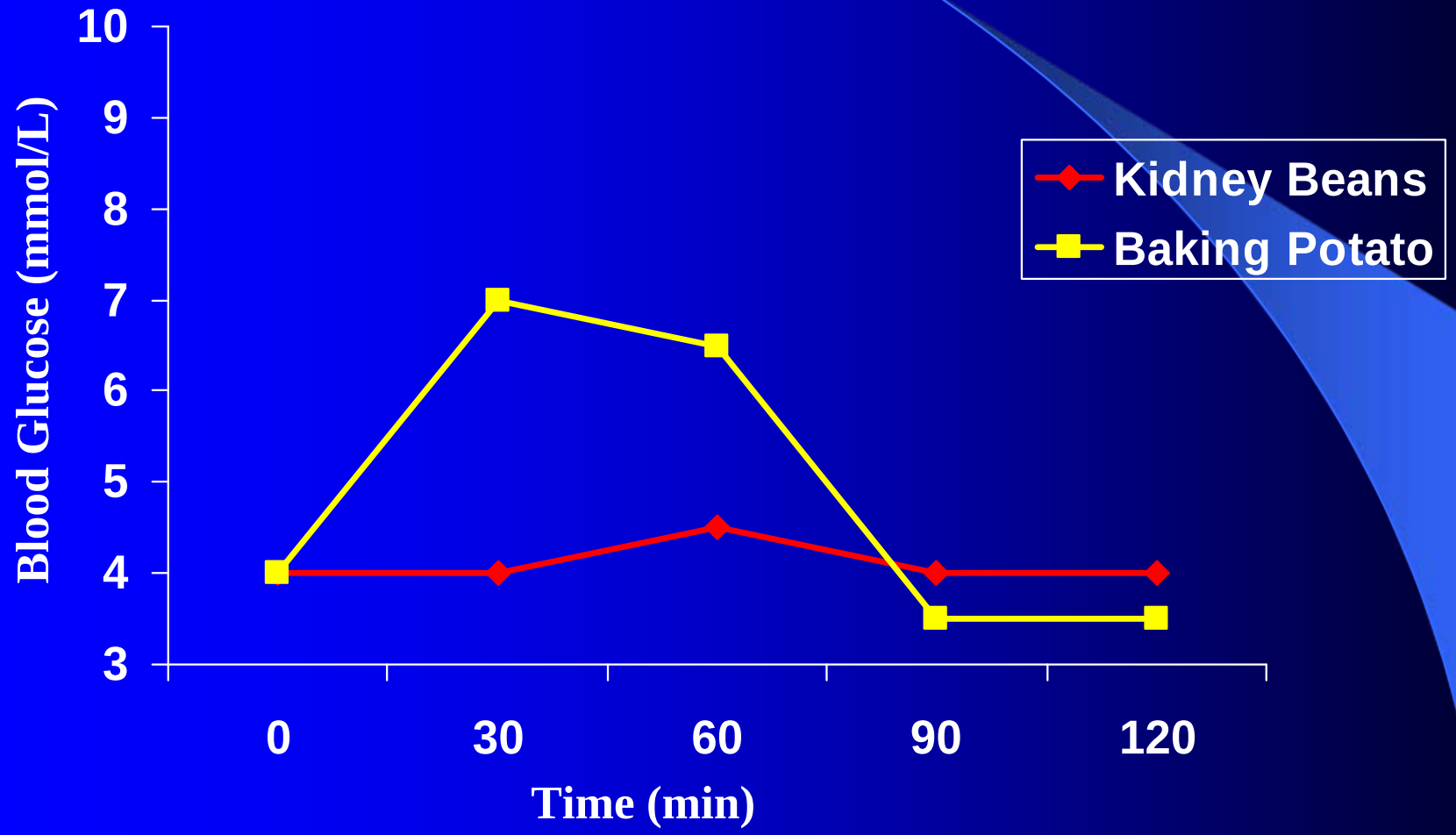
# Glycemic Index: Categories

| Category | GI Rating (%) |
| --- | --- |
| Low | ≤ 55 |
| Medium | 55-69 |
| High | ≥ 70 |

# Glycemic Index of Spaghetti



# Blood Glucose Concentrations with High vs. Low GI Foods




Adapted from: Anderson et al. *Modern Nutrition in Health and Disease*. 2001

# Areas of Controversy

- Application in mixed meals
- Effectiveness (relevance to health)
- Use in clinical practice

# Application in Mixed Meals

- **Typical servings may not reflect portions used in GI testing (i.e. 25g or 50g carbohydrate)**

- **Impact of other nutrients, *especially fat and protein***

# Application in Mixed Meals : Evidence

- **GI can predict *glycemic* and *insulin* responses when applied to mixed meals in individuals with and without diabetes**

**Wolever et al. Diabetes Care, 1988; Collier et al. Am J Clin Nutr, 1986; Chew et al. Am J Clin Nutr, 1988; Wolever et al. Diabetes Care, 1990; Wolever et al. J Nutr, 1996**

# Evidence for Glycemic Index

- Prevention of type 2 Diabetes
- Management of BG and Lipids in type 1 and 2 diabetes
- Prevention of Cardiovascular Disease
- Prevention and management of Obesity

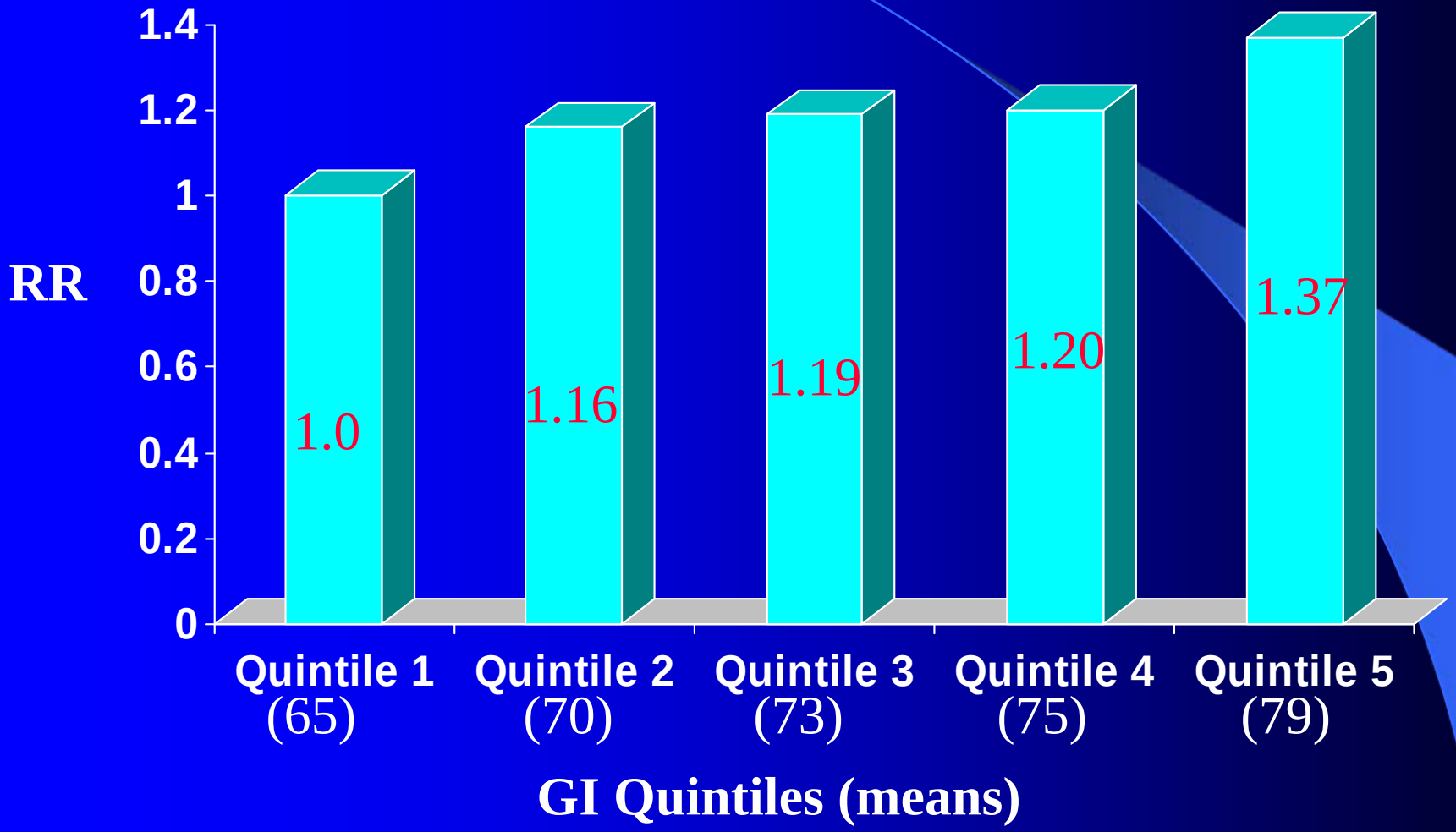
# GI in Prevention of type 2 Diabetes

- **2 large epidemiological studies:**
  - Nurses' Health Study and Health Professionals' Study of Harvard University

⇒ ***High GI intake positively associated with increased risk of developing type 2 diabetes***

**Salmeron J et al. Diabetes Care, 1997;**
**Liu et al. Am J Clin Nutr, 2000**

# Glycemic Index and type 2 DM Risk




Salmeron et al. Diabetes Care, 1997
Health Professionals' Study

# GI in Management of types 1 and 2 Diabetes

- **Meta-analysis of randomized, controlled trials of low GI diets in management of type 1 and 2 diabetes concluded that:**

  ***⇒ Choosing low GI in place of high GI foods has a clinically significant effect on glycemic control***

**Brand-Miller J et al. Diabetes Care, 2003**

# Other Benefits for People with Diabetes

- **Reduced number of hypoglycemic episodes**

  **Giacco et al. Diabetes Care, 2000**

- **Improved Quality of Life**

  **Gilbertson et al. Diabetes Care, 2001**

# GI in CVD and Risk Management

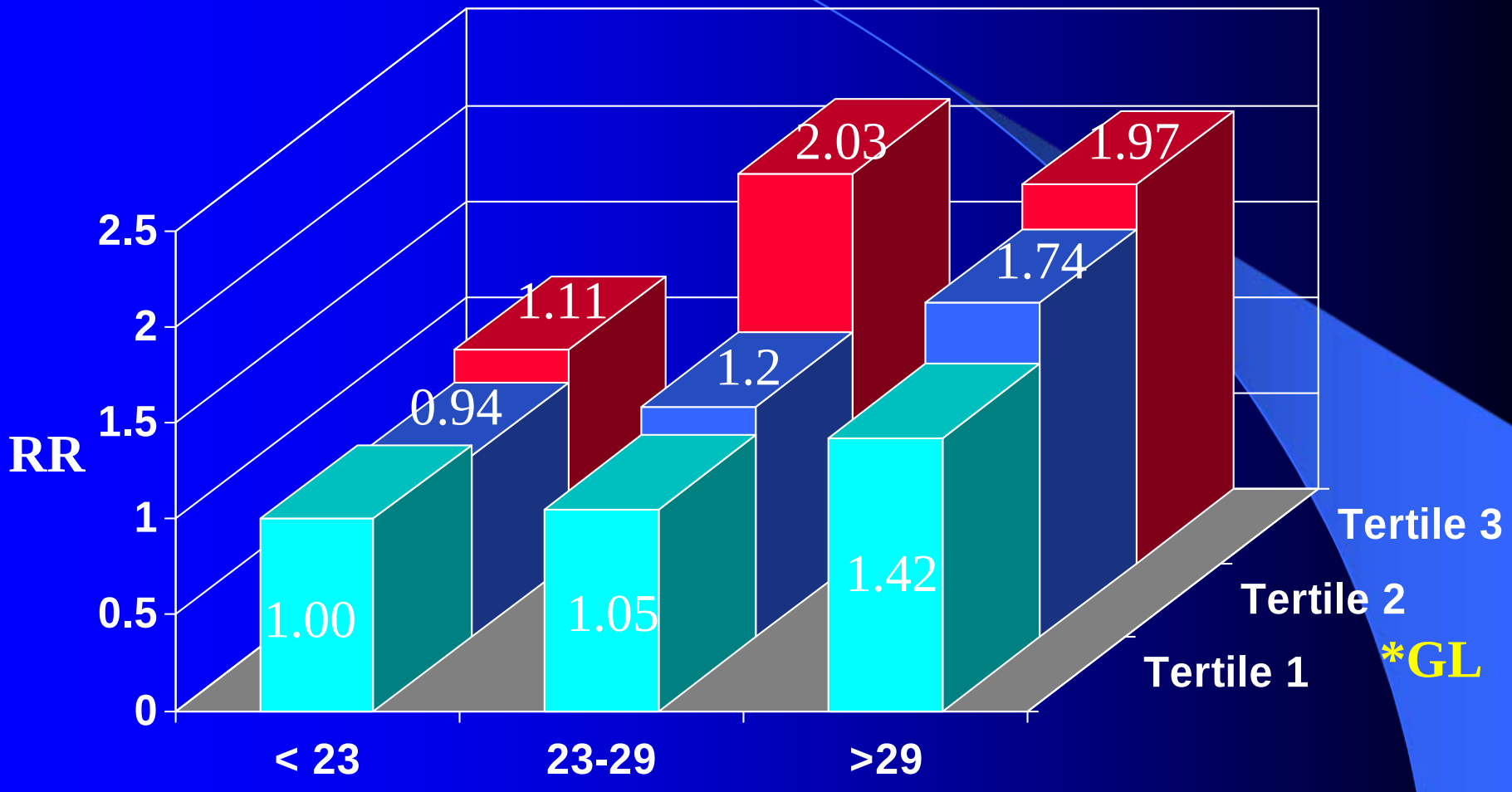
- **Studies since the 1980's have shown improved serum lipids in type 1 and 2 diabetes with low vs. high GI diets**

  **Jenkins et al. Am J Clin Nutr, 1985; Jenkins et al. Am J Clin Nutr, 1987; Collier et al. Diabetes Nutr Metab, 1988; Fontvielle et al. Diabetes Nutr Metab, 1988; Brand et al. Diabetes Care, 1991; Wolever et al. Diabet Med, 1992**

- **Recent studies have shown an association of GI with new CVD risk factors: *PAI-1 and high-sensitivity C-reactive protein***

  **Jarvi et al. Diabetes Care, 1999; Liu et al. Am J Clin Nutr, 2002**

# Glycemic Load and CHD Risk




Liu et al. Am J Clin Nutr, 2000

Nurses' Health Study

* *reflects higher GI*

# GI in Obesity and Weight Management

- **High GI diets may play a role in etiology of obesity and metabolic syndrome**

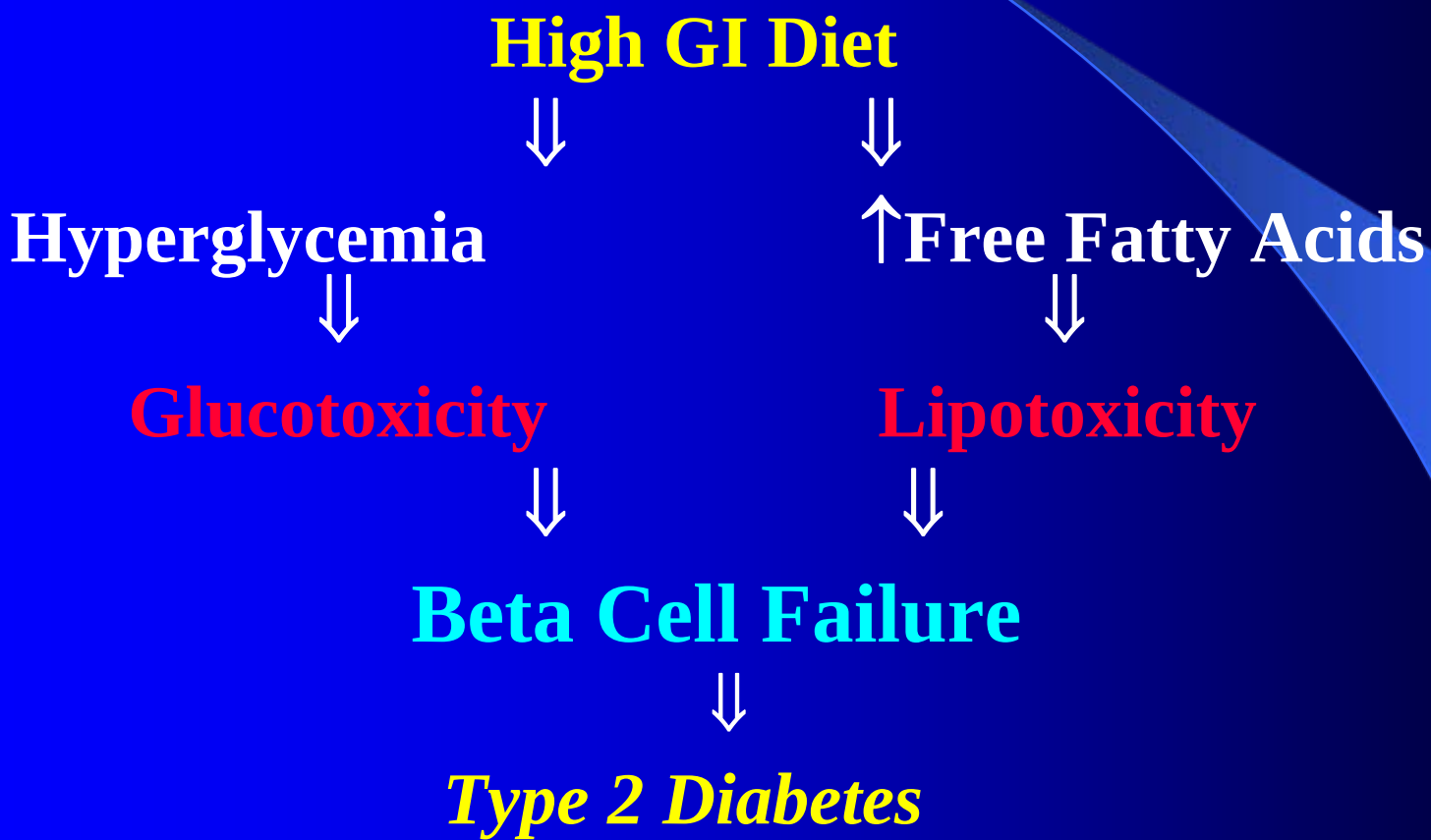
  **Kopp W. Metabolism, 2003**

- **The GI has been associated with satiety and loss of fat mass**

  **Anderson GH, Woodend D. Nutr Rev, 2003;**
  **Bouché et al, Diabetes Care, 2002**

- **More studies are needed in this area**

# GI in Development of type 2 Diabetes: Hypothetical Model




*Adapted from: Ludwig DS. JAMA, 2003*

# GI in Development of CVD: Hypothetical Model

**High GI Diet**

⇓ ⇓

**Hyperglycemia** ⇓ **Oxidative Stress** ⇓

**Hyperinsulinemia** ⇓ **Insulin Resistance** ⇓

***Cardiovascular Disease***

*Adapted from: Ludwig DS. JAMA, 2003*

# Application in Clinical Practice

- **The American Diabetes Association (ADA) does not currently endorse use of GI in clinical practice**
- **Advocated for use in clinical practice by the following organizations:**
  - **The World Health Organization (WHO), the Food and Agriculture Organization (FAO) and the diabetes associations of *Europe, Australia, South Africa and Canada***
- **Well accepted and used in countries such as Australia and New Zealand**

# Application in Clinical Practice

- **Clinicians report that individuals with diabetes find the GI concept *simple, easy to use and helpful* and they are not misapplying it**

  **Brand-Miller JB et al. Diabetes Care, 1997;**
  **Gilbertson et al. Am J Clin Nutr, 2003**

- **Two randomized, controlled trials demonstrated that nutrition education based on the GI concept was more successful than *standard nutrition education, *resulting in improvements in both A1c and quality of life***

  **Frost et al. Diab Med, 1994;**
  **Gilbertson et al. Diabetes Care, 2001**

** Standard nutrition education= emphasizing carbohydrate exchanges*

# Rationale for Study

- **Evidence for important health benefits in areas of *diabetes, obesity and CVD***
- **Recommended for use in clinical practice by most health organizations around the world including *Canadian Diabetes Association***
- **No other study that addressed perceptions and practices of dietitians regarding GI**

# Canadian Dietitians' Use and Perceptions of Glycemic Index in Diabetes Management

[1]Maria Kalergis

[1]Bonnee Belfer, [2]Alain Ishac, [1]Evelyne Pytka, [1]Jean-François Yale, [1]Nancy Mayo,

[2]Irene Strychar

[1]McGill University and [2]Université de Montréal

*Funded by: Canadian Foundation for Dietetic Research*

# Study Objectives

- Determine whether dietitians in Canada use GI in diabetes management
- Determine how GI is being used
- Determine factors associated with use and non use of GI

# Study Design

- Postal survey with case-control design
- Sampling frame:
  - all dietitians who were active members of DC and OPDQ in 2002
- Exclusion criteria:
  - students and retired members

# Sampling Strategy

**Post card sent** → **n = 6,060 (DC and OPDQ)**

↓ **47% response rate**

**n = 2,856**

↓

**Questionnaire sent** → **n = 1,805 (worked in diabetes)**

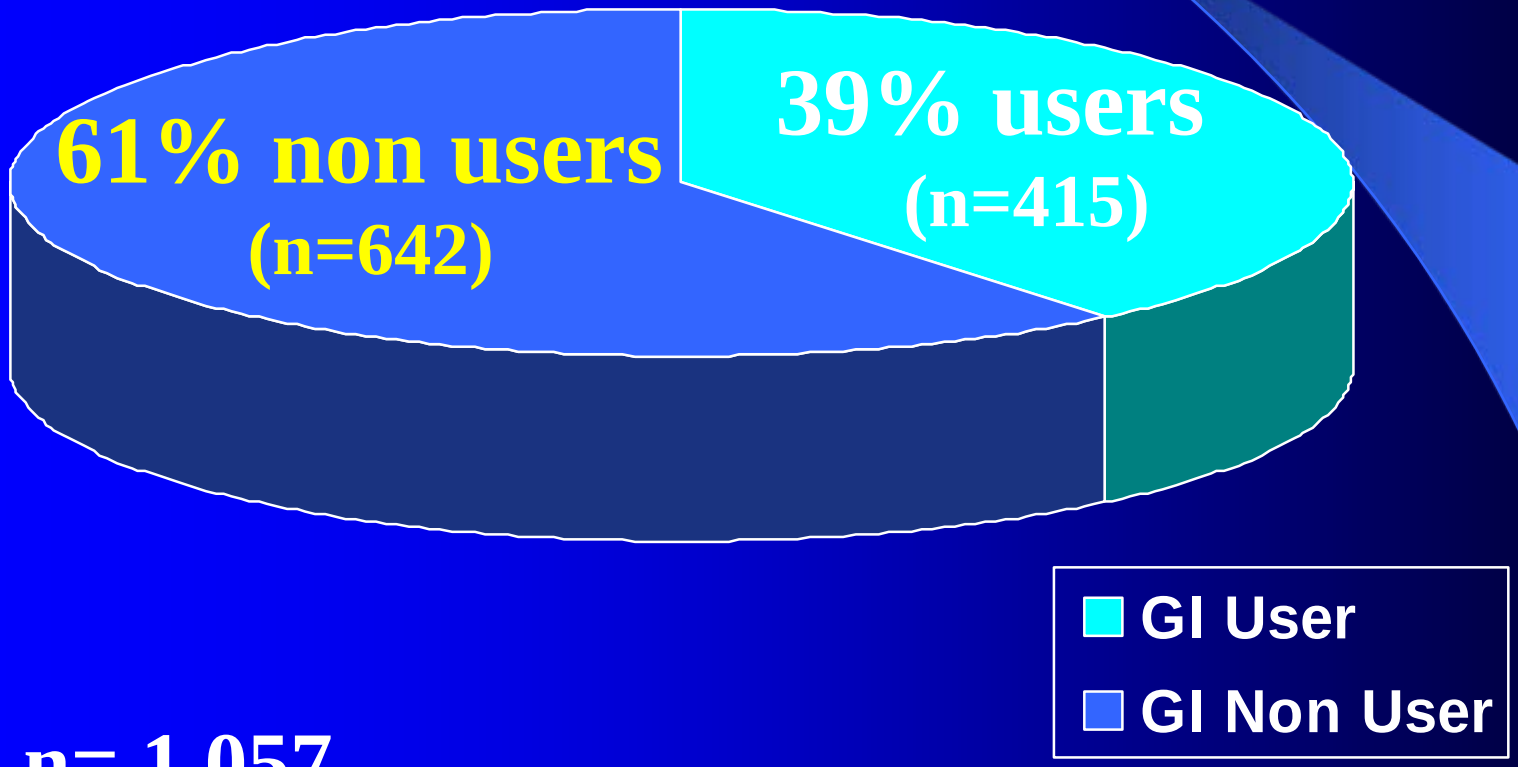
↓ **59% response rate**

**n = 1,062**

**5 excluded**

***n = 1,057 (questionnaire respondents)***

# Results:
## Use of GI by Questionnaire Respondents




n= 1,057

# Application of GI by Users

| Mode of application | % of users (n= 415) |
| --- | --- |
| General concept | 90% |
| Erratic blood sugars | 56% |
| Daily meal planning | 49% |
| Weight control | 49% |
| Treatment of hypoglycemia | 25% |

# Reasons for Non Use of GI

| Reasons | % of non users (n= 642) |
| --- | --- |
| Complex for client | 57% |
| Access to educational tools | 46% |
| Uncertain how to use | 31% |
| Complex to teach | 19% |
| No time | 15% |
| Unaware of concept | 3% |

# Factors Associated with Use and Non Use of GI

| Factors | Users | Non users |
|---|---|---|
| Knowledge of CDA recommendation of GI | 67% | 26% |
| Member of CDA Diabetes Educators | 47% | 12% |
| Counsel > 10 clients/wk | 44% | 13% |
| Certified Diabetes Educator | 31% | 2% |

# Differences between Users and Non Users of GI

| Factors | Users (mean scores) | Non users | |
|---|---|---|---|
| Perceived confidence | 2.7 | 1.8 | p<0.001 |
| Perceived benefits | 2.9 | 2.5 | p<0.001 |
| Perceived barriers | 2.2 | 2.8 | p<0.001 |
| Knowledge | 4.4 | 3.8 | p<0.001 |

# Conclusions

- Dietitians need to become aware that GI is recommended by CDA
- Continuing education is needed
- Further development of educational tools

# Impact of Study

- **Education of Healthcare Professionals**

**Dissemination of Study Results**

*Oral presentation & travel award, CDA conference, 2004*

*Publication in Canadian Journal of Dietetic Practice and Research, 2006*

**CDA review paper**

*Role of GI in the prevention and management of diabetes, Canadian Journal of Diabetes, 2005*

**Article for OPDQ**

*Target Quebec Dietitians*

**CDA GI Patient Education Tool**

# THE GLYCEMIC INDEX


## What is the Glycemic Index of food?

The Glycemic Index (GI) is a scale that ranks carbohydrate-rich foods by how much they raise blood glucose levels compared to a standard food. The standard food is glucose or white bread.

## Why should I eat foods with a low Glycemic Index?

Eating foods with a low Glycemic Index may help you to:

- Control your blood glucose level
- Control your cholesterol level
- Control your appetite
- Lower your risk of getting heart disease
- Lower your risk of getting type 2 diabetes

## Use these meal planning ideas to include the Glycemic Index as part of healthy eating.

- Enjoy vegetables, fruits and low-fat milk products with your meals. These are carbohydrate-rich foods that, in general, have low glycemic index.
- Plan your meals with foods in the low and medium Glycemic Index starch choices on the list that follows.
- Try foods such as barley, bulgar, couscous, or lentils, which have a low Glycemic Index.
- Consult a registered dietitian for help with choosing low GI foods, adapting recipes, and other ways to incorporate low GI foods in your meal plan.

## If I eat foods with a low Glycemic Index can I eat as much as I want?

No. Using the Glycemic Index to choose foods is only one part of healthy eating.

## Healthy eating also means:

- ✓ Eating at regular times
- ✓ Choosing a variety of foods from all food groups
- ✓ Limiting sugars and sweets
- ✓ Reducing the amount of fat you eat
- ✓ Including foods high in fibre
- ✓ Limiting salt, alcohol and caffeine

Remember that checking your blood glucose before and **1 or 2 hours** after a meal is the best way to know how your body handles the meal.

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Check out the Canadian Diabetes Association website, www.diabetes.ca, for more information.

Know who to turn to

CANADIAN DIABETES ASSOCIATION | ASSOCIATION CANADIENNE DU DIABÈTE

A lot of starchy foods have a high Glycemic Index (GI). Choose medium and low GI foods more often.

| **Low GI** (55 or less) *† choose most often ✓✓✓ | **Medium GI** (56-69) *† choose more often ✓✓ | **High GI** (70 or more) *† choose less often ✓ |
|---|---|---|
| **BREADS:**<br>100% stone ground whole wheat<br>Heavy mixed grain<br>Pumpernickel | **BREADS:**<br>Whole wheat<br>Rye<br>Pita | **BREADS:**<br>White bread<br>Kaiser roll<br>Bagel, white |
| **CEREAL:**<br>All Bran™<br>Bran Buds with Psyllium™<br>Oatmeal<br>Oat Bran™ | **CEREAL:**<br>Grapenuts™<br>Shredded Wheat™<br>Quick oats | **CEREAL:**<br>Bran flakes<br>Corn flakes<br>Rice Krispies™<br>Cheerios™ |
| **GRAINS:**<br>Parboiled or converted rice<br>Barley<br>Bulgar<br>Pasta/noodles | **GRAINS:**<br>Basmati rice<br>Brown rice<br>Couscous | **GRAINS:**<br>Short-grain rice |
| **OTHER:**<br>Sweet potato<br>Yam<br>Legumes<br>Lentils<br>Chickpeas<br>Kidney beans<br>Split peas<br>Soy beans<br>Baked beans | **OTHER:**<br>Potato, new/white<br>Sweet corn<br>Popcorn<br>Stoned Wheat Thins™<br>Rywita™ (rye crisps)<br>Black bean soup<br>Green pea soup | **OTHER:**<br>Potato, baking (Russet)<br>French fries<br>Pretzels<br>Rice cakes<br>Soda crackers |

*expressed as a percentage of the value for glucose †Canadian values where available

Adapted with permission from: Foster-Powell K, Holt SHA, Brand-Miller JC. International table of glycemic index and glycemic load values Am J Clin Nutr 2002;76:5-76

One change I will make now is _____

# Impact of Study

- **Education of Healthcare Professionals**

**Abbott Laboratories Inc.**

*Developed power-point slide presentation targeted at diabetes educators and physicians*

**Article in *Canadian Diabetes***

*Target family physicians*

**DC Backgrounder on GI**

**PEN (Practice-Based Evidence in Nutrition)**

*Developed content related to GI for PEN*

# abetes - Glycemic Index: Practice Questions





## Health Promotion / Prevention

**Q:** Do healthy individuals who consume a high glcemic index (GI) diet have an increased risk of developing type 2 diabetes as compared to healthy individuals who consume a low GI diet? View Key Practice Points

Last Updated: Thursday, January 04, 2007

## Planning

**Q:** Do individuals with diabetes need to adjust the timing and/or dose of their medication based on the glycemic index (GI) rating, even if the carbohydrate content is the same? View Key Practice Points

Last Updated: Thursday, January 04, 2007

**Q:** Do individuals with type 1 diabetes have better blood lipid control when they consume a low glycemic index (GI) diet compared to a high GI diet? View Key Practice Points

Last Updated: Thursday, January 04, 2007

**Q:** Do individuals with type 2 diabetes have better blood lipid control when they consume a low glycemic index (GI) diet compared to a high GI diet? View Key Practice Points

Last Updated: Thursday, January 04, 2007

**Practice Question Subcategories**

Health Promotion / Prevention

Planning

Education

All Practice Questions

**More on this Knowledge Pathway**

Background

Related Tools & Resources

Submit a Practice Question

Pathway Contributors

## Planning

Q: Do individuals with type 1 diabetes have better glycemic control when they consume a low glycemic index (GI) diet compared to a high GI diet?

Last Updated: *Thursday, January 04, 2007*

## Key Practice Points

1. Adults with type 1 diabetes have improved long-term glycemic control when they consume a low GI diet compared to a high GI diet.
   (A)
   Evidence | References
2. Adults with type 1 diabetes have less hypoglycemic episodes when they consume a low GI diet compared to a high GI diet.
   (B)
   Evidence | References
3. Children with type 1 diabetes have less episodes of hyperglycemia (>15 mmol/L) when they receive flexible nutrition education emphasizing low GI carbohydrate choices.
   (B)
   Evidence | References
4. Children with type 1 diabetes have better long-term glycemic control when they receive flexible nutrition education emphasizing low GI carbohydrate choices.
   (B)
   Evidence | References
5. Children with type 1 diabetes have no increased risk of hypoglycemia when they receive flexible nutrition education emphasizing low GI carbohydrate choices.
   (B)
   Evidence | References

**Practice Question Subcategories**

Health Promotion / Prevention

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**More on this Knowledge Pathway**

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## Planning

**Key Practice Point:**
Adults with type 1 diabetes have improved long-term glycemic control when they consume a low GI diet compared to a high GI diet.
(A)
Evidence | References

### Evidence

a. A meta-analysis of 14 randomized trials concluded that choosing low GI foods in place of high GI foods has a small but clinically significant effect (reduction of ~0.4) on long-term glycemic control as measured by glycosylated hemoglobin (A1C) in adults with type 1 diabetes (1).

Back to top

### References

1. Brand-Miller J, Hayne S, Petocz P, et al. Low-glycemic index diets in the management of diabetes: a meta-analysis of randomized controlled trials. Diabetes Care 2003 [cited 2006 11 May];26 (8):2261-2267. Available from: http://care.diabetesjournals.org/cgi/content/full/26/8/2261

Back to top

View all Key Practice Points for this Question

# Impact of Study

- **Education of Potential Patients/Consumers**

  **Canadian Health Network**

  **CDA GI Patient Education Tool**

  **Expert Committee to *Health Canada***

# Future Directions: Implications for Research

- **Applied Research**
- **Prevention and management of *Diabetes, Obesity and CVD***
- **Other conditions (eg. Cancer, Polycystic Ovarian Syndrome)**
- **Continued support of CFDR for GI-related research**

# Future Directions: Implications for Practice

- **Development of more resources for professionals to help integrate GI into practice**
  - ***eg. teaching manual, online course***
- **Workshops**
- **Client education tools and resources**
  - ***some available via PEN***

# Future Directions: Implications for Industry

- **GI testing of more Canadian foods and food products**

  ***GI Testing Inc. (Dr. Thomas Wolever)***

- **Development of low GI foods and food products**

- **Nutrition labeling (GI rating)**

- **Continued support of GI research**

# Acknowledgements


- Canadian Foundation for Dietetic Research
- Dietitians of Canada (esp. PEN team)
- Canadian Diabetes Association
- Beth Armour

# Factors Influencing GI Rating

| Factor | Examples |
| --- | --- |
| Degree of starch gelatinization (less gelatinized, lower GI) | Spaghetti, oatmeal |
| Physical form of food (more intact, lower GI) | Pumpernickle, whole grain bread |
| Amylose to Amylopectin (higher amylose, lower GI) | Basmati rice, cornstarch |
| Fibre (viscous) | Rolled oats, lentils, beans |
| Sugars (sucrose, fructose, galactose) | Some cookies & breakfast cereals, fruits, milk products |
| Acidity | Oranges, sourdough bread |

# Summary

- **GI= standardized ranking system for carbohydrates and carbohydrate-containing foods only**
  - ***No GI rating for fat and protein foods***
- **Applied to mixed meals as either *meal GI* or *Glycemic Load***
- **Evidence in prevention of type 2 diabetes, management of type 1 and 2 diabetes, prevention of CVD and obesity**
- **Can easily be applied into clinical practice**

# Glycemic Index vs. Glycemic Load

- ***Glycemic load*** **(GL) takes into account both the amount of available carbohydrate (grams), in a typical serving of a food, and the GI rating of that food**

- **Whereas GI is a fixed number, GL can vary depending on the available carbohydrate content in a typical serving**

$$\text{Glycemic Load} = \frac{\text{g carbohydrate per serving} \times \text{GI}}{100}$$

# Glycemic Index vs. Glycemic Load

- **Glycemic load is best to use, instead of GI, when a typical serving of a food has a *high GI* but a *low carbohydrate* content such as the following:**

  ***- Carrots, Pumpkin, Watermelon***

- **When a typical serving of a food has a lot less available carbohydrate than the 25g or 50g used for GI testing, it is best to use glycemic load**

***eg. ½ cup boiled carrots = 6 g available carbohydrate***

***(GI= 92 vs. GL= 6 )***

# Glycemic Load: Categories

| Category | GL Rating |
| --- | --- |
| Low | ≤ 10 |
| Medium | 11-19 |
| High | ≥ 20 |

*GL= carbohydrate quantity (g) x GI*

# Implementing GI: Practical Suggestions

- Replace half the high GI foods with low GI food choices
- Base at least 2 meals per day on low GI food choices
- Replace high GI breads and breakfast cereals with low GI choices

# Implementing GI: Practical Suggestions

- **Most *fruits, vegetables and milk products* have a low GI rating**
- **The majority of *high GI* foods are found in the *grain products and starchy food group*, therefore, this food group should be the main focus of nutrition education regarding GI**

# Glycemic Index of Selected Grain and Starchy Foods

| Low GI | Medium GI | High GI |
|---|---|---|
| Multigrain bread | Whole wheat bread | White bread |
| Oatmeal | Shredded wheat | Cornflakes |
| Converted rice | Basmati rice | Short grain rice |
| Sweet Potato | New Potato | Baking Potato |

*Adapted from: Glycemic Index Tool of Canadian Diabetes Association*

# Implementing GI:Tools and Resources

- **Glycemic Index Tool (1 page, double-sided patient education handout, based on 2003 Clinical Practice Guidelines of Canadian Diabetes Association)**

  ***available at** CDA Website (www.diabetes.ca)*

- **Book: *The New Glucose Revolution***

  **Jennie Brand-Miller, Thomas MS Wolever, Kaye Foster-Powell, Stephen Colaguiri**

  ***Marlow and Company, NY, 2002***

- **Recently revised international table of *Glycemic Index* and *Glycemic Load* values**

  ***Foster-Powell et al. Am J Clin Nutr, 2002***

# Implementing GI: Important Reminders

- **Important to use "country-specific" *Glycemic Index* and *Glycemic Load* values**

- **Remember to consider the *entire* nutrient composition of a food, not just GI**