Health benefits of the glycaemic index

The scientific world is inundated with literature on the glycaemic index (GI). The GI refers to the rate of digestion and absorption of carbohydrate foods, i.e. the blood glucose raising potential of carbohydrates.[1] The GI of a specific meal or food is determined by the nature and total amount of carbohydrate consumed, as well as by other dietary factors that affect nutrient digestibility or insulin secretion.[2]

Various health benefits have been linked to the consumption of low-GI foods. These can be divided into preventive and curative benefits. The development of diabetes mellitus, obesity and cardiovascular disease (CVD) has been reported to be linked to the intake of high-GI foods. On the other hand, intake of low-GI foods has been shown to play a positive role in the treatment of these diseases.[1-3]

Diabetes mellitus

Following the intake of high-GI foods, the body responds by secreting insulin. Within 2 - 4 hours after a high-GI meal the nutrient absorption from the gastrointestinal tract declines and the high circulating insulin levels result in a reactive hypoglycaemic situation. The constant hypersecretion of insulin after intake of high-GI meals could result in pancreatic beta-cell dysfunction, leading to insulin resistance.[2,3] Various longitudinal studies have found that the risk for diabetes was higher among individuals in the highest quintile of GI than in those in the lowest quintile.[2]

On the other hand, several studies have reported improved blood glucose control in patients with type 1 diabetes mellitus following the intake of low-GI foods. A positive correlation was reported between the GI of diets and haemoglobin A_{1C} (HbA_{1C}) values,[1] which are a marker of glycaemic control. An improvement in plasma glucose levels[4] and a decrease in insulin requirements[3,5] supported this correlation. It is suggested that a 10% fall in the GI of a diet could result in a 30% increase in insulin sensitivity.[1] Increased insulin sensitivity, as well as reduced hepatic gluconeogenesis following low-GI diets,[1] could all contribute to the improved glucose control seen in these patients.

Obesity

Hyperinsulinaemia and hypoglycaemia may stimulate the consumption of high-GI foods. The latter have a low satiety level, increase hunger and stimulate eating. The resultant cycles of hypoglycaemia and hyperphagia contribute to the development of obesity.[2]

From a treatment point of view, in obese and overweight individuals, low-GI meals increase satiety and facilitate the control of food intake.[1] General weight loss can also enhance insulin clearance and reduce hyperinsulinaemia.[6]

Cardiovascular disease

As was reported for diabetes, the risk of CVD is higher (by 11 times) among individuals in the highest quintile of GI than in those in the lowest quintile.[1] Within 4 - 6 hours after ingestion of a high-GI meal, the resulting hypoglycaemia triggers counterregulatory hormone secretion, among other things resulting in glucagon release. The latter hormone stimulates gluconeogenesis and results in elevated levels of free fatty acids (FFAs) in the circulation.[2,3] Increased hepatic uptake of FFAs results in increased hepatic secretion of very-low-density lipoprotein (VLDL) triglyceride secretion.[6] High levels of VLDL production result in reduced high-density lipoprotein (HDL)-cholesterol levels and an increase in the formation of low-density lipoprotein (LDL) cholesterol fractions.[1]

Low-GI foods are associated with reduced hepatic gluconeogenesis, suppression of FFA release and therefore increases in the HDL cholesterol fraction, demonstrating an inverse association between serum HDL and dietary GI.[1,3]

Looking at the health benefits of low-GI foods, it is sometimes difficult to understand why there still remains widespread scepticism about and caution surrounding their use by health professionals. By analysing the mechanisms involved in the determination of the actual GI values of individual foods and combined meals, however, one begins to understand the intricate processes that influence these measurements. Variables that influence the GI include, among others, the food portion size, choice of the standard food, method of area calculation, frequency and length of time of blood sampling, number of samples taken, individual characteristics, dosage of insulin and timing of its administration, type of diabetes, pre-meal content and degree of blood glucose control.[7] All these factors therefore contribute to within- and between-subject variations in GI.

Kruger *et al.* (p. 18 of this issue) further assessed one of these factors, namely choice of the standard food. They aimed to determine the within-subject and between-subject variations in glucose responses in type 2 diabetes subjects, using both glucose and white bread as reference foods.

GI values for white bread are higher than GI values for glucose by a factor of 100/73 (1.37), where 100 is the GI of glucose and 73 the mean GI of white bread.[7] It is therefore important when interpreting results from various studies only to compare results from studies that have used the same reference food, or alternatively to perform the necessary statistical adjustments to the GI values.

It was previously suggested by Wolever and co-workers[8] that in normal subjects starchy test meals are more accurate than glucose in predicting GI. No significant differences between glucose and white bread were reported in the study by Kruger

et al., although blood glucose concentrations tend to be less variable after a glucose meal than after a meal of white bread. This could indicate that glucose may be a more reliable reference food to use in subjects with type 2 diabetes, but the authors conclude that more research is needed to address this issue.

Another variable commented on by Kruger *et al*. is the number of samples that needs to be taken per individual in order to determine the GI values. Wolever *et al*.[7] recommend that each subject should have at least three tests and the mean of the three should be calculated and reported as the GI value. Kruger *et al*. report that according to their statistical calculations between 24 and 128 subjects would be needed to have 80% confidence that the GI of the standard food (white bread for this study) will be in a 10% range. This finding makes one wonder about the accuracy of the values obtained if only three measurements are used to determine the GI.

Kruger *et al*. have emphasised the importance of comparing apples with apples, and urge researchers to investigate the clinical application of the GI concept further in various individuals ranging from normal subjects to subjects with different types of diabetes mellitus.

From a practical application point of view, we as health professionals should probably be guided by the American Diabetes Association, which cautions against the use of low-GI diets as a 'primary strategy' in meal planning.[9] The main reasons for the ADA's decision revolve around the fact that there are so many variables affecting the outcome and determination of the GI values. The inclusion of the low-GI concept in the general dietary advice that we give to our patients, i.e. increasing consumption of fruits, vegetables and legumes and limiting the intake of refined sugars, could contribute to the intake of diets high in fibre, micronutrients and antioxidants and low in energy density, which forms the basis of a prudent dietary approach.

Renée Blaauw

Department of Human Nutrition
University of Stellenbosch and
Tygerberg Hospital
Tygerberg, W Cape

1. Rizkalla SW, Bellisle F, Slama G. Helath benefits of low glycaemic index foods, such as pulses, in diabetic patients and healthy individuals. *Br J Nutr* 2002; **88:** suppl 3, S255-S262.
2. Ludwig DS. The glycemic index. *JAMA* 2002. **287:** 2414- 2423.
3. Wolever TMS. Dietary carbohydrates and insulin action in humans. *Br J Nutr* 2000; **83**: suppl 1, S97-S102.
4. Lafrance L, Rabasa-Lhoret R, Poisson D, Ducros F, Chaisson J. Effects of different glycaemic index foods and dietary fibre intake on glycaemic control in type 1 diabetic patients on intensive insulin therapy. *Diabet Med* 1998; **15:** 972-978.
5. Fontvieille A, Acoata M, Rizkalla S, *et al*. A moderate switch from high to low glycemic index foods for 3 weeks improves the metabolic control of type 1 diabetic subjects. *Diabetes Nutr Metab* 1988; **1:** 139-143.
6. Davy BM, Melby CL. The effect of fiber-rich carbohydrates on features of Syndrome X. *J Am Diet Assoc* 2003; **103:** 86-96.
7. Wolever TMS, Jenkins DJA, Jenkins AL, Josse *RG*. The glycemic index: methodology and clinical implications. *Am J Clin Nutr* 1991. **54:** 846-854.
8. Wolever TMS, Vuksan V, Palmasan C. Less variation of postprandial blood glucose after starchy test meals than oral glucose. *Nutr Res* 1996; **36:** 899-905.
9. American Diabetes Association. Evidence-based nutrition principles and recommendations for the treatment and prevention of diabetes and related complications. *Diabetes Care* 2003; **26:** Suppl 1, S51-S61.

Our sincere thanks

The Editor and Editorial Board of the *SAJCN* wish hereby to acknowledge the support and contribution to the scientific standing of the journal of the following reviewers (2002):

H Bachou
R Blaauw
Tobie de Villiers
Gerda Gerike
A A Haffejee
Stephen Hough
Salomie Kruger
V Lambert
E Mansveldt
E M W Maunder
Tim Noakes
Marius Smuts
N P Steyn
R Swart
J van Schalkwyk
P van Twisk
P Wolmarans