

# Glycaemic index: Is it useful for people with diabetes?

Pam Dyson

## Article points

1. The glycaemic index (GI) is a scale that ranks carbohydrate foods by how much they raise blood glucose levels compared with a reference food containing an equivalent amount of carbohydrate.
2. This article discusses the advantages and disadvantages of low-GI diets.
3. GI values should not be solely used to inform diet, but as useful additional information to support the choices people with diabetes make about the type and amount of food they eat.

## Key words

- Glycaemic index
- Diet
- Glycaemic load

Pam Dyson is a Research Dietitian at the Oxford Centre for Diabetes, Endocrinology & Metabolism, Oxford, UK.

Many people with diabetes have been advised to adopt a of low glycaemic index (GI) diet in order to improve blood glucose levels, increase insulin sensitivity, reduce CV risk and promote weight loss. There is much confusion about which foods are low GI and which are high GI, and this confusion is exacerbated by disagreement among experts about the relative usefulness of low GI diets for people with diabetes. This article aims to define the term glycaemic index, give examples of high and low GI foods and discuss the evidence-based advantages and disadvantages of low-GI diets.

**G**lycaemic index (GI) is measured in the laboratory using a standard procedure. Foods containing 50 g of carbohydrate are given to fasting volunteers and blood samples are taken every 15 minutes for 2–3 hours in order to measure blood glucose levels. As an example, three medium–large apples contain approximately 50 g of carbohydrate, as do three chocolate digestive biscuits or one medium-sized baked potato. The results of the blood glucose tests are plotted on a graph over time and compared with a reference sample, usually pure glucose. The GI of each food is expressed as a number, and the lower the number, the lower the GI of the food. It is important to remember that the GI of a food can only be measured in the laboratory – it is impossible to accurately estimate GI any other way.

## What does the GI value mean?

The GI value of each food can be categorised as low, medium or high (Foster-Powell et al,

2002; illustrated in *Table 1*). Examples of commonly eaten low-, medium- and high-GI foods are listed in *Table 2*.

## Practical applications of low-GI diets

Applying the laboratory-measured GI values to the food that people with diabetes actually eat can be confusing, and many books and articles have been published in an attempt to translate the theory into practice. A useful web-site ([www.glycemicindex.com](http://www.glycemicindex.com)) summarises the practical recommendations as follows.

- Use breakfast cereals based on oats, barley and bran.
- Use breads with wholegrains, stone-ground flour, sour dough or rye.
- Reduce the amount of potatoes eaten.
- Use all other types of fruit and vegetables.
- Use basmati or doongara rice.
- Use pasta, noodles, quinoa, sweet potatoes and yams.
- Eat plenty of salad and vegetables with a vinaigrette dressing.

**Page points**

1. The role of low-GI diets in promoting health is clear-cut, and yet there is no consensus about the relative importance of GI diets.
2. The majority of studies that have been performed are limited by study design.
3. For people with diabetes, the advantages of low-GI diets include the benefits associated with weight reduction, improved glycaemic control, improved insulin sensitivity and reduced risk of heart disease.

**Proposed benefits of low-GI diets**

Many studies have investigated the benefits of low-GI diets in people with and without diabetes. The health benefits examined include the following.

- Weight loss and weight maintenance (Thomas et al, 2007).
- Increased insulin sensitivity (Ostman et al, 2006).
- Improved diabetes control (Brand-Miller et al, 2003).
- Reduced risk of heart disease (Kelly et al, 2004).
- Reduction in blood cholesterol levels (Thomas et al, 2007).
- Management of polycystic ovary syndrome (PCOS; Marsh and Brand-Miller, 2005).
- Hunger reduction (Jiménez-Cruz et al, 2005).
- Prolonging physical endurance (Wu and Williams, 2006).

It would appear from the above evidence that the role of low-GI diets in improving health is clear, and yet there is no consensus regarding the relative importance of such diets. Despite

the number of studies exploring the effect of low-GI diets, not all of these studies are in agreement with regard to its effectiveness. The majority of studies that have been performed are limited by study design; there are few randomised controlled trials, many studies are of short duration, there is no agreed definition of low GI and most include small numbers of participants. This lack of evidence for the effect of low-GI diets may well be associated with the paucity of well-designed, long-term trials.

**Low-GI diets and diabetes**

For people with diabetes, the advantages of low-GI diets include the benefits associated

**Table 1. Glycaemic index values corresponding to low-, medium- and high-GI foods (Foster-Powell et al, 2002).**

GI ranking	GI value
Low	0–55
Medium	56–69
High	≥70

**Table 2. The glycaemic index rankings of some common foods.**

Food	Low GI	Medium GI	High GI
<b>Bread</b>	Multigrain (granary, rye bread, bread with seeds and wholegrains)	-	All wholemeal, brown and white bread including French bread and naan bread
<b>Breakfast cereals</b>	All-Bran, Special K, muesli and porridge made with stone-ground oats	Bran-based cereals	All other cereals
<b>Potatoes</b>	Sweet potato, yams	New potatoes (any cooking method), crisps	Old potatoes – boiled, baked, mashed, roasted and chipped
<b>Pasta and rice</b>	All types of pasta, egg noodles	Basmati rice, rice noodles	Brown and white rice, rice pasta
<b>Vegetables</b>	All vegetables except root	Root vegetables	-
<b>Fruit</b>	Apples, pears, peaches, cherries, apricots, citrus fruits, oranges and strawberries	Pineapples, mangoes and grapes	Watermelon, banana
<b>Dairy products</b>	All milk (full-fat, skimmed and semi-skimmed) and yogurt	Ice cream	-
<b>Cakes and biscuits</b>	Plain sponge cake, fruit and malt bread	Digestive biscuits, rich tea biscuits, crackers	Doughnuts, scones
<b>Savoury snacks</b>	Maize or corn chips, cashew nuts and peanuts	Crisps	Extruded potato snacks (Quavers, Hula Hoops and pretzels)

**Page points**

1. In the UK, 61 % of dietitians state that they are reluctant to recommend GI diets to their patients.
2. A meta-analysis investigated the effect of these diets on glycaemic control and concluded that low-GI diets reduced HbA<sub>1c</sub> by 0.4 % over and above that produced by high-GI diets.
3. Both the amount (quantity) and type (quality) of carbohydrate will affect blood glucose levels and the concept of the glycaemic load (GL) was introduced in an attempt to rationalise these two components.
4. The GI of a food is not necessarily an indication of the healthiness of that food.

with weight reduction, improved glycaemic control, improved insulin sensitivity and reduced risk of heart disease (Brand-Miller et al, 2003). However, the use of low-GI diets and their role in the treatment of diabetes remain controversial, with some authorities recommending low-GI diets as first-line treatment (Brand-Miller et al, 2003; [www.diabetesaustralia.com.au](http://www.diabetesaustralia.com.au)). Others recommend that low-GI diets may have a useful role to play in the management of diabetes (Connor et al, 2003) and some state that there is insufficient evidence for beneficial effects over the long term to recommend GI-informed diets as a primary strategy (Sheard et al, 2004). This ambivalence is reflected among dietitians in the UK, with 61 % stating that they are reluctant to recommend low-GI diets to their patients (Usher, 2007). So, what is the evidence for the role of low-GI diets in diabetes? Brand-Miller et al (2003) investigated the effect of such diets on glycaemic control and concluded that low-GI diets reduced HbA<sub>1c</sub> by 0.4 percentage points over and above that produced by high-GI diets. There is, as yet, no robust evidence for the role of low-GI diets in weight reduction or weight maintenance, insulin resistance and cardiovascular risk in people with diabetes.

**Criticisms of low-GI diets**

The critics of low-GI diets have summarised the main disadvantages as follows.

- Such diets assume a qualitative rather than quantitative approach to carbohydrate.
- Such diets affect the general healthiness of the diet in terms of vitamins and minerals.
- Such diets reinstate a prescriptive approach to the dietary treatment of diabetes.
- There may be other factors affecting the GI of foods that have not yet been researched.

**Quality and quantity of carbohydrate**

It is widely agreed that the quantity of carbohydrate in a meal or snack predicts postprandial blood glucose levels (Franz et al, 2002), but the concept of low GI relies upon the quality rather than the quantity of carbohydrate in the diet, and its effect upon blood glucose levels. Both the amount (quantity) and type (quality) of carbohydrate will affect blood glucose levels; therefore, the concept of the glycaemic load (GL) was introduced in an attempt to rationalise these two components (Salmerón et al, 1997). The GL can be calculated using the following equation:

$$GL = (GI \text{ of a food} / 100) \times \text{net carbohydrate}^*$$

(\*where net carbs = total carbohydrate - dietary fibre)

This concept has been further refined and there are now recommendations for daily GL based upon the amount and type of carbohydrate eaten (Brand-Miller et al, 2003). These are shown in *Table 3*.

Although this may be a useful theoretical exercise for predicting postprandial blood glucose levels, it is understandable that many people with diabetes may find this impractical as a dietary guide. It can lead to confusion as foods with a low GI eaten in large amounts have a high GL, and high-GI foods with low carbohydrate content may have a low GL. For example, a medium portion of spaghetti (250 g) with a low GI of 44 has a high GL of 23; conversely, a 200g slice of watermelon (high GI: 72) has a low GL of 8.

**Healthy diets and GI**

The GI of a food is not necessarily an indication of the healthiness of that food. Many low-GI foods, such as dried beans and lentils, pasta and stone-ground oats, have a low GI and contain useful amounts of vitamins and minerals, but this is not true of all foods. Many foods that contain a large amount of fat, sugar or both have a low GI; for example, peanuts (14) and milk chocolate (42). A chocolate milkshake with cream has a GI of 37 (low), but a ripe banana has a GI of 70 (high). For many people with type 2 diabetes for whom weight gain may be

GL ranking	GL value	Daily GL
Low	≤10	≤79
Medium	11–19	80–119
High	≥20	≥120

**Page points**

1. Recent studies have shown that the addition of nut products, vinegar and cheese can lower the GI of high-GI foods.
2. In the 'old days', many people with diabetes had been advised to avoid all sugar in their diet due to the mistaken belief that sugar is absorbed more quickly and has more effect on blood glucose levels than similar amounts of carbohydrate eaten as starch.
3. There is limited evidence that low-GI diets can improve glycaemic control in people with diabetes, but the GI of a food is not the only factor that should be taken into consideration.
4. It is now generally accepted that the principles of nutritional advice should be to provide information for people with diabetes to enable them to make informed choices about the type and amount of food they eat.

an issue, the banana, despite having a higher GI, would be a healthier alternative to the milkshake. Conversely, many high-GI foods containing fibre, vitamins and minerals, such as wholemeal bread (77) and baked potatoes (85), would be excluded from a low-GI diet.

**Factors affecting the GI of foods**

Little is known about the effects of other components of the diet on the GI of individual foods. Recent studies have shown that the addition of nut products, vinegar and cheese can lower the GI of high-GI foods (Johnston and Buller, 2005; Ostman et al, 2005; Henry et al, 2006; Jenkins et al, 2006). Food preparation methods have also been shown to affect the GI of individual carbohydrate-rich foods, with the GI value of foods that had been roasted or baked higher than the same foods undergoing boiling or frying (Bahado-Singh et al, 2006). Research in this area is limited and investigation of the GI of composite meals may prove to be of importance (Henry et al, 2006).

**Discussion**

In the 'old days', many people with diabetes had been advised to avoid all sugar in their diet due to the mistaken belief that sugar is absorbed more quickly and has more effect on blood glucose levels than similar amounts of carbohydrate eaten as starch. Studies investigating the GI of different foodstuffs have shown that many sugar-rich carbohydrate foods produce a lower glycaemic response than starchy foods alone, and that moderate amounts of sugar can be included in the diet of people with diabetes without compromising glycaemic control (Connor et al, 2003). This has improved the quality of life of many people with diabetes and especially those with type 1 diabetes who have adopted the practice of carbohydrate counting and insulin adjustment (DAFNE study group, 2002).

It is now generally accepted that the principles of nutritional advice should be to provide information for people with diabetes to enable them to make informed choices about the type and amount of food they eat, and that there is recognition of, and respect for, an individual's quality of life (Connor et al, 2003). Imposing a list of foods that should be included or avoided based upon the GI of that food and ignoring the individual's likes and dislikes is reinstating a prescriptive approach to dietary education and may

Page points

1. Many people within the UK, for whom bread, potatoes and certain types of breakfast cereals form the staples of their diet, have struggled with the concept that they should be reducing or avoiding these foods, and the suggestion that they include more pasta and muesli in their diet may be unrealistic.
2. Providing people with diabetes with a list of high-, moderate- and low-GI foods gives the necessary information about the relative effects of different foods on postprandial glucose levels, but does not provide the full picture.
3. There is limited evidence that low-GI diets can improve glycaemic control in people with diabetes – the GI of a food is not the only factor that should be taken into consideration.

be counter-productive. Many people within the UK, for whom bread, potatoes and certain types of breakfast cereals form the staples of their diet, have struggled with the concept that they should be reducing or avoiding these foods, and the suggestion that they include more pasta and muesli in their diet may be unrealistic.

It is also somewhat challenging for many health professionals to apply GI in practice. Providing people with diabetes with a list of high-, moderate- and low-GI foods gives the necessary information about the relative effects of different foods on postprandial glucose levels, but does not provide the full picture. For example, many people would assume that they should completely avoid all white and wholemeal breads and potatoes as they have a high-GI value. Adopting this approach this could compromise overall nutrition as bread and potatoes are useful sources of fibre, vitamins and minerals. The approach that is usually adopted is to make general recommendations, for example to substitute pasta or Basmati rice for potatoes and to eat more wholegrain or stoneground breads. Advice about low-GI diets is probably best delivered as part of the package of dietary information and not as a stand-alone therapy. In the author's experience, many health professionals who use the concept of GI in practice have found that supporting and respecting the dietary choices made by people with diabetes is more effective than simply providing a list of foods that can be included and foods that should be avoided.

Conclusion

There is limited evidence that low-GI diets can improve glycaemic control in people with diabetes – the GI of a food is not the only factor that should be taken into consideration. Information and understanding about the glycaemic effect of different carbohydrate foods can be useful in managing diabetes, but should be used within the context of a healthy diet and with an understanding of the effects of the amount of carbohydrate consumed and its effect on postprandial blood glucose levels. GI should not be seen as a diet that can be

used in isolation to manage diabetes, but as useful additional information to support the choices people with diabetes make about the type and amount of food they eat. ■

Bahado-Singh PS, Wheatley AO, Ahmad MH et al (2006) Food processing methods influence the glycaemic indices of some commonly eaten West Indian carbohydrate-rich foods. *British Journal of Nutrition* 96: 476–81

Brand-Miller J, Hayne S, Petocz P, Colagiuri S (2003) Low-glycemic index diets in the management of diabetes: a meta-analysis of randomized controlled trials. *Diabetes Care* 26: 2261–7

Brand-Miller J, Wolever TM, Foster-Powell K, Colagiuri S (2005) *The New Glucose Revolution: The Authoritative Guide to the Glycemic Index—the Dietary Solution for Lifelong Health*. Hodder, London

Connor H, Annan F, Bunn E et al (2003) The implementation of nutritional advice for people with diabetes. *Diabetic Medicine* 20: 786–807

DAFNE study group (2002) Training in flexible, intensive insulin management to enable dietary freedom in people with type 1 diabetes: dose adjustment for normal eating (DAFNE) randomised controlled trial. *BMJ* 325: 746

Foster-Powell K, Holt SH, Brand-Miller JC (2002) International table of glycemic index and glycemic load values: 2002. *American Journal of Clinical Nutrition* 76: 5–56

Franz MJ, Bantle JP, Beebe CA et al (2002) Evidence-based nutrition principles and recommendations for the treatment and prevention of diabetes and related complications. *Diabetes Care* 25: 148–98

Henry CJ, Lightowler HJ, Kendall FL, Storey M (2006) The impact of the addition of toppings/fillings on the glycaemic response to commonly consumed carbohydrate foods. *European Journal of Clinical Nutrition* 60: 763–9

Jenkins DJ, Kendall CW, Josse AR et al (2006) Almonds decrease postprandial glycemia, insulinemia, and oxidative damage in healthy individuals. *Journal of Nutrition* 136: 2987–92

Jiménez-Cruz A, Gutiérrez-González AN, Bacardi-Gascon M (2005) Low glycemic index lunch on satiety in overweight and obese people with type 2 diabetes. *Nutricion Hospitalaria* 20: 34–50

Johnston CS, Buller AJ (2005) Vinegar and peanut products as complementary foods to reduce postprandial glycemia. *Journal of the American Dietetic Association* 105: 1939–42

Kelly S, Frost G, Whittaker V, Summerbell C (2004) Low glycaemic index diets for coronary heart disease. *Cochrane Database Systematic Reviews* 18: CD004467

Marsh K, Brand-Miller J (2005) The optimal diet for women with polycystic ovary syndrome? *British Journal of Nutrition* 94: 154–65

Ostman E, Granfeldt Y, Persson L, Björck I (2005) Vinegar supplementation lowers glucose and insulin responses and increases satiety after a bread meal in healthy subjects. *European Journal of Clinical Nutrition* 59: 983–8

Ostman EM, Frid AH, Groop LC, Björck IME (2006) A dietary exchange of common bread for tailored bread of low glycaemic index and rich in dietary fibre improved insulin economy in young women with impaired glucose tolerance. *European Journal of Clinical Nutrition* 60: 334–41

Salmerón J, Manson JE, Stampfer MJ et al (1997) Dietary fiber, glycemic load, and risk of non-insulin-dependent diabetes mellitus in women. *JAMA* 277: 472–7

Sheard NF, Clark NG, Brand-Miller JC et al (2004) Dietary carbohydrate (amount and type) in the prevention and management of diabetes: a statement by the American diabetes association. *Diabetes Care* 27: 2266–71

Thomas DE, Elliott EJ, Baur L (2007) Low glycaemic index or low glycaemic load diets for overweight and obesity. *Cochrane Database Systematic Reviews* 18: CD005105

Usher A (2007) Mind your language. *Diabetes Update Summer*: 47

Wu CL, Williams C (2006) A low glycemic index meal before exercise improves endurance running capacity in men. *International Journal of Sport Nutrition and Exercise Metabolism* 16: 510–27