# Managing Dietary Carbohydrates for Better Health

Increasingly, scientific evidence is confirming that both the quantity and the quality of dietary carbohydrates, proteins, and fats in the diet contribute to how much and how fast blood glucose (sugar) rises after foods are consumed. **Glycemic index (GI) and glycemic load (GL)** are two objective ways of measuring blood sugar response to foods. Insulin is an important hormone that helps the body to use and manage blood sugar. The **food insulin index (FII)** is a measure of how much insulin the body normally releases in response to a whole food or meal. All of these factors contribute to how the body manages blood sugar and energy. This handout explains these concepts and how they can be used to manage the effects of carbohydrates for better health.

What is the glycemic index?

When we eat carbohydrate-containing foods (sugars and starches), our bodies convert the sugars and starches to glucose, which then enters the bloodstream and makes our blood glucose (sugar) levels rise. Various carbohydrate-containing foods affect blood sugar levels differently. This is because the quality of carbohydrate, the "matrix" or structure of the food, how the food is prepared, and the presence of other substances in the food such as fat, protein, and fiber can affect the extent that the glucose is released and absorbed into the blood stream.

The glycemic index (GI) of a food is a numerical ranking, on a scale of 0 to 100 of the extent to which a food will raise blood sugar after eating it. The glycemic index compares the rise in blood sugar level after eating a particular food to a reference food, often the sugar glucose (glucose is a very basic sugar and not the same as table sugar). One of the foods that is often used as a reference food is white bread. It has a relatively high glycemic index of 70 when compared to glucose, which has an index of 100. A high glycemic index may be considered to be a number between 70 and 100; medium, between 50 and 70; and low, under 50 (See Table 1).
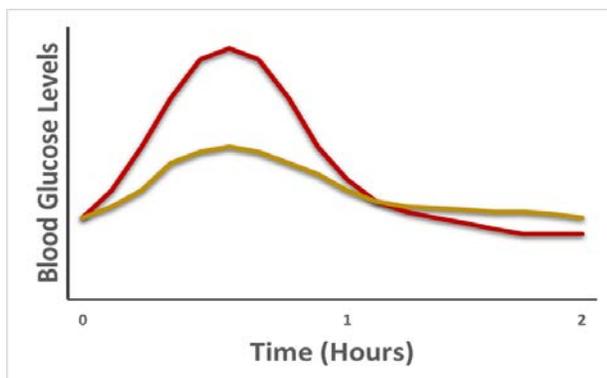
The GI of a food is measured by feeding 10 healthy people a portion of the food containing 50 grams of digestible (available) carbohydrate and then measuring the effect on their blood sugar for the next 2 hours.

What is the glycemic load (GL)?

The glycemic index of a particular food can be a useful value to understand the relative ranking of different foods, **but does not accurately reflect the effect on blood sugar of an actual serving of food**. This is where the glycemic load (GL) comes in. **The GL combines both the quality and the quantity of carbohydrate into one value.** You can think about GL as the amount of carbohydrate in a food adjusted for its glycemic potency. GL is a more accurate way to predict the impact on blood glucose of different types and amounts of food. For example, watermelon has a high GI (72-80), but a low GL (4-5) because there isn't a lot of sugar in a serving of watermelon, since it is mostly water and fiber. One serving of watermelon (120 grams) only contains 6 grams of carbs. A GL below 10 is considered "low", from 11 to 19 "moderate", and above 20 is "high" (See Table 1).

Table 1 Reference Ranges

Relative Level	Glycemic Index	Glycemic Load
High	70-100	>20
Moderate	55-69	11-19
Low	<55	<10

The GL of a food is calculated by multiplying the GI of that food by the amount of carbohydrate in an actual serving of the food. Low GL meals are recommended for weight loss and better blood sugar control.

The Food Insulin Index (FII)

The GI and GL are useful indicators of how blood sugar is affected by a food, but they are still only part of the story. When we eat carb-containing foods, blood sugar rises and the body (specifically, the pancreas) produces the hormone **insulin** that acts like a key to open the door to the cells and shuttle the sugar out of the bloodstream and into the cells. It can be used for immediate energy or stored as glycogen or fat. Insulin acts like a hormonal "switch" that helps the body to store energy in times of plenty. During times of food scarcity, lower levels of insulin help the body to access stored energy for fuel.

The amount of insulin produced as a result of food intake is a complex process and is affected not only by carb-containing foods, but also by the amount and type of protein and fat, the food matrix, and other factors. The insulin response to foods is not always proportional to the GI or GL because these values only account for carb-containing foods.[1]

Enter the food insulin index (FII). **The FII is a ranking of foods based on the insulin response to equal caloric portions of various whole foods and mixed meals**. The FII measures the increase in insulin as opposed to the GI or GL which measure the increase in blood-sugar. The FII is dependent on the quantity and quality of carbohydrate, protein and fat and how they interact. However, because insulin secretion is complex, the FII cannot necessarily be predicted from the amounts of carbohydrate, protein, and fat in a food or mixed meal and must be tested and measured in people.[2]

Choosing foods to lower your "insulin demand", or how much insulin your body needs to make to metabolize your food, may be an additional tool to help you lower the stress on your pancreas. This may reduce the risk for weight gain, development of diabetes, and other health problems [3].

Tips for Using the Food Insulin Index

Table 2 below contains the FII for a selection of foods. More research is needed to catalog larger numbers and varieties of foods. However, recent research on the FII allows for the following generalizations and helpful suggestions:

- Generally speaking, the higher the GL, the higher the FII, but not always. Notable examples include regular and sweet potatoes that both have higher FII than their GL would suggest.

- Of the grain-based carbohydrate-rich foods, lower FII choices include pasta and noodles. These are best cooked "al dente" to keep the insulin response low. Rice, bread, and couscous tend to be high FII foods, even their whole-grain versions. So choose whole, unprocessed grains whenever possible.

- Choose higher fiber bread and cereal options that have a lower FII, like grainy bread made with whole grains and seeds, and traditional whole grain breakfast cereals like rolled oats.

- Make sure to balance meals with some carbs, lean protein, healthy fats, and lots of salad or non-starchy vegetables. Since most all foods stimulate insulin, you cannot entirely eliminate an insulin response.

- Dietary fat by itself does not stimulate insulin secretion, but when added to carbohydrates, it amplifies the insulin response over the carbohydrate alone. This means two things: 1) be careful with added fat, some is OK, but more not only increases calories, it may also increase your insulin demand; and 2) Keep your carb amounts under control and choose low GL and FII options.

- Good snack choices include fruit and non-starchy vegetables with bean dips, as these are low FII foods and also full of vitamins, minerals and fiber.

- Meat sources of protein generally have a lower FII than carbohydrates, but be sure to choose leans cuts and pair them with vegetables and salad to keep your saturated fat intake under control and your intake of vitamins, minerals, and fiber high.

Why is all of this important?

The higher the rise in glucose in the blood stream, and the more insulin that is stimulated by high FII foods, the more insulin is produced. Over time this can lead to higher insulin levels (hyperinsulinemia) that can result in inflammation, weight gain and resistance to insulin's ability to make the body utilize sugar. The end result can be the progression to type 2 diabetes. Many studies have found that people that eat diets with high GI and GL are at increased risk not only type 2 diabetes, but also for stroke and coronary heart disease.[4,5]

How can I use these tools to improve my health?

By making careful food choices, you can influence your hunger and energy as well as blood sugar and insulin levels, cholesterol and triglyceride levels. If you have hypoglycemia, diabetes, or high triglyceride levels, or if you have problems controlling how much food you eat, paying attention to the GL and FII in your food choices will be helpful.What are some guidelines to follow to use these tools?

If you think that considering glycemic load and food insulin index in your diet would be helpful, follow these guidelines and see Table 2 below.

1. **Eat low and medium glycemic load and insulin index foods** like beans, oatmeal, and whole grain pasta regularly but in moderate quantity. Eat high glycemic index foods like bread, bagels, English muffins, baked potato, and snack foods rarely and only in very small quantities.

   - **Use beans (e.g., lentils, black, chickpeas) as a side dish** instead of rice or potatoes. Use beans as a snack food instead of chips, crackers or rice cakes. For example, eat hummus with raw vegetables.
   - **Cook pasta to the *al dente* state**. Al *dente* translates from Italian as "to the tooth." It refers to pasta cooked only until it offers slight resistance when bitten into, not soft or overdone. Serve one cup cooked pasta with at least one cup vegetables and a sauce of your choice.
   - **Focus on lower glycemic load fruits** like berries, apples, pears, and citrus more than higher glycemic index fruits like bananas and honeydew melon. Remember that the sugar in fruit is also combined with fiber which helps slow down the absorption of sugar into the blood stream. So, eating a fruit or vegetable is much better than eating a "white food" or sugar (high fructose corn syrup or sweets) that is not combined with fiber.
   - If you eat cereal, choose one with a low GL and FII such as oatmeal, of cold cereals with high amounts of bran.
   - **Avoid sugary foods** like candy, soda and other sweetened beverages that can really spike your blood sugar and your insulin. If you do eat them, eat them in small quantities and with a meal.
   - A helpful rule is the "80-20" rule. Eighty percent of the time, eat multi-colored whole foods rich in fiber, and twenty percent of the time, you can treat yourself to foods you enjoy.

2. **Eat meals with regularity and make lunch bigger than dinne**r.

   - Eating meals at the same time every day and not delaying meals helps to keep blood sugars more stable.[6]
   - Have a moderate sized lunch. Routinely have smaller dinners, like a small portion of fish, chicken or meat and vegetables, or a bowl of soup with a salad.

What are the glycemic index (GI), glycemic load (GL), and food insulin index (FII) of common foods?

Remember that GI and GL can only be measured on foods that contain carbohydrates. GI and GL values have not been determined on all foods; however, more complete lists can be found in the resources listed on page 6. FII values have been determined for even fewer foods and are included in Table 2 below to illustrate some general trends. Much more research is needed in this area. The reference food for the table below is glucose.

How can I keep this simple?

Most people won't have the patience to look up a number for each of the food groups. But if you follow the recommendations in the box to the right, you will change your diet resulting in the health benefits of a low glycemic load and insulin demand diet without having to look up a bunch of numbers.

- Eat multi-colored whole foods that were recently alive.
- Limit "white" foods such as fluffy white bread, bagels, pasta and potatoes.
- Combine fiber (fruits and vegetables) and protein (meat, beans, and nuts) with your carbohydrates (starches) with each meal.
- Take time and enjoy each bite of your food and recognize when you are full so you don't consume too many calories.

Where can I learn more information?

Books:

- *The New Glucose Revolution* by Jennie Brand-Miller, Thomas M.S. Wolever, Stephen Colagiuri and Kaye Foster-Powell. 2006
- *The Low GI Handbook: The New Glucose Revolution Guide to the Long-Term Health Benefits of Low GI Eating (New Glucose Revolutions)* by Jennie Brand-Miller, Thomas M.S. Wolever, Stephen Colagiuri and Kaye Foster-Powell. 2010

Websites:

- www.mendosa.com/gilists.htm

- http://www.glycemicindex.com/ (University of Sydney's Website)

- http://www.health.harvard.edu/newsweek/Glycemic_index_and_glycemic_load_for_100_foods.htm

Table 2. Glycemic Index, Glycemic Load, and Food Insulin Index of Common Foods

Food	Glycemic Index*	Serving Size	Carbs per serving (g)¥	Glycemic Load per serving‡	Food Insulin Index£
CARBOHYDRATE-RICH FOODS					
White bread	70	1 slice (30 g)	14	10	73
Whole wheat bread	69	1 slice (30 g)	14	10	70
Grainy bread (made with whole seeds and grains)	50	1 slice (41 g)	14	7	41
White pasta spirals	46	½ C cooked	20	9	29
Whole wheat pasta	42	½ C cooked	20	8	29
White basmati rice	50	½ C cooked	25	13	nd
Brown basmati rice	45	½ C cooked	25	11	nd
White Rice	72	½ C cooked	21	15	58
Brown rice	72	½ C cooked	23	17	45
Millet	70	½ C cooked	21	15	nd
Barley	30	½ C cooked	22	7	nd
Wild rice	45	½ C cooked	16	7	nd
Potatoes (boiled, peeled)	78	½ C boiled	14	11	88

Food	Glycemic Index*	Serving Size	Carbs per serving (g)¥	Glycemic Load per serving‡	Food Insulin Index£
CEREALS					
Oatmeal	57	½ C cooked	12	7	29
Special K	54	1 ¼ C	29	16	48
All bran	60	½ C	37	22	55
Cheerios	74	1 C	18	13	63
Corn flakes	81	1 C	24	19	82
Shredded wheat	75	2 Biscuits	37	28	91
Rice Krispies	88	1 ¼ C	29	26	94
Grapenuts	75	½ C	40	30	110
BEANS					
Baked beans	44	½ C cooked	22	10	88
Chickpeas	35	½ C cooked	16	6	nd
Black beans	35	½ C cooked	13	5	nd
Lentils	37	½ C cooked	12	4	42
Kidney/pinto beans, canned	40	½ C cooked	14	6	nd
VEGETABLES					
Spinach, raw	15	1 C	2	-	nd
Beet greens, raw	30	1 C	1	-	nd
Green beans, raw	30	½ C	2	1	nd
Sweet corn, from frozen	47	½ C	14	7	39
Sweet potato	61	½ C mashed	25	15	96
Broccoli, steamed	15	½ C chopped	2	-	29
Carrots, peeled and steamed	33	½ C chopped	4	1	44
Carrot juice	43	6 oz	15	6	41
Green peas, steamed	22	½ C	6	1	37
Tomato pasta sauce	31	½ C	12	4	41
Avocado	0	⅓ medium	4	-	4
FRUIT					
Watermelon	72	1 C cubed	11	8	nd
Blueberries	25	1 C	18	5	nd
Raspberries	25	1 C	7	2	nd
Strawberries	25	1 C sliced	10	3	nd
Honeydew Melon	62	1 C cubed	14	9	93
Banana	52	1 small	20	11	59
Raisins	64	¼ C	26	17	31
Orange	42	1 medium	13	5	44
Apple	36	1 medium	18	6	43
Pear	30	1 medium	22	7	nd
Peach	56	1 medium	12	7	39
Canned peach, in juice	40	½ C	13	5	54
Orange juice	53	6 oz	20	11	55
Unsweetened apple juice	39	6 oz	20	8	47

Food	Glycemic Index*	Serving Size	Carbs per serving (g)¥	Glycemic Load per serving‡	Food Insulin Index£
DAIRY PRODUCTS					
Whole milk	31	1 C	12	4	24
1% Lowfat Milk	29	1 C	12	3	34
Chocolate Lowfat milk	26	1 C	25	7	46
Skim milk	29	1 C	12	3	60
Yogurt plain	18	8 oz	16	3	46
Lowfat fruit yogurt	31	8 oz	45	14	84
Cottage Cheese reduced fat	10	1 C	6	1	40
Cream Cheese	0	1½ oz	1	-	18
Cheddar Cheese	0	1½ oz	1	-	33
PROTEIN-RICH FOODS					
Eggs, poached	0	1 large	1	-	23
Beef steak	0	3 oz	0	-	26
Bacon	0	3 strips	0	-	9
Tuna, canned in water	0	3 oz	0	-	26
Chicken, fried in oil with skin	0	3 oz	0	-	19
Roast chicken without skin	0	3 oz	0	-	17
White fish	0	3 oz	0	-	43
Tofu	15	½ C cubes	1	-	21
Peanuts	14	1 oz	2	-	15
Peanut Butter	14	2 Tbl	4	-	11
Almonds	1.5	1 oz	3	-	nd
Walnuts	0	1 oz	2	-	nd
FAT-RICH FOODS					
Butter	0	1 Tbl	0	-	2
Olive Oil	0	1 Tbl	0	-	3
BEVERAGES					
Coca-cola	53	8 oz	25	13	44
Beer, Budweiser, 4.9% alcohol	66	12 oz	11	7	20
Gin, 40% alcohol	0	1 oz	0	0	1
White wine	0	5 oz	4	0	3

*Glycemic index values from online database: http://www.glycemicindex.com/index.php (accessed 8/2018) and Bao J et al. 2011.[1] Referenced against glucose.

¥ From USDA Food Composition Databases: https://ndb.nal.usda.gov/ndb/search/list?home=true (accessed 8/2018). Values are carbohydrate by difference minus total dietary fiber.

‡Glycemic Load = GI * Carbs per serving/100; "-": no data, food does not contain appreciable carbs.

£ From Bao J et al. 2011 and Bell K. 2014.[1,7]; "nd": no data available; Insulin Index based on 1000 kilojoule portions determined against 1000 kilojoules of glucose.

The information in this handout is for general education. Please work with your health care practitioner to use this information in the best way possible to promote your health and happiness.

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