# Nutrition Discussion Forum

# The use of glycaemic index tables to predict glycaemic index of breakfast meals

Since its inception in 1981, some members of the nutrition community have misunderstood the application of the glycaemic index (GI). It is disappointing that the study by Flint *et al.* (2004) in a recent issue of this journal adds further confusion. As originally conceived, Jenkins and colleagues saw the value of introducing a mechanism of comparing the glycaemic potential of carbohydrate exchanges as an adjunct to food composition tables (Jenkins *et al.* 1981). At that time, the universal emphasis on increasing carbohydrate intake at the expense of fat highlighted the need to identify carbohydrate sources that could be encouraged without worsening postprandial glycaemia. It was well recognised that adding fat or protein content to the meal could reduce blood glucose levels (Nuttall & Gannon, 1991), but that was at cross-purposes with the goal of increasing carbohydrate energy.

It is important therefore to use the GI in the way that it was intended, as a mechanism of exchange of one source of carbohydrate for another ('this for that'), so that the overall macronutrient distribution remains approximately the same. Thus a high-GI bread can be replaced by a low-GI bread, or a high-GI breakfast cereal by a low-GI one. This simple change has been shown to lower glucose levels over the next 2 or 3 h in many studies of composite meals in normal and diabetic subjects (Wolever & Jenkins, 1986; Bornet *et al.* 1987; Chew *et al.* 1988; Ludwig *et al.* 1999).

Like the GI (a measure of carbohydrate quality), measures of fat and protein quality are based on comparison of equivalent weights of fat or protein. In the real world, the amounts of protein and fat will vary from meal to meal but that does not make the quality of fat (e.g. the ratio of saturated to unsaturated fat) or the quality of protein (e.g. the biological value) any less relevant. We do not tell people that there is no difference between olive oil and butter in 'real' diets. Of course, if fat contributes a large proportion of the energy (say >40 %, as it did in five of the meals studied by Flint *et al.* 2004), then the quality of fat becomes more important than that of carbohydrate. Moreover, to assess the usefulness of any measure of nutrient quality, we should seek to normalise the energy content of the meal. We would not design a study to assess the impact of sugar *v.* starch or soluble *v.* insoluble fibre on postprandial parameters, and simultaneously vary energy over a threefold range, as did Flint *et al.* in their study. Had energy been held constant (rather than the 50 g carbohydrate portion size), then the GI together with the amount of carbohydrate is likely to predict the relative ranking of glycaemic and insulin responses, even in mixed meals. This was demonstrated recently in 10 h profiles comparing four diets of varying glycaemic load (Atkinson *et al.* 2004).

Apart from the inappropriate application of the GI in the study by Flint *et al.* (2004), we had several methodological concerns that also challenge the validity of the study's findings.

(1) Although Flint *et al.* used the FAO/WHO (FAO/WHO Joint Expert Consultation, 1998) method for predicting the GI, they did not use the recommended method for actually measuring the GI. Specifically, they assessed the glycaemic response to the reference food only once in each individual, rather than three times as is specified. This is an important aspect of GI testing because it reduces the effect of day-to-day (within-individual) variation in glucose tolerance (Wolever *et al.* 1990).

(2) The 50 g available carbohydrate portion was measured as 'the sum of free glucose and glucose released from starch after 120 min of *in vitro* digestion (Englyst *et al.* 1992)'. If this were the case, it would not include all the available carbohydrate in the meal. Specifically, it would exclude fructose and galactose, products of the digestion of sucrose and milk, respectively. Six of the meals in the study by Flint *et al.* contained large amounts of milk and eight of the meals contained significant amounts of sucrose. Hence the total available carbohydrate content would have been markedly underestimated. This might explain the very high observed GI of many of the meals, e.g. porridge + apple sauce (GI = 116).

(3) Although the expressed objective of the paper was to determine the value of published GI tables for predicting the GI of mixed meals, three of the meals contained foods without values listed in the tables. The GI of All-Bran, for example, was determined by personal communication with Kellogg Europe. It is surprising that this value (GI = 102) is almost double that reported for Kellogg's All-Bran in other parts of the world (average GI = 59 on the bread scale; Foster-Powell *et al.* 2002). Considering that All-Bran is manufactured from coarsely ground particles of whole wheat, it would be expected to have a slow rate of digestion and absorption. We therefore question the accuracy of the values obtained by personal communication. Similarly, apple sauce is not included in the published tables, and the value assigned (GI = 89) seems exceptionally high for a product based on pureed apples (GI of apples = 52).

(4) There are many GI values listed in the international tables and the range is particularly high for different varieties of bread and porridge. For this reason, the preamble to the revised tables (Foster-Powell *et al.* 2002) specifies that it is appropriate in some instances for countries to test their own local foods.

(5) Flint *et al.* claimed that they chose a wide range in predicted GI. However, apart from one meal in the low GI range, all the meals had a predicted GI in the 'medium' range between 74 and 100. This is a small range in which to expect a good correlation between observed and predicted responses. It would

seem logical to design a study with a third of the meals in each of the low, medium and high categories of predicted GI.

(6) Flint *et al.* also used venous blood rather than capillary blood. While this is suitable for most purposes, it is the least sensitive way to detect differences between foods or meals (Ellison *et al.* 2002) and hence to test correlations within a narrow range. One of the outcomes of the inter-laboratory study was to recommend the use of capillary blood for GI testing (Wolever *et al.* 2003).

Finally, there are many randomised controlled trials documenting differences in glucose and/or lipid metabolism in subjects consuming low-GI *v.* high-GI diets (Brand-Miller *et al.* 2003; Opperman *et al.* 2004), all of which relied on previously published GI values. One such study from Flint's laboratory (Sloth *et al.* 2004) concludes that a low-GI diet over 10 weeks significantly reduces LDL-cholesterol despite no difference in body weight. Recently, the American Diabetes Association recognised that the GI 'can provide an additional benefit over that observed when total carbohydrate is considered alone' (Sheard *et al.* 2004). Taken together, this evidence attests to the reliability of published GI values to predict average blood glucose levels in realistic meals over the course of the day. The breakfast study of Flint *et al.* (2004) is not only doubtful in design and execution but also immaterial when the GI of single foods can be shown to be of practical value in the free-living situation.

## Conflict of interest

J. C. B.-M. serves on the board of directors of Glycemic Index Ltd, a non-profit company that administers a food labelling program in Australia (www.gisymbol.com.au). She is the director of a GI testing service at the University of Sydney (www.glyce-micindex.com) and co-author of a series of books under the title *The New Glucose Revolution* (Marlowe and Co., USA; Hodder and Stoughton, UK). T. M. S. W. is the director of Glycaemic Index Testing Inc. Canada (www.gitesting.com) and co-author of *The New Glucose Revolution*.

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