

## Glycemic load is critical for development of diabetes mellitus

Diabetes mellitus (DM) is the most common chronic metabolic and endocrine disorder in India and in other developing and developed nations.<sup>[1]</sup> In India, one in three in urban population and one in five in rural population are found to have latent (glucose intolerance) or frank DM.<sup>[2,3]</sup> Moreover, the prevalence trend is steadily rising worldwide. The reason for increasing trend in diabetes prevalence, especially in type 2 DM, can be attributed to a change in lifestyle favoring towards excess calorie intake, sedentary life, increased work stress, etc., and the genetic predisposition, which are among the major contributors. Diabetes is usually treated by insulin and oral hypoglycemic agents.<sup>[4]</sup> However, lifestyle modification through the practice of regular exercise, relaxation of body-mind, and proper nutrition improves the condition to a greater extent and plays an important role in the long-term treatment of DM. Nevertheless, planning and achieving a proper diet for diabetic patients is the mainstay in clinical strategy in the diabetic management.<sup>[5]</sup> Once diabetes sets in, the general psychological distress among patients is created against consumption of carbohydrate-rich food. However, one should understand that eating carbohydrate *per se* does not cause diabetes, rather the persistence of increased load of the carbohydrate diet also can play a role in the genesis of DM.<sup>[6]</sup> Diabetes is diagnosed usually with fasting glucose level greater than equal to 126 mg/dL on two different occasions. However, if a person's postprandial blood glucose is more than 200 mg/dL, it is again diagnostic of diabetes. Usually, the advice is to eat less simple sugar such as glucose or fructose and to eat more complex carbohydrates or polysaccharides is based on the fact that consuming more starch foods would cause smaller rise in blood glucose than the simple sugars. However, such an assumption is more simplistic since the glycemic response (the level of rise in blood glucose following intake of that particular food) to the complex carbohydrates has been found to vary considerably. Recently, it has been observed that the more accurate indicator of the relative glycemic response is glycemic load (GL), which incorporates the relative quality of carbohydrates characterized by their glycemic index (GI).<sup>[6]</sup>

The GI is a measure to assess the glucose-raising capacity of carbohydrate-rich foods after consumption, in comparison to pure glucose compared to direct intake of glucose.<sup>[7]</sup> Accordingly, it is divided into three scales:

High - ( $\geq 70$ ), moderate - (56–69), or low GI ( $\leq 55$ ) relative to pure glucose which has a GI of 100 (for reference). GI reflects on the intestinal absorption rate of food. It indicates that if the absorption of glucose in the intestine is quicker for a food, it is with high GI, and if it is slower, then it is a food with low GI. Accordingly, consumption of a meal containing high GI foods will lead to a rapid rise in blood glucose level compared to a meal having low GI foods, containing the similar content of calories and nutrients.

Therefore, it has been advocated in general to consume less of high GI foods and opt for low and medium GI foods to avoid a sharp spike in postprandial blood glucose. A high GI meal quick raises blood sugar level which stimulates the pancreas to secrete insulin into circulation. However, rapid lowering of blood glucose in turn stimulates neoglucogenesis for the maintenance of minimum blood glucose level associated with increased hunger and appetite which occurs in next 3–5 h. It also increases cerebral blood flow, especially to the striatum which is the site for reward and food craving.<sup>[8]</sup> This increases hunger and hence food intake. Hence, a vicious cycle sets, in which increases the cumulative food intake; and in the long run, this exhausts the pancreatic secretion. If the transport of glucose from intestine to blood is faster compared to the speed of movement of glucose into the tissues by insulin, the blood glucose remains high for a longer duration ( $>2$  h), and the excess glucose gets converted and deposited as fat.<sup>[9]</sup> This leads to obesity along with the glucose intolerance. A food item may not have high carbohydrate content but has high GI; for example, the carbohydrate content of carrot is only 10.7%, but its GI is 101, which is quite high.

Consumption of low GI food, on the other hand, leads to a sustained release of glucose into circulation thus minimizing requirement of neoglucogenesis and thus preventing successive hunger episodes. Hence, low GI food increases satiety and prevents frequent food intake.

GL is a number obtained by multiplying the GI with total carbohydrate content of a food item. The GL is obtained by dividing GI by 100 and multiplying with its available carbohydrate content (carbohydrates without its fiber content, expressed in grams). It is categorized into high (GL  $\geq 20$ ), medium (GL between 11 and 19) and

low ( $GL \leq 10$ ). For example, the GI of watermelon is 103, which is very high among the fruits. However, the GL for watermelon calculated on basis of 6 g per serving quantity is  $103/100 \times 6 = 6.18$ . Thus, the GL of watermelon is about 6. Similarly, the GL of ice cream is just 8, whereas the GL of white rice is 23.

Therefore, even though a low GI food is considered to be good for diabetic patient if he/she consumes excess quantity of low GI food, it leads to increased GL. As the types of carbohydrate, fat, protein, and other dietary factors in a mixed meal can modify the glycemic impact of carbohydrate GI values, the GI of a mixed meal affecting the postprandial glucose response can vary. In addition to this, the total quantity of the carbohydrate consumed also significantly determines degree and duration of blood glucose level and insulin response, the total GL if higher for a food item, at the long run will negate any good effect of low GI of the food consumed. In simple physiological term, excess GL food will lead to persistence of insulin in circulation, thus leading to insulin resistance at receptor level.

Therefore, recently, the concept of GL has evolved to describe the quantity and quality of the carbohydrate that should be present in the meal or the diet for attaining and maintaining a particular blood glucose level. The GI indicates how rapidly a particular carbohydrate food increases blood sugar level, whereas the GL of the food item determines how much of the carbohydrate item should be consumed to attain a longer blood glucose level. A sustained blood glucose level as attained by high GL foods contributes more than the transient hyperglycemia in the genesis of insulin resistance.

Diabetes being a problem of persistent hyperglycemia, dietary modifications should be done to encourage intake of foods having low GI and low GL. This can be achieved by: (1) Increasing the consumption of whole grains, nuts, legumes, fruits, and nonstarchy vegetables, (2) decreasing the consumption of starchy high GI foods such potatoes, white rice, and white bread, and (3) decreasing the consumption of sugary foods such as cookies, cakes, candy, and soft drinks.<sup>[6]</sup>

The rapid economic growth in India associated with high level of stress, easy accessibility, and availability of junk foods with very high GL and sedentary lifestyle has contributed to the development of diabetes in an epidemic form. Therefore, in addition to the practice of regular exercise and yoga, emphasis should also be

given on dietary modification keeping in mind the GL of the nutrients.

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