Nutrition Therapy Recommendations for the Management of Adults With Diabetes

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A healthful eating pattern, regular physical activity, and often pharmacotherapy are key components of diabetes management. For many individuals with diabetes, the most challenging part of the treatment plan is determining what to eat. It is the position of the American Diabetes Association (ADA) that there is not a "one-size-fits-all" eating pattern for individuals with diabetes. The ADA also recognizes the integral role of nutrition therapy in overall diabetes management and has historically recommended that each person with diabetes be actively engaged in self-management, education, and treatment planning with his or her health care provider, which includes the collaborative development of an individualized eating plan (1,2). Therefore, it is important that all members of the health care team be knowledgeable about diabetes nutrition therapy and support its implementation.

This position statement on nutrition therapy for individuals living with diabetes replaces previous position statements, the last of which was published in 2008 (3). Unless otherwise noted, research reviewed was limited to those studies conducted in adults diagnosed with type 1 or type 2 diabetes. Nutrition therapy for the prevention of type 2 diabetes and for the management of diabetes complications and gestational diabetes mellitus is not addressed in this review.

A grading system, developed by the ADA and modeled after existing methods, was utilized to clarify and codify the evidence that forms the basis for the recommendations (1) (Table 1). The level of evidence that supports each recommendation is listed after the recommendation using the letters A, B, C, or E. A table linking recommendations to evidence can be reviewed at http://professional.diabetes.org/nutrition. Members of the Nutrition Recommendations Writing Group Committee disclosed all potential financial conflicts of interest with industry. These disclosures were discussed at the onset of the position statement development process. Members of this committee, their employers, and their disclosed conflicts of interest are listed in the ACKNOWLEDGMENTS. The ADA uses general revenues to fund development of its position statements and does not rely on industry support for these purposes.

Goals of nutrition therapy that apply to adults with diabetes

- To promote and support healthful eating patterns, emphasizing a variety of nutrient-dense foods in appropriate portion sizes, in order to improve overall health and specifically to:
  - Attain individualized glycemic, blood pressure, and lipid goals. General recommended goals from the ADA for these markers are as follows:*
    - o A1C <7%.
    - o Blood pressure <140/80 mmHg.
    - o LDL cholesterol <100 mg/dL; triglycerides <150 mg/dL; HDL cholesterol >40 mg/dL for men; HDL cholesterol >50 mg/dL for women.
  - Achieve and maintain body weight goals.
  - Delay or prevent complications of diabetes.
- To address individual nutrition needs based on personal and cultural preferences, health literacy and numeracy, access to healthful food choices, willingness and ability to make behavioral changes, as well as barriers to change.
- To maintain the pleasure of eating by providing positive messages about food choices while limiting food choices only when indicated by scientific evidence.
- To provide the individual with diabetes with practical tools for day-to-day meal planning rather than focusing on individual macronutrients, micronutrients, or single foods.

*A1C, blood pressure, and cholesterol goals may need to be adjusted for the individual based on age, duration of diabetes, health history, and other present health conditions. Further recommendations for individualization of goals can be found in the ADA Standards of Medical Care in Diabetes (1).

Metabolic control can be considered the cornerstone of diabetes management. Achieving A1C goals decreases the risk for microvascular complications (4,5) and may also be important for cardiovascular disease (CVD) risk reduction, particularly in newly diagnosed patients (6–8). In addition, achieving blood pressure and lipid goals can help reduce risk for CVD events (9,10). Carbohydrate intake has a direct

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Table 1—*Nutrition therapy recommendations*

Topic	Recommendation	Evidence rating
Effectiveness of nutrition therapy	Nutrition therapy is recommended for all people with type 1 and type 2 diabetes as an effective component of the overall treatment plan.	A
	Individuals who have diabetes should receive individualized MNT as needed to achieve treatment goals, preferably provided by an RD familiar with the components of diabetes MNT.	A
	o For individuals with type 1 diabetes, participation in an intensive flexible insulin therapy education program using the carbohydrate counting meal planning approach can result in improved glycemic control.	A
	o For individuals using fixed daily insulin doses, consistent carbohydrate intake with respect to time and amount can result in improved glycemic control and reduce risk for hypoglycemia.	B
	o A simple diabetes meal planning approach such as portion control or healthful food choices may be better suited to individuals with type 2 diabetes identified with health and numeracy literacy concerns. This may also be an effective meal planning strategy for older adults.	C
	People with diabetes should receive DSME according to national standards and diabetes self-management support when their diabetes is diagnosed and as needed thereafter.	B
	Because diabetes nutrition therapy can result in cost savings (B) and improved outcomes such as reduction in A1C (A), nutrition therapy should be adequately reimbursed by insurance and other payers. (E)	B, A, E
Energy balance	For overweight or obese adults with type 2 diabetes, reducing energy intake while maintaining a healthful eating pattern is recommended to promote weight loss.	A
	Modest weight loss may provide clinical benefits (improved glycemia, blood pressure, and/or lipids) in some individuals with diabetes, especially those early in the disease process. To achieve modest weight loss, intensive lifestyle interventions (counseling about nutrition therapy, physical activity, and behavior change) with ongoing support are recommended.	A
Optimal mix of macronutrients	Evidence suggests that there is not an ideal percentage of calories from carbohydrate, protein, and fat for all people with diabetes (B); therefore, macronutrient distribution should be based on individualized assessment of current eating patterns, preferences, and metabolic goals. (E)	B, E
Eating patterns	A variety of eating patterns (combinations of different foods or food groups) are acceptable for the management of diabetes. Personal preferences (e.g., tradition, culture, religion, health beliefs and goals, economics) and metabolic goals should be considered when recommending one eating pattern over another.	E
Carbohydrates	Evidence is inconclusive for an ideal amount of carbohydrate intake for people with diabetes. Therefore, collaborative goals should be developed with the individual with diabetes.	C
	The amount of carbohydrates and available insulin may be the most important factor influencing glycemic response after eating and should be considered when developing the eating plan.	A
	Monitoring carbohydrate intake, whether by carbohydrate counting or experience-based estimation remains a key strategy in achieving glycemic control.	B
	For good health, carbohydrate intake from vegetables, fruits, whole grains, legumes, and dairy products should be advised over intake from other carbohydrate sources, especially those that contain added fats, sugars, or sodium.	B
Glycemic index and glycemic load	Substituting low–glycemic load foods for higher–glycemic load foods may modestly improve glycemic control.	C
Dietary fiber and whole grains	People with diabetes should consume at least the amount of fiber and whole grains recommended for the general public.	C
Substitution of sucrose for starch	While substituting sucrose-containing foods for isocaloric amounts of other carbohydrates may have similar blood glucose effects, consumption should be minimized to avoid displacing nutrient-dense food choices.	A
Fructose	Fructose consumed as "free fructose" (i.e., naturally occurring in foods such as fruit) may result in better glycemic control compared with isocaloric intake of sucrose or starch (B), and free fructose is not likely to have detrimental effects on triglycerides as long as intake is not excessive (>12% energy). (C)	B, C
	People with diabetes should limit or avoid intake of SSBs (from any caloric sweetener including high fructose corn syrup and sucrose) to reduce risk for weight gain and worsening of cardiometabolic risk profile.	B

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Table 1—*Continued*

Topic	Recommendation	Evidence rating
NNSs and hypocaloric sweeteners	Use of NNSs has the potential to reduce overall calorie and carbohydrate intake if substituted for caloric sweeteners without compensation by intake of additional calories from other food sources.	B
Protein	For people with diabetes and no evidence of diabetic kidney disease, evidence is inconclusive to recommend an ideal amount of protein intake for optimizing glycemic control or improving one or more CVD risk measures; therefore, goals should be individualized.	C
	For people with diabetes and diabetic kidney disease (either micro- or macroalbuminuria), reducing the amount of dietary protein below usual intake is not recommended because it does not alter glycemic measures, cardiovascular risk measures, or the course of GFR decline.	A
	In individuals with type 2 diabetes, ingested protein appears to increase insulin response without increasing plasma glucose concentrations. Therefore, carbohydrate sources high in protein should not be used to treat or prevent hypoglycemia.	B
Total fat	Evidence is inconclusive for an ideal amount of total fat intake for people with diabetes; therefore, goals should be individualized (C); fat quality appears to be far more important than quantity. (B)	C, B
MUFAs/PUFAs	In people with type 2 diabetes, a Mediterranean-style, MUFA-rich eating pattern may benefit glycemic control and CVD risk factors and can therefore be recommended as an effective alternative to a lower-fat, higher-carbohydrate eating pattern.	B
Omega-3 fatty acids	Evidence does not support recommending omega-3 (EPA and DHA) supplements for people with diabetes for the prevention or treatment of cardiovascular events.	A
	As recommended for the general public, an increase in foods containing long-chain omega-3 fatty acids (EPA and DHA) (from fatty fish) and omega-3 linolenic acid (ALA) is recommended for individuals with diabetes because of their beneficial effects on lipoproteins, prevention of heart disease, and associations with positive health outcomes in observational studies.	B
	The recommendation for the general public to eat fish (particularly fatty fish) at least two times (two servings) per week is also appropriate for people with diabetes.	B
Saturated fat, dietary cholesterol, and *trans* fat	The amount of dietary saturated fat, cholesterol, and *trans* fat recommended for people with diabetes is the same as that recommended for the general population.	C
Plant stanols and sterols	Individuals with diabetes and dyslipidemia may be able to modestly reduce total and LDL cholesterol by consuming 1.6–3 g/day of plant stanols or sterols typically found in enriched foods.	C
Micronutrients and herbal supplements	There is no clear evidence of benefit from vitamin or mineral supplementation in people with diabetes who do not have underlying deficiencies.	C
	o Routine supplementation with antioxidants, such as vitamins E and C and carotene, is not advised because of lack of evidence of efficacy and concern related to long-term safety.	A
	o There is insufficient evidence to support the routine use of micronutrients such as chromium, magnesium, and vitamin D to improve glycemic control in people with diabetes.	C
	o There is insufficient evidence to support the use of cinnamon or other herbs/ supplements for the treatment of diabetes.	C
	It is recommended that individualized meal planning include optimization of food choices to meet recommended dietary allowance/dietary reference intake for all micronutrients.	E
Alcohol	If adults with diabetes choose to drink alcohol, they should be advised to do so in moderation (one drink per day or less for adult women and two drinks per day or less for adult men).	E
	Alcohol consumption may place people with diabetes at increased risk for delayed hypoglycemia, especially if taking insulin or insulin secretagogues. Education and awareness regarding the recognition and management of delayed hypoglycemia is warranted.	C
Sodium	The recommendation for the general population to reduce sodium to less than 2,300 mg/day is also appropriate for people with diabetes.	B
	For individuals with both diabetes and hypertension, further reduction in sodium intake should be individualized.	B

effect on postprandial glucose levels in people with diabetes and is the primary macronutrient of concern in glycemic management (11). In addition, an individual's food choices have a direct effect on energy balance and, therefore, on body weight, and food choices can also impact blood pressure and lipid levels. Through the collaborative development of individualized nutrition interventions and ongoing support of behavior changes, health care professionals can facilitate the achievement of their patients'/clients' health goals (11–13).

Diabetes nutrition therapy

Diabetes nutrition therapy—Ideally, the individual with diabetes should be referred to a registered dietitian (RD) (or a similarly credentialed nutrition professional if outside of the U.S.) for nutrition therapy at—or soon after—diagnosis (11,14) and for ongoing follow-up. Another option for many people is referral to a comprehensive diabetes self-management education (DSME) program that includes instruction on nutrition therapy. Unfortunately, a large percentage of people with diabetes do not receive any structured diabetes education and/or nutrition therapy (15,16). National data indicate that about half of the people with diabetes report receiving some type of diabetes education (17) and even fewer see an RD. In one study of 18,404 patients with diabetes, only 9.1% had at least one nutrition visit within a 9-year period (18). Many people with diabetes, as well as their health care provider(s), are not aware that these services are available to them. Therefore this position statement offers evidence-based nutrition recommendations for all health care professionals to use.

In 1999, the Institute of Medicine (IOM) released a report concluding that evidence demonstrates that medical nutrition therapy (MNT) can improve clinical outcomes while possibly decreasing the cost to Medicare of managing diabetes (19). The IOM recommended that individualized MNT, provided by an RD upon physician referral, be a covered Medicare benefit as part of the multidisciplinary approach to diabetes care (19). MNT is an evidence-based application of the Nutrition Care Process provided by the RD and is the legal definition of nutrition counseling by an RD in the U.S. (20). The IOM also defines nutrition therapy, which has a broader definition than MNT (19). Nutrition therapy is the treatment of a disease or condition through the modification of nutrient or whole-food intake. The definition does not specify that nutrition therapy must be provided by an RD (19). However, both MNT and nutrition therapy should involve a nutrition assessment, nutrition diagnosis, nutrition interventions (e.g., education and counseling), and nutrition monitoring and evaluation with ongoing follow-up to support long-term lifestyle changes, evaluate outcomes, and modify interventions as needed (20).

Nutrition therapy studies included in this position statement use a wide assortment of nutrition professionals as well as registered and advanced practice nurses or physicians. Health care professionals administering nutrition interventions in studies conducted outside the U.S. did not provide MNT as it is legally defined. As a result, the decision was made to use the term "nutrition therapy" rather than "MNT" in this article, in an effort to be more inclusive of the range of health professionals providing nutrition interventions and to recognize the broad definition of nutrition therapy. However, the unique academic preparation, training, skills, and expertise of the RD make him/her the preferred member of the health care team to provide diabetes MNT (Table 2).

Table 2—*Academy of Nutrition and Dietetics Evidence-Based Nutrition Practice Guidelines*

Academy of Nutrition and Dietetics Evidence-Based Nutrition Practice Guidelines recommend the following structure for the implementation of MNT for adults with diabetes (11)
• A series of 3–4 encounters with an RD lasting from 45–90 min.
• The series of encounters should begin at diagnosis of diabetes or at first referral to an RD for MNT for diabetes and should be completed within 3–6 months.
• The RD should determine whether additional MNT encounters are needed.
• At least 1 follow-up encounter is recommended annually to reinforce lifestyle changes and to evaluate and monitor outcomes that indicate the need for changes in MNT or medication(s); an RD should determine whether additional MNT encounters are needed.

Diabetes self-management education/support

Diabetes self-management education/support—In addition to diabetes MNT provided by an RD, DSME and diabetes self-management support (DSMS) are critical elements of care for all people with diabetes and are necessary to improve outcomes in a disease that is largely self-managed (21–26). The National Standards for Diabetes Self-Management Education and Support recognize the importance of nutrition as one of the core curriculum topics taught in comprehensive programs. The American Association of Diabetes Educators also recognizes the importance of healthful eating as a core self-care behavior (27). For more information, refer to the ADA's National Standards for Diabetes Self-Management Education and Support (21).

Effectiveness of nutrition therapy

- Nutrition therapy is recommended for all people with type 1 and type 2 diabetes as an effective component of the overall treatment plan. (A)
- Individuals who have diabetes should receive individualized MNT as needed to achieve treatment goals, preferably provided by an RD familiar with the components of diabetes MNT. (A)
    - For individuals with type 1 diabetes, participation in an intensive flexible insulin therapy education program using the carbohydrate counting meal planning approach can result in improved glycemic control. (A)
    - For individuals using fixed daily insulin doses, consistent carbohydrate intake with respect to time and amount can result in improved glycemic control and reduce the risk for hypoglycemia. (B)
    - A simple diabetes meal planning approach such as portion control or healthful food choices may be better suited to individuals with type 2 diabetes identified with health and numeracy literacy concerns. This may also be an effective meal planning strategy for older adults. (C)
- People with diabetes should receive DSME according to national standards and DSMS when their diabetes is diagnosed and as needed thereafter. (B)
- Because diabetes nutrition therapy can result in cost savings (B) and improved outcomes such as reduction in A1C (A), nutrition therapy should be adequately reimbursed by insurance and other payers. (E)

The common coexistence of hyperlipidemia and hypertension in people with diabetes requires monitoring of metabolic

parameters (e.g., glucose, lipids, blood pressure, body weight, renal function) to ensure successful health outcomes (28). Nutrition therapy that includes the development of an eating pattern designed to lower glucose, blood pressure, and alter lipid profiles is important in the management of diabetes as well as lowering the risk of CVD, coronary heart disease, and stroke. Successful approaches should also include regular physical activity and behavioral interventions to help sustain improved lifestyles (11).

Findings from randomized controlled trials (RCTs) and from systematic and Cochrane reviews demonstrate the effectiveness of nutrition therapy for improving glycemic control and various markers of cardiovascular and hypertension risk (13,14,29–46). In the general population, MNT provided by an RD to individuals with an abnormal lipid profile has been shown to reduce daily fat (5–8%), saturated fat (2–4%), and energy intake (232–710 kcal/day), and lower triglycerides (11–31%), LDL cholesterol (7–22%), and total cholesterol (7–21%) levels (47).

Effective nutrition therapy interventions may be a component of a comprehensive group diabetes education program or an individualized session (14,29–38,40–42,44,45). Reported A1C reductions are similar or greater than what would be expected with treatment with currently available pharmacologic treatments for diabetes. The documented decreases in A1C observed in these studies are type 1 diabetes: −0.3 to −1% (13,39,43,48) and type 2 diabetes: −0.5 to −2% (5,14,29–38,40–42,44,45,49).

Due to the progressive nature of type 2 diabetes, nutrition and physical activity interventions alone (i.e., without pharmacotherapy) are generally not adequately effective in maintaining persistent glycemic control over time for many individuals. However, after pharmacotherapy is initiated, nutrition therapy continues to be an important component of the overall treatment plan (2). For individuals with type 1 diabetes using multiple daily injections or continuous subcutaneous insulin infusion, a primary focus for nutrition therapy should be on how to adjust insulin doses based on planned carbohydrate intake (13,39,43,50–53). For individuals using fixed daily insulin doses, carbohydrate intake on a day-to-day basis should be consistent with respect to time and amount (54,55). Intensive insulin management education programs that include nutrition therapy have been shown to reduce A1C (13). Retrospective studies reveal durable A1C reductions with these types of programs (51,56) and significant improvements in quality of life (57) over time. Finally, nutritional approaches for reducing CVD risk, including optimizing serum lipids and blood pressure, can effectively reduce CVD events and mortality (1).

Energy balance

- For overweight or obese adults with type 2 diabetes, reducing energy intake while maintaining a healthful eating pattern is recommended to promote weight loss. (A)
- Modest weight loss may provide clinical benefits (improved glycemia, blood pressure, and/or lipids) in some individuals with diabetes, especially those early in the disease process. To achieve modest weight loss, intensive lifestyle interventions (counseling about nutrition therapy, physical activity, and behavior change) with ongoing support are recommended. (A)

More than three out of every four adults with diabetes are at least overweight (17), and nearly half of individuals with diabetes are obese (58). Because of the relationship between body weight (i.e., adiposity) and insulin resistance, weight loss has long been a recommended strategy for overweight or obese adults with diabetes (1). Prevention of weight gain is equally important. Long-term reduction of adiposity is difficult for most people to achieve, and even harder for individuals with diabetes to achieve given the impact of some medications used to improve glycemic control (e.g., insulin, insulin secretagogues, and thiazolidinediones) (59,60). A number of factors may be responsible for increasing adiposity in people with diabetes, including a reduction in glycosuria and thus retention of calories otherwise lost as an effect of therapeutic intervention, changes in food intake, or changes in energy expenditure (61–64). If adiposity is a concern, medications that are weight neutral or weight reducing (e.g., metformin, incretin-based therapies, sodium glucose co-transporter 2 [SGLT-2] inhibitors) could be considered. Several intensive DSME and nutrition intervention studies show that glycemic control can be achieved while maintaining weight or even reducing weight when appropriate lifestyle counseling is provided (14,31,35,41,42,44,45,50,65,66).

In interventional studies lasting 12 months or longer and targeting individuals with type 2 diabetes to reduce excess body weight (35,67–75), modest weight losses were achieved ranging from 1.9 to 8.4 kg. In the Look AHEAD trial, at study end (~10 years), the mean weight loss from baseline was 6% in the intervention group and 3.5% in the control group (76,77). Studies designed to reduce excess body weight have used a variety of energy-restricted eating patterns with various macronutrient intakes and occasionally included a physical activity component and ongoing follow-up support. Studies achieving the greatest weight losses, 6.2 kg and 8.4 kg, respectively, included the Mediterranean-style eating pattern (72) and a study testing a comprehensive weight loss program that involved diet (including meal replacements) and physical activity (76). In the studies reviewed, improvements in A1C were noted to persist at 12 months in eight intervention groups within five studies (67,69,72,73,76); however, in one of the studies including data at 18 months, the A1C improvement was not maintained (69). The Mediterranean-style eating pattern reported the largest improvement of A1C at 1 year (−1.2%) (72), and the Look AHEAD study intensive lifestyle intervention reported the next largest improvement (−0.64%) (76). One of these studies included only individuals with newly diagnosed diabetes (72), and the other included predominantly individuals with diabetes early in the disease process (<30% were on insulin) (76). Significant improvements in A1C at 1 year were also reported in other studies using energy-restricted eating plans; these studies used meal replacements (67), or low-fat (72)/high-protein (73), or high-carbohydrate eating patterns (73). Not all weight loss interventions reviewed led to improvements in A1C at 1 year (35,68,70,71,74,75), although these studies tended to achieve less weight loss.

Among the studies reviewed, the most consistently reported significant changes of reducing excess body weight on cardiovascular risk factors were an increase in HDL cholesterol (67,72,73,75–77), a decrease in triglycerides (72,73,76–78), and a decrease in blood pressure (67,70,72,75–77). Despite some improvements in cardiovascular risk factors, the Look AHEAD trial failed to demonstrate reduction in CVD events among individuals randomized to an intensive lifestyle intervention for sustained weight loss (77). Of note, however, those randomized to the intervention experienced

statistically significant weight loss, requiring less medication for glycemic control and management of CVD risk factors, and experienced several additional health benefits (e.g., reduced sleep apnea, depression, and urinary incontinence and improved health-related quality of life) (79–82).

Intensive lifestyle programs (ongoing, with frequent follow-up) are required to achieve significant reductions in excess body weight and improvements in A1C, blood pressure, and lipids (76,83). Weight loss appears to be most beneficial for individuals with diabetes early in the disease process (72,76,83). In the Look AHEAD study, participants with early-stage diabetes (shortest duration, not treated with insulin, good baseline glycemic control) received the most health benefits with a small percentage of individuals achieving partial or complete diabetes remission (84). It is unclear if the benefits result from the reduction in excess weight or the energy restriction or both. Long-term maintenance of weight, following weight reduction, is possible, but research suggests it requires an intensive program with long-term support. Many individuals do regain a portion of their initial weight loss (77,85). Factors contributing to the individual's inability to retain maximal weight loss include socioeconomic status, an unsupportive environment, and physiological changes (e.g., compensatory changes in circulating hormones that encourage weight regain after weight loss is achieved) (86).

The optimal macronutrient intake to support reduction in excess body weight has not been established. Thus, the current state of the literature does not support one particular nutrition therapy approach to reduce excess weight, but rather a spectrum of eating patterns that result in reduced energy intake. A weight loss of >6 kg (approximately a 7–8.5% loss of initial body weight), regular physical activity, and frequent contact with RDs appear important for consistent beneficial effects of weight loss interventions (85). In the Look AHEAD study, weight loss strategies associated with lower BMI in overweight or obese individuals with type 2 diabetes included weekly self-weighing, regular consumption of breakfast, and reduced intake of fast foods (87). Other successful strategies included increasing physical activity, reducing portion sizes, using meal replacements (as appropriate), and encouraging individuals with diabetes to eat those foods with the greatest consensus for improving health.

Health professionals should collaborate with individuals with diabetes to integrate lifestyle strategies that prevent weight gain or promote modest, realistic weight loss. The emphases of education and counseling should be on the development of behaviors that support long-term weight loss or weight maintenance with less focus on the outcome of weight loss. Bariatric surgery is recognized as an option for individuals with diabetes who meet the criteria for surgery and is not covered in this review. For recommendations on bariatric surgery, see the ADA Standards of Medical Care (1).

Optimal mix of macronutrients

- Evidence suggests that there is not an ideal percentage of calories from carbohydrate, protein, and fat for all people with diabetes (B); therefore, macronutrient distribution should be based on individualized assessment of current eating patterns, preferences, and metabolic goals. (E)

Although numerous studies have attempted to identify the optimal mix of macronutrients for the meal plans of people with diabetes, a systematic review (88) found that there is no ideal mix that applies broadly and that macronutrient proportions should be individualized. On average, it has been observed that people with diabetes eat about 45% of their calories from carbohydrate, ~36–40% of calories from fat, and the remainder (~16–18%) from protein (89–91). Regardless of the macronutrient mix, total energy intake should be appropriate to weight management goals. Further, individualization of the macronutrient composition will depend on the metabolic status of the individual (e.g., lipid profile, renal function) and/or food preferences. A variety of eating patterns have been shown modestly effective in managing diabetes including Mediterranean-style, Dietary Approaches to Stop Hypertension (DASH) style, plant-based (vegan or vegetarian), lower-fat, and lower-carbohydrate patterns (36,46,72,92,93).

Eating patterns

- A variety of eating patterns (combinations of different foods or food groups) are acceptable for the management of diabetes. Personal preferences (e.g., tradition, culture, religion, health beliefs and goals, economics) and metabolic goals should be considered when recommending one eating pattern over another. (E)

Eating patterns, also called dietary patterns, is a term used to describe combinations of different foods or food groups that characterize relationships between nutrition and health promotion and disease prevention (94). Individuals eat combinations of foods, not single nutrients, and thus it is important to study diet and disease relationships (95). Factors impacting eating patterns include, but are not limited to, food access/availability of healthful foods, tradition, cultural food systems, health beliefs, knowledge of foods that promote health and prevent disease, and economics/resources to buy health-promoting foods (95).

Eating patterns have also evolved over time to include patterns of food intake among specific populations to eating patterns prescribed to improve health. Patterns naturally occurring within populations based on food availability, culture, or tradition and those prescribed to prevent or manage health conditions are important to research. Eating patterns studied among individuals with type 1 or type 2 diabetes were reviewed to evaluate their impact on diabetes nutrition goals. The following eating patterns (Table 3) were reviewed: Mediterranean, vegetarian, low fat, low carbohydrate, and DASH.

The Mediterranean-style eating pattern, mostly studied in the Mediterranean region, has been observed to improve cardiovascular risk factors (i.e., lipids, blood pressure, triglycerides) (11,72,88,100) in individuals with diabetes and lower combined end points for CVD events and stroke (83) when supplemented with mixed nuts (including walnuts, almonds, and hazelnuts) or olive oil. Individuals following an energy-restricted Mediterranean-style eating pattern also achieve improvements in glycemic control (88). Given that the studies are mostly in the Mediterranean region, further research is needed to determine if the study results can be generalized to other populations and if similar levels of adherence to the eating pattern can be achieved.

Six vegetarian and low-fat vegan studies (36,93,101–103,131) in individuals with type 2 diabetes were reviewed. Studies ranged in duration from 12 to 74 weeks, and the diets did not consistently improve glycemic control or CVD risk factors except when energy intake was restricted and weight was lost. Diets often did result in weight loss (36,101–103,131). More research on vegan and vegetarian diets is needed to assess diet

Table 3—*Reviewed eating patterns*

Type of eating pattern	Description
Mediterranean style (96)	Includes abundant plant food (fruits, vegetables, breads, other forms of cereals, beans, nuts and seeds); minimally processed, seasonally fresh, and locally grown foods; fresh fruits as the typical daily dessert and concentrated sugars or honey consumed only for special occasions; olive oil as the principal source of dietary lipids; dairy products (mainly cheese and yogurt) consumed in low to moderate amounts; fewer than 4 eggs/week; red meat consumed in low frequency and amounts; and wine consumption in low to moderate amounts generally with meals.
Vegetarian and vegan (97)	The two most common ways of defining vegetarian diets in the research are vegan diets (diets devoid of all flesh foods and animal-derived products) and vegetarian diets (diets devoid of all flesh foods but including egg [ovo] and/or dairy [lacto] products). Features of a vegetarian-eating pattern that may reduce risk of chronic disease include lower intakes of saturated fat and cholesterol and higher intakes of fruits, vegetables, whole grains, nuts, soy products, fiber, and phytochemicals.
Low fat (98)	Emphasizes vegetables, fruits, starches (e.g., breads/crackers, pasta, whole grains, starchy vegetables), lean protein, and low-fat dairy products. Defined as total fat intake <30% of total energy intake and saturated fat intake <10%.
Low carbohydrate (88)	Focuses on eating foods higher in protein (meat, poultry, fish, shellfish, eggs, cheese, nuts and seeds), fats (oils, butter, olives, avocado), and vegetables low in carbohydrate (salad greens, cucumbers, broccoli, summer squash). The amount of carbohydrate allowed varies with most plans allowing fruit (e.g., berries) and higher carbohydrate vegetables; however, sugar-containing foods and grain products such as pasta, rice, and bread are generally avoided. There is no consistent definition of "low" carbohydrate. In research studies, definitions have ranged from very low-carbohydrate diet (21–70 g/day of carbohydrates) to moderately low-carbohydrate diet (30 to <40% of calories from carbohydrates).
DASH (99)	Emphasizes fruits, vegetables, and low-fat dairy products, including whole grains, poultry, fish, and nuts and is reduced in saturated fat, red meat, sweets, and sugar-containing beverages. The most effective DASH diet was also reduced in sodium.

quality given studies often focus more on what is not consumed than what is consumed.

The low-fat eating pattern is one that has often been encouraged as a strategy to lose weight or to improve cardiovascular health within the U.S. In the Look AHEAD trial (77), an energy-reduced low-fat eating pattern was encouraged for weight loss, and individuals achieved moderate success (76). However, in a systematic review (88) and in four studies (70,71,75,103a) and in a meta-analysis (103b) published since the systematic review, lowering total fat intake did not consistently improve glycemic control or CVD risk factors. Benefit from a low-fat eating pattern appears to be more likely when energy intake is also reduced and weight loss occurs (76,77).

For a review of the studies focused on a low-carbohydrate eating pattern, see the CARBOHYDRATES section. Currently there is inadequate evidence in isocaloric comparison recommending a specific amount of carbohydrates for people with diabetes.

In people without diabetes, the DASH eating plan has been shown to help control blood pressure and lower risk for CVD and is frequently recommended as a healthful eating pattern for the general population (104–106). Limited evidence exists on the effects of the DASH eating plan on health outcomes specifically in individuals with diabetes; however, one would expect similar results to other studies using the DASH eating plan. In one small study in people with type 2 diabetes, the DASH eating plan, which included a sodium restriction of 2,300 mg/day, improved A1C, blood pressure, and other cardiovascular risk factors (46). The blood pressure benefits are thought to be due to the total eating pattern, including the reduction in sodium and other foods and nutrients that have been shown to influence blood pressure (99,105).

The evidence suggests that several different macronutrient distributions/eating patterns may lead to improvements in glycemic and/or CVD risk factors (88). There is no "ideal" conclusive eating pattern that is expected to benefit all individuals with diabetes (88). Total energy intake (and thus portion sizes) is an important consideration no matter which eating pattern the individual with diabetes chooses to eat. Because dietary patterns are influenced by food availability, perception of healthfulness of certain foods and by the individual's preferences, culture, religion, knowledge, health beliefs, and access to food and resources (e.g., budget/income) (95), these factors should be considered when individualizing eating pattern recommendations.

Individual macronutrients

Carbohydrates

- Evidence is inconclusive for an ideal amount of carbohydrate intake for people with diabetes. Therefore, collaborative goals should be developed with the individual with diabetes. (C)
- The amount of carbohydrates and available insulin may be the most important factor influencing glycemic response after eating and should be considered when developing the eating plan. (A)
- Monitoring carbohydrate intake, whether by carbohydrate counting or experience-based estimation, remains a key strategy in achieving glycemic control. (B)
- For good health, carbohydrate intake from vegetables, fruits, whole grains, legumes, and dairy products should be advised over intake from other carbohydrate sources, especially those that contain added fats, sugars, or sodium. (B)

Evidence is insufficient to support one specific amount of carbohydrate intake for all people with diabetes. Collaborative

goals should be developed with each person with diabetes. Some published studies comparing lower levels of carbohydrate intake (ranging from 21 g daily up to 40% of daily energy intake) to higher carbohydrate intake levels indicated improved markers of glycemic control and insulin sensitivity with lower carbohydrate intakes (92,100,107–111). Four RCTs indicated no significant difference in glycemic markers with a lower-carbohydrate diet compared with higher carbohydrate intake levels (71,112–114). Many of these studies were small, were of short duration, and/or had low retention rates (92,107, 109,110,112,113).

Some studies comparing lower levels of carbohydrate intake to higher carbohydrate intake levels revealed improvements in serum lipid/lipoprotein measures, including improved triglycerides, VLDL triglyceride, and VLDL cholesterol, total cholesterol, and HDL cholesterol levels (71,92,100,107,109,111,112,115). A few studies found no significant difference in lipids and lipoproteins with a lower-carbohydrate diet compared with higher carbohydrate intake levels. It should be noted that these studies had low retention rates, which may lead to loss of statistical power and biased results (110,113,116). In many of the reviewed studies, weight loss occurred, confounding the interpretation of results from manipulation of macronutrient content.

Despite the inconclusive results of the studies evaluating the effect of differing percentages of carbohydrates in people with diabetes, monitoring carbohydrate amounts is a useful strategy for improving postprandial glucose control. Evidence exists that both the quantity and type of carbohydrate in a food influence blood glucose level, and total amount of carbohydrate eaten is the primary predictor of glycemic response (55,114,117–122). In addition, lower A1C occurred in the Diabetes Control and Complications Trial (DCCT) intensive-treatment group and the Dose Adjustment For Normal Eating (DAFNE) trial participants who received nutrition therapy that focused on the adjustment of insulin doses based on variations in carbohydrate intake and physical activity (13,123).

As for the general U.S. population, carbohydrate intake from vegetables, fruits, whole grains, legumes, and milk should be encouraged over other sources of carbohydrates, or sources with added fats, sugars, or sodium, in order to improve overall nutrient intake (105).

Quality of carbohydrates

Glycemic index and glycemic load

- Substituting low–glycemic load foods for higher–glycemic load foods may modestly improve glycemic control. (C)

The ADA recognizes that education about glycemic index and glycemic load occurs during the development of individualized eating plans for people with diabetes. Some organizations specifically recommend use of low–glycemic index diets (124,125). However the literature regarding glycemic index and glycemic load in individuals with diabetes is complex, and it is often difficult to discern the independent effect of fiber compared with that of glycemic index on glycemic control or other outcomes. Further, studies used varying definitions of low and high glycemic index (11,88,126), and glycemic response to a particular food varies among individuals and can also be affected by the overall mixture of foods consumed (11,126).

Some studies did not show improvement with a lower–glycemic index eating pattern; however, several other studies using low–glycemic index eating patterns have demonstrated A1C decreases of −0.2 to −0.5%. However, fiber intake was not consistently controlled, thereby making interpretation of the findings difficult (88,118,119,127). Results on CVD risk measures are mixed with some showing the lowering of total or LDL cholesterol and others showing no significant changes (120).

Dietary fiber and whole grains

- People with diabetes should consume at least the amount of fiber and whole grains recommended for the general public. (C)

Intake of dietary fiber is associated with lower all-cause mortality (128,129) in people with diabetes. Two systematic reviews found little evidence that fiber significantly improves glycemic control (11,88). Studies published since these reviews have shown modest lowering of preprandial glucose (130) and A1C (−0.2 to −0.3%) (119,130) with intakes of >50 g of fiber/day. Most studies on fiber in people with diabetes are of short duration, have a small sample size, and evaluate the combination of high-fiber and low–glycemic index foods, and in some cases weight loss, making it difficult to isolate fiber as the sole determinant of glycemic improvement (119,131–133). Fiber intakes to improve glycemic control, based on existing research, are also unrealistic, requiring fiber intakes of >50 g/day.

Studies examining fiber's effect on CVD risk factors are mixed; however, total fiber intake, especially from natural food sources (vs. supplements), seems to have a beneficial effect on serum cholesterol levels and other CVD risk factors such as blood pressure (11,88,134). Because of the general health benefits of fiber, recommendations for the general public to increase intake to 14 g fiber/1,000 kcals daily or about 25 g/day for adult women and 38 g/day for adult men are encouraged for individuals with diabetes (105).

Research has also compared the benefits of whole grains to fiber. The *Dietary Guidelines for Americans, 2010* defines whole grains as foods containing the entire grain seed (kernel), bran, germ, and endosperm (105). A systematic review (88) concluded that the consumption of whole grains was not associated with improvements in glycemic control in individuals with type 2 diabetes; however, it may have other benefits, such as reductions in systemic inflammation. Data from the Nurses' Health Study examining whole grains and their components (cereal fiber, bran, and germ) in relation to all-cause and CVD-specific mortality among women with type 2 diabetes suggest a potential benefit of whole-grain intake in reducing mortality and CVD (128). As with the general population, individuals with diabetes should consume at least half of all grains as whole grains (105).

Resistant starch and fructans—Resistant starch is defined as starch physically enclosed within intact cell structures as in some legumes, starch granules as in raw potato, and retrograde amylose from plants modified by plant breeding to increase amylose content. It has been proposed that foods containing resistant starch or high amylose foods such as specially formulated cornstarch may modify postprandial glycemic response, prevent hypoglycemia, and reduce hyperglycemia. However, there are no published long-term studies in subjects with diabetes to prove benefit from the use of resistant starch.

Fructans are an indigestible type of fiber that has been hypothesized to have a glucose-lowering effect. Inulin is a fructan commonly added to many processed food

products in the form of chicory root. Limited research in people with diabetes is available. One systematic review that included three short-term studies in people with diabetes showed mixed results of fructan intake on glycemia. There are no published long-term studies in subjects with diabetes to prove benefit from the use of fructans (135).

Substitution of sucrose for starch

- While substituting sucrose-containing foods for isocaloric amounts of other carbohydrates may have similar blood glucose effects, consumption should be minimized to avoid displacing nutrient-dense food choices. (A)

Sucrose is a disaccharide made of glucose and fructose. Commonly known as table sugar or white sugar, it is found naturally in sugar cane and in sugar beets. Research demonstrates that substitution of sucrose for starch for up to 35% of calories may not affect glycemia or lipid levels (11). However, because foods high in sucrose are generally high in calories, substitution should be made in the context of an overall healthful eating pattern with caution not to increase caloric intake. Additionally, as with all people, selection of foods containing sucrose or starch should emphasize more nutrient-dense foods for an overall healthful eating pattern (105).

Fructose

- Fructose consumed as "free fructose" (i.e., naturally occurring in foods such as fruit) may result in better glycemic control compared with isocaloric intake of sucrose or starch (B), and free fructose is not likely to have detrimental effects on triglycerides as long as intake is not excessive (>12% energy). (C)
- People with diabetes should limit or avoid intake of sugar-sweetened beverages (SSBs) (from any caloric sweetener including high-fructose corn syrup and sucrose) to reduce risk for weight gain and worsening of cardiometabolic risk profile. (B)

Fructose is a monosaccharide found naturally in fruits. It is also a component of added sugars found in sweetened beverages and processed snacks. The term "free fructose" refers to fructose that is naturally occurring in foods such as fruit and does not include the fructose that is found in the form of the disaccharide sucrose, nor does it include the fructose in high-fructose corn syrup.

Based on two systematic reviews and meta-analyses of studies conducted in persons with diabetes, it appears that free fructose (naturally occurring from foods such as fruit) consumption is not more deleterious than other forms of sugar unless intake exceeds approximately 12% of total caloric intake (136,137). Many foods marketed to people with diabetes may contain large amounts of fructose (such as agave nectar); these foods should not be consumed in large amounts to avoid excess caloric intake and to avoid excessive fructose intake.

In terms of glycemic control, Cozma et al. (138) conducted a systemic review and meta-analysis of controlled feeding trials to study the impact of fructose on glycemic control compared with other sources of carbohydrates. Based on 18 trials, the authors found that isocaloric exchange of fructose for carbohydrates reduced glycated blood proteins and did not significantly affect fasting glucose or insulin. However, it was noted that applicability may be limited because most of the trials were less than 12 weeks in duration. With regard to the treatment of hypoglycemia, in a small study comparing glucose, sucrose, or fructose, Husband et al. (139) found that fructose was the least effective in eliciting the desired upward correction of the blood glucose. Therefore, sucrose or glucose in the form of tablets, liquid, or gel may be the preferred treatment over fruit juice, although availability and convenience should be considered.

There is now abundant evidence from studies of individuals without diabetes that because of their high amounts of rapidly absorbable carbohydrates (such as sucrose or high-fructose corn syrup), large quantities of SSBs should be avoided to reduce the risk for weight gain and worsening of cardiometabolic risk factors (140–142). Evidence suggests that consuming high levels of fructose-containing beverages may have particularly adverse effects on selective deposition of ectopic and visceral fat, lipid metabolism, blood pressure, insulin sensitivity, and de novo lipogenesis, compared with glucose-sweetened beverages (142). In terms of specific effects of fructose, concern has been raised regarding elevations in serum triglycerides (143,144). Such studies are not available among individuals with diabetes; however, there is little reason to suspect that the diabetic state would mitigate the adverse effects of SSBs.

Nonnutritive sweeteners and hypocaloric sweeteners

- Use of nonnutritive sweeteners (NNSs) has the potential to reduce overall calorie and carbohydrate intake if substituted for caloric sweeteners without compensation by intake of additional calories from other food sources. (B)

The U.S. Food and Drug Administration has reviewed several types of hypocaloric sweeteners (e.g., NNSs and sugar alcohols) for safety and approved them for consumption by the general public, including people with diabetes (145). Research supports that NNSs do not produce a glycemic effect; however, foods containing NNSs may affect glycemia based on other ingredients in the product (11). An American Heart Association and ADA scientific statement on NNS consumption concludes that there is not enough evidence to determine whether NNS use actually leads to reduction in body weight or reduction in cardiometabolic risk factors (146). These conclusions are consistent with a systematic review of hypocaloric sweeteners (including sugar alcohols) that found little evidence that the use of NNSs lead to reductions in body weight (147). If NNSs are used to replace caloric sweeteners, without caloric compensation, then NNSs may be useful in reducing caloric and carbohydrate intake (146), although further research is needed to confirm these results (147).

Protein

- For people with diabetes and no evidence of diabetic kidney disease, evidence is inconclusive to recommend an ideal amount of protein intake for optimizing glycemic control or improving one or more CVD risk measures; therefore, goals should be individualized. (C)
- For people with diabetes and diabetic kidney disease (either micro- or macroalbuminuria), reducing the amount of dietary protein below the usual intake is not recommended because it does not alter glycemic measures, cardiovascular risk measures, or the course of glomerular filtration rate (GFR) decline. (A)
- In individuals with type 2 diabetes, ingested protein appears to increase insulin response without increasing plasma glucose concentrations. Therefore, carbohydrate sources high in protein should not be used to treat or prevent hypoglycemia. (B)

Several RCTs have examined the effect of higher protein intake (28–40% of total energy) to usual protein intake (15–19% total) on diabetes outcomes. One study demonstrated decreased A1C with a higher-protein diet (148). However, other studies showed no effect on glycemic control (149–151). Some trials comparing higher protein intakes to usual protein intake have shown improved levels of serum triglycerides, total cholesterol, and/or LDL cholesterol (148,150). However, two trials reported no improvement in CVD risk factors (149,151). Factors affecting interpretation of this research include small sample sizes (148,151) and study durations of less than 6 months (148–150).

Several RCTs comparing protein levels in individuals with diabetic kidney disease with either micro- or macroalbuminuria had adequately large sample sizes and durations for interpretation. Four studies reported no difference in GFR and/or albumin excretion rate (152–155), while one smaller study found some potentially beneficial renal effects with a low-protein diet (156). Two meta-analyses found no clear benefits on renal parameters from low-protein diets (157,158). One factor affecting interpretation of these studies was that actual protein intake differed from goal protein intake. Two studies reported higher actual protein intake in the lower protein group than in the control groups. None of the five reviewed studies since 2000 demonstrated malnourishment as evidenced by hypoalbuminemia with low-protein diets, but both meta-analyses found evidence for this in earlier studies.

There is very limited research in people with diabetes and without kidney disease on the impact of the type of protein consumed. One study did not find a significant difference in glycemic or lipid measures when comparing a chicken- or red meat–based diet (156). For individuals with diabetic kidney disease and macroalbuminuria, changing the source of protein to be more soy-based may improve CVD risk factors but does not appear to alter proteinuria (159,160).

For individuals with type 2 diabetes, protein does not appear to have a significant effect on blood glucose level (161,162) but does appear to increase insulin response (161,163,164). For this reason, it is not advised to use protein to treat hypoglycemia or to prevent hypoglycemia. Protein's effect on blood glucose levels in type 1 diabetes is less clear (165,166).

Total fat

- Evidence is inconclusive for an ideal amount of total fat intake for people with diabetes; therefore goals should be individualized (C); fat quality appears to be far more important than quantity. (B)

Currently, insufficient data exist to determine a defined level of total energy intake from fat at which risk of inadequacy or prevention of chronic disease occurs, so there is no adequate intake or recommended daily allowance for total fat (167). However, the IOM did define an acceptable macronutrient distribution range (AMDR) for total fat of 20–35% of energy with no tolerable upper intake level defined. This AMDR for total fat was "estimated based on evidence indicating a risk for CHD [coronary heart disease] at low intake of fat and high intakes of carbohydrate and on evidence for increased obesity and its complications (CHD) at high intakes of fat" (167). These recommendations are not diabetes-specific; however, limited research exists in individuals with diabetes. Fatty acids are categorized as being saturated or unsaturated (monounsaturated or polyunsaturated). *Trans* fatty acids may be unsaturated, but they are structurally different and have negative health effects (105). The type of fatty acids consumed is more important than total fat in the diet in terms of supporting metabolic goals and influencing the risk of CVD (83,105,168); thus more attention should be given to the type of fat intake when individualizing goals. Individuals with diabetes should be encouraged to moderate their fat intakes to be consistent with their goals to lose or maintain weight.

Monounsaturated fatty acids/ polyunsaturated fatty acids

- In people with type 2 diabetes, a Mediterranean-style, monounsaturated fatty acid (MUFA)-rich eating pattern may benefit glycemic control and CVD risk factors and can, therefore, be recommended as an effective alternative to a lower-fat, higher-carbohydrate eating pattern. (B)

Evidence from large prospective cohort studies, clinical trials, and a systematic review of RCTs indicate that high-MUFA diets are associated with improved glycemic control and improved CVD risk or risk factors (70,169–171). The intake of MUFA-rich foods as a component of the Mediterranean-style eating pattern has been studied extensively over the last decade. Six published RCTs that included individuals with type 2 diabetes reported improved glycemic control and/or blood lipids when MUFA was substituted for carbohydrate and/or saturated fats (70,72,83,100,108,172). However, some of the studies also included caloric restriction, which may have contributed to improvements in glycemic control or blood lipids (100,108).

In 2011, the Evidence Analysis Library (EAL) of the Academy of Nutrition and Dietetics found strong evidence that dietary MUFAs are associated with improvements in blood lipids based on 13 studies including participants with and without diabetes. According to the EAL, 5% energy replacement of saturated fatty acid (SFA) with MUFA improves insulin responsiveness in insulin-resistant and type 2 diabetic subjects (173).

There is limited evidence in people with diabetes on the effects of omega-6 polyunsaturated fatty acids (PUFAs). Controversy exists on the best ratio of omega-6 to omega-3 fatty acids; PUFAs and MUFAs are recommended substitutes for saturated or *trans* fat (105,174).

Omega-3 fatty acids

- Evidence does not support recommending omega-3 (EPA and DHA) supplements for people with diabetes for the prevention or treatment of cardiovascular events. (A)
- As recommended for the general public, an increase in foods containing long-chain omega-3 fatty acids (EPA and DHA) (from fatty fish) and omega-3 linolenic acid (ALA) is recommended for individuals with diabetes because of their beneficial effects on lipoproteins, prevention of heart disease, and associations with positive health outcomes in observational studies. (B)
- The recommendation for the general public to eat fish (particularly fatty fish) at least two times (two servings) per week is also appropriate for people with diabetes. (B)

The ADA systematic review identified seven RCTs and one single-arm study (2002–2010) using omega-3 fatty acid supplements and one cohort study on whole-food omega-3 intake. In individuals with type 2 diabetes (88), supplementation with omega-3 fatty acids did not improve glycemic control, but higher-dose supplementation decreased triglycerides.

Additional blood-derived markers of CVD risk were not consistently altered in these trials. In subjects with diabetes, six short-duration (30 days to 12 weeks) RCTs were published after the macronutrient review comparing omega-3 (EPA and DHA) supplements to placebo and reported minimal or no beneficial effects (175,176) or mixed/inconsistent beneficial effects (177–180) on CVD risk factors and other health issues (e.g., depression). Supplementation with flaxseed (32 g/day) or flaxseed oil (13 g/day) for 12 weeks did not affect glycemic control or adipokines (181). Three longer-duration studies (4 months [182]; 40 months [183]; 6.2 years [184]) also reported mixed outcomes. Two studies reported no beneficial effects of supplementation (183,184). In one study, patients with type 2 diabetes were randomized to atorvastatin or placebo and/or omega-3 supplements (2 g/day) or placebo. No differences on estimated 10-year CVD risks were observed with the addition of omega-3 fatty acid supplements compared with placebo (182). In the largest and longest trial, in patients with type 2 diabetes, supplementation with 1 g/day omega-3 fatty acids compared with placebo did not reduce the rate of cardiovascular events, death from any cause, or death from arrhythmia (184). However, in one study in postmyocardial patients with diabetes, low-dose supplementation of omega-3 fatty acids (400 mg/day) exerted a protective effect on ventricular arrhythmia–related events, and a reduction in mortality was reported (183). Thus, RCTs do not support recommending omega-3 supplements for primary or secondary prevention of CVD despite the strength of evidence from observational and preclinical studies.

Studies in persons with diabetes on the effect of foods containing marine-derived omega-3 fatty acid or the plant-derived omega-3 fatty acid, α-linolenic acid, are limited. Previous studies using supplements had shown mixed effects on fasting blood glucose and A1C levels. However, a study comparing diets with a high proportion of omega-3 (fatty fish) versus omega-6 (lean fish and fat-containing linoleic acid) fatty acids reported both diets had no detrimental effect on glucose measures, and both diets improved insulin sensitivity and lipoprotein profiles (185).

Saturated fat, dietary cholesterol, and *trans* fat

- The amount of dietary saturated fat, cholesterol, and *trans* fat recommended for people with diabetes is the same as that recommended for the general population. (C)

Few research studies have explored the relationship between the amount of SFA in the diet and glycemic control and CVD risk in people with diabetes. A systematic review by Wheeler et al. found just one small 3-week study that compared a low-SFA diet (8% of total kcal) versus a high-SFA diet (17% of total kcal) and found no significant difference in glycemic control and most CVD risk measures (88,186).

In addition, there is limited research regarding optimal dietary cholesterol and *trans* fat intake in people with diabetes. One large prospective cohort study (171) in women with type 2 diabetes found a 37% increase in CVD risk for every 200 mg cholesterol/1,000 kcal.

Due to the lack of research in this area, people with diabetes should follow the guidelines for the general population. The *Dietary Guidelines for Americans, 2010* (105) recommends consuming less than 10% of calories from SFAs to reduce CVD risk. Consumers can meet this guideline by replacing foods high in SFA (i.e., full-fat dairy products, butter, marbled meats and bacon, and tropical oils such as coconut and palm) with items that are rich in MUFA and PUFA (i.e., vegetable and nut oils including canola, corn, safflower, soy, and sunflower; vegetable oil spreads; whole nuts and nut butters, and avocado). CVD is a common cause of death among individuals with diabetes. As a result, individuals with diabetes are encouraged to follow nutrition recommendations similar to the general population to manage CVD risk factors. These recommendations include reducing SFAs to <10% of calories, aiming for <300 mg dietary cholesterol/day, and limiting *trans* fat as much as possible (105).

Plant stanols and sterols

- Individuals with diabetes and dyslipidemia may be able to modestly reduce total and LDL cholesterol by consuming 1.6–3 g/day of plant stanols or sterols typically found in enriched foods. (C)

Plant sterol and stanol esters block the intestinal absorption of dietary and biliary cholesterol (3). Currently, the EAL from the Academy of Nutrition and Dietetics recommends individuals with dyslipidemia incorporate 2–3 g of plant sterol and stanol esters per day as part of a cardioprotective diet through consumption of plant sterol and stanol ester–enriched foods (187). This recommendation, though not specific to people with diabetes, is based on a review of 20 clinical trials (187). Furthermore, the academy reviewed 28 studies that showed no adverse effects with plant stanol/sterol consumption (187).

There is a much smaller body of evidence regarding the cardioprotective effects of phytosterol/stanol consumption specifically in people with diabetes. Beneficial effects on total, LDL cholesterol, and non-HDL cholesterol have been observed in four RCTs (188–191). These studies used doses of 1.6–3 g of phytosterols or stanols per day, and interventions lasted 3–12 weeks. Two of these studies were in people with type 1 diabetes (188,189), and one found an added benefit to cholesterol reduction in those who were already on statin treatment (189). In addition, two RCTs compared the efficacy of plant sterol consumption (1.8 g daily) in subjects with type 2 diabetes and subjects without diabetes (191, 192). Neither study found a difference in lipid profiles between the two groups, suggesting that efficacy of this treatment is similar for those with and without diabetes who are hypercholesterolemic (191,192).

A wide range of foods and beverages are now available that contain plant sterols including many spreads, dairy products, grain and bread products, and yogurt. These products can contribute a considerable amount of calories. If used, patients should substitute them for comparable foods they eat in order to keep calories balanced and avoid weight gain (3,187).

Micronutrients and herbal supplements

- There is no clear evidence of benefit from vitamin or mineral supplementation in people with diabetes who do not have underlying deficiencies. (C)
  - Routine supplementation with antioxidants, such as vitamins E and C and carotene, is not advised because of lack of evidence of efficacy and concern related to long-term safety. (A)
  - There is insufficient evidence to support the routine use of micronutrients such as chromium, magnesium, and vitamin D to improve glycemic control in people with diabetes. (C)

- There is insufficient evidence to support the use of cinnamon or other herbs/supplements for the treatment of diabetes. (C)
- It is recommended that individualized meal planning include optimization of food choices to meet recommended dietary allowance/dietary reference intake for all micronutrients. (E)

There currently exists insufficient evidence of benefit from vitamin or mineral supplementation in people with or without diabetes in the absence of an underlying deficiency (3,193,194). Because uncontrolled diabetes is often associated with micronutrient deficiencies (195), people with diabetes should be aware of the importance of acquiring daily vitamin and mineral requirements from natural food sources and a balanced diet (3). For select groups of individuals such as the elderly, pregnant or lactating women, vegetarians, and those on calorie-restricted diets, a multivitamin supplement may be necessary (196).

While there has been significant interest in antioxidant supplementation as a treatment for diabetes, current evidence not only demonstrates a lack of benefit with respect to glycemic control and progression of complications, but also provides evidence of potential harm of vitamin E, carotene, and other antioxidant supplements (197–203).

Findings from supplement studies with micronutrients such as chromium, magnesium, and vitamin D are conflicting and confounded by differences in dosing, micronutrient levels achieved with supplementation, baseline micronutrient status, and/or methodologies used. A systematic review on the effect of chromium supplementation on glucose metabolism and lipids concluded that larger effects were more commonly observed in poor-quality studies and that evidence is limited by poor study quality and heterogeneity in methodology and results (204). Evidence from clinical studies evaluating magnesium (205,206) and vitamin D (207–211) supplementation to improve glycemic control in people with diabetes is likewise conflicting.

A systematic review (212) evaluating the effects of cinnamon in people with diabetes concluded there is currently insufficient evidence to support its use, and there is a lack of compelling evidence for the use of other herbal products for the improvement of glycemic control in people with diabetes (213). It is important to consider that herbal products are not standardized and vary in the content of active ingredients and may have the potential to interact with other medications (214). Therefore, it is important that patients/clients with diabetes report the use of supplements and herbal products to their health care providers.

Alcohol

- If adults with diabetes choose to drink alcohol, they should be advised to do so in moderation (one drink per day or less for adult women and two drinks per day or less for adult men). (E)
- Alcohol consumption may place people with diabetes at increased risk for delayed hypoglycemia, especially if taking insulin or insulin secretagogues. Education and awareness regarding the recognition and management of delayed hypoglycemia is warranted. (C)

Moderate alcohol consumption has minimal acute and/or long-term detrimental effects on blood glucose in people with diabetes (215–219), with some epidemiologic data showing improved glycemic control with moderate intake. Moderate alcohol intake may also convey cardiovascular risk reduction and mortality benefits in people with diabetes (220–223), with the type of alcohol consumed not influencing these beneficial effects (221,224). Accordingly, the recommendations for alcohol consumption for people with diabetes are the same as for the general population. Adults with diabetes choosing to consume alcohol should limit their intake to one serving or less per day for women and two servings or less per day for men (105). Excessive amounts of alcohol (≥3 drinks/day) consumed on a consistent basis may contribute to hyperglycemia (221). One alcohol-containing beverage is defined as 12 oz beer, 5 oz wine, or 1.5 oz distilled spirits, each containing approximately 15 g of alcohol. Abstention from alcohol should be advised, however, for people with a history of alcohol abuse or dependence, women during pregnancy, and people with medical conditions such as liver disease, pancreatitis, advanced neuropathy, or severe hypertriglyceridemia (3).

Despite the potential glycemic and cardiovascular benefits of moderate alcohol consumption, use may place people with diabetes at increased risk for delayed hypoglycemia. This is particularly true in those using insulin or insulin secretagogue therapies. Consuming alcohol with food can minimize the risk of nocturnal hypoglycemia (3,225–227). Individuals with diabetes should receive education regarding the recognition and management of delayed hypoglycemia and the potential need for more frequent self-monitoring of blood glucose after consuming alcoholic beverages.

Sodium

- The recommendation for the general population to reduce sodium to less than 2,300 mg/day is also appropriate for people with diabetes. (B)
- For individuals with both diabetes and hypertension, further reduction in sodium intake should be individualized. (B)

Limited studies have been published on sodium reduction in people with diabetes. A Cochrane review of RCTs found that decreasing sodium intake reduces blood pressure in those with diabetes (228). Likewise, a small study in people with type 2 diabetes showed that following the DASH diet and reducing sodium intake to about 2,300 mg led to improvements in blood pressure and other measures on cardiovascular risk factors (46).

Incrementally lower sodium intakes (i.e., to 1,500 mg/day) show more beneficial effects on blood pressure (104,229); however, some studies in people with type 1 (230) and type 2 (231) diabetes measuring urine sodium excretion have shown increased mortality associated with the lowest sodium intakes, therefore warranting caution for universal sodium restriction to 1,500 mg in this population. Additionally, an IOM report suggests there is no evidence on health outcomes to treat certain population subgroups—which includes individuals with diabetes—differently than the general U.S. population (232).

In the absence of clear scientific evidence for benefit in people with combined diabetes and hypertension (230,231), sodium intake goals that are significantly lower than 2,300 mg/day should be considered only on an individual basis. When individualizing sodium intake recommendations, consideration must also be given to issues such as the palatability, availability, and additional cost of specialty low sodium products and the difficulty in achieving both low sodium recommendations and a nutritionally adequate diet given these limitations (233).

While specific dietary sodium targets are highly debated by various health groups, all agree that the current average

Table 4—*Summary of priority topics*

1. Strategies for all people with diabetes:
   - Portion control should be recommended for weight loss and maintenance.
   - Carbohydrate-containing foods and beverages and endogenous insulin production are the greatest determinant of the postmeal blood glucose level; therefore, it is important to know what foods contain carbohydrates—starchy vegetables, whole grains, fruit, milk and milk products, vegetables, and sugar.
   - When choosing carbohydrate-containing foods, choose nutrient-dense, high-fiber foods whenever possible instead of processed foods with added sodium, fat, and sugars. Nutrient-dense foods and beverages provide vitamins, minerals, and other healthful substances with relatively few calories. Calories have not been added to them from solid fats, sugars, or refined starches.
   - Avoid SSBs.
   - For most people, it is not necessary to subtract the amount of dietary fiber or sugar alcohols from total carbohydrates when carbohydrate counting.
   - Substitute foods higher in unsaturated fat (liquid oils) for foods higher in *trans* or saturated fat.
   - Select leaner protein sources and meat alternatives.
   - Vitamin and mineral supplements, herbal products, or cinnamon to manage diabetes are not recommended due to lack of evidence.
   - Moderate alcohol consumption (one drink/day or less for adult women and two drinks or less for adult men) has minimal acute or long-term effects on blood glucose in people with diabetes. To reduce risk of hypoglycemia for individuals using insulin or insulin secretagogues, alcohol should be consumed with food.
   - Limit sodium intake to 2,300 mg/day.
2. Priority should be given to coordinating food with type of diabetes medicine for those individuals on medicine.
   - For individuals who take insulin secretagogues:
     - o Moderate amounts of carbohydrate at each meal and snacks.
     - o To reduce risk of hypoglycemia:*
       - ■ Eat a source of carbohydrates at meals.
       - ■ Moderate amounts of carbohydrates at each meal and snacks.
       - ■ Do not skip meals.
       - ■ Physical activity may result in low blood glucose depending on when it is performed. Always carry a source of carbohydrates to reduce risk of hypoglycemia.*
   - For individuals who take biguanides (metformin):
     - o Gradually titrate to minimize gastrointestinal side effects when initiating use:
       - ■ Take medication with food or 15 min after a meal if symptoms persist.
       - ■ If side effects do not resolve over time (a few weeks), follow up with health care provider.
       - ■ If taking along with an insulin secretagogue or insulin, may experience hypoglycemia.*
   - For individuals who take α-glucosidase inhibitors:
     - o Gradually titrate to minimize gastrointestinal side effects when initiating use.
     - o Take at start of meal to have maximal effect:
       - ■ If taking along with an insulin secretagogue or insulin, may experience hypoglycemia.
       - ■ If hypoglycemia occurs, eat something containing monosaccharides such as glucose tablets as drug will prevent the digestion of polysaccharides.
   - For individuals who take incretin mimetics (GLP-1):
     - o Gradually titrate to minimize gastrointestinal side effects when initiating use:
       - ■ Injection of daily or twice-daily GLP-1s should be premeal.
       - ■ If side effects do not resolve over time (a few weeks), follow up with health care provider.
       - ■ If taking along with an insulin secretagogue or insulin, may experience hypoglycemia.*
       - ■ Once-weekly GLP-1s can be taken at any time during the day regardless of meal times.
   - For individuals with type 1 diabetes and insulin-requiring type 2 diabetes:
     - o Learn how to count carbohydrates or use another meal planning approach to quantify carbohydrate intake. The objective of using such a meal planning approach is to "match" mealtime insulin to carbohydrates consumed.
     - o If on a multiple-daily injection plan or on an insulin pump:
       - ■ Take mealtime insulin before eating.
       - ■ Meals can be consumed at different times.
       - ■ If physical activity is performed within 1– 2 h of mealtime insulin injection, this dose may need to be lowered to reduce risk of hypoglycemia.*
     - o If on a premixed insulin plan:
       - ■ Insulin doses need to be taken at consistent times every day.
       - ■ Meals need to be consumed at similar times every day.
       - ■ Do not skip meals to reduce risk of hypoglycemia.
       - ■ Physical activity may result in low blood glucose depending on when it is performed. Always carry a source of quick-acting carbohydrates to reduce risk of hypoglycemia.*
     - o If on a fixed insulin plan:
       - ■ Eat similar amounts of carbohydrates each day to match the set doses of insulin.

GLP-1, glucagon-like peptide-1. *Treatment of hypoglycemia: current recommendations include the use of glucose tablets or carbohydrate-containing foods or beverages (such as fruit juice, sports drinks, regular soda pop, or hard candy) to treat hypoglycemia. A commonly recommended dose of glucose is 15–20 g. When blood glucose levels are ~50–60 mg/dL, treatment with 15 g of glucose can be expected to raise blood glucose levels ~50 mg/dL (239). If self-monitoring of blood glucose and about 15–20 min after treatment shows continued hypoglycemia, the treatment should be repeated.

intake of sodium of 3,400 mg/day (excluding table salt) is excessive and should be reduced (105,234–237). The food industry can play a major role in lowering sodium content of foods to help people meet sodium recommendations (233,234).

Clinical priorities for nutrition management for all people with diabetes—A wide range of diabetes meal planning approaches or eating patterns have been shown to be clinically effective, with many including a reduced energy intake component. There is not one ideal percentage of calories from carbohydrates, protein, or fat that is optimal for all people with diabetes. Nutrition therapy goals should be developed collaboratively with the individual with diabetes and be based on an assessment of the individual's current eating patterns, preferences, and metabolic goals. Once a thorough assessment is completed, the health care professional's role is to facilitate behavior change and achievement of metabolic goals while meeting the patient's preferences, which may include allowing the patient to continue following his/her current eating pattern. If the individual would like to try a different eating pattern, this should also be supported by the health care team. Various behavior change theories and strategies can be used to tailor nutrition interventions to help the client achieve specific health and quality-of-life outcomes (238).

Multiple meal planning approaches and eating patterns can be effective for achieving metabolic goals. Examples include: carbohydrate counting, healthful food choices/simplified meal plans (i.e., the Plate Method), individualized meal planning methods based on percentages of macronutrients, exchange list for meal planning, glycemic index, and eating patterns including Mediterranean style, DASH, vegetarian or vegan, low carbohydrate, and low fat. The meal planning approach or eating pattern should be selected based on the individual's personal and cultural preferences; literacy and numeracy; and readiness, willingness, and ability to change. This may need to be adjusted over time based on changes in life circumstances, preferences, and disease course.

A summary of key topics for nutrition education can be found in Table 4.

Future research directions—The evidence presented in this position statement concurs with the review previously published by Wheeler et al. (88) that many different approaches to nutrition therapy and eating patterns are effective for the target outcomes of improved glycemic control and reduced CVD risk among individuals with diabetes. Evaluating nutrition evidence is complex given that multiple dietary factors influence glycemic control and CVD risk factors, and the influence of a combination of factors can be substantial. Based on a review of the evidence, it is clear that gaps in the literature continue to exist and further research on nutrition and eating patterns is needed in individuals with type 1 and type 2 diabetes.

For example, future studies should address:

- The relationships between eating patterns and disease in diverse populations.
- The basis for the beneficial effects of the Mediterranean-style eating pattern and approaches to translation of the Mediterranean-style eating pattern into diverse populations.
- The development of standardized definitions for high– and low–glycemic index diets and implementation of these definitions in long-term studies to further evaluate their impact on glycemic control.
- The development of standardized definitions for low- to moderate-carbohydrate diets and determining long-term sustainability.
- Whether NNSs, when used to replace caloric sweeteners, are useful in reducing caloric and carbohydrate intake.
- The impact of key nutrients on cardiovascular risk, such as saturated fat, cholesterol, and sodium in individuals with both type 1 and type 2 diabetes.
- Intake of SFA and its relationship to insulin resistance.

Importantly, research needs to move away from just evaluating the impact of individual nutrients on glycemic control and cardiovascular risk. More research on eating patterns, unrestricted and restricted energy diets, and diverse populations is needed to evaluate their long-term health benefits in individuals with diabetes. Individuals eat nutrients from foods and within the context of mixed meals, and nutrient intakes are intercorrelated, so overall eating patterns must be studied to fully understand how these eating patterns impact glycemic control (88, 240). Eating patterns are selected by individuals based on more than the healthfulness of food and food availability; tradition, cultural food systems, health beliefs, and economics are also important (95). Studies on gene-diet interactions will also be important, as well as studies on potential epigenetic effects that depend on nutrients to moderate gene expression.

Given the benefits of both nutrition therapy and MNT for individuals with diabetes, it is also important to study systematic processes within the context of health care delivery that encourage more individuals with diabetes to receive nutrition therapy initially, upon diagnosis, and long term. Further research is also needed on the best tools and strategies for educating individuals with diabetes (e.g., the Plate Method) and how to improve adherence to healthful eating patterns among individuals with diabetes. This research should include multiple settings that can impact food choices for individuals with diabetes, such as where they live, work, learn, and play. Individuals with diabetes spend the majority of their time outside health care settings so more research on how public health, the health care system, and the community can support individuals with diabetes in their efforts to achieve healthful eating is needed.

In summary—There is no standard meal plan or eating pattern that works universally for all people with diabetes (1). In order to be effective, nutrition therapy should be individualized for each patient/client based on his or her individual health goals; personal and cultural preferences (241,242); health literacy and numeracy (243,244); access to healthful choices (245,246); and readiness, willingness, and ability to change. Nutrition interventions should emphasize a variety of minimally processed nutrient-dense foods in appropriate portion sizes as part of a healthful eating pattern and provide the individual with diabetes with practical tools for day-to-day food plan and behavior change that can be maintained over the long term.

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