

Carbohydrates and the postprandial state: have our cake and eat it too?^{1–3}

David S Ludwig and David J Jenkins

Since the 1960s, the US Department of Agriculture and major professional health associations have recommended low-fat, high-carbohydrate diets for the prevention and treatment of cardiovascular disease and diabetes. In the 1990s, out of concern for the adverse effects of dietary carbohydrate on serum lipids and other risk factors, some experts advocated increased intake of fat (1). Interest in very-high-fat, low-carbohydrate diets has grown recently with the recognition that these diets may lower triacylglycerols, raise HDL cholesterol, and improve insulin sensitivity (2, 3). For optimal health, various popular diets presently recommend a ratio of carbohydrate to fat that ranges from >5:1 (4) to <1:5 (5).

The article by Harbis et al (6) in this issue of the Journal has relevance to this controversy because it shows that carbohydrate quality can affect plasma lipids in the postprandial state. Harbis et al studied 2 mixed meals that were reasonably well matched for macronutrient and fatty acid composition but differed in their content of slowly available glucose: a cereal flake-based meal (2 g slowly available glucose/100 g carbohydrate) and a biscuit-based meal (17 g slowly available glucose/100 g carbohydrate). The subjects included 8 women and 1 man with central obesity and insulin resistance but normal plasma triacylglycerol concentrations. The flakes meal produced, as intended, substantially higher plasma glucose and insulin responses than did the biscuit meal. The investigators found that plasma triacylglycerol, apolipoprotein (apo) B-100, and apo B-48 concentrations increased markedly after the flakes meal but not after the biscuit meal and that concentrations differed significantly between the 2 meals.

The basis of this meal effect is likely related to the rate at which starchy foods are digested. Since the 1980s, studies have shown that the rate of intraluminal amyolytic digestion determines the blood glucose response, and thus the glycemic index, of starchy food (7, 8). The rapid influx of carbohydrate after a high-glycemic index meal stimulates insulin secretion, both directly and indirectly via the gut incretins glucose-dependent insulinotropic polypeptide and glucagon-like peptide 1. The combination of increased glucose and insulin concentrations and decreased glucagon concentrations (suppressed by hyperglycemia and hyperinsulinemia) (9) in portal blood perfusing the liver would be expected to drive hepatic apo B-100 and VLDL synthesis. The data from Harbis et al suggest that gut-derived apo B-48 and chylomicron synthesis is also increased, with implications for atherogenic remnant particle production, especially in the absence of effective chylomicron clearance. This finding is of considerable importance because an increasing emphasis is being

placed on the control of triacylglycerol concentrations to reduce the risk of cardiovascular disease (10). The results of the study by Harbis et al build on the results of studies dating back to the 1980s that showed a reduction in fasting triacylglycerols in hyperlipidemic subjects treated with low-glycemic index diets (11, 12) and on the results of epidemiologic studies that found positive associations between glycemic index and triacylglycerols (13).

Increased triacylglycerol concentrations correlate with decreased HDL-cholesterol concentrations, a further diagnostic criterion of the metabolic syndrome and an independent risk factor for cardiovascular disease (10). Interventional studies found that subjects who consume a high-glycemic index diet tend to have lower ratios of HDL to total cholesterol than do those who consume a low-glycemic index diet, and cross-sectional analyses observed inverse associations between glycemic index (and glycemic load) and HDL cholesterol (9). Furthermore, glycemic index and glycemic load appear to affect C-reactive protein (14) and plasminogen activator inhibitor 1 (15), which are novel cardiovascular disease risk factors.

The pathophysiologic significance of postprandial metabolism has become the subject of particular attention in recent years with the realization that postprandial hyperglycemia and hypertriglyceridemia increase the risks of diabetes and cardiovascular disease. Indeed, these events appear to be intimately related: the amount and type of fat consumed in a meal is known to affect insulin sensitivity (16); the study by Harbis et al shows that the type of carbohydrate in a meal can also affect lipid metabolism. Other aspects of carbohydrate quality, including fiber, have also been shown to alter the postprandial triacylglycerol response, and fiber, in turn, is protective against cardiovascular disease (17).


One notable strength of the study by Harbis et al was the use of mixed meals having a nutrient composition that was clearly within prevailing norms. A commonly cited concern about the concept of the glycemic index relates to its validity in practice. Some investigators have reported that the glycemic responses to mixed meals cannot be accurately predicted from the glycemic index of the constituent foods (18), whereas other investigators

¹ From the Department of Medicine, Children's Hospital, Boston (DSL), and the Department of Nutrition, University of Toronto (DJJ).

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³ Address reprint requests to DS Ludwig, Department of Medicine, Children's Hospital, 300 Longwood Avenue, Boston, MA 02115. E-mail: david.ludwig@childrens.harvard.edu.

argue that these reports suffer from methodologic problems (19). However, this debate may be moot if meals or diets composed of low—rather than high—glycemic index foods produce significant and reproducible reductions in disease risk. Further research is needed both to determine whether the effects of glycemic index on postprandial lipid metabolism occur in healthy populations and in populations with other diseases and to elucidate the relevant molecular mechanisms.

The study by Harbis et al adds to the growing body of research suggesting that diets focused primarily on macronutrient quantity, be they low in fat or low in carbohydrate, may be too simplistic from the standpoint of cardiovascular disease prevention—and perhaps also from the standpoint of obesity treatment (20). Just as high-fat diets do not necessarily increase LDL cholesterol, high-carbohydrate diets do not necessarily increase triacylglycerols. Humans can probably do well over the long term by consuming diets that vary widely in macronutrients, so long as adequate attention is paid to nutrient quality. The current popularity of the Atkins diet notwithstanding, perhaps we can have a piece of cake after all, provided that it is made from healthful fat and low-glycemic index flour. 

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