

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

**Incremental BG area of 25g or 50g
carbohydrate in test food**

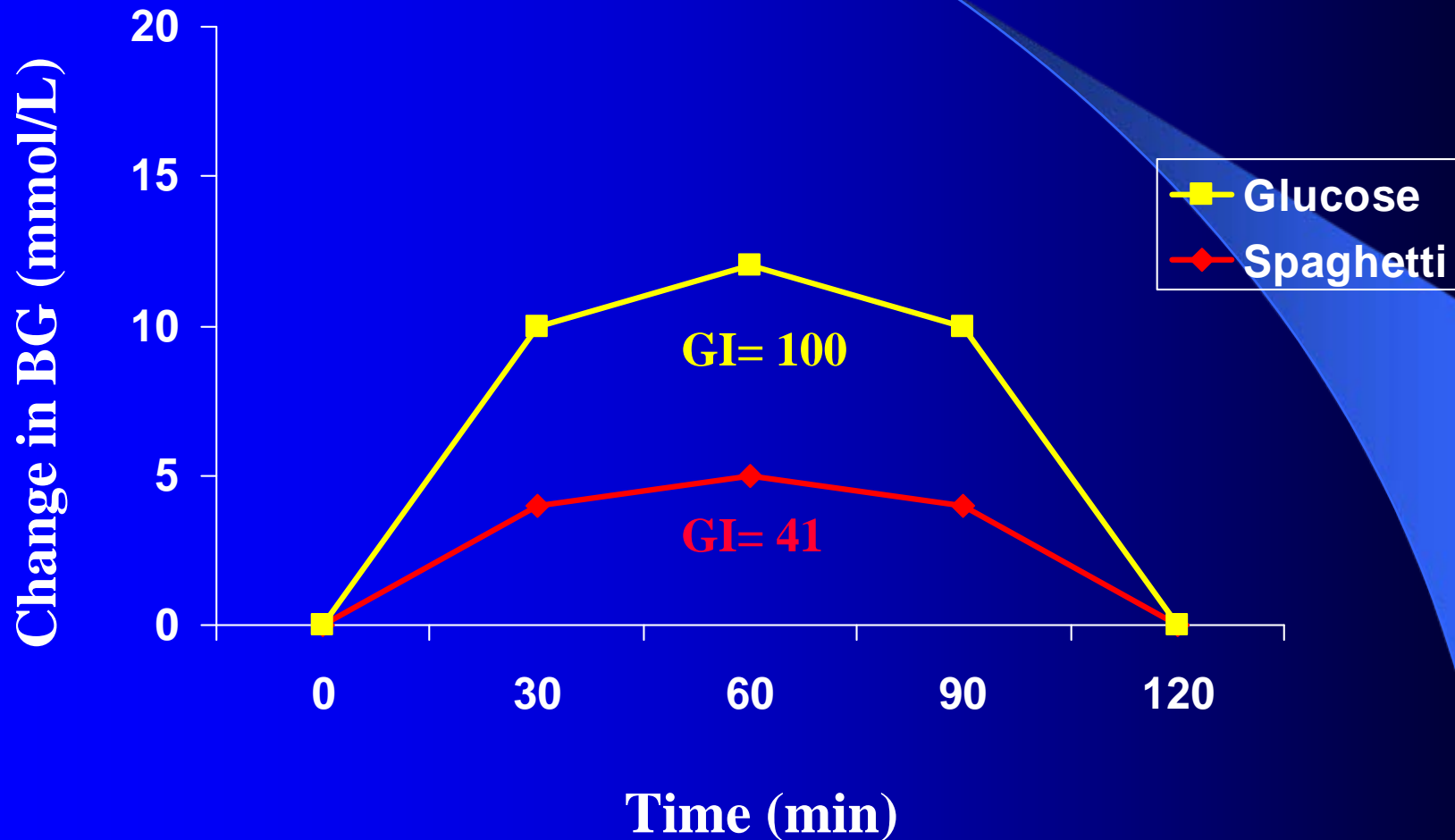
$$\text{GI} = \frac{\text{Incremental BG area of 25g or 50g carbohydrate in test food}}{\text{Incremental BG area of 25g or 50g carbohydrate in reference food}} \times 100\%$$

**Incremental BG area of 25g or 50g
carbohydrate in reference food**

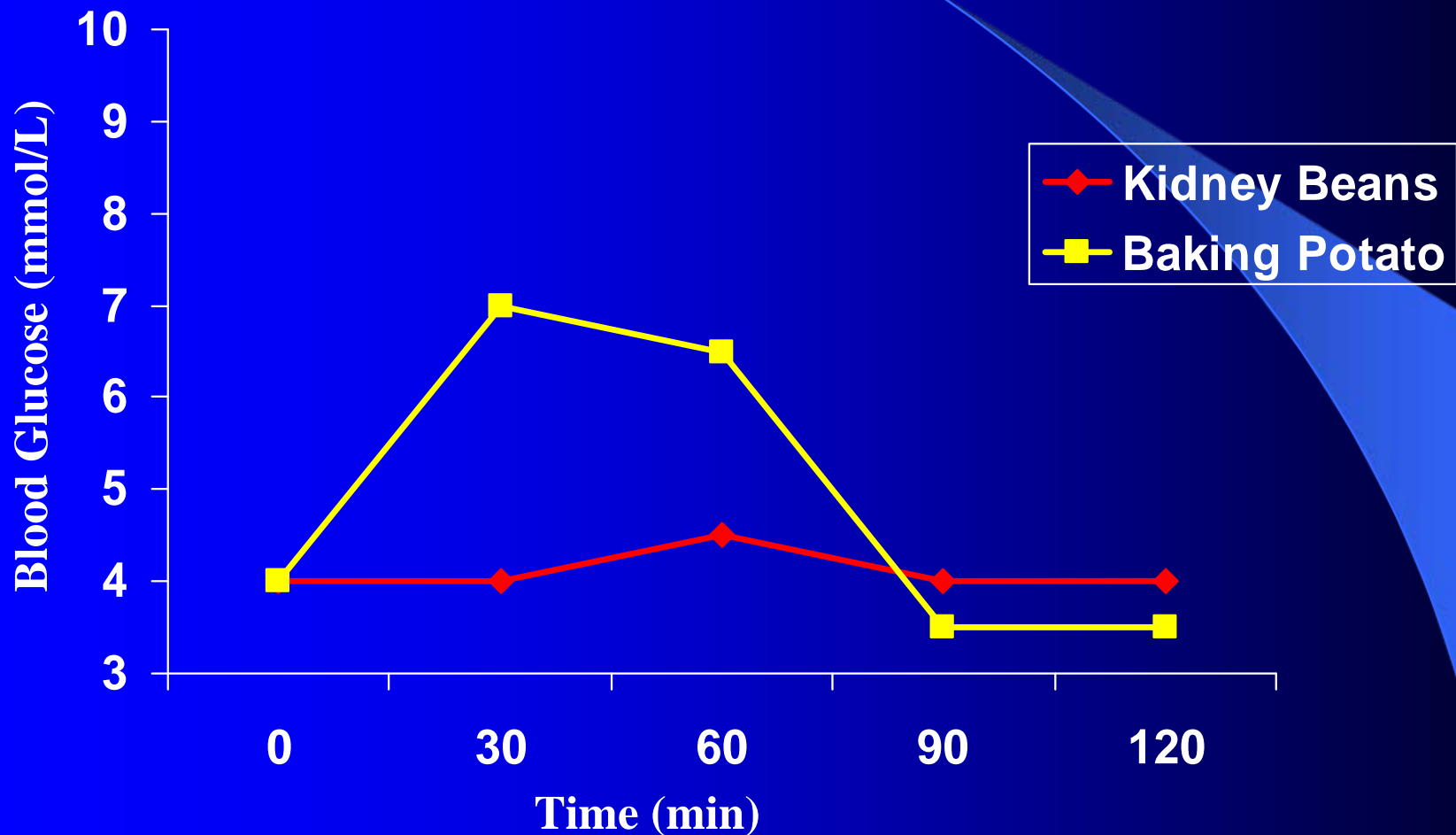
Glycemic Index: Categories

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**

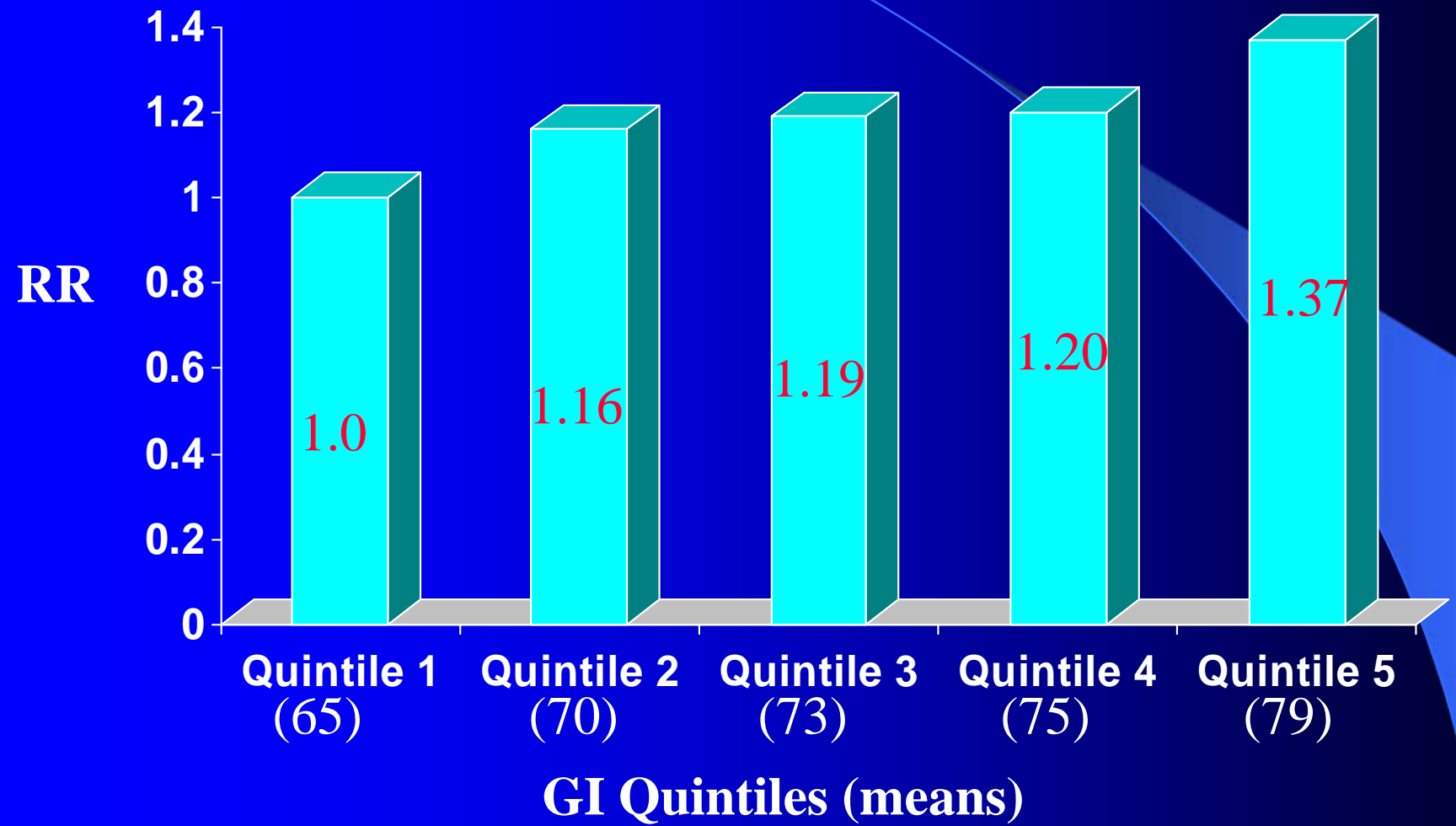
GI in Prevention of type 2 Diabetes

- **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

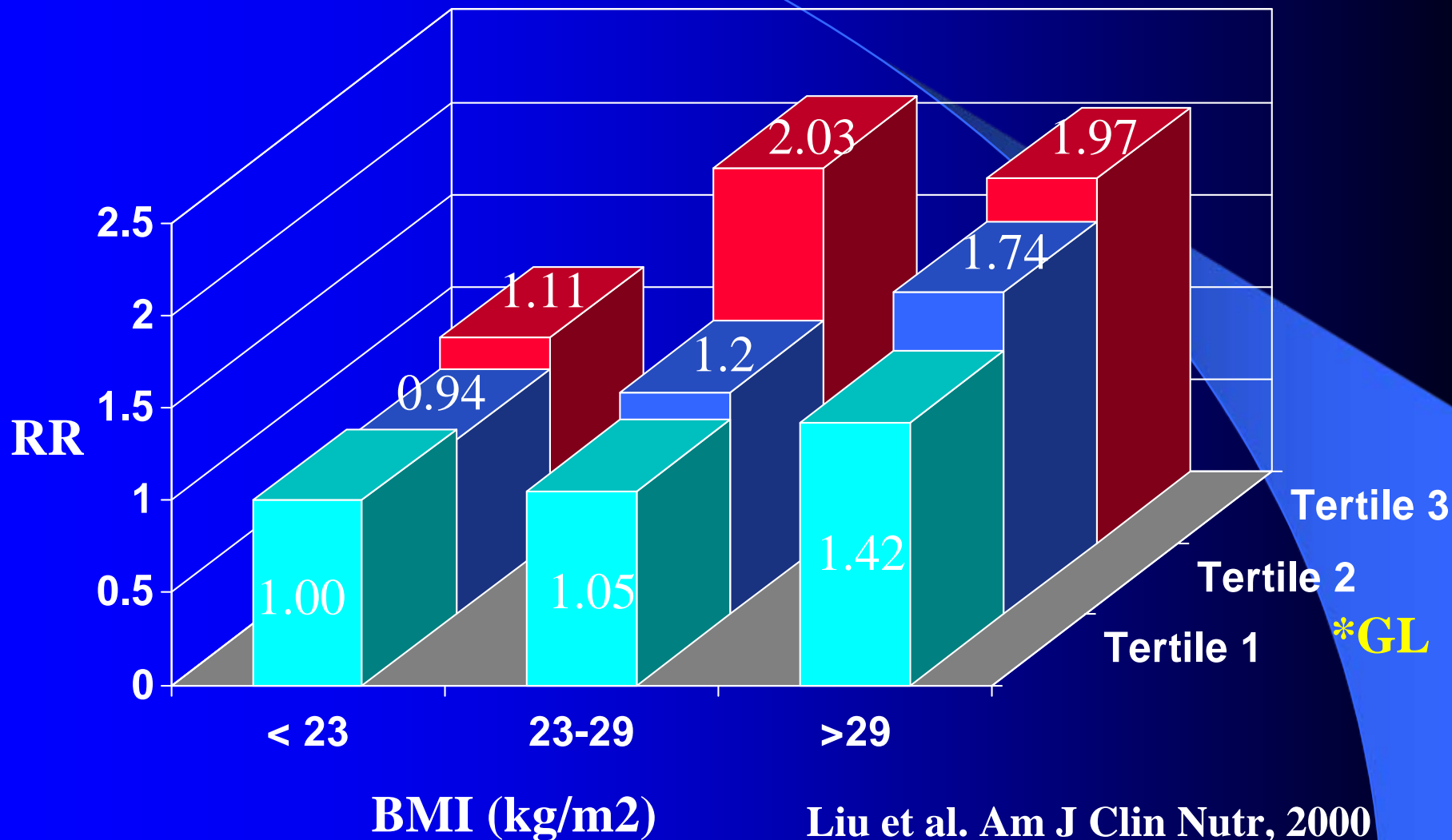
- **Studies since the 1980's have shown improved serum lipids in type 1 and 2 diabetes with low vs. high GI diets**

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



* reflects higher GI

Liu et al. Am J Clin Nutr, 2000
Nurses' Health Study

GI in Obesity and Weight Management

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

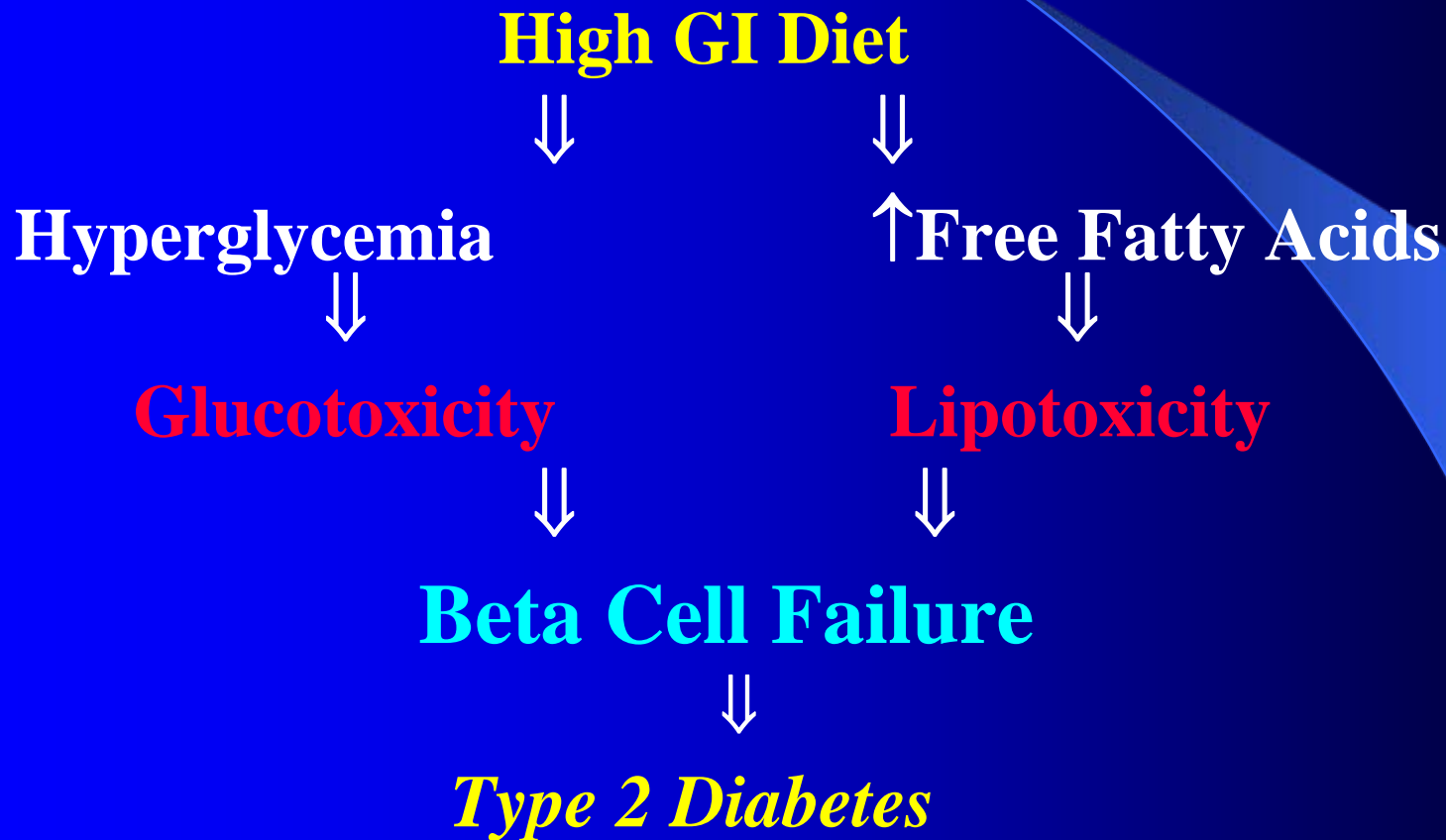
Kopp W. Metabolism, 2003

- **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**

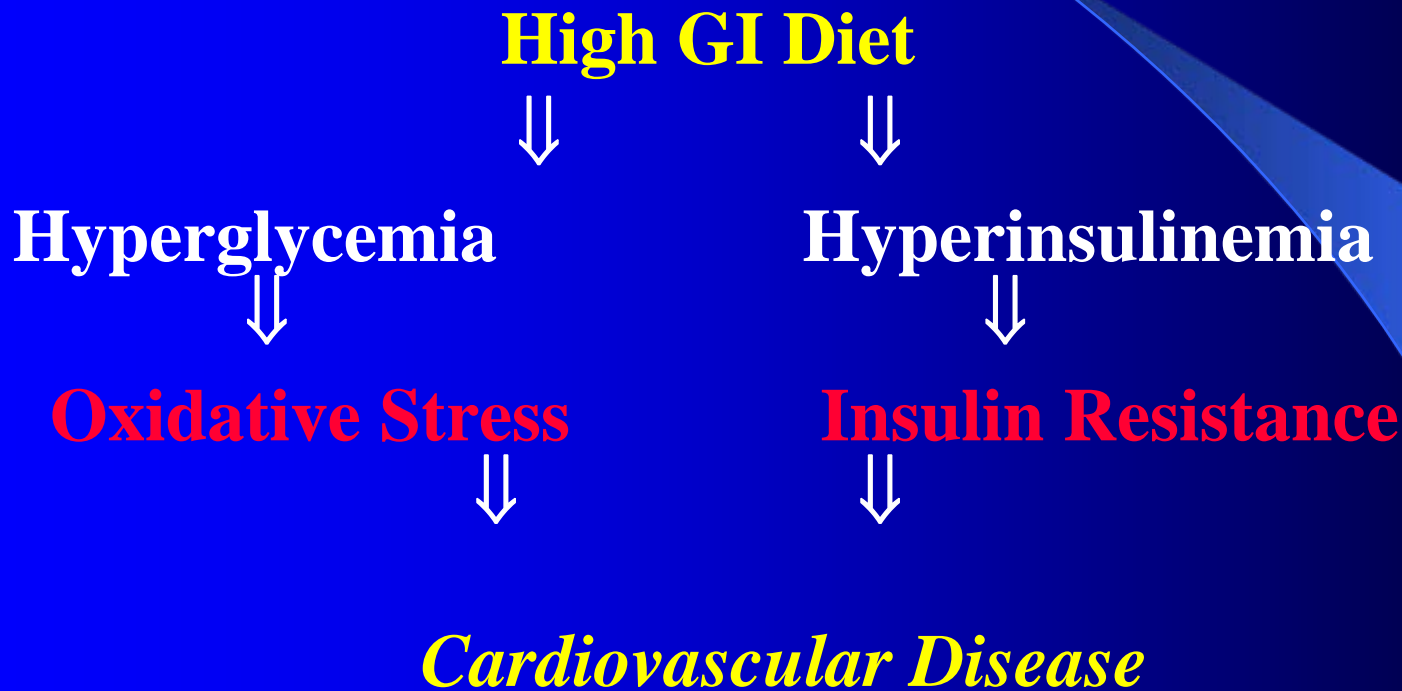
- **More studies are needed in this area**

GI in Development of type 2 Diabetes: Hypothetical Model



Adapted from: Ludwig DS. JAMA, 2003

GI in Development of CVD: Hypothetical Model



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

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¹Bonnee Belfer, ²Alain Ishac, ¹Evelyne Pytka,
¹Jean-François Yale, ¹Nancy Mayo,
²Irene Strychar

¹McGill University and ²Université 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

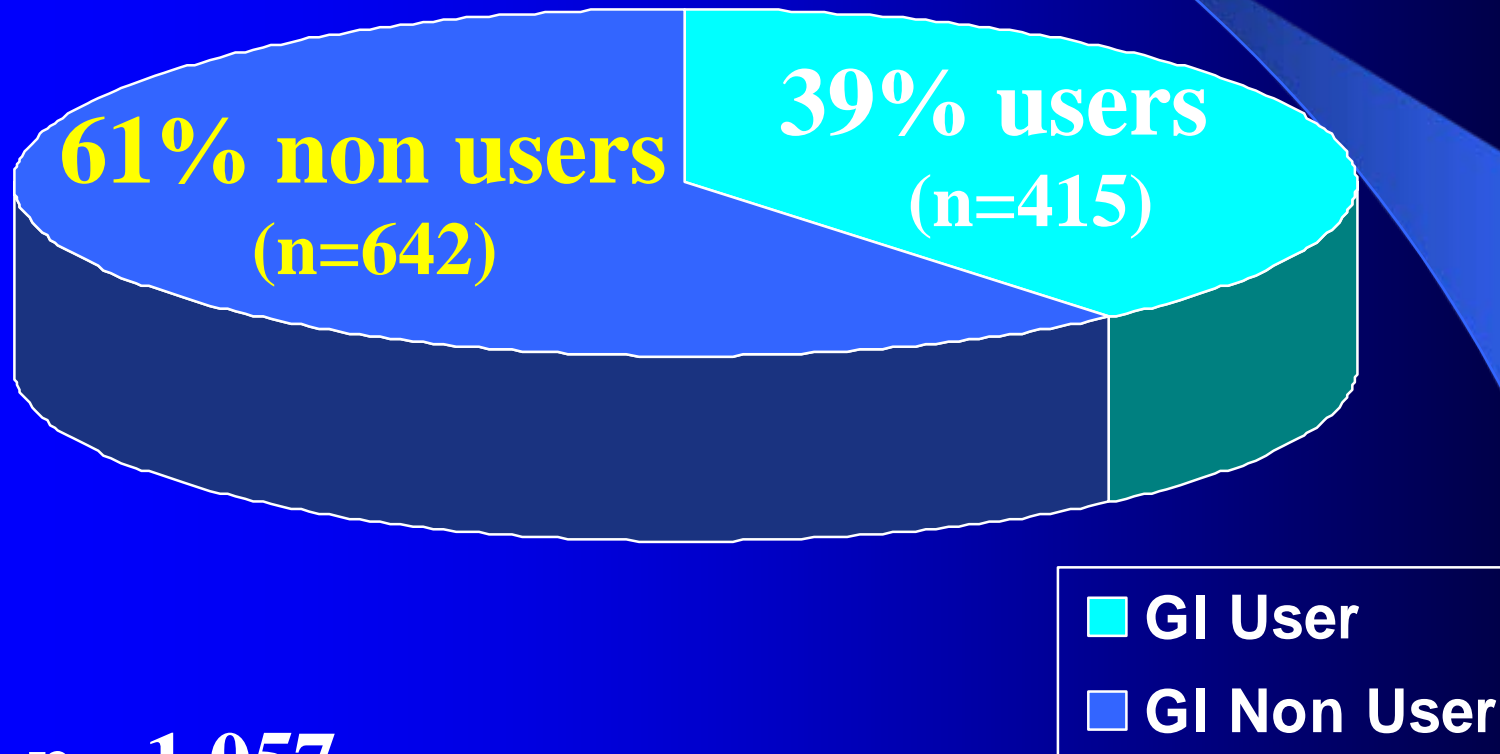
$n = 1,062$

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	Non users	
	(mean scores)		
● 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.



This publication was made possible through an unrestricted grant from President's Choice®. For Food To Be True®, registered trademarks of Loblaws Inc.

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



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DU DIABÈTE

Know who to turn to

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: 100% stone ground whole wheat Heavy mixed grain Pumpernickel	BREADS: Whole wheat Rye Pita	BREADS: White bread Kaiser roll Bagel, white
CEREAL: All Bran™ Bran Buds with Psyllium™ Oatmeal Oat Bran™	CEREAL: Grape-nuts™ Shredded Wheat™ Quick oats	CEREAL: Bran flakes Corn flakes Rice Krispies™ Cheerios™
GRAINS: Parboiled or converted rice Barley Bulgar Pasta/noodles	GRAINS: Basmati rice Brown rice Couscous	GRAINS: Short-grain rice
OTHER: Sweet potato Yam Legumes Lentils Chickpeas Kidney beans Split peas Soy beans Baked beans	OTHER: Potato, new/white Sweet corn Popcorn Stoned Wheat Thins™ Ryvita™ (rye crisps) Black bean soup Green pea soup	OTHER: Potato, baking (Russet) French fries Pretzels Rice cakes Soda crackers

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

Adapted with permission from: Foster-Powell K, Holt SH, 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

<http://www.dieteticsatwork.com/pen/KnowledgePathway.asp?kpid=3876&pqcatid=ALL>

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PEN - Practice-Based Evidence in Nutrition

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Diabetes - Glycemic Index: Practice Questions

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- Practice Question Subcategories**
- [Health Promotion / Prevention](#)
 - [Planning](#)
 - [Education](#)
 - [All Practice Questions](#)

Health Promotion / Prevention

Q: Do healthy individuals who consume a high glycemic 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

- More on this Knowledge Pathway**
- [Background](#)
 - [Related Tools & Resources](#)
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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](#)
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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
 - Planning
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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).

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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>

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[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. 1/2 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

Multigrain bread

Oatmeal

Converted rice

Sweet Potato

Medium GI

Whole wheat bread

Shredded wheat

Basmati rice

New Potato

High GI

White bread

Cornflakes

Short grain rice

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 Colaguirri
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