Plant-Based Diets and Diabetes Risk: Which Foods, What Mechanisms?

Dariush Mozaffarian

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COMMENTARY

Increasing recognition of the dire impact of poor nutrition on global cardiometabolic health has created new urgency to identify optimal diets to address these burdens. Among various outcomes, type 2 diabetes is particularly diet sensitive, serving as an obvious marker for a population's nutritional health.

Yet, the optimal diet for prevention and management of diabetes remains controversial and has changed over time. For decades, recommendations focused on total calories and major macronutrients. In the 1990s, these emphasized lowering total fat, saturated fat, and cholesterol; reducing protein to preserve kidney function; encouraging water-soluble fiber; and being relatively liberal in allowing sugar (1). In the early 2000s, guidelines for diabetes prevention shifted toward low-calorie, low-fat diets for weight loss and increasing dietary fiber and whole grains (2). In the last 10 years, emerging science has again shifted nutritional guidance for diabetes prevention, this time away from macronutrient targets and toward overall food-based patterns. The Centers for Disease Control and Prevention, for instance, recommends greater intake of nonstarchy vegetables, fruits, whole grains, low-fat dairy, and lean-protein foods like fish, poultry, and eggs, and lower intake of packaged snacks, packaged meat, chips, granola bars, sweets, fast foods, sugary drinks, alcohol, and industrial trans fat (3).

However, the relevance of this "generally healthy" diet pattern, which is adapted from the Dietary Guidelines for Americans, the DASH (Dietary Approaches to Stop Hypertension) diet, and the Mediterranean diet, for diabetes and weight control has increasingly been questioned by newer popular trends like low-carb, ketogenic, and paleo diets. These diets reduce carbohydrates and/or processed foods and increase dietary fats and protein, including from animal-source foods, with evidence for benefits in weight loss and metabolic health. At the other extreme, vegan, vegetarian, and plant-based diets eschew animal-source foods, partly related to concerns for health but also for harms of industrial livestock production for climate change, agricultural resources, and animal welfare (4). A further new direction in dietary guidance abjures macronutrients, food groups, and diet patterns altogether, instead focusing on levels of food processing, particularly "ultraprocessed" foods (5).

In this swirling milieu of conflicting concepts, Sullivan et al. (6), in this issue of *Diabetes Care*, report a new investigation of plant-based dietary patterns and incident diabetes in a U.S. community-based cohort. Dietary habits were assessed in nearly 12,000 adults by food frequency questionnaire and scored as more or less adherent to a plant-based diet index (PDI), based on higher intake of plant-source foods and lower intake of animal-source foods. Recognizing that certain minimally processed, fiber- and bioactive-rich plant foods may be healthy (e.g., fruits, vegetables, nuts, legumes, and whole grains) while other processed, nutrient-poor, starch- and sugar-rich plant foods may cause harm (e.g., refined grains, potatoes, sweets, and sugar-sweetened beverages [SSBs]), the authors also stratified plant-based diets based on higher intake of healthy items (hPDI) versus higher intake of unhealthy items (uPDI).

Over 22 years of follow-up, 4,208 participations (more than 1 in 3) developed incident diabetes. After adjustment for potential confounders, an overall plant-based diet pattern was associated with lower onset of diabetes (PDI, 11% lower risk across quintiles). However, when types of plant-based foods were considered, only the hPDI was associated with lower risk (15% lower risk), not the uPDI (no significant association). These findings suggest that a minimally processed, fiber- and bioactive-rich plant-based diet, not just a plant-based diet, is important for diabetes prevention. Among the processed plant-based foods, the most influential negative item was SSBs, with little effect of inclusion or exclusion of the other processed plant-based foods on the association of PDI, hPDI, or uPDI with diabetes.

A critical related question is the incremental health benefit of avoiding animal foods. In other words, was the beneficial association seen with hPDI due to higher intake of healthy plant-source foods, lower intake of animal-source foods, or both? The investigators explored this question in sensitivity analyses, evaluating alternative versions of hPDI that scored animal-source foods in different ways. After excluding red meat from the score (in other words, ignoring how much red meat people

Food Is Medicine Institute, Friedman School of Nutrition Science and Policy, Tufts University, Boston, MA

Corresponding author: Dariush Mozaffarian, dariush.mozaffarian@tufts.edu

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ate), the protective association of hPDI was substantially attenuated, decreasing from 15% lower risk across quintiles to 8% lower risk. This suggests that about half the lower diabetes risk seen with a healthy plant-based diet pattern was attributable to lower red meat intake. In contrast, after excluding all other animal-source foods except red meat from the score (in other words, ignoring how much dairy, eggs, fish, poultry, and animal fat people ate), the protective association was similar, with 14% lower diabetes risk across quintiles of hPDI, compared with 15% originally. This suggests that little of the lower diabetes risk observed with a healthy plant-based diet pattern was attributable to avoidance of any of these other animal foods.

In sum, these new results provide evidence that minimally processed, fiber- and bioactive-rich plant-source foods may reduce risk of diabetes, SSBs and red meat may increase risk, and other animal-source foods as well as other processed plant-source foods may be relatively neutral, on average, for diabetes risk (Fig. 1). These findings are consistent with prior systematic reviews and evidence grading on the science of effects of specific dietary factors on diabetes and cardiovascular risk (7).

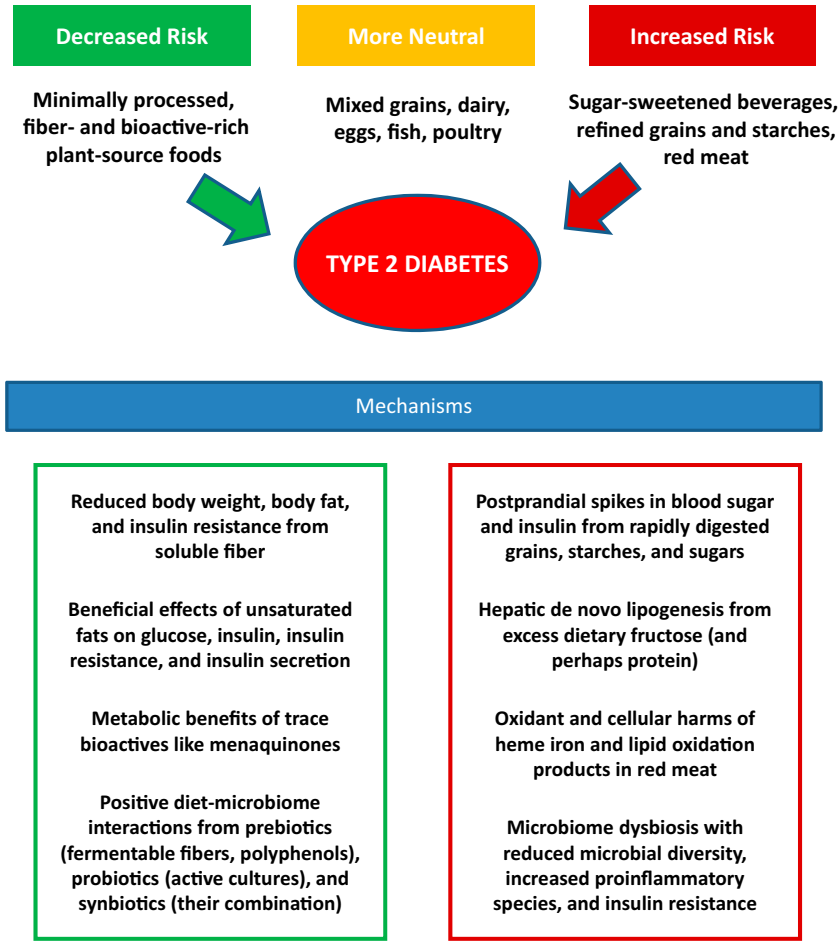

Figure 1—Diet patterns and type 2 diabetes risk.

What biologic mechanisms underlie these findings? Clinical attention and popular interest often focus on harms of high doses of rapidly digested glucose, whether from various added sugars (which are ∼50% glucose) or refined grains and starches (which approach 100% glucose). These foods rapidly spike postprandial blood glucose, an obvious barometer for metabolic risk, leading people to "count carbs" in their diets or scrutinize their continuous glucose monitor readings (8). However, acute effects on blood glucose represent only one pathway of risk, and other nutritional factors influence diabetes in more enigmatic but no less potent ways. For example, excess dietary fructose, and possibly dietary protein, have little acute effect on blood glucose levels but drive hepatic de novo lipogenesis, which, if chronically elevated, can contribute to fatty liver, visceral adiposity, and hepatic and systemic insulin resistance (9,10). Heme iron (found in red meat) is heavily implicated in diabetes risk, based on animal experiments, gestational diabetes, and inborn errors of iron metabolism (11–13). Lipid oxidation products formed during production, processing, and cooking of red meat may also contribute to harms (14).

On the protective side, soluble fiber reduces body weight, body fat, and insulin resistance (15); unsaturated fats improve fasting blood glucose and insulin, hemoglobin A_{1c}, and insulin resistance; and polyunsaturated fats increase insulin secretion capacity (16). Other trace bioactive compounds in foods may also influence diabetes. Cheese, for example, is the most common fermented food in the U.S. and the main source of menaquinones (vitamin K_2), which may lower diabetes risk (17).

The gut microbiome is central to many of these dietary-metabolic interactions. Diets low in nondigestible carbohydrates and higher in fructose and nonnutritive sweeteners can induce microbiome dysbiosis, with reduced microbial diversity, increased proinflammatory species, greater intestinal permeability, and higher host insulin resistance (18,19). In contrast, diets rich in prebiotics (food for the microbiota, like fermentable fibers and polyphenols), probiotics (active bacterial cultures), and synbiotics (their combination) nourish the gut microbiota and, in controlled trials, improve fasting glucose, fasting insulin, hemoglobin A_{1c}, and insulin resistance (20).

All these findings manifest the foundational role of diet in diabetes while also highlighting the critical knowledge yet to be gained about specific foods and underlying mechanisms of action. The new report from Sullivan and colleagues (6) adds another block to the emerging edifice of nutritional know-how around our diets and diabetes. Their results support an overall healthy diet pattern consistent with the Dietary Guidelines for Americans, DASH diet, and Mediterranean diet, which can include a range of minimally processed plant- and certain animal-source foods. The growing scourge of type 2 diabetes calls for a national nutrition science moonshot to enable more accurate, definitive dietary guidance

for diabetes prevention and management while still implementing the knowledge we possess today in clinical practice and public policy.

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