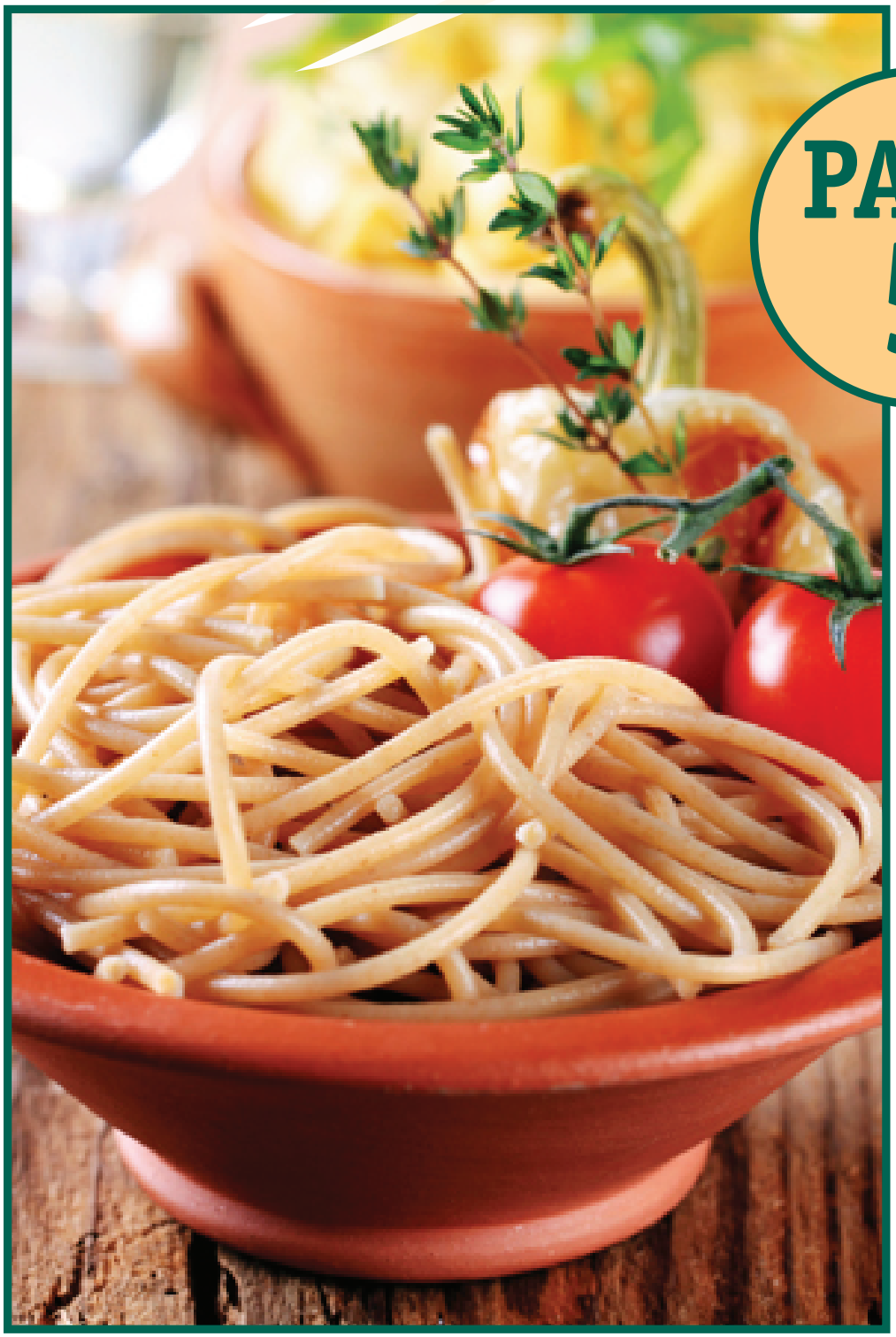
Glycemic Index: The State of the Science, Part 5:

Diabetes



PART 5

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Diabetes

Diabesity is global. The National Diabetes Clearinghouse of the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) estimated in 2010 diabetes affected 25.8 million or 8.3% of the U.S. population. Their data indicated that 18.8 million people have been diagnosed and the other 7.0 million are undiagnosed. (1) About 30% of the U.S. – about 79 million people – have pre-diabetes, but only about 7% are aware they have it. (2)

The Diabetes Program Prevention Trial (DPPT) presented compelling data that diabetes can be prevented or delayed even in those at high risk. (3) Thus, it is important both to identify those at risk and to delineate dietary factors that can be useful as either a prevention or treatment strategy. Alterations of dietary glycemic index (GI) and glycemic load (GL) have been postulated as dietary strategies to help delay or prevent type 2 diabetes mellitus (T2DM) and to be used in improving glycemic control for those with the disease. Various types of studies – epidemiological, intervention and mechanistic studies – find a positive role of GI or GL. But as with other endpoints, the findings do not agree amongst the different studies, making a clear-cut endorsement of this dietary strategy one with controversy.

This paper is the last in the series of papers, which stemmed from a large review supported by the Wheat Foods Council, on the role of GI and GL in the prevention and treatment of diabetes. It will review the strength of the evidence to date.

GI or GL and Diabetes Prevention

Large epidemiological studies show associations which suggest that a low GI/GL diet might be useful in reducing the risk of T2DM, although not all studies show a decrease in risk. Cohort studies done over 10 years ago show a typical pattern with several studies showing an inverse association between GI and/or GL and T2DM risk and some studies failing to show an association. The Physicians' Health Study (PHS) (n ~ 42,000 male, health professionals), the Nurses' Health Study (NHS) (n ~ 84,000 female nurses), and the Iowa Women's Health Study (IWHS) (n~36,000 post-menopausal women), gave mixed results. While the PHS and NHS showed that high GI and/or GL diets are associated with the development of T2DM, (4, 5) no associations were seen in the IWHS. (6) Analysis of the 20-year follow-up data for NHS I and II, showed that the risk more than doubled for the highest decile of intakes compared to the lowest decile. (7) A systematic review by Barclay published in 2008, which looked at data from 37 prospective cohort studies, stated that those whose diets had the highest GI or GL had an elevated risk of T2DM compared to those with the lowest. (8) The meta-analysis calculated the adjusted relative risk (RR) for T2DM comparing the highest and the lowest quintiles of intake to be 1.40 for GI and 1.27 for GL. The conclusion of the Dietary Guidelines Advisory Committee did not agree with the Barclay review. They concluded, "A moderate body of inconsistent evidence supports a relationship between

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high glycemic index and type 2 diabetes. Strong, convincing evidence shows little association between glycemic load and type 2 diabetes." (9)

Data from ethnic groups at high risk for diabetes also show associations between high GI or GL and increased T2DM risk. Findings from the Black Women's Health Study (10) show a strong association between GI and/or GL and T2DM risk and the increased risk for those black women with high GI diets and **normal BMIs**. In South Asian populations, the risk of diabetes increased more than four-fold for those with the highest GL. (11) High GI and GL increased risk in middle-aged Chinese women, but the degree of increase was far less than the marked increase observed for Asian Indians. (12) The interaction seen between dietary GL and BMI in Chinese women was diametrically different than that observed in black women in the USA because Chinese women ingesting a high GL diet and having **elevated BMI** were at greater risk. (13) Thus, the studies cited indicate that high dietary GI and/or GL raise the risk of T2DM, but the effects differ somewhat by race and BMI. Further, not all studies show an association. In the UK Whitehall II study with 70% men and 30% women (n= 7321), dietary GI was not associated with increased risk of diabetes. (14) In fact, high dietary GL was associated with **decreased** risk for T2DM for those who had diets in the highest tertile of GL. The hazard ratio (HR) for the highest tertile, compared to the lowest tertile, was 0.70. In the Health, Aging and Body Composition prospective cohort study of 70-80-year-olds (n = 2,248), there was no association between dietary GI or GL and the risk of developing T2DM. (15) In a representative sample of 2000 Australians over 49 years of age, neither GI nor GL were associated with the risk of developing T2DM in the cohort overall. (16) However, subdividing the cohort by age showed that for those under 70 years of age, a high GI CHO diet was linked to increased risk of T2DM. In a study on another Australian cohort of men and women (n= 36,787) 40-69 years, for those in the quartile eating the most white bread or with the highest dietary GI, compared with the lowest quartile, there was significant increase in risk of T2DM (OR 1.37). (17) However, the increased risk of T2DM was attenuated after adjustment for BMI and waist-to-hip ratio.

Thus, the data show a number of studies where a low GI/GL diet may be associated with lower risk of T2DM and other studies where the risk is unchanged. More data are needed on diet quality and subject differences and effects on certain high-risk groups.

GI and GL in Intervention Studies to Prevent Diabetes

Only a few intervention studies have looked at preventing T2DM by altering dietary GI. Results of the Diabetes Prevention Program show that those at high risk for the T2DM, who regularly exercised and followed recommendations to eat according to the USDA Pyramid, which would be a high-CHO, low-fat, high-fiber diet, had a markedly reduced risk of T2DM. While this and other studies emphasize the importance of diet and dietary fiber, they fail to give evidence regarding the role of low GI or GL diets in T2DM prevention. (18)

GI and GL and Mechanisms to Prevent Diabetes

Some studies indicate that the GI or GL of the diet may impact pancreatic functioning and this can

impact diabetes. In one study with 270 Japanese immigrants classified as prediabetic, (19) a low GI diet was found to improve pancreatic ß-cell functioning. In Latino adolescents at genetic risk for T1DM, a higher GI was associated with more rapid progression to type 1 diabetes in children, perhaps due to increased demand on the ß-cells. (20) Also, a low GI diet and exercise improved glucose metabolism and insulin secretion in 22 obese, prediabetic children in Denver. (21) Compared to the high GI diet, ß-cell glucose exposure was lowered for those in the low GI group, but became significantly elevated in the high GI group. In an intervention study with 22 prediabetic individuals, an intensive diet and exercise program not only resulted in weight loss and improved insulin resistance, but reduced postprandial insulin only if the subjects ate a low GI diet. (22) These data showed that a high GI diet impairs pancreatic ß-cell and intestinal K cell functioning. Such studies imply that a low GI diet may help prevent ß-cell dysfunctioning and sustain pancreatic functioning.

In summary, many studies suggest an increased risk of T2DM when diets are high in GI or GL, but there are many confounders and variables. The association is affected in some studies by age, BMI and other lifestyle and dietary factors. There appears to be strong evidence that diets low in dietary fiber are also associated with increased risk of T2DM. Some studies show that the risks of T2DM are even greater when diets are both low in dietary fiber and high in dietary GI or GL. However, since foods naturally low in GI/GL are often high in fiber and other important nutrients, the GI or GL of the food or diet may simply flag a dietary choice that helps reduce risk of diabetes, rather than being specifically related to their GI or GL. Thus, among the recommendations from the American Diabetes Association (ADA) to prevent T2DM are as follows: "There is not sufficient, consistent information to conclude that low–glycemic load diets reduce the risk for diabetes." Nevertheless, low–glycemic index foods that are rich in fiber and other important nutrients are to be encouraged. (23) The Dietary Guidelines Advisory Committee came to a similar conclusion and noted that randomized, controlled, intervention studies are needed to provide the final answer. (9)

GI and GL in the Treatment of Diabetes

Tight glycemic control can prevent and/or delay the development of chronic complications of diabetes mellitus (DM). This is true both in Type 1 and T2DM. The role of diets low in GI and GL in promoting tight glycemic control needs greater substantiation. This conclusion is reflected in both the recommendations of the ADA and of the Dietary Guidelines Advisory Committee. In 2008, the ADA evidence-based review gave the use of GI and GL a grade of 'B' and suggested that they could be useful adjuncts in diet planning for people with T2DM. (23) One reason cited for the B grade is that studies supporting the use of GI/GL are of short duration and have few subjects.

Some professionals argue that a higher grade is warranted and that the use of low GI foods and low GL diets by diabetics should be endorsed. Therein lies the controversy. One evidence-based review of 11 randomized controlled trials involving 402 participants done in 2009 for the Cochrane database appears to support the use of GI/GL in diabetic diets because it was associated with: 1) a significant decrease in HbA1c, 2) fewer episodes of hypoglycemia, and 3) a smaller proportion of subjects having at least 15 hyperglycemic episodes per month than those using traditional exchange diets. (24) Studies done after the Cochrane review generally support that there is a benefit for both type 1 or type 2 diabetics who adopt a lower GI diet. With lower dietary GI, they not only dropped BMI, but also showed a 19% reduction in HbA1c. (25). Type 1 diabetics fitted with insulin pumps showed that those eating low versus high GI meals had lower daytime mean blood glucose excursions with the low GI meals. (26) This lower excursion of blood glucose resulted in a change in HbA1c in an Italian study with 901 subjects. Both

dietary GI and GL were positively associated with HbA1c in a dose-dependent fashion. (27)

While these studies are encouraging – as the evidence-based review grade of 'B' would indicate – not all studies show a positive impact. In the Diabetes Control and Complications Trial, which did not assess GI or GL directly, there was an adverse effect of lower CHO and higher fat in type 1 diabetics (n = 532). (28) The lower CHO, which would usually mean a lower dietary GL, was associated with higher HbA1c concentrations and less good diabetes control. There were mixed results from a large intervention trial, the Canadian Trial of Carbohydrates in Diabetes with 167 type 2 diabetics. (29) Low GI, compared with a low CHO diet or a high GI diet, had no impact on HbA1c. However, there were other positive effects of a low GI diet. Blood glucose excursions after an oral glucose challenge were lower than with the other two diets, perhaps due to changed insulin sensitivity or insulin secretion (or improvements in both). Diastolic blood pressure and high-sensitivity C-reactive protein (hs-CRP), a marker of inflammation seen in diabetics, was 30% lower when subjects followed the low GI diet than when they ate the other diets. This controlled study may indicate that a low GI diet may prove to be advantageous, perhaps not through consistently better HbA1c, but through lower markers of inflammation, reduced circulating plasma lipid levels, and other changes. Therefore, the authors of this trial proposed that a low GI diet may be preferred for the dietary management of T2DM.

Low GI/GL Diets, Diet Quality and Practical Considerations

Many diabetics already have modified their diets to include more fruits, vegetables and whole grains. These dietary changes may mean that the diets are higher in fiber and phytochemicals and tend to be low to moderate GI or GL. One study documented that low GI/GL diets were higher in all types of fiber, fruits, vegetables and legumes. (31) General nutrition advice indicates that diets filled with legumes, whole grains, fruits, vegetables and low-fat dairy are important for reduction of disease risk and may be important in decreasing diabetes risk.

Some call for the adoption of low GI or GL diets for all who are at risk for diabetes or who have diabetes. They argue that there is no downside associated with such a diet. However, there are potentially some downsides because some studies indicate that low CHO, which is one way to achieve lower dietary GI or GL, worsens some parameters measured. Further, foods chosen to achieve a low GI or GL diet may not be optimal and may be high in fat or other components that meet the glycemic criteria, but may offer lower nutritive value or increased cardiovascular or other risks. A move to lower dietary GI or GL might cause the avoidance of certain fruits (or other foods believed to elevate the glycemic response) that make important contributions to the diet. In some cases, foods may be avoided because the reported values are high, but the person may be ingesting a variety or form that may not be in the high GI/GL category. This means that accurately explaining low GI/GL diet to consumers is very complicated.

One Australian study indicates that the latter concern may not be as difficult as thought. (32) Responses

from 104 parent-child pairs showed that children with type 1 diabetes who followed the low GI diet instructions had significantly lower HbA1c levels than those seen in the same children where the families used the traditional CHO exchange system. Furthermore, the rates of excessive hyperglycemia were significantly lower while using the low GI diet. Both the parents and the children preferred the low GI diet to using the exchange system and stated it was easier to learn and follow. Other aspects of quality of life were also reported as improved by the low GI diet. These include items such as: 1) it was easier for the child to select their own meals at the end of the study, 2) the diet was less likely to interfere with family activities, and 3) the diabetes was less likely to be source of tension or conflict.

On the other hand, use of the exchange system and controlling total CHO are believed to be the important difference. They argue further that a personalized nutrition intervention plan is best for long-term compliance and tight glucose control over time. Most recently the European Food Safety Authority recognized the importance of carbohydrate foods that are more slowly digested, absorbed, and metabolized in the reduction of post-prandial glucose responses and have authorized the use of a health claim on foods that would show this. (30) Some low GI and GL foods/diets may qualify.

Summary

In summary, data exist which both support and do not support low GI/GL diets in the prevention and management of diabetes. Both sides of the argument have studies and reviews that support their case. Yet, the data show a great deal of heterogeneity and variability. This could be due to a number of factors. Various ethnic groups or subjects with certain risk factors may respond more strongly and may show greater benefits from diets that are low in GI and GL. Further research is needed to understand these subject variations and learn who might benefit.

Various authors and advocates propose that there is no risk associated with advocating the adoption of a low GI or GL diet as an adjunct to other measures, both for the prevention of T2DM and the management of both type 1 and type 2 diabetes. (33) The ADA Recommendations for the Management of Diabetes suggest that diabetics consuming a high GI diet switch to a lower GI diet as one more strategy that might be of modest benefit in controlling postprandial hyperglycemia.

Full endorsement of GI/GL as a strategy for diabetic diets has some hurdles. First, not all are convinced that it offers any advantage over tested dietary regimens such as the exchange system. Second, the classification of foods as low, medium or high is both arbitrary and imprecise because of the methodological problems and effects of many aspects of both the food – such as variety, ripeness and degree of cooking – and the eater, especially effects of ethnicity, genetics and metabolism. Third, a low GI/GL diet can be achieved by a healthful diet high in fiber, legumes, nuts, fruits and vegetables, or by a diet with foods which are high in fat, sweetened with low glycemic sweeteners and may not be nutrient- or fiber-rich.

Thus, low GI foods and low GL diets may be helpful if nutrient-dense, fiber-rich foods are consumed for both preventing and managing prediabetes and diabetes.

(For a glossary of terms used in this paper, please go to page 29 of the comprehensive paper written by Dr. Miller-Jones, "The Role of Glycemic Index & Glycemic Load on Carbohydrate Food Quality: A Status Report," www.wheatfoods.org)

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