# The Value of the Glycaemic Index in Diabetes

***It is important to recognise the limitations of the concept of the glycaemic index in the day to day management of diabetes***

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For many years the dietary management of diabetes has been based on the presumption that isoenergetic diets which contain similar amounts of carbohydrate, protein and fat have similar effects on the post-meal glycaemic response. The portion or exchange lists which have been used to quantify diabetic diets, particularly with respect to carbohydrate, have been based on this presumption. However, recent studies have indicated that, in addition to the amount of carbohydrate ingested, both the type of carbohydrate and the physical form of the food appear to be important determinants of the post-meal glycaemic response.

There has been some interest in the possibility of establishing exchange lists for use in the diabetic diet which are based on the glycaemic response to a particular food rather than on its chemical composition.

## *The Glycaemic Index: Non-Diabetics*

The term 'glycaemic index' (GI) was first used by Dr David Jenkins in 1981 in a paper entitled 'Glycemic index of foods: a physiological basis for carbohydrate exchange' [1]. Dr Jenkins and coworkers examined the effects of different foods on blood glucose in non-diabetics. Blood samples were taken at intervals over 2 hours after the ingestion of a certain food. The ratio of the area under the blood glucose/time curve (AUC) after the test food (containing 50g of carbohydrate) to the corresponding area after 50g of glucose (= reference or standard) was calculated. This value was called the glycaemic index. Thus, the glycaemic index is expressed as:

$$GI = \left(\frac{\text{Blood glucose AUC of test food}}{\text{Blood glucose AUC of reference food}}\right) \times 100$$

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In this study of non-diabetics, differences in glycaemic index were observed between individual foods. For example, the GI of wholemeal bread was greater than that for wholemeal spaghetti, cornflakes had a higher GI than 'All Bran', and both new and instant potatoes had higher GI values than sweet potato. As a group, legumes produced a comparatively low glycaemic response. However, of all the foods tested, the lowest glycaemic response was produced by peanuts.

In contrast, there were no real differences in GI between white and wholemeal bread, between white and wholemeal spaghetti, or between oranges and orange juice. In other words, the naturally occurring fibre present in wholegrain cereals and whole fruits did not reduce the glycaemic response.

## The Glycaemic Index: Diabetics

In a subsequent study published in 1983, Dr Jenkins investigated the glycaemic responses to various foods in a small group of diabetics [2]. In this study, he selected a group of high-carbohydrate, low-fat foods which were likely to be considered suitable for diabetics. Unlike his previous study in non-diabetics, the glycaemic response to a food was measured over 3 hours, and the standard or reference food was a meal of wholemeal bread (providing 50g of carbohydrate) and cottage cheese. The cottage cheese was added in order to make the protein content of the reference food equivalent to that of legumes, the highest protein food tested.

***Opinions vary as to whether differences in glycaemic effect are an important clinical entity or not***

Again, differences in glycaemic response between individual foods were observed. For example, the GI values of rice, 'All Bran', spaghetti and legumes were all lower than that of the reference food (wholemeal bread + cottage cheese), with the legumes producing particularly low values. As for non-diabetics, there was no difference in GI between white and wholemeal bread.

Interestingly, the glycaemic response to wholemeal bread was not significantly altered by either the addition of cottage cheese or milk, or by the substitution of some of the starch in wholemeal bread with marmalade.

The glycaemic index has generated considerable debate. Opinions vary as to whether differences in glycaemic effect are an important clinical entity or merely an interesting physiological phenomenon. The uncertainty expressed by some authorities concerns the questions of reproducibility, precision, relevance of using excessively large serving sizes and non-linearity of the relationship between amount of carboyhydrate and glycaemic response. Of particular concern is the fact that foods are tested as single dietary items rather than as part of a mixed meal.

***TABLE I.*** *Factors affecting blood glucose control*

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|---|
| ***Baseline blood glucose level*** |
| Background diet (long term) |
| ***Glycaemic response*** |
| The meal composition (short term) |
| Type of carbohydrate |
| Physical form of carbohydrate |
| Leguminous fibre |
| Fat (? diabetics) |
| Protein (? diabetics) |
| Time of day |
| Rate of eating |
| Frequency of meals |
| Presence of anti-nutrients |

## Factors Affecting the Glycaemic Response to a Mixed Meal (table I)

### Type of Carbohydrate

Recent studies have indicated that the presumption that simple sugars are more rapidly absorbed than complex carbohydrates is incorrect. In fact, variable responses to different simple sugars (e.g. glucose, sucrose, fructose) as well as variable responses to different complex carbohydrates (e.g. starches) have been observed.

### Physical Form of Carbohydrate

Blending, grinding, processing and cooking have all been shown to increase the glycaemic response to certain carbohydrate-containing foods. For example, tinned, baked beans show a higher glycaemic response than unprocessed beans. In some instances, this effect may be due to increased exposure of the starch granule, thereby making it more accessible to enzyme degradation. Other proposed mechanisms include the destruction of enzyme inhibitors by high temperatures and sodium-enhanced intestinal absorption.

### Fibre

Contrary to popular belief, the naturally occurring dietary fibres commonly consumed in Western diet, e.g. wholegrain cereals, vegetables and fruits, do not reduce the post-meal glycaemic response in either diabetics or non-diabetics. In contrast, a high leguminous fibre meal, e.g. kidney beans, lentils, chick peas, does reduce the post-meal glycaemic response in both non-diabetics and diabetics. However, a diet consisting principally of leguminous food would not be acceptable to most diabetics.

### Fat

In non-diabetics, the addition of fat to a carbohydrate-containing meal reduces the post-meal glycaemic response. The effect of fat ingestion on glycaemic response appears to be dose-related and is presumably due to delayed gastric emptying. However, this mechanism may not be applicable to diabetics, many of whom may have some degree of gastroparesis due to autonomic neuropathy. In any case, high-fat meals are not recommended as a means of controlling post-meal glycaemic peaks because of the well-established relationship between high-fat diets and vascular disease.

### Protein

In non-diabetics, the co-ingestion of large amounts of protein also reduces the glycaemic effect of a carbohydrate-containing meal. This is associated with an increased insulin response to the meal. Again, this mechanism may not be applicable to diabetics, many of whom have limited insulin reserve due to impaired $\beta$-cell function.

### Other Factors

Various other factors appear to play a role in determining glycaemic response, e.g. time of day, rate of eating, frequency of meals, background diet, presence of anti-nutrients, e.g. enzyme inhibitors, phytates, tannins, lectins and saponins. However, their relative importance has not yet been established.

## *Short Term* vs *Long Term Studies*

The improvement in diabetic control which is achieved after several weeks on a high carbohydrate-fibre diet is principally due to the lowering of the baseline blood glucose (fasting and pre-meal levels). This lowering of baseline blood glucose results in a downward shift of the entire 24-hour blood glucose profile and has been attributed to an increase in insulin sensitivity. One of the major criticisms of the glycaemic index is that it only looks at one aspect of the 24-hour blood glucose profile, i.e. the post-meal glycaemic response. It does not provide any information on the longer term effects of foods on baseline blood glucose levels.

Hence, although some low glycaemic index foods (e.g. legumes) may be 'good' for diabetics, high glycaemic index foods (e.g. wholemeal bread, potatoes) are not necessarily 'bad'. Longer term studies indicate that an improvement in overall diabetic control can still be achieved when a high glycaemic index food (e.g. wholemeal bread) becomes the major carbohydrate source in a high carbohydrate diet [3].

## *The Glycaemic Index* vs *the Current Exchange System*

Glycaemic index studies have shown that there are differences in the glycaemic response to foods containing similar amounts of carbohydrate.

However, it appears that this finding cannot necessarily be extrapolated to a mixed meal sit-

## POINTS IN BRIEF

### The value of the glycaemic index

1. *Glycaemic index (GI)*
$$\left(\frac{\text{Blood glucose AUC of test food}}{\text{Blood glucose AUC of reference food}}\right) \times 100$$

2. *As a group, legumes produce a significantly lower glycaemic response than other carbohydrate foods, in both non-diabetics and diabetics*

3. *Uncertainty regarding the relevance of GI data concerns questions of reproducibility, precision, the use of excessively large serving sizes, non-linearity and testing of single dietary items*

4. *The major determinants of the glycaemic response (to a carbohydrate-containing meal) appear to be the amount, type and physical form of carbohydrate and the meal fat and protein content. Some of these factors may operate to a lesser extent in diabetics*

5. *The improvement in diabetic control which is achieved with high carbohydrate-fibre diets is principally due to the lowering of the baseline blood glucose. The glycaemic index cannot provide any information on the longer term effects of foods on baseline blood glucose levels*

6. *Food exchange lists based on chemical composition continue to remain useful in meal planning for diabetics*

uation. In 1983, Dr Frank Nuttall and coworkers published a study which examined the glycaemic effect of 4 different, approximately isoenergetic breakfasts in a group of non-insulin dependent diabetics. The meals were designed according to food exchange lists and were calculated to contain similar amounts of carbohydrate, fat and protein.

The glycaemic responses to the different meals were very similar, except for 1 meal which resulted in a slightly greater, but explicable, blood glucose response. There were no differences in insulin response between the 4 meals. These findings indicate that food exchange lists based on chemical composition continue to remain useful in meal planning for diabetics [4].

## General Nutritional Considerations

The glycaemic index fails to consider the important principles of nutrition which are to achieve a nutritionally adequate diet, and to decrease the risk of developing diet-related chronic disease.

*In summary,* the glycaemic index is an interesting physiological phenomenon. However, it is important to recognise the limitations of the concept of the glycaemic index in the dietary management of diabetes. The major reservations about its value in the management of diabetes concern the use of single foods rather than mixed meals and the limitations of short term studies in determining which foods are most appropriate for diabetics. Furthermore, the glycaemic index fails to consider several important principles of dietary management. The glycaemic index has not been shown to be an improvement on the current exchange system.

## References


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## Further Reading


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