

# Preparing to Prescribe Plant-Based Diets for Diabetes Prevention and Treatment

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The number of people worldwide with type 2 diabetes is expected to double by 2030.<sup>1</sup> In the United States, diabetes affects ~ 26 million people of all ages, about one-fourth of whom are not yet diagnosed.<sup>2</sup> Despite the availability of a wide range of pharmacological treatments and the best efforts of diabetes educators and other health care professionals, good control of diabetes and its comorbidities remains elusive for much of the population, as evidenced by rates of cardiovascular morbidity and mortality that are two to four times higher than those of people who do not have diabetes.<sup>2</sup>

Although dietary habits and body weight play undisputed roles in type 2 diabetes, the question of what eating pattern best addresses glycemia, cardiovascular risk factors, and weight control remains controversial. The uniform, calorie-controlled diabetic diet plans of the past have been replaced by individualized meal-planning approaches, and in more recent years, nutrition guidance has focused on carbohydrate counting and minimizing saturated and *trans* fats. With the release of the U.S. Department of Agriculture's 2010 Dietary Guidelines for Americans<sup>3</sup> came praise for plant-based eating patterns, which have been extensively studied for weight management and disease prevention and treatment.

Individuals following a plant-based eating pattern typically consume fewer calories and less fat, saturated fat, and cholesterol and have lower BMIs than nonvegetarians. They also consume more fiber, potassium, and vitamin C.

In prospective studies of adults, compared to nonvegetarian eating patterns, vegetarian eating patterns have been associated with lower prevalence rates of type 2 diabetes,<sup>4</sup> cardiovascular disease (CVD),<sup>5</sup> hypertension,<sup>6</sup> and obesity<sup>7,8</sup> and reduced medical care usage.<sup>9</sup> Both the American Academy of Nutrition and Dietetics and the American Diabetes Association (ADA) now include well-planned, plant-based eating patterns (vegetarian and vegan) as a meal-planning option in their nutrition recommendations for people with diabetes.<sup>10,11</sup> This article provides a brief discussion of research on plant-based eating patterns, relevant nutrition issues, and practical applications for clinicians.

## Prevention of Type 2 Diabetes

Diabetes prevalence in the United States is lower among vegetarians than nonvegetarians.<sup>12-15</sup> In two large Adventist cohort studies ( $n = 25,698$  and  $n = 60,903$ ), the prevalence of diagnosed diabetes was 1.6–2.0 times higher among nonvegetarians than among vegetarians or vegans.<sup>12,15</sup> Part of the difference is attributable to higher body weight among nonvegetarians, but much of the difference persists after adjustment for body weight.

A 2009 study<sup>14</sup> found that, among a range of diets from vegan to nonvegetarian, as consumption of animal products increased, so did diabetes prevalence, ranging from 2.9% in vegans to 7.8% among individuals with unlimited consumption of animal products.

Data from the Harvard Women's Health Study, the Nurses' Health

Study, the Health Professionals Follow-Up Study, and other trials were part of a systematic review<sup>15</sup> of 12 cohort studies that found that men and women who ate the most meat had the highest risk of type 2 diabetes. Intake levels of red meat, processed meat, and fish were all associated with risk of type 2 diabetes.<sup>13–18</sup> These studies suggest that the total amount of meat consumed may be more important than the type of meat.

### Treatment of Type 2 Diabetes

Plant-based eating patterns combined with exercise have been found to improve diabetes control and reduce the need for medication in intervention trials as far back as 1976.<sup>19,20</sup> A more recent study<sup>21</sup> funded by the National Institutes of Health set out to examine the effect of a plant-based eating pattern isolated from the effect of exercise on type 2 diabetes. This prospective, randomized study compared 49 participants on a very-low-fat (10%), low-glycemic index (GI), vegan (legumes, fruits, vegetables, and whole grains) diet to a control group of 50 participants following individualized diet plans that included animal products and were based on macronutrient recommendations from the ADA's 2002 nutrition principles and recommendations.<sup>22</sup> Those recommendations included the following energy intake distribution and cholesterol levels: carbohydrate and monounsaturated fat together should provide 60–70% of caloric intake, protein should provide 15–20% calories, saturated fat should account for < 7% of calories, and cholesterol should be limited to ≤ 200 mg/day.

In the vegan group, portion sizes, carbohydrate intake, and energy intake were unrestricted; subjects in the control diet group with a BMI ≥ 25 kg/m<sup>2</sup> (all but three) were prescribed an energy intake deficit of 500–1,000 kcal/day. All participants were instructed not to modify their exercise habits during the intervention period.

Both groups experienced improvements at 22 weeks. However, among medication-stable

participants after 22 weeks, the vegan arm had greater weight loss (14.3 vs. 6.8 lb,  $P < 0.001$ ) and a greater reduction in A1C (1.23 vs. 0.38 percentage points,  $P = 0.01$ ). Medication-stable participants in the vegan group lowered their LDL cholesterol levels by an average of 22.6 mg/dl (21.2%) compared to an average reduction of 10.7 mg/dl (9.3%) in the conventional group ( $P = 0.02$ ).

Although medication changes were not a goal of the study, requirements for medication also dropped; 43% (21 of 49) of those following the vegan diet reduced their diabetes medications compared to 26% (13 of 50) in the conventional diet group. After 74 weeks, improvements in glycemia and plasma lipid concentrations remained greater in the vegan group.<sup>23</sup>

An assessment was conducted of the nutrient intake and dietary quality of participants in the two arms of the study described above. Using Harvard School of Public Health's Alternative Healthy Eating Index (AHEI), a nine-component dietary quality index that predicts the risk of cardiovascular and other major diseases,<sup>24</sup> Turner-McGrievy et al.<sup>25</sup> found that both nutritional approaches resulted in beneficial decreases in total calories, total fat, *trans* fat, and cholesterol.

The vegan group increased intake of fruits and vegetables, soluble and insoluble fiber, and several micronutrients and demonstrated improvements in AHEI score in all categories. The AHEI score for those in the conventional diet group remained unchanged.<sup>23</sup>

The study found that those in the vegan arm consumed adequate vitamin B<sub>12</sub> (through fortified foods) and iron, two nutrients often cited as concerns for those following vegan eating patterns. The authors concluded that both groups had difficulty meeting the recommended intake levels for vitamins D and E, calcium, and potassium and consumed excessive sodium, although less than at baseline.

### CVD Prevention and Treatment

Low-fat, plant-based eating patterns have shown efficacy in reducing LDL cholesterol concentrations and result in significant reductions in CVD risk and cardiovascular events.<sup>5,6,21,26–29</sup> Appleby et al.<sup>6</sup> studied hypertension across a range of eating patterns and found that blood pressure control was inversely proportional to the amount of animal products consumed, with those abstaining from all animal products achieving the most significant improvements. In a review of 27 randomized controlled and observational trials, Ferdowsian et al.<sup>5</sup> concluded that a plant-based eating pattern that includes nuts, soy, and/or soluble fiber can reduce LDL cholesterol by 25–30%, an amount comparable to what can be achieved with statin drugs. Ornish et al.<sup>26</sup> effectively used a low-fat (10%), plant-based eating pattern in the 5-year landmark Multicenter Lifestyle Demonstration Project (MLDP) clinical trial demonstrating reversal of heart disease. The MLDP included a subset of people with diabetes ( $n = 55$  men and 36 women) who achieved the same improvements in cardiovascular risk factors as those who did not have diabetes.<sup>30</sup>

### Long-Term Weight Loss

In observational studies, vegetarians and vegans are slimmer than non-vegetarians.<sup>7</sup> When vegetarian and vegan eating patterns are used in clinical trials, they elicit significant weight loss.<sup>21,26,27,31</sup> Importantly, weight loss occurs in the absence of intentional calorie restriction (providing an obvious benefit with regard to facilitating adherence), even when exercise regimens remain constant.<sup>21,31</sup>

Clinical trials show that weight loss achieved in short-term interventions is partially sustained over the longer term.<sup>8,26</sup> In a study<sup>8</sup> of overweight postmenopausal women who began a low-fat, vegan diet without added exercise as part of a 14-week randomized clinical trial, body weight was followed for an additional 2 years. Median net weight reduction was 4.9 kg at 1 year and 3.1 kg at 2 years, both of which were greater than weight changes

associated with a comparison diet based on National Cholesterol Education Program (NCEP) guidelines. Among individuals with CVD, a lifestyle program including a low-fat, vegetarian diet and mild exercise was associated with a net weight loss of 10.9 kg at 1 year and 5.8 kg at 5 years.<sup>30</sup>

**Mechanisms: Why Does It Work?**

Three biological factors may explain why a low-fat, plant-based eating pattern is effective for glycemic control. First, foods from plants contain less total and saturated fat, resulting in reduced caloric intake, weight loss, and improved A1C levels.<sup>21</sup> Second, independent of weight loss, a low-fat, plant-based diet improves insulin sensitivity,<sup>31</sup> presumably by reducing intramyocellular lipid accumulation.<sup>32</sup> As insulin sensitivity improves, carbohydrate tolerance increases. Third, participants in the diabetes studies by Barnard et al.<sup>28</sup> consumed low-GI carbohydrates and limited high-GI foods, which has been shown to be beneficial in other studies<sup>10,28,33</sup> and may also explain why triglyceride levels did not increase even with higher carbohydrate intake.

**Translating Research into Practice**

Clinicians may agree that plant-based eating patterns are effective for weight loss, glycemic control, and reduced cardiovascular risk but believe that this approach is too difficult for their patients to follow. Indeed, meat and dairy are now commonly consumed for breakfast, lunch, and dinner in the United States across a wide range of ethnic and socioeconomic groups, and a shift to plant-based food choices from current eating patterns represents a significant dietary change for many. This section will review research on the acceptability of a plant-based eating pattern and present ideas on how to effectively incorporate instructions for following it into clinical practice.

**Acceptability research**

Nutrition researcher Neal Barnard, MD, has extensively studied adherence to and acceptability of

plant-based eating patterns compared to other therapeutic eating patterns.<sup>34-40</sup> In quantitative comparisons in which individuals beginning vegan eating patterns rate several parameters of acceptability (e.g., taste and effort), vegan eating patterns have scored similarly to eating patterns based on NCEP<sup>36</sup> and ADA<sup>39</sup> guidelines. Furthermore, beneficial outcomes were achieved without requiring participants to limit unrefined or minimally refined carbohydrates or to adhere to a fixed daily caloric intake, which may have improved adherence. A University of Pittsburgh survey<sup>38</sup> of young women who had tried either a vegetarian or calorie-restricted diet showed that the mean duration of adherence to vegetarian diets was at least 2 years, compared to only 4 months for calorie-restricted diets.

**Practical applications for clinicians**

After assessing a patient's current eating pattern and readiness for change, a clinician could state, "Studies have shown there are many health benefits when individuals eat fewer meat and dairy products." If true, it is also helpful to say, "I have seen people in this practice improve their diabetes control by avoiding

animal products altogether." Follow with the question, "Would you like to know more about this meal-planning approach?"

A visual aid, such as The Power Plate (Figure 1; available online from [www.ThePowerPlate.org](http://www.ThePowerPlate.org)), may be used to explain the four plant-based food groups (legumes, grains, vegetables, and fruits), and a hand-out such as "Diet and Diabetes: Recipes for Success" (available online for download at <http://www.pcrm.org/search/?cid=129>) can be provided to explain the scientific evidence behind this approach and offer a list of low-fat, plant-based ideas for meals and snacks.



*Figure 1: The Power Plate. The Power Plate is a useful plant-based nutrition educational tool. This diagram consists of four food groups: fruits, vegetables, legumes, and grains. It was created by the Physicians Committee for Responsible Medicine in 2009 to offer a simple plant-based nutrition blueprint for the public. Additional information is available online at [www.ThePowerPlate.org](http://www.ThePowerPlate.org).*

**Table 1. Grocery List**

A good beginning grocery list includes the following:

**Grains:**

- Rolled oats
- High-fiber or pumpernickel bread
- Brown rice
- Quinoa
- Whole-wheat pasta

**Beans:**

- Fortified soy, rice, almond, or plant milk of choice
- Black beans, canned or dried
- Garbanzo beans, canned or dried
- Dried red, green, or French lentils
- Frozen edamame
- Hummus, 2 g fat/serving or less

**Fruits:**

- Apple butter
- Bananas
- Apples
- Berries, fresh or frozen
- Raisins

**Vegetables:**

- Broccoli, fresh or frozen
- Spinach, fresh or frozen
- Sweet potatoes
- Kale
- Lettuce
- Carrots
- Cucumbers
- Canned tomatoes
- Marinara sauce

**Condiments:**

- Balsamic or other flavored vinegar
- Cinnamon
- Mustard
- Soy sauce
- Agave nectar

**Table 2. Sample Menu**

A 3-day sample menu of low-fat vegan foods would not have portion sizes. Low-fat plant-based meal plans may be created online at [www.NutritionMD.org](http://www.NutritionMD.org).

Breakfast	Lunch	Snack	Dinner
Old-fashioned oatmeal made with water or plant-based milk,* raisins, banana, and cinnamon	Lentil soup with hummus sandwich on rye bread; add mustard, lettuce, tomatoes, and onions	Air-popped popcorn with spices Apple	Stir-fry (sauté in water or vegetable broth) mixed vegetables, tofu, and brown rice; add low-sodium soy sauce
Vegan buckwheat pancakes topped with whole fruit and a touch of real maple syrup	Spinach salad with low-fat dressing and a baked sweet potato	Baked corn tortillas with salsa Fruit smoothie (frozen berries, banana, and almond milk)	Beans, greens, and grains: cook a pot of your favorite grain (such as quinoa) with a bean (such as red lentils) and throw in a leafy green (such as kale) near the end of cooking time; add spices to taste
Scrambled tofu with vegetables and pumpernickel toast with apple butter	Burrito with black beans, lettuce, tomato, salsa, corn, rice, and cilantro	Hummus with carrots and celery Grapes	Whole-wheat penne pasta with vegetable and marinara sauce; side salad with low-fat dressing

\*Fortified plant-based milks come in a many varieties and are easily found in health food stores and larger grocery store chains. Varieties include soy, rice, and almond.

**Table 3. Principles of a Low-Fat, Plant-Based Eating Pattern**

- Ad libitum foods from four food groups: whole grains, legumes (beans, peas, and lentils), vegetables, and fruits. Individuals who adjust insulin based on carbohydrate intake will still need to count carbohydrate grams or servings; insulin requirements may change, requiring dose adjustments.
- Whole foods or unprocessed or minimally processed foods are best.
- Limit added vegetable oils and other high-fat foods to aid in weight loss and weight maintenance efforts and to help optimize glycemic control. Include about 1 oz of nuts or seeds per day but not significantly more because of their high caloric content.
- Choosing low-GI foods such as old-fashioned oatmeal, sweet potatoes, beans, whole grains, and most fruits and vegetables may help to improve glycemia and reduce triglyceride levels.
- Getting > 40 g of fiber from whole foods per day is recommended. A gradual increase is suggested for people who are not used to digesting fibrous foods. The 40-g recommendation can be achieved when choosing fruits, vegetables, whole grains, and legumes for each meal and snack.
- Avoiding all animal products eliminates dietary intake of cholesterol and significantly minimizes sources of saturated fat.
- Vitamin B<sup>12</sup> supplementation of 2.4 µ/day (e.g., a regular multivitamin) is recommended for anyone avoiding animal products and all people > 50 years of age.
- A macronutrient profile of ~ 75–80% of energy from carbohydrate, 10–15% from protein, and 10% from fat is recommended.

In the authors' experience, it is not unusual to find that patients have some familiarity with this eating pattern, perhaps through hearing about famous vegan athletes, celebrities, or politicians, or they may have a son or daughter who has been encouraging them to try it, or they have tried it themselves in the past. Sometimes, just validation from a health care professional that plant-based eating is effective, along

with useful educational resources, provides the impetus to give it a try.

Table 1 provides a sample 3-day menu. Table 2 provides a grocery list. Additional resources are provided in Table 3. Key educational issues identified for healthful eating will need to be addressed, relative to plant-based nutrition. These include shopping and cooking, modifying recipes, eating out, snacking, and managing special situations such as travel and holidays.

Clinicians should be prepared to provide some general diabetes nutrition “un-learning.” In this eating pattern, pasta, grains, starchy vegetables, and other whole or minimally processed carbohydrates are not limited; sufficient protein intake will likely occur if patients are eating enough calories (even skinless chicken and fish are sources of fat and cholesterol and are recommended to be left off the plate); and calcium is obtained from



**Table 4. Plant-Based “Power Plate” Sources of Key Nutrients**

**Protein**

An assortment of plant foods eaten over the course of a day can provide all essential amino acids and ensure adequate nitrogen retention and use in healthy adults. Thus, complementary proteins do not need to be consumed at the same meal.<sup>42</sup> Athletes can also meet their protein needs on plant-based diets.<sup>43</sup> Plant-based protein sources include beans, tofu, tempeh, seitan, and grains. Consider options such as lentil or black bean soup, stir-fries with steamed tofu, “bacon”-lettuce-tomato sandwich made with tempeh instead of bacon, hummus roll-up sandwich, bean burrito, pasta with white beans, and quinoa and chick pea salad.

**Vitamin B<sup>12</sup>**

For individuals following a diet free of animal products, vitamin B<sup>12</sup> needs can be met by consuming fortified breakfast cereals, fortified non-dairy milk, and fortified meat analogs or with a daily multivitamin or supplement containing 2.4 μg of B<sup>12</sup>. Older adults following any eating pattern are at risk of B<sup>12</sup> deficiency because absorption decreases with age.

**Iron**

Green, leafy vegetables and legumes provide iron. The incidence of iron deficiency anemia is similar among vegetarians and nonvegetarians.<sup>44</sup>

**Omega 3 Fatty Acids**

Fish flesh contains omega-3 fatty acids because fish eat plants. Plant sources of omega-3 fatty acids include ground flaxseeds, walnuts, cauliflower, soybeans, tofu, and Brussels sprouts. These non-animal sources are free of saturated fat and cholesterol.

**Calcium and Vitamin D**

Bok choy, broccoli, Chinese cabbage, collard greens, and kale are highly bioavailable sources of calcium, as are fortified foods such as some juices, breakfast cereals, non-dairy milks, and calcium-set tofu. Almonds and dried beans also contain calcium, although these have a lower bioavailability. Vitamin D status depends on sun exposure and intake of fortified foods. Vitamin D<sup>2</sup> (ergocalciferol) supplements are made from non-animal sources. Limiting salt, getting regular weight-bearing exercise, and not smoking are other important actions for building strong bones.

**Table 5. Resources**

**For Clinicians**

- Continuing education offerings are available online at no cost from [www.NutritionCME.org](http://www.NutritionCME.org).
- Evidence-based nutrition recommendations for many chronic diseases are available online at [www.NutritionMD.org](http://www.NutritionMD.org) and in the book *Nutrition Guide for Clinicians*, 2nd ed. Washington, D.C., Physicians Committee for Responsible Medicine, 2009
- Patient education resources are available online at [www.PCRM.org/Nurses](http://www.PCRM.org/Nurses).

**For Patients or Anyone Wishing to Try a Plant-Based Diet**

- Barnard N, Grogan BC: *Dr. Neal Barnard’s Program for Reversing Diabetes*. New York, Rodale, 2007
- Barnard N, Webb R: *Get Healthy, Go Vegan*. Cambridge, MA, De Capo Press, 2010
- Physicians Committee for Responsible Medicine Web site: [www.PCRM.org/Diabetes](http://www.PCRM.org/Diabetes)
- Physicians Committee for Responsible Medicine Power Plate Web site: [www.ThePowerPlate.org](http://www.ThePowerPlate.org)
- Physicians Committee for Responsible Medicine 21-Day Vegan Kickstart Web site: [www.21DayKickstart.org](http://www.21DayKickstart.org)

beans, green leafy vegetables, and fortified foods rather than from dairy products.

Specific nutrition considerations should be addressed for those who maintain long-term adherence to a plant-based eating pattern, including finding a consistent source of vitamin B<sub>12</sub>. Tables 4 and 5 offer more information.

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Practical information for patients**

When adopting a plant-based eating pattern, are patients better off avoiding all meat and dairy products

“cold-turkey?” Or, is a slow and steady shift better? Either option may work. Dean Ornish, MD, encourages what he calls the “spectrum approach”: begin with moderate changes, such as meatless meals on a certain number of days per week, and progress to more significant changes if the moderate changes do not achieve the desired goals.<sup>39</sup> Alternatively, Barnard recommends a 3-week trial of 100% plant-based eating. With this approach, a short-term commitment is manageable, and individuals might see results faster, which may provide

motivation to continue.<sup>40,41</sup> Free online support for initiating a plant-based eating pattern is available online from [www.21DayKickstart.org](http://www.21DayKickstart.org).

**What should patients expect?**

A change in blood glucose levels can occur almost immediately, or blood glucose could gradually decrease to the normal range over weeks or months. Less frequently, some patients initially see their blood glucose level increase. By selecting unrefined and low-GI carbohydrates, this response can be mitigated.

Patients need to be prepared for both possibilities; a review of recognition, treatment, and prevention of hypoglycemia is important for those who are on oral hypoglycemic agents or insulin, along with information on what types of blood glucose patterns would warrant action, such as a call to discuss changes in medication dose or type.

Current blood glucose levels, along with patients' level of confidence that they will make and sustain dietary changes, could suggest a need to reduce medication with implementation of a plant-based eating pattern. For those who see blood glucose levels initially increase, it is usually acceptable to watch this for a short period without concluding that the eating pattern is ineffective or rushing to add medication. Over time, blood glucose levels do generally decrease in those who adhere to the guidelines of a low-fat, low-GI, and vegan diet.

Of note, blood pressure may also decrease in patients taking antihypertensive medications. A review of signs of low blood pressure and encouragement to contact a health care provider to review medications should they have symptoms is warranted.

Insulin doses might need to be adjusted. This varies greatly among patients, depending on factors such as their degree of hyperglycemia, the quality of their eating pattern before adopting a plant-based diet, and their degree of adherence. Initially, some patients who use insulin might need a change in their insulin-to-carbohydrate ratios and specifically higher bolus and lower basal insulin doses. As with any significant dietary change, it is important to closely monitor blood glucose patterns and adjust insulin to avoid hypoglycemia.

Patients with persistent hyperglycemia will benefit from diet reassessment; it is common to find that those who do not achieve glycemic control are continuing to consume excessive dietary fat, often hidden in the form of cooking oils and salad dressings, especially in restaurant meals. If blood glucose control is not achieved, offer other

useful lifestyle interventions such as physical activity and stress management.

Another key practical consideration is the eating pattern's impact on gastrointestinal function. Some people believe that they cannot tolerate beans because of flatulence; they should be assured that the body will adjust over time if they regularly consume beans. Some also need reassurance that more frequent bowel movements, as opposed to constipation and straining, is a normal and beneficial sign of significant dietary changes. To promote a smooth transition, provide instruction about how to manage discomfort. Advise patients to choose lentils and split peas initially instead of larger beans because these are easier to digest, begin with small portions of larger beans, cook beans thoroughly, and discard soaking water if preparing dried beans. Beans suffer from a lack of advertising and marketing, yet they are a healthful and economic choice worthy of our advocacy.

### Summary and Conclusions

Like other meal-planning approaches that result in weight loss, a plant-based eating pattern can reduce the risk of developing type 2 diabetes. For those who already have diabetes, a low-fat, plant-based approach has shown efficacy for metabolic control, weight loss, and cardiovascular risk reduction, with demonstrated acceptability and adherence comparable to other therapeutic eating patterns.

The Power Plate is a diagram that provides a simple means to begin instruction. Many other free or low-cost evidence-based nutrition education resources are available. Clinicians are encouraged to increase their knowledge and expertise as needed and to offer a plant-based eating pattern as an option for individuals who are at risk for or already have type 2 diabetes.

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