

The science of blood sugar

As growing numbers of people struggle with obesity, glycaemic monitoring is catching on – and will be featured as a special topic at the Nutracon conference. But while the glycaemic index is gaining cachet on packaging, PATRICK HOLFORD shows that a better measure of how foods affect blood sugar is actually the ‘glycaemic load’

People are eating less. Calorie consumption has gone down. Fat intake has gone down even more. Yet obesity continues to rocket. Why? The simple reason is that we are consuming more sugar, refined foods and caffeinated drinks. These upset the body’s blood-sugar balance, which causes weight gain.

Dr Atkins was right in this regard. He maintained that the best way to stabilise weight was to stabilise blood sugar by limiting the amount of carbohydrates consumed, substituting protein and fat in their stead. This approach works, but the side effects aren’t worth it – increased risk for kidney problems, osteoporosis, and breast and prostate cancers. All of these diseases have been linked to high-protein diets based on meat and dairy products.

ing volunteers however many oats they need to eat to obtain 50g of available carbohydrate (fibre doesn’t count).

LOAD TRUMPS INDEX

Diets based on eating low-GI foods have a major problem. They are unquantifiable because the GI of foods only tells about the quality of the sugars in a food with respect to raising blood-sugar levels. The GI score tells nothing about the quantity of carbohydrate within a food.

For example, carrots and chocolate contain a similar GI score. However, carrots contain a fraction of the amount of available carbohydrates compared to



lated by multiplying the amount of carbohydrate in, for example, a slice of bread, and the GI of that particular bread.

Low-GI diets are therefore only crude indicators of the benefits of low-GL diets because it is possible to eat low-GI foods in abundant quantity, resulting in a high-

GL diet. GL is therefore a superior, quantifiable and accurate measure of a diet’s effect on blood-sugar balance.

The formula is very simple: If a person eats 40 GLs a day, he or she will lose weight; 60 GLs a day assures the maintenance of an even energy level.

GL STUDIES ON WEIGHT

GL principles show exactly what foods do to blood sugar and, consequently, body weight. A tightly controlled animal study demonstrated the GL’s benefit for weight loss. One group of rats was given a high-GL diet, the other a low-GL diet. They had exactly the same amount of calories.¹ The low-GL rats gained no weight, whereas the high-GL diet rats gained weight, week on week. By the end of the 32 weeks, they were not only 16 per cent heavier, they had gained 40 per cent more body fat. Same calories – very different results.

Does the same thing happen to humans? One human study compared

Low-GL diets cause weight loss that is more likely to be sustained than conventional diets

There must be a better way – and there is. The ‘GI’ or glycaemic index of foods is a measure of how much of the sugar within a food raises sugar in the blood. It’s an index, which means that each food is compared to glucose, with a GI score defined as 100. Oats, for example, score 49. This means that the sugar in oats raises a body’s blood sugar level half as much as 50g of glucose. It is measured by feed-

chocolate. Hence, you would need to eat a lot more carrots to end up with the same effect on blood-sugar levels.

On the other hand, by knowing both the quantity of carbohydrates eaten as well as the GI of the food in question, one can determine the total glycaemic load, or GL, of a food. It measures what each piece of food actually does to one’s blood sugar and body weight. It is calcu-

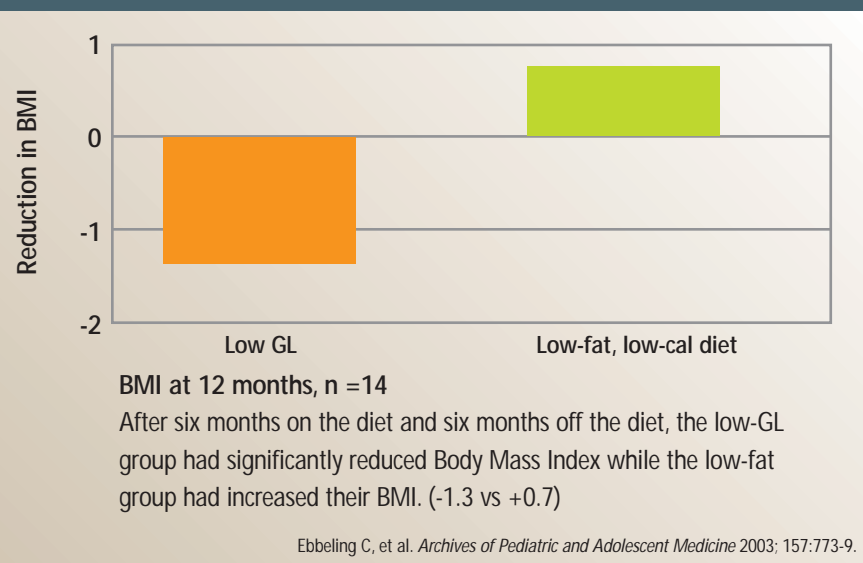
weight loss between dieters placed on a low-GL diet vs a conventional low-fat, calorie-controlled diet, each diet providing the same number of calories. Researchers in the Department of Human Nutrition at South Africa's University of the Orange Free State assigned 15 volunteers to a low-GL diet and 15 others to a normal, calorie-controlled diet for 12 weeks.

During the first 12 weeks, both groups lost weight, but those on the low-GL diet lost 1.9kg more weight (9.3kg vs 7.4kg). After the initial 12 weeks, seven subjects who had been on the low-GL diet and nine subjects who had been on the conventional diet switched diets for 12 weeks.

During the second 12-week period, those placed on the low-GL diet had an average further weight loss of 2.9kg more than those on the low-fat, low-calorie diet (7.4kg vs 4.5kg). That equates to 10 per cent weight loss compared to seven per cent – 40 per cent more weight loss on the GL diet. Of note, fasting insulin concentrations were significantly lower in the low-GL group. Lower fasting insulin is associated with decreased risk of obesity, diabetes and heart failure.²

Low-GL diets cause more weight loss on identical calories. Animals fed high-calorie diets providing the identical number of calories show less weight gain and fat gain on a low-GL diet. Two groups of rats were fed identical diets, except one group (n=10) ate low-GL and

TABLE 1: Reduced GL diet vs low-fat, low-calorie diet



the other (n=11) ate high-GL food. The low-GL fed rats gained no weight. But the high-GL rats gained weight week on week. By the end of 32 weeks, the low-GL group was 14 per cent lighter and had 29 per cent less body fat.³

Two studies show that low-GL diets cause weight loss that is more likely to be sustained than conventional dieting. In a study published in the Canadian journal *Cardiology*, one group of people was put on a low-GL diet and another group on a conventional low-fat, low-calorie diet. Those following the low-GL diet lost significantly more weight compared to those following the conventional low-fat, low-calorie diet (2.8kg loss vs 0.2kg gain). Weight loss was sustained over 12 months.⁴

Researchers at Harvard Medical

School put a group of 14 obese teenagers on either a low-GL diet with no calorie restrictions or a low-fat, low-calorie diet for six months. After six months on the diet and a further six months 'off the diet,' the low-GL group had significantly reduced body mass index (BMI) while those on the low-fat diet increased their BMI (-1.3 vs +0.7).⁵

Low-GL diets can also cause rapid fat loss. Studies show that low-GL diets cause fat loss, while high-GL diets cause rapid fat gain, demonstrating that sugar and refined carbohydrates promote weight gain as fat. In a study published in *Lancet*, two groups of mice (n = 21) were fed either low-GL or high-GL diets for 18 weeks. The researchers controlled the rats' feeding to ensure that the mice from both groups maintained the same ►

average body weight throughout. The group on the low-GL diet had almost half the body fat and significantly more lean body mass compared to the high-GL group.⁶

One of the main problems associated with dieting is that the body responds to a low-calorie intake by reducing the body's metabolic rate, hence burning fewer calories. This means that dieters

find it increasingly difficult to lose weight. Low-GL diets cause half the reduction in metabolic rate compared to a typical low-fat diet.

In a study published in the *Journal of the American Medical Association*, 39 overweight or obese adults were assigned to one of two diets. One group was on a low-GL diet, the other group followed a conventional low-fat, low-calorie diet.

They were then followed for two years while on these diets. Each person had his or her metabolic rate measured once 10 per cent of body weight had been lost. The group on the conventional low-fat, low-calorie diet had almost twice the reduction in metabolic rate compared with the low-GL group.⁷

As well as losing more weight and more fat on the same calories, people who eat a low-GL diet eat significantly less because they feel more satiated. Thirty-nine overweight or obese young adults, aged 18 to 40, followed a calorie-restricted diet, either low-GL or low-fat. Participants on the low-GL diet reported less hunger than those on the low-fat, low-calorie diet.^{7,8}

It can also be said that GL diets are more effective than high-protein diets. High-protein diets are not significantly better at causing sustained weight loss when compared with a conventional low-fat, low-calorie diet. As shown earlier, low-GL diets are superior to conventional low-fat, low-calorie diets. Therefore, GL diets are superior to high-protein diets.

This was borne out when researchers at the University of Pennsylvania, where two groups of obese people were put on either a high-protein, low-carbohydrate, high-fat diet or a low-calorie, low-fat, high-carbohydrate (conventional) diet. Whilst the high-protein group had lost more weight after three and six months on the diet, after 12 months there was no significant difference between the groups.⁹

Researchers at Australia's CSIRO Health Sciences and Nutrition Centre put 100 overweight middle-aged women onto either a high-protein or a high-carbohydrate diet for 12 weeks. Both groups were restricted to 1,333 calories per day. Both groups of women lost the same amount of weight (7.3kg), showing that a high-protein diet is similar to a conventional low-fat, low-calorie diet.¹⁰

A review of all the high-protein/low-

DIET DEBATE

Why GL diets are the future

The Atkins Diet is out and GI diets are in. We are told to avoid 'fast-releasing' foods with a GI of 70 or more and guzzle anything with a GI of 50 or less. Although a step in the right direction, these are inherently confusing. This is because the GI is only a measure of how the carbohydrates within a food raise blood-sugar levels compared to pure glucose. It tells you nothing about how much – the quantity of – carbohydrates are in a food. So, foods with fast-releasing sugars, but very little quantity of sugar, get unfairly maligned.

The only way you can see the truth, the whole truth and nothing but the truth is to multiply the GI (quality measure) by the amount of carbohydrate (quantity measure), which is GLs or glycaemic load.

FOOD	GI	GL	Carbs(g) per serving(g)
Watermelon	72	4.3	4.2/120
Broad beans	79	4.1	5.2/80
Pumpkin	75	4.3	4.3/80
Carrot	92	3.9	3.9/80
Sweet potato	44	11.4	26 (150g)
SlimFast	33	12.8	12.8 (325ml)

For example, let's say you wanted to eat a carrot (92 GI in some books) and pumpkin soup (75 GI), followed by some salmon, broad beans (79 GI) and sweet potato (44 GI in some books), followed by a slice of watermelon. You'd get a big tut-tut from the GI fanatics, who scorn any food above 70 GIs as fast releasing, with a mild brownie point for choosing sweet potato.

This is entirely the wrong advice because watermelon (GLs 4.3 per 120g serving), broad beans (4.1GLs), carrots (3.9GLs), pumpkin (4.3GLs) all have a low GL because there are very few carbohydrates in them.

Conversely, the one apparently 'good' low-GI food – sweet potato – is full of sugars. If you want to lose weight, you need to have no more than 40 GLs a day, or 10 per meal. To keep blood sugar in balance you should eat no more than 60 GLs a day.

Companies can manipulate the GI score of foods to be low by including slow-releasing sugars, but lots of it. A classic example is SlimFast. A 325ml serving of this sugar-laden 'diet' drink has an impressive GI of 33, but a GL of 12.8 – above the 10 GLs a meal that equates to optimum weight loss.

The fact is that no food is 'good' or 'bad' – it just depends on how much you consume. To limit your intake on quantity only is dead boring – aka Atkins. To limit on GI is inaccurate. GLs, on the other hand, don't lie.

carbohydrate diet studies done to date concludes, "Weight loss was principally associated with decreased calorie intake and increased diet duration but not with reduced carbohydrate content."¹¹

GL's OTHER BENEFITS

Many studies show that low-GL diets have immediate and long-term health benefits, including improving cholesterol levels, stabilising blood glucose levels and improving insulin sensitivity, and reducing diabetes and cardiovascular disease risk.

Two groups of overweight or obese people followed either a low-GL diet or a low-fat, low-calorie diet for two years. After each person had lost 10 per cent of body weight, other health measures were taken. Those on the low-GL diet had greater improvements in insulin resistance (blood-sugar control), triglycerides (fat circulating in the blood), inflammation and blood pressure compared with those on the conventional low-fat low-calorie diet. The researchers concluded that a reduction in glycaemic load may aid in the prevention or treatment of obesity, cardiovascular disease and diabetes mellitus.⁷

One group of people followed a low-GL diet while another group followed a conventional low-fat, low-calorie diet. Those following the low-GL diet not only lost more weight, they also had greater improvements in HDL cholesterol, triglycerides and fasting glucose compared to those on the conventional low-fat, low-calorie diet after six months. These health gains were sustained or improved upon after 12 months. The researchers concluded that 'implementation of a low-GL diet is associated with substantial and sustained improvements in abdominal obesity, cholesterol and blood-sugar control.'⁴

Diabetes markers can also be positively changed with a low-GL diet. Researchers at the Harvard School of Public Health monitored the health of ▶

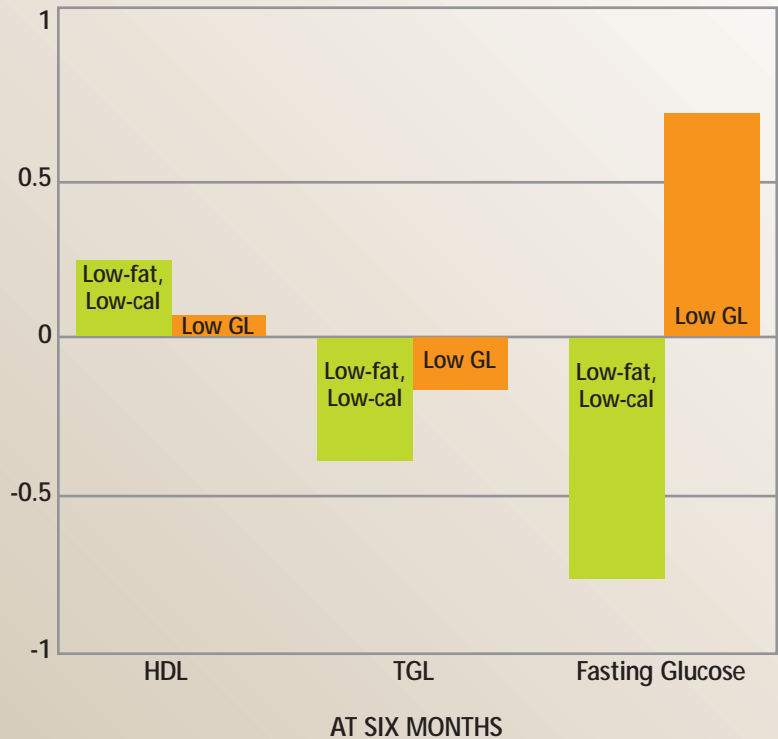
TABLE 2: Energy expenditure comparison



Reduction in energy expenditure (kcal/d) after 10 per cent weight loss. The body responds to low calorie intake by reducing the body's metabolic rate, hence burning fewer calories. Low-GL diets cause half the reduction in metabolic rate compared to a typical low-fat diet.

Pereira M, et al. *Journal of the American Medical Association* 2004; 292:2482-90.

TABLE 3: Health improvements - low GL



Those following the low-GL diet not only lost more weight, they also had greater improvements in HDL cholesterol, triglycerides and fasting glucose compared to those on the conventional low-fat, low-calorie diet.

LaHaye SA, et al., *Canadian Journal of Cardiology* 2005; 21(6):489-94.



MINI-DIRECTORY: GI suppliers target fibre and polyol sources

Low-GI ingredients can substitute for fast-digesting ones. Among these are fibres such as inulin, FOS, resistant starch, polydextrose and oat fibres; and polyols such as lactitol, xylitol, isomalt and maltitol. Select companies with ingredient offerings follow.

ADM/Matsutani: Fibersol-2, a soluble fibre. www.admworld.com and www.matsutani.com

Arla: Gaio tagatose is a prebiotic sweetener for use in beverages, foods and gums. www.arlafoodsingredients.com

Cargill: Barliv has 70 per cent concentration of barley beta-glucan, a soluble fibre. Sucromalt is a low-GI syrup. www.cargillhft.com

Cevena: ViscoFiber, from oat or barley beta-glucan, a soluble fibre. The barley version of the high-viscosity beta-glucan is 60 per cent concentrate, whereas the oat version is 50 per cent. www.cevena.com

CNI: Fibregum is 100 per cent acacia gum, odourless and tasteless and used for texturisation in confectionery, emulsion stabilisation especially in beverages, film-forming ability, as a compression agent, encapsulation agent, and well-known binding properties. www.cniworld.com

Corn Products Intl: Maltodextrin is a low-conversion starch hydrolysis product that can be used for bulking benefits and as complex carbohydrates in many applications. www.cornproducts.com

Danisco: Litesse polydextrose is a 90 per cent prebiotic fibre known as a bulking ingredient and used for sugar-free, low-glycaemic, low-calorie applications. Lactitol and Xylitol are other ingredients, with glycaemic indices between 3 and 8. www.danisco.com/sweeteners

GTC Nutrition: Natureal oat brain concentrate is a natural soluble and insoluble oat fibre high in beta-glucan, used to develop bakery products for low GI and cholesterol management. NutraFlora is a short-chain fructooligosaccharide prebiotic fibre. www.gtcnutrition.com

Glycaemic Index Testing: Established by GI pioneer Dr Thomas Wolever at the University of Toronto to provide confidential and scientifically valid assessment of the glycaemic responses of food products. www.gitesting.com

Hammersmith Food Research: Provides glycaemic index measurement and advice, as well as novel food testing in human volunteers. foodresearch.co.uk

InterHealth Nutraceuticals: ChromeMate niacin-bound chromium nicotinate helps insulin function and maintenance of blood-sugar levels. For use in supplements, foods and beverages. www.interhealthusa.com

MGP Ingredients: Fibersym is a family of resistant starches that possess low water-holding capacity and total dietary fibre ranging from 70 per cent to 80 per cent. www.mgpingredients.com

National Starch: Hi-maize resistant starch helps to maintain healthy blood sugar levels in healthy individuals by increasing insulin sensitivity. The fermentation by-products of Hi-maize may be responsible for the increase in insulin sensitivity. www.5-in-1-fiber.com

Nutrition 21: Chromax chromium picolinate patented for glycaemic control. www.chromax.com

Orafti: Raftilose, an oligofructose prebiotic fibre, used as a sugar replacer. Raftiline can replace carbohydrates with fibre, especially in bread. www.orafti.com

Palatinit: Isomalt bulk sweetener replaces sugar at a 1:1 ratio. Palatinose is isomaltulose, a disaccharide sweetener used as an excipient. www.palatinit.com

Pharmachem Laboratories: Phase 2 Starch Neutralizer, a proprietary, standardised extract of the white bean, has been shown to significantly reduce the GI of white bread. www.phase2info.com

RSSL: Services for food producers to develop low-GI products, test GI levels of foods and explore how GI could affect their business. www.rssl.com

Sensus: Frutafit and Frutalose brand inulin and fructooligosaccharides (FOS) fibre sources. www.sensus.us

SPI Polyols: Alternative sweeteners like maltitol can be used with fibre to lower the added sugar and corn syrup content and decrease overall GI in foods. www.spipolyols.com

NUTRACON

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The Latest Science on GI and Weight Loss

Tom Wolever, University of Toronto, Canada

Hear an overview of the latest technical research on the glycaemic index and its impact for weight loss and energy from a pioneer in GI research. www.nutraconference.com