Nutritional Aspects of Metabolic Syndrome

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Learning Objectives
At the end of this presentation you will be able to:

• 1. **Name the scoring system used in Reasor’s** and about 2,000 other grocery stores in the U.S. which ranks foods based on how much glucose they push into the liver.

• 2. **Explain why starch** from different plant sources shows a big difference in how much glucose gets pushed into the liver.

• **Explain why pushing glucose or fructose** into the liver produces abdominal obesity which can then lead to metabolic syndrome.

• **Name the website** that will allow you and your patients to choose foods with a low glycemic load.
This was a first! There never had been before, in the history of the Public Health Service or any other agency of the United States government, a report on nutrition and health. This was put together by the folks at the Office of Health Promotion and Disease Prevention with the help of a great many nutritional and health experts around the country. It was a landmark report in the effort of the Public Health Service to improve the health of the American people. For the first time we presented our consensus on the state of knowledge of the link between diet and a broad range of health issues. The report particularly places emphasis on the role of diet and prevention of chronic diseases that are leading causes of death and disability in America. It also defines ways in which we can change our diets to reduce the risk for these diseases. And finally the report reveals clearly that the health of Americans could be improved by changing their diet to one that contains less fat.

The term Metabolic Syndrome first appeared in the Medical Literature in the 50’s. By the late 70’s, it was a term in use in the U.S. but Dr. Koop did not cover it.
Nutrition in Clinical Practice is written to guide health professionals in providing well-informed, compassionate, and effective dietary and weight-management counseling. This fully updated 3rd edition is edited by a leading authority in nutrition and preventive medicine. Practical and evidence-based, chapters address the effects of diet on health and a comprehensive array of illnesses, making it a vital and timely addition to any caregiver's library.

Table of Contents:

- Chapter 1: Clinically Relevant Carbohydrate Metabolism
- Chapter 2: Clinically Relevant Fat Metabolism
- Chapter 3: Clinically Relevant Protein Metabolism
- Chapter 4: Overview of Clinically Relevant Micronutrient Metabolism
- Chapter 5: Diet, Weight Regulation, and Obesity
- Chapter 6: Diet, Diabetes Mellitus, and Insulin Resistance
- Chapter 7: Diet, Atherosclerosis, and Ischemic Heart Disease
- Chapter 8: Diet and Hypertension
- Chapter 9: Diet and Hemostasis
- Chapter 10: Diet and Cerebrovascular and Peripheral Vascular Disease
- Chapter 11: Diet and Immunity
- Chapter 12: Diet and Cancer
- Chapter 13: Diet and Hematopoiesis: Nutritional Anemias
- Chapter 14: Diet, Bone Metabolism, and Osteoporosis
- Chapter 15: Diet and Respiratory Disease
- Chapter 16: Diet and Renal Disease
- Chapter 17: Diet and Hepatobiliary Disease
- Chapter 18: Diet and Common Gastrointestinal Disorders
- Chapter 19: Diet, Dyspepsia, and Peptic Ulcer Disease
- Chapter 20: Diet and Rheumatologic Disease
- Chapter 21: Diet and Neurologic Disorders
- Chapter 22: Diet and Dermatosis
- Chapter 23: Diet and Wound Healing
- Chapter 24: Food Allergy and Intolerance
- Chapter 25: Eating Disorders
- Chapter 26: Malnutrition and Cachexia
- Chapter 27: Diet, Pregnancy, and Lactation
- Chapter 28: Diet and the Menstrual Cycle
- Chapter 29: Diet and Early Development: Pediatric Nutrition
- Chapter 30: Diet and Adolescence
- Chapter 31: Diet and Senescence
- Chapter 32: Epigenetic Effects of Foods and Nutrients: Diet and Athletic Performance & Sports Nutrition
- Chapter 33: Endocrine Effects of Diet: Phytoestrogens
- Chapter 34: Diet, Sleep–Wake Cycles, and Mood
- Chapter 35: Diet and Cognitive Function
- Chapter 36: Diet and Vision
- Chapter 37: Diet and Dementia
- Chapter 38: Hunger, Appetite, Taste, and Satiety
- Chapter 39: Anti-Aging Effects of Nutrition
Product: threshold values-

Dr. Katz’s NuVal Score

- **Numerator Nutrients**
  - Fiber: ##
  - Folate: ##
  - Vitamin A: ##
  - Vitamin C: ##
  - Vitamin D: ##
  - Vitamin E: ##
  - Vitamin B12: ##
  - Vitamin B6: ##
  - Potassium: ##
  - Calcium: ##
  - Zinc: ##
  - Omega-3 fatty acids: ##
  - Total bioflavonoids: ##
  - Total carotenoids: ##
  - Magnesium: ##
  - Iron: ##

- **Denominator Nutrients**
  - Saturated fat: ##
  - Trans fat: ##
  - Sodium: ###
  - Sugar: ##
  - Cholesterol: ##
  - Glucose Push ➔

- **Universal Adjustors**
  - Fat quality
  - Protein quality
  - Glycemic load
  - Energy density

- **Healthy Fatty Acids**
- **Plant Antioxidants**
The NuVal Nutritional Scoring System\[6\] ranks foods on a scale of 1 to 100; the higher the NuVal Score, the more nutritious the food. The system is currently available in more 2,000 supermarkets across the U.S. in 31 states. The system is also found in school cafeterias in Minnesota, Missouri, Tennessee, and Connecticut. The system is endorsed by the American College of Preventive Medicine and a recent study \[7\] from the Harvard School of Public Health has concluded that people who eat food with more favorable NuVal Scores have a lower risk of chronic disease and have a better chance of living a longer, healthier life.

The NuVal System is marketed by NuVal LLC, a joint venture formed in 2008 by Topco Associates, LLC\[8\] of Elk Grove Village, IL, a private label cooperative, and Griffin Hospital\[9\] of Derby, Connecticut, a non-profit community hospital.
Maltodextrins

- **Partially hydrolyzed starch that is 4 to 20 glucose residues in length with only alpha 1,4 bonds (no branch points).**
- **First produced in 1959.** Best way to get large amounts of glucose into the blood very quickly during a race.
- Major component in sports drinks used to produce a very high glycemic index.
- Occur naturally in foods where plant starch has been broken down to produce glucose (fruit ripening process).
- **Produced during the beer making process** (the small pieces of starch produced by the malting process where called maltodextrins).

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**High Carb Drinks**

<table>
<thead>
<tr>
<th>Product</th>
<th>Source</th>
<th>[Carb]</th>
<th>Cal/16oz</th>
<th>Na/16oz</th>
</tr>
</thead>
<tbody>
<tr>
<td>GatorLuad</td>
<td>MG</td>
<td>20</td>
<td>375</td>
<td>125</td>
</tr>
<tr>
<td>Carboplex</td>
<td>M</td>
<td>24</td>
<td>440</td>
<td>0</td>
</tr>
<tr>
<td>Carbo Power</td>
<td>MF</td>
<td>18</td>
<td>330</td>
<td>100</td>
</tr>
<tr>
<td>Cybercharge</td>
<td>GMF</td>
<td>21</td>
<td>385</td>
<td>20</td>
</tr>
<tr>
<td>Carbo Fire</td>
<td>GMF</td>
<td>24</td>
<td>440</td>
<td>80</td>
</tr>
<tr>
<td>Ultra Fuel</td>
<td>MGF</td>
<td>21</td>
<td>385</td>
<td>0</td>
</tr>
</tbody>
</table>

*Source: Maltodextrin, fructose, glucose*

With glucose as the standard, maltodextrin produces a GI of 105.
Beer Carbs (g/12 ounces) – Beer Belly

_Maltodextrin is 2.8 to 61% of total carbs_, maltotriose is 1.3 to 39% of total carbs, maltose is 0 to 2% of total carbs, glucose is 0 to 8% of total carbs and fructose is 0 to 5.5% of total carbs.

**Boston Beer Company**
1. Sam Adams Cream Stout – 23.94
2. Sam Adam Boston Ale – 19.9
3. Sam Adams Cherry Wheat – 16.86
4. Sam Adams Light – 9.7

**Miller/Coors Beer Company**
1. Blue Moon – 13.7
3. Miller High Life – 13.1
4. Coors – 12.2
5. Coors light – 5.3
6. Miller Light - 3.2

**Anheuser Bush Beer Company**
1. Michelob Honey – 17.9
2. Michelob Golden – 14.1
3. O’Doul’s – 13.3
4. Old Milwaukee 12.9
5. Busch Ice – 12.5
6. Bud – 10.6
7. Michelob Light – 11.7
8. Busch Light 6.7
9. Bud Light – 6.6
10. Bud Select – 3.1
11. Michelob Ultra – 2.6

*For comparison, a 12 ounce can of Coke has 36 grams of carbohydrate*

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Why does starch from different sources get digested and absorbed at different rates?

**Glycogen**
A glycogen molecule contains hundreds of glucose units in highly branched chains. Each new glycogen molecule needs a special protein for the attachment of the first glucose (shown here in red).

**Starch (amyllopectin)**
A starch molecule contains hundreds of glucose molecules in either occasionally branched chains (amyllopectin) or unbranched chains (amylose).

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*Stepped Art*
Fig. 4-8, p. 106
The absence of branch points allows amylose to be packed very tightly.

**Factors Influencing GI Ranking**

**Type of Starch**

<table>
<thead>
<tr>
<th>Amylose</th>
<th>Amylopectin</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Absorbs <em>less</em> water</td>
<td>• Absorbs <em>more</em> water</td>
</tr>
<tr>
<td>• Molecules form <em>tight clumps</em></td>
<td>• Molecules are <em>more open</em></td>
</tr>
<tr>
<td>• <em>Slower rate of digestion</em></td>
<td>• <em>Faster rate of digestion</em></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lower GI</th>
<th>Higher GI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kidney beans (28)</td>
<td>Russet potato (85)</td>
</tr>
<tr>
<td>Uncle Ben's converted LG rice (50)</td>
<td>Glutinous rice (98)</td>
</tr>
</tbody>
</table>

Glutinous rice is a type of rice grown mainly in Southeast and East Asia, which has opaque grains, very low amylose content, and is especially sticky when cooked.
Potatoes are many peoples' favourite food but for many years they have been incorrectly branded by some as a 'bad' food...
For all you potato lovers out there, you may be interested to read about the arrival of Australia’s First Certified low Glycemic Index potato, a variety exclusive to Coles supermarkets known as the 'Carisma' potato. The Carisma G.I. potato has a G.I. of 55 (the average G.I. of Australian potatoes is 70), because they are low G.I. Carisma potatoes deliver a slower, smaller rise in blood glucose for more sustained energy.

Carisma’s low GI qualities were uncovered by the Sydney University’s GI Research Service and it’s now the only potato to be officially recognised as low GI by the Glycemic Index Foundation. This medium-sized potato represents all the great things about Australian produce. It is grown locally and occurs naturally, without any fancy experiments or ‘accidents’ in the lab. In fact, the only time Carisma saw a lab was as part of regular testing to check the quality and health of produce before it makes it to our tables and stomachs. It was here, through routine testing, that scientists discovered Carisma was different. It contained all the goodness of a regular potato - being naturally grown, here in Australia - but also boasted a low GI rating.

Carisma is different to other potatoes. The University of Sydney and the GI Foundation is in the process of trying to identify the exact reasons why it has a lower GI than all other varieties tested so far. Once this is known, the information may help to identify other low GI potato varieties.
### Starch Composition

<table>
<thead>
<tr>
<th>Starch</th>
<th>% amylose</th>
<th>% amylopectin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tapioca</td>
<td>17%</td>
<td>83%</td>
</tr>
<tr>
<td>Potato</td>
<td>~20%</td>
<td>~80%</td>
</tr>
<tr>
<td>Wheat</td>
<td>25-26%</td>
<td>~75%</td>
</tr>
<tr>
<td>Corn</td>
<td>24-28%</td>
<td>~75%</td>
</tr>
<tr>
<td>Waxy corn</td>
<td>~0%</td>
<td>~100%</td>
</tr>
<tr>
<td>Hi amylose Corn</td>
<td>~75%</td>
<td>~25%</td>
</tr>
<tr>
<td>Rice</td>
<td>22%</td>
<td>78%</td>
</tr>
</tbody>
</table>

All naturally occurring starch is a mixture of amylose and amylopectin. For the Typical American diet, amylose is 20-30% and amylopectin is 70-80%.

The typical American diet is a high glycemic index diet.
Amylopectin Potato

- First notification for commercial release in EU 1998 (still pending– market release 2006/7)
- ~100% amylopectin in starch
- First Amylopectin variety named Amflora
- Possible application areas (from a technical viewpoint):
  - Non-Food uses for paper (wet-end, coating), adhesives, textile sizing and waste water treatment

Amylose Potato

- 75-100% apparent amylose
  - True long chain amylose
  - Phosphate content increased
- Possible application areas (from a technical viewpoint):
  - Non-Food uses
    - Thin “plastic” films (oxygen barrier)
  - Low cost fillers in biodegradable plastics
  - Food uses
    - Higher viscosity gels
Origins of Glycemic Index

Two German Physicians whose first publication “Current Problems in the Diet Therapy of Diabetes Mellitus” was published in 1971.

- Otto and Niklas (1980)
  - Classify foods in terms of glycemic response
  - For use in management of diabetes

A group of Toronto Physicians who ran a diabetes clinic in Toronto

- Jenkins, Wolever, et al. (1981)
  - Independently develop “Glycemic Index” as classification of glycemic effects of food
  - For use as supplement to chemical composition information contained in food tables

**Figure 1. Blood sugar response.** Depicted are a normal response to a high glycemic load and to a low glycemic load, and a Type II diabetic’s response to a high glycemic load.
Benefits of Low GI Diet
Low GI diet helps lower blood glucose levels.
Meta-analysis of 14 studies, 356 subjects (types 1 & 2 DM), 2-52 weeks duration

Mean difference
- 7.4% in *glycated proteins over & above* reduction from high GI diet.
- 0.43% points in *HbA1c over & above* reduction from high GI diet

*Brand-Miller et al. Diabetes Care. 2003; 26; 2263.*

- GI logo in Australia – in collaboration with ANZFA
- GI labelling in South Africa (plus several other countries)
- Sweden – GI seen as product specific physiological claim
- USA – no formal ruling by FDA but widespread use of ‘net carb’, ‘impact carb’ and GI labelling
- USDA will permit qualitative statements about carbohydrate content
- FDA has been petitioned re carbohydrate labelling
- HPB Canada will outlaw ‘impact carb’ labelling
- Some GI labelling in Japan, Egypt

In Europe
- GI labelling is used throughout Europe – currently no harmonised legislation. Overriding principle is to inform but not mislead consumers
- EU Nutrition & Health Claim Regulation is under development
**Effects of Glycemic Index in an Animal Model**

- Sprague-Dawley rats identical diets
  - high GI (amylopectin starch), n = 11
  - low GI (high amylose starch), n = 10

- Energy intake controlled to maintain identical mean body weight between groups

- Body composition measured after 18 weeks

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**Animal Study: Body Composition**

*At identical mean body wt, 548 vs 549 g*

Adiposity (%)

\[ p < .01 \]

![Graph showing Adiposity](image)

Animal Study


Visceral Adiposity: The Critical Adipose Depot

Subcutaneous Fat
Abdominal Muscle Layer
Intra-abdominal Fat
Liver cells have an insulin receptor.

SREBP1 – Sterol Response Element Binding Protein - 1. Induces gene expression for genes that code for key enzymes in the conversion of glucose to fatty acids. Insulin and glucose both work to increase fatty acid synthesis in the liver.

Glucose also works through SREBP.

If enough fructose enters the liver, triglyceride synthesis can be pushed to the point that the liver stops responding to Insulin (insulin resistance) and Leptin. We can over drive triglyceride formation enough to end up with abdominal obesity (metabolic syndrome), small LDL (heart disease) and insulin resistance (Type II diabetes).

BIG → Produces Small LDL
LDL Particle Size Subclass Patterns

*Hepatic Lipase has to be used to convert IDL to LDL. The fatty acids released end up being taken up by adipose tissue around the liver.*

IDL  L3  L2  L1
large, buoyant  small, dense

The Metabolic Syndrome

Three Make The Diagnosis

- **Abdominal Obesity** (Male-40”, Female 35”)
- Fasting Glucose over 110
- Triglycerides over 150
- HDL (men <40, women <50)
- Blood pressure: >130/>85

- Also: Polycystic Ovary Disease, multiple skin tags, hyperuricemia, NASH, microalbuminuria
Having extra adipose tissue increases inflammation.

Cytokines:
- TNF-alpha
- Interleukin 6
- ‘Adipokines’
- Resistin
- Adiponectin
- Prothrombotic mediators: PAI-1

Adiponectin regulates both glucose utilization and fatty acid beta-oxidation, it may play a role in insulin resistance.

Rader, NEJM 2000; 343: 1181.
Rebound hypoglycemia can cause hunger


Glycemic Index and Hunger

Blood glucose

Glycemic Index and Hunger

Cumulative food intake

Low Glycemic Load Pyramid

Fruits and Vegetables are the base of a healthy diet

Understanding the glycemic index and then using it can really help diabetics control their blood glucose levels

Potato, baked, flesh and skin, without salt

Nutrition Facts
Serving size: 1 potato large (299g)

<table>
<thead>
<tr>
<th>Nutrition Facts</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount Per Serving</td>
<td>Calories 275</td>
</tr>
<tr>
<td></td>
<td>Carbohydrate 63g</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total Carbohydrate 63g</td>
</tr>
<tr>
<td></td>
<td>Dietary Fiber 7g</td>
</tr>
<tr>
<td></td>
<td>Sugars 4g</td>
</tr>
<tr>
<td>Protein 7g</td>
<td>Vitamin  A 1%</td>
</tr>
<tr>
<td></td>
<td>Vitamin C 48%</td>
</tr>
<tr>
<td></td>
<td>Calcium 4%</td>
</tr>
<tr>
<td></td>
<td>Iron 18%</td>
</tr>
</tbody>
</table>

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs.

NutritionData.com

Glycemic Load
High > 20
Moderate 11-19
Low < 10

63 grams of carbohydrate
Potatoes, hashed brown, home-prepared

Nutrition Facts
Serving Size: 156 g

Amount Per Serving
Calories: 413  Calories from Fat: 176
% Daily Value
Total Fat: 20g  30%
Saturated Fat: 5g  15%
Trans Fat: 0%
Cholesterol: 0mg  0%
Sodium: 524mg  22%
Total Carbohydrate: 55g  18%
Dietary Fiber: 9g  20%
Sugars: 2g
Protein: 5g

Vitamin A: 0%  •  Vitamin C: 54%
Calcium: 2%  •  Iron: 5%

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs.

Estimated Glycemic Load: 27
55 grams of carbohydrate

McDonald’s side order: French Fries

Nutrition Facts
Serving Size: 176 g

Amount Per Serving
Calories: 542  Calories from Fat: 202
% Daily Value
Total Fat: 26g  40%
Saturated Fat: 4g  22%
Trans Fat: 0%
Cholesterol: 0mg  0%
Sodium: 347mg  14%
Total Carbohydrate: 85g  23%
Dietary Fiber: 6g  25%
Sugars: 9g
Protein: 5g

Vitamin A: 0%  •  Vitamin C: 30%
Calcium: 2%  •  Iron: 7%

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs.

Estimated Glycemic Load: 35
68 grams of carbohydrate
Soft Drinks and Obesity –
Global Threats to Diet and Health

“Our Achilles heel is the discussion about obesity. It’s gone from a small, manageable U.S. issue to a huge global issue. It dilutes our marketing and works against it. It’s a huge, huge issue.”

Quote from Coke CEO who addressed the attendees at the 2007 Venice Festival of Media

Coca Cola Company Chief Creative Officer - Ms. Esther Lee, April 23, 2007

Advertising Age article by Stephanie Thompson and Kate Macarthur