An Update on the Mediterranean, Vegetarian, and DASH Eating Patterns in People With Type 2 Diabetes

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When it comes to eating, there is no "one-size-fits-all" solution. This article provides an overview of recommendations and research for three evidence-based eating patterns—Mediterranean, DASH (Dietary Approaches to Stop Hypertension), and vegetarian/vegan—that can be individualized for people with type 2 diabetes. In an effort to improve adherence and health outcomes, practical considerations for improving nutrition are highlighted with the aim of helping patients successfully adopt an eating pattern that meets their individual needs and sociocultural and personal preferences.

In the past several years, a notable shift toward recommending whole foods and food patterns over individual nutrients has emerged (1,2), recognizing that individuals rarely eat foods in isolation. According to the most recent American Diabetes Association nutrition guidelines, the evidence does not support a clear preference for one specific eating pattern; rather, it recommends that a variety of eating patterns should be considered in the overall strategy for diabetes management (1,3). The Mediterranean, DASH (Dietary Approaches to Stop Hypertension), and vegetarian eating patterns have garnered particular interest with respect to their potential health benefits. The popularity of these diets is also noteworthy, with the DASH and Mediterranean diets consistently rated as top diets by *U.S. News & World Reports* for the past 8 years (4).

These dietary patterns all share similar characteristics; they are nutrient-rich, emphasizing fruits and vegetables, whole grains, and legumes with reduced intake of refined grains and added sugars (5). It appears that the combination of the foods that are plentiful in these eating patterns may have a synergistic effect on individuals with type 2 diabetes (6,7). Two systematic reviews published in 2019 found the vegetarian (6,8), Mediterranean (6,8), and DASH (6) eating patterns positively affected glycemic control. Collectively, they reduced A1C by an average of 0.8% (6). The vegetarian/vegan pattern yielded a 0.68% mean reduction in A1C in four studies; DASH a 1.7% reduction in one study (9); and the Mediterranean pattern 1.2 and 0.9% reductions after 1 year and 4 years, respectively, in one study (10). In addition to glycemic control, these eating patterns have been found to improve blood lipids in individuals with diabetes (11).

The purpose of this article is to review the Mediterranean, DASH, and vegetarian/vegan eating patterns as they relate to glycemic response in individuals with type 2 diabetes. Diabetes educators can help individuals with diabetes select the appropriate eating pattern, while considering the overall goals of individualized nutrition therapy—to improve health by improving A1C, blood pressure, and cholesterol while maintaining the pleasure of eating and limiting unnecessary avoidance of certain foods (1). Each of the three eating patterns reviewed in this article can be adapted to an appropriate calorie level to help individuals achieve or maintain a healthy body weight. Additionally, both the Mediterranean and DASH diets can be adapted to accommodate a vegetarian lifestyle.

High-Level Dietary Pattern Recommendations

The 2015–2020 *Dietary Guidelines for Americans* cite the Mediterranean, vegetarian, and DASH patterns as examples of healthful eating plans (2). The importance of quality versus quantity of macronutrients cannot be overstated, regardless of the food pattern selected. Emphasis in each eating pattern is on whole, minimally processed, protective foods, including increased intake of plant-based foods (i.e., fruits, vegetables, whole grains, legumes, nuts, and seeds), healthy fats (i.e., avocados, nuts, seeds, fatty fish, olive oil, and nontropical vegetable oils), dairy products (i.e., milk, yogurt, and cheese), plant (i.e., legumes, nuts, and seeds) and fish sources of protein, and reduced intake of red, and

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especially processed, meats. Table 1 provides a comparison of the three eating patterns with respect to their food recommendations (2,12).

Unfortunately, the guidelines are in stark contrast to reality; only 1 in 10 Americans gets the recommended amount of fruits and vegetables (1 1/2 to 2 1/2 cups/day), and most Americans are not meeting the goals of 2–3 cups/day of dairy products and 2 servings/week of fish (13). Recommended amounts of added sugars, saturated fats, and sodium are generally exceeded in the typical American diet (2).

Nationally, the Healthy Eating Index score is used to evaluate dietary patterns and inform the *Dietary Guidelines for Americans*. From 1999 to 2016, there have been slight improvements in intake of whole grains, whole fruits, nonstarchy vegetables, and legumes. Still, much improvement is needed in dietary quality because of the excessive intake of saturated fat, added sugar, salt, and refined grains (14). This information provides helpful context to diabetes educators as they look to help individuals with type 2 diabetes make diet-related shifts.

Literature Review

We conducted a search of PubMed and Google Scholar, mainly to identify original research articles, meta-analyses/systematic reviews, and organizational recommendations published since 2010. Using the search terms "diabetes," "Mediterranean," "DASH," "Vegetarian," "glycemic control," "A1C," and "dietary patterns," we initially identified 52 articles. We then limited inclusion to patients with type 2 diabetes. We also employed an ancestry approach for studies reviewed.

Although studies were not limited in terms of length, this is an important consideration when assessing research findings regarding the effectiveness of eating patterns with regard to A1C reduction. Given that the half-life of A1C is ~60 days, shorter study time frames make it difficult to fully understand glycemic impact.

Table 2 provides a detailed overview of studies included in this review (9,15–28).

Research on the Mediterranean Eating Pattern

The Mediterranean eating pattern has shown promising results for individuals with diabetes in terms of improving glycemia compared with other eating patterns (29,30). Although challenging from a research perspective because the Mediterranean diet does not have a consistent definition, this review provides evidence from studies looking at Mediterranean-style eating patterns.

Four meta-analyses found that a Mediterranean diet was associated with lower A1C (−0.3 to −0.47%) (19,20,30,31), and two found improvement in cardiovascular disease (CVD) risk factors compared mainly to lower-fat diets (20,31). In randomized controlled trials (RCTs), a low-calorie Mediterranean eating pattern resulted in a greater reduction of A1C, higher rates of diabetes remission, and delayed need for diabetes medication (by ~2 years) compared with a low-fat diet in patients with newly diagnosed type 2 diabetes (18).

Itsiopoulos et al. (16) found that in a small sample of people with type 2 diabetes, A1C was reduced after following a Mediterranean diet mostly provided by the study for 12 weeks. A 12-month study comparing a low-carbohydrate Mediterranean diet to a traditional Mediterranean diet and a 2004 American Diabetes Association (ADA) diet found A1C reductions in all three groups (−1.6 to −2.0%); however, the largest A1C reduction occurred in the low-carbohydrate Mediterranean diet group. Importantly, based on food frequency questionnaires, the percentage of carbohydrate among the three groups only differed by 3.5% (15).

Toobert et al. (17) did not find a long-term (2-year) glycemic benefit in those assigned to a culturally adapted Mediterranean eating plan and lifestyle intervention. Although 6-month results looked promising, those assigned to the Mediterranean intervention had an A1C consistent with baseline by study end. This study was an adaptation of a previous study that did find a glycemic benefit with a Mediterranean lifestyle intervention over 6 months (17).

Although not the focus of this article, it is well established that individuals with diabetes are at greater risk for CVD. The Mediterranean eating pattern has also been found to have CVD benefits. In people at high CVD risk (49% of participants had diabetes or three other risk factors), the incidence of major CVD events was lower among those assigned to a Mediterranean eating plan supplemented with extra-virgin olive oil or nuts compared with those on a reduced-fat diet (32). The proposed mechanisms for this reduced CVD risk include that this eating pattern decreases oxidative stress and inflammation (5,33).

Research on the Vegetarian Eating Pattern

Vegetarian eating patterns vary from vegan (excluding all animal products) to vegetarian plans that may or may not include eggs or dairy products. Recent studies have shown mixed results on glycemia. Two meta-analyses comparing

TABLE 1 Comparison of Food Recommendations for the Mediterranean, Vegetarian, and DASH Eating Patterns

Foods	Mediterranean (2)	Vegetarian (2)	DASH (12)
Vegetables	2 1/2 c-eq/day	2 1/2 c-eq/day	4–5 servings/day
			1 cup raw leafy vegetables
			1/2 cup cut-up raw or cooked vegetables
			1/2 cup vegetable juice
Fruit	2 c-eq/day	2 c-eq/day	4–5 servings/day
			1 medium fruit
			1/4 cup dried fruit
			1/2 cup fresh, frozen, or canned fruit
			1/2 cup fruit juice
Grains	6 oz-eq/day (whole grains ≥3 oz-eq/day)	6 1/2 oz-eq/day (whole grains ≥3 1/2 oz-eq/day)	6–8 servings/day
			1 slice bread
			1 oz dry cereal
			1/2 cup cooked rice, pasta, or cereal
Dairy	2 c-eq/day	3 c-eq/day	2–3 servings/day (specifies low-fat dairy)
			1 cup milk or yogurt
			1 1/2 oz cheese
Nuts, seeds, and legumes	5 oz-eq/week nuts, seeds, and soy; 1 1/2 c-eq/week (legumes)	3 c-eq/week legumes; 14 oz-eq/week (seeds, nuts, and soy)	4–5 servings/week
			1/3 cup or 1 1/2 oz nuts
			2 Tbsp peanut butter
			2 Tbsp or 1/2 oz seeds
			1/2 cup cooked legumes (dried beans or peas)
Fats and oils	27 g (2 Tbsp)/day; extra-virgin olive oil preferred as principle source of fat	27 g (2 Tbsp)/day	2–3 servings/day
			1 tsp soft margarine
			1 tsp vegetable oil
			1 Tbsp mayonnaise
			2 Tbsp salad dressing
Meats, poultry, eggs, and fish	6 1/2 oz-eq/day; fish/seafood 15 oz-eq/week; meat, poultry, and eggs 26 oz-eq/week	3 1/2 oz-eq/day; eggs 3 oz-eq/week	6 oz-eq/day
			1 oz cooked meats, poultry, or fish
			1 egg
Sweets and added sugars	<13% of calories (260 calories) from sugars, solid fats, added refined starches, and alcohol	<15% of calories (290 calories) from sugars, solid fats, added refined starches, and alcohol	≤5 servings/week
			1 Tbsp sugar
			1 Tbsp jelly or jam
			1/2 cup sorbet or gelatin dessert
			1 cup sugar-sweetened beverage

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TABLE 1 Comparison of Food Recommendations for the Mediterranean, Vegetarian, and DASH Eating Patterns

Foods	Mediterranean (2)	Vegetarian (2)	DASH (12)
Sodium	Less added salt; use of herbs and spices encouraged		<2,300 mg or <1,500 mg for those with high blood pressure
Alcohol	Mainly wine during meals		<2 drinks/day for men <1 drink/day for women
Other	Not to exceed calorie needs	Not to exceed calorie needs	Not to exceed calorie needs
Water	6–8 cups daily		

Based on 2,000 calories/day. c-eq, cup equivalent; oz-eq, ounce equivalent.

vegetarian and vegan eating patterns to conventional diabetes meal plans (with animal protein) found that vegetarian eating patterns significantly lowered A1C (by −0.29 and −0.39%) (22,23). Two RCTs that compared a vegan eating pattern to a conventional diabetes meal plan found significant reductions in A1C with the vegan pattern (−0.7 vs. −0.1% and −0.5 vs. −0.2%) (24,25). However, a shorter-term 12-week RCT comparing a vegetarian eating pattern to a conventional diabetes meal plan (both calorie restricted) found no statistical differences in A1C (21). In another small, randomized trial that compared a vegan plan to a portion-controlled plan, Barnard et al. (26) found A1C improvements in both groups (−0.40%) but no significant differences between eating patterns. Overall, high-quality, plant-based eating patterns may be effective in improving glucose parameters, especially for those who prefer a vegetarian eating pattern.

It has been reported that vegan/vegetarian dietary patterns may present adoption and adherence challenges for patients (34). To address this concern, Lee et al. (25) performed an adherence study comparing a vegan eating pattern to a conventional meal plan. The mean compliance score for the vegan eating pattern was 9.2 (of a possible 10) compared with 8.2 with the conventional diet meal plan. Similarly, a worksite diabetes intervention found good adherence to plant-based eating patterns (34). Flexible, plant-based dietary patterns (e.g., lacto-ovo– and semivegetarian) may be just as realistic for patients to follow as other eating plans.

Research on the DASH Eating Pattern

The DASH eating plan was designed to lower blood pressure and was first introduced in 1997 based on the results of a multicenter trial (35). Significant benefit was seen in the National Heart, Lung, and Blood Institute–funded study, and the DASH diet has since been touted as one of the top eating patterns for individuals to improve their health (12,35,36). However, glycemic response to this particular eating plan has not been adequately studied to strongly recommend it to people with diabetes. In fact, in a 2019 systematic review, none of the four included studies looked at A1C as a primary outcome. Their pooled analyses did demonstrate that the DASH eating pattern was associated with a 20% reduced CVD incidence and blood pressure benefits, which may translate to a 20% reduction in risk of CVD, along with meaningful benefits in other established CVD risk factors in those with and without diabetes (28). Given the comorbidities associated with diabetes, DASH is likely a good eating plan to follow (35), but we need to understand more about its glycemic impact.

Two small randomized trials that looked at glycemic response reported promising findings. An 8-week randomized crossover clinical trial found a reduction in A1C of 1.7% after the DASH diet was followed compared with a traditional ADA diet. This trial was short, and only 31 people completed the study, making it difficult to generalize these findings (9). In another 4-week trial, the DASH diet coupled with increased walking was associated with statistically significant reductions in blood pressure (measured by ambulatory blood pressure monitoring) compared with a diet based on ADA recommendations while maintaining usual activity level (control group). A1C improved in both groups (−0.6% for intervention, −0.5% for control) (27).

Practical Considerations

Regardless of the eating plan that resonates most with a patient, it is always helpful to assess an individual's current eating pattern and what it will take to successfully adopt the desired eating pattern. Focusing on a few key considerations may be helpful when working with patients to improve their nutrition.

TABLE 2 Studies Conducted Since 2010 Assessing the Glycemic Impact of the Mediterranean, Vegetarian, and DASH Eating Patterns

Study	Design	*n*	Intervention	Blood Glucose Impact
Mediterranean eating pattern				
Elhayany et al., 2010 (15)	12-month RCT	259 (179 completers)	Comparison of LCM (35% CHO, 45% fat), TM, and 2003 ADA diet (both TM and ADA diets 50–55% CHO, 30% fat, and 15–20% protein)	A1C reduction was significantly greater in the LCM diet than in the ADA diet (−2.0 and −1.6%, respectively; $P < 0.022$); no statistically significant difference with TM (−1.8%) compared with LCM and ADA diets
Itsiopoulos et al., 2011 (16)	12-week randomized crossover clinical trial	31 (27 completers)	Comparison of Mediterranean diet (40% fat, 44% CHO, 12% protein, 4% alcohol via red wine) ad libitum provided by study to usual care	A1C decreased from 7.1% on usual diet to 6.8% on Mediterranean intervention diet (−0.3%, $P = 0.012$)
Toobert et al., 2011 (17)	24-month RCT	280 (190 completers)	Comparison of a culturally modified Mediterranean eating pattern to enhanced usual care (usual care + option of one free class) in a Latina population	Baseline A1C 8.4% in both groups; at 6 months, A1C improved in intervention (7.8%) compared with usual care (8.4%) ($P < 0.05$); improvements not sustained at 24 months (intervention 8.4%, usual care 7.8%)
Esposito et al., 2014 (18)	4-year follow-up RCT	215 ($n = 108$ for LCM and $n = 107$ for low-fat)	Comparison of LCM to a low-fat diet (≤30% kcal from fat and ≤10% kcal from saturated fat); 1,500 kcal/day for women and 1,800 kcal/day for men for both groups	During first year, LCM group had greater A1C improvement than low-fat group (MD −0.5%, $P < 0.001$); after 4 years, cumulative incidence of participants requiring diabetes medications was 44% in LCM group vs. 70% in low-fat group ($P < 0.001$); need for diabetes medications reached in all participants after follow-up of 6.1 years in low-fat group and 8.1 years in LCM group
Carter et al., 2014 (19)	Meta-analysis of eight trials	FBG: $n = 972$; A1C: $n = 487$	Comparison of Mediterranean diets to usual care, low-fat, or Paleolithic diets (lean meat, fish, fruits, leafy and cruciferous vegetables, root vegetables with restricted potato intake, eggs, and nuts)	None of the interventions were significantly better than the others at lowering A1C or FBG; compared with usual care, Mediterranean diets with education (WMD −0.31%) and Paleolithic diets with education (WMD −0.21%) significantly reduced A1C, whereas low-fat diets did not; Mediterranean diets did not reduce A1C significantly more than Paleolithic diets
Huo et al., 2015 (20)	Meta-analysis of nine trials	1,178	Comparison of Mediterranean-style diet to control diets	Compared with control diets, Mediterranean-style diet led to greater reductions in A1C (MD −0.30%, $P = 0.001$) and FBG (MD −0.72 mmol/L, $P = 0.007$)
Vegetarian eating pattern				
Kahleova et al., 2011 (21)	12-week RCT	74 (68 completers) first 12 weeks of diet only	Comparison of vegetarian diet to conventional diabetes diet; both kcal restricted (500/day)	Vegetarian group: A1C change of −0.68%; control group: −0.59%; no statistically significant differences between groups
Yokoyama et al., 2014 (22)	Meta-analysis of six trials	225	Comparison of vegetarian and vegan diet patterns to conventional diabetes diets with animal protein	Vegetarian diets associated with a significant reduction in A1C (−0.39% $P = 0.001$); nonsignificant reduction in FBG concentration (−0.36 mmol/L, $P = 0.301$)
Viguiliouk et al., 2019 (23)	Meta-analysis of nine trials	664	Comparison of vegetarian and vegan diet patterns to conventional diabetes diets with animal protein	Significant reduction in A1C and FBG observed for vegetarian diet patterns compared with conventional diets (A1C MD −0.29%, $P = 0.0006$; FBG MD −0.56 mmol/L, $P = 0.01$)

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TABLE 2 Studies Conducted Since 2010 Assessing the Glycemic Impact of the Mediterranean, Vegetarian, and DASH Eating Patterns

Study	Design	*n*	Intervention	Blood Glucose Impact
Vegan eating pattern				
Mishra et al., 2013 (24)	18-week RCT	291 (211 completers)	Comparison of low-fat vegan diet to control group (no dietary changes)	A1C reductions of 0.7 and 0.1% in the intervention and control groups, respectively ($P < 0.01$)
Lee et al., 2016 (25)	12-week RCT	93	Comparison of vegan diet (excluding animal-based food including fish) to a conventional 2011 Korean Diabetes Association diet	Both groups showed significant reductions in A1C, and reductions were significantly different between groups: −0.5 vs. −0.2% for vegan and Korean diets, respectively ($P = 0.017$ for interaction)
Barnard et al., 2018 (26)	20-week randomized translational study	45 (40 completers)	Comparison of vegan diet to a portion-controlled eating plan (typically restricted by 500 kcal/day)	A1C improved significantly in both groups (−0.40%); no significant differences between eating plans ($P = 0.68$)
DASH eating pattern				
Azadbakht et al., 2011 (9)	8-week randomized crossover clinical trial	44 (31 completers)	Comparison of DASH eating pattern to control diet (50–60% CHO, 15–20% protein, <30% fat, and <5% of daily kcal from simple sugars)	After following the DASH eating pattern, participants reduced A1C by 1.7% and FBG by 29.4 mg/dL compared with usual care reductions of A1C by 0.5% and FBG by 12.8 mg/dL ($P = 0.04$)
Paula et al., 2015 (27)	4-week RCT	40	Comparison of DASH eating pattern plus physical activity to 2015 ADA guidelines with usual physical activity	A1C change −0.6% for intervention ($P = 0.002$), −0.5% for control ($P = 0.001$); no significant difference between groups ($P = 0.944$); changes in FBG not significant
Chiavaroli et al., 2019 (28)	Meta-analysis of two controlled trials for A1C and 10 controlled trials for FBG	A1C: $n = 65$; FBG: $n = 826$	A1C: Comparison of DASH to usual diet FBG: Comparison of DASH to usual diet and a variety of other interventions (weight loss, behavioral interventions, and other diets)	DASH resulted in A1C reduction of 0.53% ($P < 0.001$); FBG change not significant

CHO, carbohydrate; FBG, fasting blood glucose; kcal, calories; LCM, low-carbohydrate Mediterranean; MD, mean difference; TM, traditional Mediterranean; WMD, weighted mean difference.

- Small, gradual changes are often more realistic than significantly shifting eating habits overnight, but personal preference is imperative. Some examples of gradual changes include:
  - Adding a vegetable or fruit to each meal and snack
  - Eating at least one meatless meal per week
  - Asking to substitute a vegetable or salad for refined carbohydrate (e.g., white bread or fries) when dining out
- Emphasize the quality of foods eaten. A healthy eating pattern focuses on consuming a variety of whole foods and combinations of foods rather than emphasizing a single nutrient or food. An individual can follow a plant-based diet and yet still choose foods that are not healthful (e.g., refined grains or foods with large amounts of added sugars). To address this concern, encourage individuals to:
  - Consume whole, fresh foods (fruits, vegetables, and whole grains) as much as possible.
  - Choose plant-based or healthier sources of protein such as fish or legumes over processed options
  - Have at least one meatless meal per week.
  - Incorporate healthy fats, including vegetable oils, olive oil, fatty fish (i.e., salmon, tuna, trout, mackerel, herring, and sardines), nuts, seeds, and avocado.
  - Limit foods that are sold in packages with labels as much as possible (i.e., processed foods) and avoid products with extensive ingredient lists, preferring foods with only one or two ingredients.
  - Choose fruits in small portions to satisfy a desire for something sweet.
- When starting a new eating pattern, individuals with diabetes may need to check their blood glucose levels more frequently to learn how these changes affect their glycemic control, especially if they are taking insulin or other medications that might need to be adjusted.
- Weight management remains an important component of diabetes care. Factor weight/calorie goals and portion awareness into all eating patterns while maintaining the pleasure of eating.
- When making nutrition and lifestyle recommendations, blood pressure and lipids should be addressed as well as glycemic control.
- Encourage a holistic focus. A healthful lifestyle is defined by more than just food. Discuss other behaviors that are crucial for optimal health, including weight management, physical activity, adequate sleep, being tobacco free, and stress management.
- Adherence matters. Being able to follow a dietary pattern over time predicts long-term success. Nutrition recommendations that reflect individuals' needs, sociocultural factors, and personal preferences can improve adherence and long-term health outcomes.

Conclusion

Overall, the Mediterranean, vegetarian/vegan, and DASH eating patterns share similar characteristics in that they encourage more intake of fruits, vegetables, and whole grains and generally discourage processed foods that are higher in sodium and added sugars. Although more evidence is now available to support the Mediterranean and vegetarian eating patterns with respect to positive effects on glycemia, all three of the eating patterns reviewed may help individuals with type 2 diabetes achieve improved health, including better blood glucose control. Additionally, there appears to be cardiovascular benefit to these three eating patterns. It is important to personalize each approach to promote adherence and long-term adoption. Working closely with a diabetes care team, especially a registered dietitian nutritionist, may help patients with diabetes find a plan that works best.

DUALITY OF INTEREST

No potential conflicts of interest relevant to this article were reported.

AUTHOR CONTRIBUTIONS

G.B. drafted the manuscript and researched data. J.H. researched articles to include and edited the manuscript. G.B. is the guarantor of this work and, as such, had full access to all of the data included and takes responsibility for the integrity of the data and the accuracy of the review.

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