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Review Article

THE GLYCEMIC INDEX - A SCIENCE BASED DIET

S Thilakavathy[1]* and N Karthiga Pandeeswari[1]

*Corresponding Author: **S Thilakavathy,** ✉ thilaka.ravichandran@gmail.com

Lifestyle diseases, like coronary disorders, high blood pressure, diabetes or obesity cause the predominant part of all the mortality worldwide as countries become more industrialized.. More importantly, they are potentially preventable and can be lowered by modifications in diet with low glycemic index foods,and changes in lifestyle and environment. Foods containing carbohydrates that are quickly digested have the highest glycemic index, since the blood sugar response is fast and high. Slowly digested carbohydrates have a low glycemic index, since they release glucose gradually into the bloodstream. A healthy low GI diet is easily able to achieve these goals, perhaps better than other dietary interventions. Low GI diet can achieve greater reduction in blood pressure, increase the body's sensitivity to insulin, improve diabetes control, reduce the risk of heart disease, and reduce blood cholesterol level, reduction in weight. Low GI foods, , delay hunger and help the body burn more fat and less muscle by increasing satiety or fullness after eating, low GI foods help reduce the calories consumed later in the day and reduce postprandial blood glucose levels, the beneficial role for low GI diets by reducing oxidative damage, thereby lowering heart disease risk.

Keywords: Low Glycemic Index, Reduce blood glucose, Cholesterol, Heart disease, Dietary interventions

INTRODUCTION

Health is the level of functional or metabolic efficiency of a living being. In humans, it is the general condition of a person's mind, body and spirit, usually meaning to be free from illness, injury or pain (as in 'good health' or 'healthy') (World Health Organization, 2006). According to the World Health Organization, the main determinants of health include the social and economic environment, the physical environment, and the person's individual characteristics and behaviors (World Health Organization, 2011).

'Lifestyle', in the context of preventive health care, indicates the behavioural patterns which we routinely adopt and the way we tend to (involuntarily) live our daily life, unless coerced to change by some external stimulus. Lifestyle is thus mainly dependent on psycho-social and environmental factors and, to a smaller extent, on genetic influences. Lifestyle is developed in the form of a set pattern of behaviour, very gradually, over many years, in the way we eat, drink, exercise, use intoxicants, and are predisposed to own health care and personal protection, sexual practices and so on. Since these behavioral patterns are acquired very gradually, changing them becomes a difficult proposition and needs a lot of persuasiveness as well as persistent approach on the part of the

[1] Department of Food Science and Nutrition, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore.

health care providers including health educators. (Leeder *et al*., 2004).

Lifestyle diseases are that they appear to become ever more widespread as countries become more industrialized.

They are the result of an inappropriate relationship of people with their environment. The lifestyle diseases, like coronary disorders, heart diseases, high blood pressure, diabetes or obesity cause the predominant part of all the mortality worldwide. These are such diseases which occur resulting from the way people live their lives. In developed countries and societies, these diseases become more frequent as economic growth starts. More importantly, they are potentially preventable and can be lowered by changes in diet, lifestyle and environment (Bhikha, 2007).

Type 2 Diabetes Mellitus (T2DM) is a disease resulting mainly from the dysfunction in the carbohydrate metabolism, characterized by hyperglycemia. Its prevalence in recent decades has been increasing, reaching nearly 6% of the population, (Sociedade Brasileira, 2006) data shows that in the world there are about 246 million people with diabetes (IDA, 2006) and this number is expected to grow to 366 million in 2030 (Wild *et al*., 2004) .

WHAT IS GLYCEMIC INDEX?

Glycemic index (GI) is a measure of the glucose response to ingestion of a fixed amount of available carbohydrates; glycemic load (GL) combines the qualitative and quantitative measures of carbohydrates and is the product of the GI and the amount of carbohydrates consumed. High-GI diet has been positively associated with obesity in adult, but epi-demiological studies in humans so far have been inconsistent.

The glycemic index ranks carbohydrate-containing foods on how quickly they elevate blood sugar levels. It is measured by comparing the increase in blood sugar after eating 50 grams of carbohydrate from a single food with the increase in blood sugar after eating the same quantity of carbohydrate from a reference food, which is either pure glucose or white bread. The average change in blood sugar levels over the next two hours, compared to the change in blood sugar levels after consuming the reference food, is the glycemic index value of that particular food. The blood sugar response of the reference food is given a value of 100 and all other foods are compared to this value (Brand-Miller *et al*., 2003).

Foods containing carbohydrates that are quickly digested have the highest glycemic index, since the blood sugar response is fast and high. Slowly digested carbohydrates have a low glycemic index, since they release glucose gradually into the bloodstream (Brand-Miller *et al*., 2003). In general, most refined carbohydrate-rich foods have a high glycemic index, while non starchy vegetables, fruits and legumes tend to have a low glycemic index (Ludwig, 2002).

Glycemic index values are grouped into three categories:

High GI 70 or higher

Intermediate GI 56-69

Low GI 0-55

Determining Glycemic index of food

Foods with carbohydrates that break down quickly during digestion and release glucose rapidly into the bloodstream tend to have a high

GI; foods with carbohydrates that break down more slowly, releasing glucose more gradually into the bloodstream, tend to have a low GI. The concept was developed by Dr. David J. Jenkins and colleagues in 1980-1981 at the University of Toronto in their research to find out which foods were best for people with diabetes. A lower glycemic index suggests slower rates of digestion and absorption of the carbohydrate foods' and may also indicate greater extraction from the liver and periphery of the products of carbohydrate digestion. A lower glycemic response usually equates to a lower insulin demand but not always, and may improve long-term blood glucose control (David and Jenkins, 2008) and blood lipids. The insulin index is also useful for providing a direct measure of the insulin response to a food.

The glycemic index of a food is defined as the incremental area under the two-hour blood glucose response curve (AUC) following a 12-hour fast and ingestion of a food with a certain quantity of available carbohydrate (usually 50 g). The AUC of the test food is divided by the AUC of the standard (either glucose or white bread, giving two different definitions) and multiplied by 100. Both the standard and test food must contain an equal amount of available carbohydrate. The result gives a relative ranking for each tested food (Brouns *et al*., 2005).

The current validated methods use glucose as the reference food, giving it a glycemic index value of 100 by definition. This has the advantages of being universal and producing maximum GI values of approximately 100. White bread can also be used as a reference food, giving a different set of GI values (if white bread = 100, then glucose H" 140). For people whose staple carbohydrate source is white bread, this has the advantage of conveying directly whether replacement of the dietary staple with a different food would result in faster or slower blood glucose response. The dis-advantages with this system are that the reference food is not well-defined and the GI scale is race-dependent.

The GI of a food is influenced by many different factors including the type of sugar (e.g., fructose vs glucose), the type of starch (e.g., amylose vs amylopectin), the gelatinization of the starch, the type of fiber (e.g., soluble vs insoluble), the processing of a food, and the presence of fat or protein in a mixed meal. It cannot be easily predicted nor measured *in vitro*, which is a measure of carbohydrate digestibility rather than the true in vivo response of a food on blood glucose levels. There is now a significant body of evidence demonstrating the benefits of healthy low GI diets. Although a high carbohydrate diet has been shown to worsen many of the features of insulin resistance, including postprandial glycemia and insulinemia, fasting hypertriglyceridemia, low high-density lipoprotein (HDL) levels and fibrinolysis, this is not seen when the carbohydrate comes from low GI sources. Many studies show that low and high GI foods have significantly different effects on metabolism (Jenkins *et al*., 2002).

High GI meals result in a rapid increase in blood glucose and insulin levels followed by reactive hypoglycemia, counterregulatory hormone secretion, and elevated free fatty acid concentrations, which may then lead to â-cell dysfunction, dyslipidemia, and endothelial dysfunction (Ludwig, 2002). Although the GI predicts the potential of a food's carbohydrate to

raise blood glucose levels, the overall blood glucose response to a food or meal is determined by both the quantity and quality (GI) of the carbohydrate consumed (Brand-Miller *et al*., 2003) .

Thus the concept of glycemic load—defined as the GI multiplied by the amount of carbohydrate per serving of food in grams—was introduced as a measure of the overall effect of a food on blood glucose and insulin levels. Dietary GL can be reduced in two ways: either by lowering the GI of the carbohydrate or by reducing the total carbohydrate in the diet, but the metabolic effects of these changes are likely to be different. Defects in carbohydrate metabolism, which characterize diabetes, mean that the GI and GL of a food or meal are particularly relevant to the management of this condition (Wolever and Mehling, 2002).

What Determines a Food's Glycemic Index?

Several factors affect the glycemic index of a food:

Cooking Method: Heat, amount of water and cooking time affect a food's GI. During cooking, water and heat expand the starch granules to varying degrees. Foods containing starch that has swollen (or gelatinized) to the bursting point, like boiled or baked potatoes, are more easily digested, and therefore, have higher GIs, than foods containing starch granules that are less gelatinized, like oatmeal, brown rice, and al dente spaghetti. For example, the GI of a baked potato is 85; brown rice is 50 (Brand-Miller *et al*., 2003) .

Processing Method: Grinding, rolling or milling starchy foods reduces particle size and makes it easier for water to be absorbed and digestive enzymes to attack the food. Processing can also remove the fibrous outer coat of the grain that slows down the access of digestive enzymes to the starch inside. Finely milled flours generally have a high GI. Coarse, stone-ground flours have larger-sized particles and lower GIs (Brand-Miller *et al*., 2003).

Type of Starch: The two types of starch in foods, amylose and amylopectin, have different effects on GI. Amylose molecules are harder to digest than amylopectin molecules. Legumes and basmati rice have a higher ratio of amylose to amylopectin, and therefore, have a lower GI than foods with more amylopectin. For example, the GI of basmati rice is 58; instant rice is 87 (Brand-Miller *et al*., 2003) .

Fiber: The extent that fiber affects GI is unclear. Some researchers believe that viscous, soluble fiber thickens the mixture of food in the digestive tract, which slows response, and a lower GI. Legumes and oats contain soluble fiber and have low GIs (Willett, 2001).

Sugar: GI is affected by the type of sugar in a food. Sucrose (table sugar), which is made up of glucose and fructose, has a lower GI than glucose because half of the sucrose molecule is made up of fructose, a type of sugar that elicits a very small blood sugar response. For example, the GI of sucrose is 68; the GI of glucose is 100. It would seem that adding sugar to a meal should lower the GI, but, surprisingly, a few studies have not found this to be so (Willett, 2001).

Fat: Fat increases the time it takes for food to leave the stomach and enter the intestine. By slowing the rate that carbohydrates are digested in the intestine, fat-containing foods may temper the rise in blood sugar and yield a lower GI than similar foods without fat. For example, the GI of potato chips is 57, French fries are 75 and baked potato is 85. However, that does not make potato

chips a better choice than the more nutritious baked potato (Sunyer Pi and FX, 2002).

Acidity: Acid in food slows down stomach emptying, which slows the rate that carbohydrates are digested. Increasing the acidity in a meal can lower its GI and the blood sugar response. Vinegar, lemon juice and sourdough bread provide this benefit (Sunyer Pi and FX, 2002).

Does the Glycemic Index Have a Role in Preventing Disease?

High GI meals cause an inordinate rise in blood glucose and insulin levels, which, in many people, is followed by a rapid drop in blood glucose levels. As a result, counter regulatory hormones are secreted to bring blood sugar levels back to normal, and free fatty acid concentrations are elevated. These events are believed to promote excessive food intake, impaired pancreatic β cell function and endothelial function, and abnormal blood lipid levels. This, in turn, may increase the risk of obesity, diabetes, heart disease, and possibly, cancer. Some studies suggest that low GI diets play a role in preventing these diseases (Ludwig, 2002).

Glycemic Index and Obesity

A variety of popular weight-loss books blame high GI diets for our obesity woes. They claim that the high insulin levels that result from eating high GI foods stimulate hunger, increase enzymes that promote fat storage, and reduce the body's ability to burn fat for energy (Webb, 2002). Low GI foods, on the other hand, delay hunger and help the body burn more fat and less muscle. By increasing satiety or fullness after eating, low GI foods help reduce the calories consumed later in the day (Miller, 2002).

Glycemic Index and Diabetes

The utility of the glycemic index in managing diabetes is fraught with controversy. The American Diabetes Association (ADA) reviewed the evidence on glycemic index as a nutrition intervention for diabetes and concluded that the total amount of carbohydrate is more important than the source (starch or sugar) or type (low or high GI). While acknowledging that low GI foods may reduce postprandial blood glucose levels, they assert that there is insufficient evidence of long-term benefit to recommend using low GI diets as a primary strategy in meal planning (American Diabetes Association, 2002).

Type 2 Diabetes

The use of glycemic index to prevent or treat type 2 diabetes is also controversial. It is believed that high blood sugar levels lead to the loss of function of pancreatic beta cells—the cells that produce insulin—and in susceptible people, may result in diabetes. One theory suggests that a high GI diet, which raises blood sugar levels and increases insulin demand, over burdens the ability of the pancreas to produce insulin, thereby increasing the risk of type 2 diabetes (Webb, 2002).

Research suggests that the effects of a high GI diet vary greatly among individuals and are influenced by the degree of insulin resistance. Since obesity and inactivity are believed to promote insulin resistance, the adverse health effects of high GI foods may be worse in overweight, sedentary or genetically susceptible people. However, not all studies connect high GI diets with insulin resistance. Some studies have found greater insulin sensitivity with high GI or high carbohydrate diets (Willett *et al*., 2002) .

Glycemic Index and Heart Disease

Glycemic index or glycemic load have been linked to heart disease in several ways. The high blood sugar and insulin levels that result after eating a high GI diet may increase the risk for heart disease via the insulin resistance syndrome (also known as metabolic syndrome or Syndrome X). This syndrome is a cluster of metabolic abnormalities that includes high blood levels of insulin, glucose and triglycerides; low levels of HDL (good) cholesterol; and high blood pressure. A high glycemic index or glycemic load is believed to induce high blood sugar and insulin levels, which can lead to high blood pressure, abnormal blood lipids and possibly impaired blood clotting tendencies, all of which can increase the risk of heart disease (Liu *et al*. , 2000). The beneficial role for low GI diets by reducing oxidative damage, thereby lowering heart disease risk.

What are the benefits of the Glycemic Index

A healthy low GI diet is easily able to achieve these goals, perhaps better than other dietary interventions. Low GI diet can achieve greater:

- Reduction in blood pressure
- Increase the body's sensitivity to insulin
- Improve diabetes control
- Reduce the risk of heart disease
- Reduce blood cholesterol level
- Reduction in weight

Furthermore, the most successful dietary intervention for diseases conditions have been the DASH (Dietary Approaches to Stopping Hypertension) diet, which is high in fruit, vegetables, whole grains, and low-fat dairy products and therefore likely to be relatively low GI.

CONCLUSION

A healthy low GI diet is easily able to achieve these goals, perhaps better than any other dietary interventions. Low GI diet can achieve greater:

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