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Review

Behavioral approaches to nutrition and eating patterns for managing type 2 diabetes: A review

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ABSTRACT

Nutritional interventions are a key component of type 2 diabetes management; making health-supporting changes in eating patterns can improve postprandial glycemic excursions and lower HbA1c to reduce diabetes-related morbidity and mortality. Research around implementing calorie-restricted and/or low-carbohydrate diets is plentiful, though the ability to sustain physiologic and behavioral changes for longer than 12 months is a concern. An understanding of intervention goals and adherence is needed to apply this research to patient care and translate expectations to real-world living contexts. Diverse dietary patterns including a Mediterranean eating pattern, vegetarian or plant-based eating pattern, or others that emphasize high-quality carbohydrates (e.g., whole grains), vegetables, whole fruits, legumes, and fish can support achievement of glycemic targets. Counseling strategies like motivational interviewing can be used to build eating competence. These approaches prioritize collaborative decision-making with the goal of increasing patient empowerment and self-efficacy. Strategies for incorporating these tools and frameworks in a clinical setting are highlighted. Providing ongoing diabetes and nutrition education, paired with appropriate support to address the challenges in implementing and sustaining behavior changes, is warranted. Further, social determinants of health including environmental context, education, socioeconomic status, access to healthcare, and experiences of systemic stigma (e.g., racism or weight bias) can interfere with individuals' diabetes self-care and nutrition behaviors. Providing medical nutrition therapy and tailoring nutrition interventions to individual needs and circumstances can be an important way physicians, dietitians, and diabetes providers can support individuals with type 2 diabetes.

Introduction

Managing type 2 diabetes (T2DM) and improving glycemic outcomes can reduce the individual and social costs of morbidity and mortality associated with T2DM but intervening in a clinical setting and fostering sustained behavior change can present challenges for patients and providers. Implementing nutrition recommendations in the setting of insulin resistance and pancreatic beta-cell dysfunction can play a role in improving glycemic control. Insulin resistance is the decreased ability of tissue cells to utilize insulin, leading to higher blood glucose levels. It is also associated with decreased ability to suppress hepatic glucose production.¹ In the setting of insulin resistance, more insulin is required to maintain normal glucose levels, resulting in increased insulin production by pancreatic beta-cells and hyperinsulinemia.^{2,3} Eventually, the increased insulin production is insufficient to normalize glucose levels, resulting in hyperglycemia. With high blood glucose levels sustaining demand for insulin, beta-cell function continually declines over time. By the time an individual is diagnosed with T2DM, they've lost approx-

imately 70-80% of beta-cell function.^{1,4} Reducing glycemic excursions, and thus the demand for insulin, can preserve beta-cell function¹. For this reason, eating and activity patterns serve as cornerstones of diabetes management.

Carbohydrate intake is a primary, though not the only, driver of postprandial blood glucose levels. Protein intake can improve insulin response and impact postprandial glucose excursions.⁵ Physical activity can be an important component of a lifestyle-focused approach to managing T2DM because it improves tissue responsiveness to insulin, reducing insulin resistance and subsequently reduces demand for insulin from pancreatic beta cells.^{1,6} Engaging in physical activity can also help by reducing insulin resistance and improving cellular uptake of glucose independent of insulin, and the impact can last up to 48 h.⁷

The goal of interventions for managing type 2 diabetes is to improve long-term glycemic control to reduce the risk of complications and premature death.^{8,9} Because cardiovascular disease is a common comorbidity and type 2 diabetes is a major risk factor for cardiac events, managing blood pressure and lipids along with blood glucose levels is typically a

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co-occurring goal. Nutrition-focused interventions attune to eating patterns, meal timing, nutrient composition, and food choices to improve overall and postprandial glycemic control, ideally bringing blood glucose levels into a therapeutically established target range. Although dietary modifications are viewed as key components of type 2 diabetes management (along with physical activity and medication), there can be uncertainty for physicians and patients alike regarding which nutrition recommendations to adopt or eating pattern to follow. Our goal in this review is to equip clinicians with evidence-based dietary guidance and effective behavioral strategies to empower their patients' diabetes self-care. Our approach endorses a focus on including nutrient-rich foods and supporting process-oriented behavior change, especially for patients who have attempted and struggled with a range of confusing or conflicting dietary recommendations or outcomes-focused goals in the past.

Macronutrient-focused and calorie-restricted diets

Two strategies that are often proposed for the nutritional management of type 2 diabetes include caloric restriction with the specific goal of weight loss and/or managing macronutrient balance to reduce glycemic excursions. Weight loss, with the goal of improving insulin sensitivity and other cardiometabolic risk factors like blood pressure and blood lipids, is often a first focus of lifestyle interventions to prevent or manage T2DM, while macronutrient recommendations often focus on dietary intake of carbohydrates because carbohydrates are a primary driver of postprandial blood glucose levels.¹⁰ Low-carbohydrate diets have replaced low-fat diets as one of the most frequently recommended diets to manage T2DM.

Because carbohydrates are digested into glucose, reducing carbohydrate quantity to improve blood glucose levels has been the focus of many diet-intervention studies. Thresholds for the definition of low carbohydrate and very-low carbohydrate vary between studies. Typically, less than ~35% of daily calories from carbohydrate is considered low carbohydrate, less than ~25% of daily calories is considered very low, while <10% of calories is ketogenic.

Research on low-carbohydrate diets for managing T2DM is plentiful. A recent systematic review reported that while some studies reported significant differences in weight loss and A1c reductions at 6 months, these differences were not sustained at 12 months.⁸ Additionally, several meta-analyses have emerged evaluating and summarizing these results (Table 1). One meta-analysis of randomized controlled trials¹¹ found low-carbohydrate diets resulted in moderate but significant reductions in HbA1c (-0.17%) at 3 months, but differences between groups were no longer seen at 6- and 12-month follow-up, and A1c increased at 24-month follow-up among the low-carbohydrate participants (+0.23%). Very-low carbohydrate diets resulted in A1c reductions at 3 and 6 months (-0.43% and -0.40%, respectively) but not at 12- and 24-month follow-ups. Similarly, changes in BMI observed at 6 months (-1.35 kg/m²) were not sustained at 12 months. The research team concluded that low-carbohydrate diets may have some short-term benefits but "are not more effective than balanced diets, and possibly are detrimental, in the longer term".¹¹ A second meta-analysis found "clinically important" decreases in weight and triglycerides, as well as increased insulin sensitivity at 6 months, which subsequently decreased at 12 months.¹² Both physiologic and behavioral outcomes were difficult to maintain. Adherence to low-carbohydrate diets diminished over time, making the efficacy of a short-term intervention on long-term morbidity and mortality difficult to ascertain and altogether unclear.^{9,13} The reported beneficial effects of low-carbohydrate diets in the literature are driven by short-term results (<12 months duration).¹² A summary of the findings of recent meta-analyses is reported in Table 1.

Very-low-carbohydrate diets (VLCDs) have lower efficacy compared to the relatively less restrictive low-carbohydrate diets for weight loss at six months, which appears to be attributable to diet adherence; among patients who closely followed VLCDs (all intervention durations were at least 3 months), a clinically important reduction in weight was seen

compared to observed effects in patients with lower adherence to VLCDs.¹²

Carbohydrate quality, usually conceptualized in terms of the fiber content or glycemic index (GI) or glycemic load (GL) of foods, has also been studied. Fiber is indigestible plant matter that slows transit time of ingested food through the gastrointestinal tract. This physiologic advantage of high-fiber diets blunts the glycemic excursion caused by digestible carbohydrates consumed at the meal. Foods that are higher on the glycemic index or have a higher glycemic load are digested quickly, which increases the spike in blood glucose and subsequent demand for insulin.⁹ Recent studies have shown that consumption of low-GI foods and low-GL diets can decrease HbA1c levels in persons with T2DM when compared to control diets or high-GI diets.^{1,9,14} While consideration of GI or GL are relevant, oversimplifying these constructs can be confusing for patients. The complexity of how foods are consumed together, at a meal, and in the context of an overall eating pattern is an important consideration that clients need education and guidance to implement this dietary strategy. For example, diabetes educators or Registered Dietitian Nutritionists (RDNs) can support patients in designing food exposures and meal experiments to explore how GL impacts individuals' glycemic excursions. However, if patients have difficulty keeping track of which foods are low-GI, distinguishing the importance of the GI of individual foods from the impact of the total diet's GL, or applying this information to their food choices and blood glucose management, simpler meal planning strategies are needed.

Some (but not all) low-carbohydrate diets also involve a component of caloric restriction. Of note, improvement in glycemic outcomes was also observed in studies where weight loss did not occur, suggesting the potential benefit of carbohydrate reduction that is independent of body weight or weight loss.^{9,15-19} Isocaloric, high-protein diets where carbohydrate intake is reduced and replaced with a higher proportion of daily calories from protein have also been associated with improvements in insulin response and reduced hyperglycemia.^{20,21} In these studies, the diets were not designed to be calorically deficient to induce weight loss. However, the limitations of small sample sizes and short duration of the intervention (6-12 months) remain notable concerns that limit the applicability of these findings to clinical populations. More research is needed on this topic. Similarly, clarity on research methods and an understanding not only of intervention goals but intervention adherence are needed to apply this research to patient care and translate expectations to real-world living contexts. It is tempting, but premature, to draw conclusions to inform clinical practice without evaluating these important caveats and without carefully considering the best, individualized approach that is client-centered.

Calorie-restricted diets (using a variety of macronutrient distributions) have been frequently recommended and studied in the setting of T2DM treatment. A notable example is the Action for Health in Diabetes (Look AHEAD) trial that implemented an intensive intervention with the goal of achieving weight loss. While no significant reduction in cardiovascular events occurred and weight regain was common, a study evaluating body weight two years after the end of the intervention compared with baseline weight reported greater weight loss in the intervention group (-6.1% of baseline weight) compared to the diabetes-education control group (-4.1% of baseline weight).²² However, several systematic reviews and meta-analyses evaluating weight and diabetes outcomes suggest that sustaining weight loss for longer timeframes (e.g., 12 or 24 months) is challenging. A recent umbrella review of weight-management trials for T2DM describes a pattern of statistically significant weight loss achieved in short-term studies (<12 months duration), with attenuated differences that lack statistical significance observed in studies with follow-up periods longer than one year.²³

Another review suggests that a weight loss of 5% or more may not be a realistic primary treatment strategy for many individuals if, to achieve this goal, intensive interventions with frequent contact with health professionals combined with caloric restriction and increased physical activity are required.²⁴ It is important to note that even in the setting

Table 1

Summary of recent meta-analyses reporting impact of low-carbohydrate diets on T2DM outcomes.

Year	Author	Diets compared		Studies	Study Duration Range	Mean Difference in Weight (95% Confidence Interval)		Mean Difference in Glycemic Control (95% Confidence Interval)	
		Intervention	Control			6 months	≥12 months	6 months	≥12 months
2021	Goldenberg et al.	LCD* and VLCD**	Low-fat and low-glycemic diets	23	3-24 months	3.46 kg loss (-5.25 to -1.67 kg) 18 trials	0.29 kg gain (-1.02 to 1.60 kg) 7 trials	A1c 0.47% lower (-0.60 to -0.34%) 17 trials Fasting BG 0.73 mmol/L lower (-1.19 to -0.27 mmol/L) 14 trials	A1c 0.23% lower (-0.46 to 0.00%) 8 trials Fasting BG 0.06 mmol/L higher (-0.37 to 0.48 mmol/L) 6 trials
2020	Silverii et al.	LCD	Balanced (45-60% kcals) carbohydrate diet	37	3-48 months	BMI 1.35 kg/m² lower (-2.18 to -0.52 kg/m ²) 7 trials	BMI 0.52 kg/m ² lower (-1.30 to 0.26 kg/m ²) 4 trials BMI 1.18 kg/m ² lower (-2.90 to 0.54 kg/m ²) 2 trials	A1c 0.19% lower (-0.40 to 0.01%) 17 trials	A1c -0.02% lower (-0.12 to 0.07%) 16 trials A1c 0.23% higher (0.02 to 0.44%) 6 trials
2018	Huntriss et al.	LCD	Multiple	7	48 weeks – 4 years		0.28 kg gain (-1.37 to 1.92 kg) 6 trials		A1c 0.28% lower (-0.53 to -0.02%) 7 trials
2017	Meng et al.	LCD	Normal or high-carbohydrate diets	9	3-24 months	0.94 kg loss (-1.92 to 0.05 kg) 9 trials	0.24 kg loss (-2.18 to 1.70 kg) 3 trials	Reported as one result across all studies (3 months to 24 months): A1c 0.44% lower (-0.61 to -0.26%)	
2017	Snorgaard et al.	LCD and moderate-carbohydrate diets	High-carbohydrate diets	10	3-24 months	<12 months: BMI 1.02 lower (-2.58 to 0.54) 4 trials	BMI 0.43 lower (-1.38 to 0.53) 2 trials	At 3 or 6 months: A1c 0.34% lower (-0.63 to -0.06%) 8 trials	A1c 0.04% lower (-0.04 to 0.13%) 7 trials

* Low-carbohydrate diet (LCD).

** Very low carbohydrate diet (VLCD) Statistically significant results are indicated in bold type.

of research-based interventions where clients have access to frequent and intensive counseling and support from nutrition and medical professionals, the adherence to and sustainability of low-carbohydrate and/or low-calorie diets falls short of expectations, contributing to waning effects on glucose management over time. It is not difficult to imagine that long-term or high adherence to low-carbohydrate diets would be even more elusive for individuals in general clinical practice or those with less access or lower utilization of healthcare services. Notably, social determinants of health including environmental context, education, socioeconomic status, access to healthcare, and experiences of systemic stigma (e.g., racism or weight bias) can interfere with individuals' diabetes self-care and nutrition behaviors.²⁵

Eating patterns: the Mediterranean diet, vegetarian/vegan diets, and supporting the gut microbiome

There is ample and emerging research looking at broad eating patterns, particularly the Mediterranean diet and vegetarian/vegan diets, which focus less on managing intake of individual macronutrients to achieve positive diabetes-related outcomes.

The Mediterranean diet is a plant-based eating pattern that is high in whole grains, legumes, vegetables, fruit, nuts and seeds, fresh herbs

and spices, monounsaturated fatty acids with olive oil as the predominant fat source and includes a moderate amount of fish and red wine, dairy predominantly consumed as cheese and yogurt, and limited inclusion of red meat with very few processed foods and refined grains.²⁶ Because of the emphasis on whole grains, legumes, and fruit, the daily eating pattern is not low in carbohydrates, but the fiber content of foods helps blunt post-prandial glycemic excursions.²⁷ In addition, this dietary pattern is abundant in antioxidant nutrients, phytochemicals, and a variety of phenolic compounds found in fruits, vegetables, and red wine which are associated with anti-inflammatory properties.^{5,28} Consumption of a Mediterranean eating pattern is associated lower HbA1c levels, decreased insulin resistance, delayed requirement for diabetes medications, and greater reductions in body weight over time.^{8,29,30} Physicians and educators may find it helpful to articulate and frame the nutrition goal as overall healthful eating patterns that are plant-based and high in fiber though not explicitly low in carbohydrate to reduce possible confusion. Enthusiasm for the Mediterranean diet has been critiqued as contributing to systemic racism in its elevation of European-centric cultural eating patterns.³¹ While the original research on this eating pattern emanated from Greece, Cyprus, Italy, Spain, and France, the diversity of plant-based, health-promoting eating patterns across the Mediterranean region includes northern Africa (Libya, Algeria, Morocco, and Tunisia),

Egypt, Croatia, Bosnia, Albania, Turkey, Malta, and Lebanon. Health-supporting eating patterns across all cultures should be supported, and research identifying and highlighting a wider array of healthy dietary patterns is warranted. For example, the African Heritage Diet embodies a culturally celebrated eating pattern based on the healthy food traditions of people with African roots; traditions that are sustained in the Caribbean, South America, and the southern United States. This eating pattern is described as “powerfully nutritious and delicious, and naturally meets the guidelines experts recommend for supporting good health”.³² Primary care providers are encouraged to support their patients to embrace their cultural eating patterns, honor the value of home-cooking, and maximize the inclusion of a diverse array of plant foods and flavorful herbs and spices. RDNs can be patient allies in these pursuits.

Vegetarian or vegan eating patterns are also associated with improvements in glycemic control. A recent meta-analysis concluded that adopting this dietary pattern reduced HbA1c levels by 0.3–0.4% among individuals with T2DM, improved blood lipid levels, and reduced weight.¹⁰ The improvement in glycemia was associated with the high-fiber and low glycemic index foods found in vegetarian eating patterns, while the low-saturated fat content also supports reductions in LDL cholesterol.⁵ Notably, vegetarian patterns and other plant-based eating patterns like the Mediterranean and African Heritage diets are supportive of planetary health goals, ecologic sustainability, and biodiversity. Plant-based diets require skills in food preparation and home-cooking to maximize the nutritional quality of the diet. As well, food access, selection and affordability within a budget are central to the sustainability of plant-based eating patterns. These realities present unique challenges to clients in certain demographics and geographic locations, making low adherence not only a matter of behavioral compliance, motivation, willpower, or choice. Creative solutions that include environmental and policy change are often needed for behavioral changes to be made and sustained.

Understanding of the importance and impact of the gut microbiome in host health outcomes has grown considerably in recent years. In particular, decreased production of bacterial short-chain fatty acids and increased gut-derived bacterial toxins are associated with metabolic derangements in the case of type 2 diabetes.^{33,34} Changes to short-term intake and long-term dietary patterns can alter the microbiome composition.^{34–36} A dietary pattern rich in plant-based, high-fiber foods and low in animal proteins has been suggested to support the diversity and composition of the gut microbiome,³³ while increased animal fat and protein intake was associated with increases in bacteria populations including bacteria populations associated with increases in insulin resistance and T2DM as well as increased energy harvest.^{33,35,37} Gut dysbiosis and inflammation stemming from consumption of ultra-processed foods has also been suggested as a biological mechanism linking these foods, the microbiome, and cardiometabolic diseases.^{38,39}

Probiotics are the nondigestible foods/fibers consumed by humans that are fermentable by gut bacteria (examples include vegetable roots, garlic, onion, asparagus, barley, oats, apples, flaxseed, and seaweed), while probiotics are live microorganisms found in fermented foods or taken as a supplement. Interventions incorporating pre- and probiotics to support the gut microbiome may work by reducing inflammation and gut permeability and increasing insulin sensitivity.^{33,34} Studies exploring outcomes among adults with type 2 diabetes have thus far been small and produced mixed results,³³ though the overlap between the high-fiber prebiotic foods and those recommended in the plant-based eating patterns described previously is intriguing, and more research is needed in this area.

Professional consensus

Several national organizations and international collaborations have articulated management goals for T2DM and issued guidelines to inform clinicians' recommendations to patients. Areas of significant consensus

are highlighted in Fig. 1. Most official guidelines or recommendations do not articulate a single ideal distribution of macronutrients in the diet. Instead, the recommendations specify that quantities of carbohydrates, protein, and fat should ideally be tailored to meet individual needs and preferences. Honoring cultural food practices and attuning to socio-environmental constraints are factors that are central to individualized guidance. Customization of behaviorally based dietary advice for managing T2DM is best provided by a qualified nutrition professional, such as the Registered Dietitian Nutritionist (RDN).

Clinical challenges and implications for counseling

While the literature shows that many approaches to dietary change can lower HbA1c and/or contribute to weight loss in the short term, demonstrating sustained decreases over time and/or outside of the research context has proven difficult. In studies with follow-up timelines exceeding six months, continuing adherence to a carbohydrate-restricted and/or calorie-restricted diet is not achieved by most, and individuals revert to baseline eating patterns over time.^{8,46,47} Weight regain and reversal of improvements in glycemic control after discontinuing a recommended diet are common outcomes in both research and clinical practice.

The difficulties with long-term maintenance of weight loss and adherence to restrictive diets presents a challenge for clinicians and for individuals with T2DM that causes mutual frustration and a range of complex emotions. This reality points to the need for supporting people in engaging in diabetes self-management and dietary choices that are realistic, flexible, and sustainable while keeping blood glucose outcomes as a central focus.⁴⁸ Long-term adherence is the ultimate goal and a key component of an intervention's efficacy for improving insulin resistance and mitigating disease progression².

Even while recognizing that weight regain following weight-loss efforts is common, advocating for weight-loss remains a key feature of most T2DM management recommendations.¹ Successful diabetes interventions are often conceptualized as synonymous with weight loss. This approach promotes restrictive eating and negative nutrition messages where advice is grounded in foods and nutrients to avoid. In contrast, positive nutrition messages emphasize foods and nutrients to include, helping patients understand the urgency to add a colorful diversity of vegetables, fiber-rich whole grains and legumes, fish, vegetable oils, nuts, seeds, and fresh herbs that load prebiotics, antioxidants, and anti-inflammatory food sources to the daily diet. Understanding what individuals' current eating patterns are and identifying areas to incorporate nourishing food choices, adding health-promoting choices, may be more sustainable and more satisfying in the long run.

Another concern with introducing a restrictive diet with rigid parameters or thresholds for macronutrient or caloric intake is that it could exacerbate black-and-white thinking entrenched in a “good food, bad food” or “good day, bad day” dichotomy of diet adherence. Once a patient or client veers from the recommendations, they risk perceiving themselves as a failure and the eating pattern can be jettisoned all together. People with diabetes can be at increased risk for eating disorders, including restrictive- and binge-eating disorders, and the perceived rigidity of following diabetes dietary recommendations can potentially exacerbate disordered patterns.^{49–51} People report difficulties with past efforts at weight loss internalized as failure, and this negatively impacts engagement in diabetes self-care and impairs the patient-provider relationship.^{52,53} A similar pattern was also seen in individuals' relationship to physical activity, with a recent scoping review finding that “feelings of obligation, internal pressure, discomfort, and guilt” hampered sticking with physical activity plans, while self-esteem and enjoyment incentivized the sustainability of active lifestyles.⁵⁴

Because of the variety of interventions put forth, and people's varying experiences with past efforts and perceived motivations and barriers to change, individualizing nutrition recommendations is necessary to increase the efficacy of dietary changes for reducing diabetes symptoms

Diabetes Management Goals

- Improve overall health and optimize quality of life
- Delay or prevent development of diabetes complications
- Collaborate in person-centered and shared decision-making process to establish goals
- Individualize and support attaining blood glucose goal ranges
- Promote and support healthful eating patterns
- Include adequate (often ongoing) assessments and diabetes education and support
- Acquire appropriate diabetes self-management, self-nourishing, and practical meal planning skills (enhance self-efficacy)
- Promote physical activity, smoking cessation, and psychological support as appropriate
- Engage in glucose monitoring when prescribed

Nutrition Strategies to Meet Diabetes Goals

- Balanced, individualized nutrition recommendations (a variety of eating patterns may be appropriate)
- Account for and incorporate individual preferences, cultures and religions, health goals, and financial states
- Maintain the pleasure of eating
- Individualized macronutrient composition recommendations (where a range of carbohydrate and fat distributions may be appropriate)
- Focus on including a variety of nutrient-dense foods
- Emphasize carbohydrate quality (e.g., whole grains over refined grains)
- Encourage adequate fiber intake
- Decrease intake of ultra-processed foods and added sugars
- Minimize saturated and *trans* fats (both types of fat have been associated with cardiovascular disease risk) and encourage plant-based mono- and polyunsaturated fat sources
- Aim for adequate but not excessive intake of sodium

Nutrient-Dense Foods Encouraged to Meet Diabetes Goals

These foods and food groups are consistently emphasized in consensus statements and guidelines, and across recommended dietary patterns:

- Vegetables
- Whole fruits
- Whole grains
- Legumes
- Fish
- Nuts

Fig. 1. Key points in organizations' guidelines and consensus statements to emphasize in making T2DM nutrition recommendations.^{10,40-45}

and mitigating risk for complications. The conclusions drawn by several authors of the reviews and meta-analyses summarized here is that individualization of dietary recommendations based on a patient's culture, history, and current life circumstances is a key component to providing effective nutrition therapy for T2DM.^{2,5} Many organizations' guidelines emphasize the need for individualized recommendations, and customized plans to fit personal tastes, resources, and cultural preferences can improve the sustainability of adopting modifications to support diabetes management.¹⁰

Counseling strategies to individualize nutrition recommendations for T2DM

In-depth conversations with individuals to identify adequacy of and potential modifications to current dietary patterns can exceed the time constraints of medical appointments. Nutrition counseling and medical nutrition therapy (MNT) delivered by dietitians has been shown to be effective in improving clinical outcomes in patients with type 2 diabetes,^{10,55,56} and referrals should be made to RDs to support individu-

als' efforts in making dietary changes.⁵⁷ MNT for diabetes is a Medicare benefit, and adequate coverage of and reimbursement for MNT visits can improve access to RDNs for nutrition counseling and appropriate follow-up.¹⁰ There are several education and counseling approaches that can help provide individuals with the knowledge and ability to engage in diabetes self-care and self-management behaviors. Dietitians are professionally trained to apply these strategies to support clients in planning and making daily food choices, engaging in movement, self-monitoring glucose, and taking medications. The shift towards incorporating continuous glucose monitoring technologies in T2DM management only emphasizes the need to individualize dietary assessment and counseling.

Motivational interviewing

Motivational interviewing is a person-centered approach for behavior-change counseling that specifically incorporates collaboration with the individual with diabetes to engage and strengthen their own motivation for change.⁵⁸ Together, patients and clinicians explore individual situations and motivations, and motivational interviewing specifically equips clinicians and educators with the skillset to navigate real-world challenges, resistance, and ambivalence regarding behavior changes. In a diabetes counseling setting, this can look like diabetes physicians and educators acting as partners in goal setting and brainstorming incremental behavioral goals, rather than expecting or implementing sweeping changes or introducing specific diet parameters that may be unattainable for the client and their life circumstance. For example, a provider may first assess current intake patterns for the presence and consistency of meals or snack patterns and identify the health-promoting aspects of current eating behaviors. Collaboratively, the provider and client can identify a starting point for where changes may make sense, using an inclusive, positive nutrition framework.

A recent systematic review and meta-analysis of type 2 diabetes interventions utilizing motivational interviewing demonstrated that this counseling method resulted in a significant improvement in mean HbA1c, compared to a control group.⁵⁹ Another review showed that motivational interviewing was effective in improving glycemic control, increasing physical activity, and implementing dietary changes (e.g., reduced saturated fat and increased fruit intake) among people with diabetes.⁶⁰ A qualitative study among participants of a diabetes intervention grounded in motivational interviewing reported individualized direction and education as well as encouragement without judgement were important themes participants identified in their diabetes self-management success.⁶¹

Eating competence

Because the difficulty of maintaining and sustaining the behavioral changes associated with dietary interventions for diabetes-management is a key reason for decreased efficacy seen over time, a novel strategy to support longer-term diabetes management involves directly supporting the individual's ability to make health-enhancing food and nutrition decisions. Eating competence emphasizes attunement to internal regulation cues paired with appropriate skills and resource utilization to reliably and enjoyably eat foods with a diversity of nutritious choices. The *ecSatter* model conceptualizes four domains of eating competence: flexible and positive attitudes about eating and food, food acceptance (eating a variety of foods), internal regulation of food intake (honoring hunger, fullness and satiety cues), and managing (planning) the context of meals.⁶² This model was developed to characterize eating-related behavior⁶³ and has been researched in relation to health outcomes that are relevant to diabetes self-care. Education and counseling interventions can be applied to help the client acquire the skills to manage the day-to-day tasks associated with eating, including food acceptance, positive attitudes, and appropriate responses to both internal regulation and contextual cues involving food choice and eating behavior. RDNs are uniquely qualified to assist clients in this pursuit. In research, eating

competence is assessed by the *ecSI*, a validated questionnaire consisting of 16 items.⁶² Studies evaluating eating competence in adults have found higher levels of eating competence to be associated with desirable health outcomes; specifically, improved diet quality with higher fiber, fruit, vegetable, and nut intake, and lower sugar intake^{64–67} and improved biomarkers for cardiovascular health.^{67–69} Educational interventions to increase eating competence reported improvements in food resource management (budgeting) and meal planning,⁶⁴ and increased physical activity and fruit and vegetable intake.^{67,70}

Authors of a cross-sectional analysis in the *StopDia* study in Finland reported that participants with higher eating competence scores had lower risk of metabolic syndrome, independent of BMI, compared to those with lower eating competence.⁵⁹ However, the study found that individuals with higher eating competence scores were more likely to have higher household income levels and higher education levels, pointing to the possible roles these social determinants of health may play in the acquisition of eating competence skills. The *StopDia* study evaluated eating competence among individuals at risk for type 2 diabetes, and more needs to be understood regarding the effect of eating competence on self-efficacy and glycemic outcomes within populations who have type 2 diabetes. Nonetheless, it is an interesting and novel concept warranting further study as a measure of internalized and acquired knowledge and skills necessary for self-regulation of food intake and one's ability to eat an adequate diet inclusive of nourishing choices.

Mindful eating and intuitive eating

Mindful eating, the practice of observing one's eating experience in the present moment without judgement, can be explored on its own or integrated into other counseling models, like eating competence, to support individuals with diabetes tune in to physiological cues that drive eating behavior including hunger, fullness, satiety, and emotional state. Mindful eating is not specifically focused on achieving weight loss or specific macronutrient distributions; it is a daily practice that guides food choice driven by internal cues rather than external cues in the environment, social media, or diet culture. Mindful eating can be effective in reducing binge eating and emotional eating.⁷¹ A review summarizing efficacy of mindful eating interventions on eating behavior changes also included improved interoception (perceiving internal body signals), reduced external eating and cravings, reduced restrained eating, and more freedom to eat.⁷¹ These benefits were observed even as results regarding weight-loss outcomes were mixed. The review also evaluated outcomes associated with intuitive eating interventions; notably, mindful eating was studied far more than intuitive eating as a construct of interest.

Intuitive eating is an approach that is distinct from mindful eating, though both strategies reduce the focus on external dieting rules and emphasize attuning to and responding to internal cues (e.g., hunger and satiety) and eating contexts. Key tenants of intuitive eating include permission to eat (recognizing satisfaction and pleasure in eating), addressing and supporting efforts to reduce emotional eating and cognitive distortions, and respecting and nourishing the body.^{64,72} Research on intuitive eating, especially in the context of managing type 2 diabetes, is limited. One recent cross-sectional observational study found intuitive eating (as assessed by the *Intuitive Eating Scale-2*) was associated with lower risk of poor glycemic control.⁷³ More research into intuitive eating as a component of diabetes self-management is needed before drawing conclusions.

A summary of suggested inquiries and key screening questions intended to facilitate clinical conversations is presented in [Fig.2](#). Open-ended questions are preferred to stimulate a dialog about motivation, mindful eating, eating competence, and patients' agency in nutrition-related diabetes self-care. Screening questions, however, are typically yes/no questions that contribute to scores to assess risk, specifically risk of disordered eating behavior in this context. Providers need to choose carefully according to the setting and the patient relationship, remaining

Using Motivational Interviewing

- What is going well for you in terms of your eating patterns for diabetes management?
- What is challenging?
- How ready do you feel to make changes in your lifestyle to support diabetes care?
- How confident are you that you can make changes in your lifestyle to support diabetes care?
- What would help you feel more ready (or confident) in making changes?

Mindfulness

- How do you decide what to eat?
- How do you decide how much to eat?
- How is your eating different when you are alone versus with others?
- How does your mood affect your eating behavior?

Eating Competence

- Tell me about your eating patterns.
- What are your priorities when making food decisions?
- Tell me about your access to the amount and variety of food you need to take care of your diabetes.
- How would you describe your relationship with food?

Selected individual questions that appear in published screening tools for disordered eating behaviors (74-76)

- Eating Disorder Screen for Primary Care (75):
 - Are you satisfied with your eating patterns?
 - Do you ever eat in secret?
 - Does your weight affect how you feel about yourself?
 - Do you currently suffer with or have you ever suffered in the past with an eating disorder?*
- Disordered Eating in Diabetes – Revised (adapted (76)):
 - Do you skip meals or snacks?
 - Do you eat more alone than when you eat with others?
 - Do you avoid checking your blood sugar when you feel like it is out of range?
 - Do you feel that your eating is out of control?
 - Do you alternate between eating very little and eating large amounts?

Fig. 2. Suggested questions to explore motivation, mindfulness, eating competence, and disordered eating risk.

* Note: Individuals' preconceived ideas about what an eating disorder is or who gets diagnosed with eating disorders may influence responses here.⁵² It can be helpful for providers to recognize that binge eating disorder is a relatively new diagnosis and, as such, many who experience it may not have been diagnosed. Further, disordered eating patterns (including restriction and binge eating) occur across a wide range of body sizes (These references cited in this figure.⁷⁴⁻⁷⁶).

aware that close-ended questions may not foster the honest exchange of information desired to fully inform a clinical assessment.

Patient empowerment, self-efficacy, and collaborative decision-making

The counseling approaches reviewed above can selectively be integrated into an individualized diabetes education process to empower patients to understand their diagnosis and how eating patterns and behaviors impact glycemic control. The end goal is to support confidence and

self-efficacy in making the daily decisions involved in diabetes self-care. A patient-centered approach, where individuals with diabetes are included in a shared decision-making process and where their preferences, culture, and values are explicitly considered, has been advocated as a way to improve patient outcomes. Patient-centered self-management interventions have been associated with positive psychosocial and behavioral outcomes and improved glycemic control.⁷⁷ Early and adequate access to patient-centered and skills-based diabetes self-management education can improve patient empowerment and self-efficacy,⁷⁸ if in-

dividuals with diabetes develop skills in planning, selecting, preparing, and consuming foods that support behavioral goals, which, when paired with appropriate glucose monitoring and medication use, can support improved diabetes outcomes.^{79–81} These pieces of evidence endorse the rationale for provider attempts to customize patient interactions and diabetes management plans, applying the tools of motivational interviewing, eating competence, mindfulness and/or intuitive eating to guide each individual patient on their own path toward health-enhancing behavior change.

Ongoing diabetes and nutrition education are warranted as part of individualized care to support clients' evolving understanding of their diabetes, their personal needs, and lifestyle changes necessitated by the progression of the disease over time. In a qualitative study exploring patients' experiences with diabetes nutrition education, many participants described feeling the education they received was insufficient, too simplistic, or outdated and not tailored to their individual needs.⁵² Duration of diabetes, presence or onset of diabetes-related complications, and evolving approaches to providing and implementing diabetes self-management education^{82,83} may inform the decision to recommend additional diabetes education sessions. It may be the case that people need more frequent education, certainly more than what they get at the time of diagnosis when the emotional burden of the news is perhaps highest and the patient's ability to learn and absorb new information is low. Longer-term, consistent follow-up and engagement with a variety of health professionals including diabetes education specialists and RDNs is likely needed to optimize self-efficacy and maintain behavioral changes. Learning and sustaining long-term self-management are necessary to prevent diabetes complications.⁸¹

Finally, mental health concerns, including diabetes distress or burnout, fear of complications or disease progression, experiencing weight stigma, and binge eating can impact individuals' ability to engage in or sustain self-management activities and interfere with optimal blood glucose management.^{52–54,59} For example, a scoping review assessing the barriers and facilitators among adults with T2DM for engaging in physical activity identified three key components to engagement and adherence to recommendations: a self-efficacy component, a clinical component, and a mental health component⁵⁴. Dieting for weight-loss is a risk factor for the development of binge eating behaviors,^{52,84} and the prevalence of disordered eating among people with diabetes has been estimated to be between 18 and 40%.¹⁰ Because binge eating is associated with worse glycemic control, and interrupting binges can improve diabetes-related outcomes^{52,85} people with diabetes should be screened for disordered eating and referred to eating disorder providers for appropriate treatment.^{10,53}

Conclusions

Behavioral approaches to nutritional management of type 2 diabetes are likely to be most successful when a patient-centered model is adopted where treatment plans and advice are highly individualized and respectful of cultural, social, economic, and environmental factors, and supported over time with ongoing education and high-impact patient-provider interactions. Expansion of the team surrounding the client to include, as needed, diabetes educators, registered dietitian nutritionists, mental health providers, and eating disorder specialists will augment the effectiveness of the primary care provider. There is no universally recommended eating pattern, and diabetes self-care requires attunement to both nutrition and physical activity. The common features of evidence-based guidelines endorse positive nutrition: a balanced eating pattern inclusive of meals and snacks, emphasizing fiber-rich plant foods (legumes, nuts, seeds, herbs), a diversity of non-starchy vegetables, nutrient-dense carbohydrate foods (whole grains), fish, and unsaturated vegetable oils. Tools including motivational interviewing and others described in this review will be useful to providers seeking to develop patient self-efficacy for diabetes self-management and health promotion.

Persons with diabetes need ongoing education and support to adopt lifestyle behaviors that promote well-being. This review endorses a variety of eating patterns and tools healthcare providers can use.

Behavioral approaches to nutritional management of type 2 diabetes are likely to be most successful when a patient-centered model is adopted where treatment plans and advice are highly individualized and respectful of cultural, social, economic, and environmental factors, and supported over time with ongoing education and high-impact patient-provider interactions. Expansion of the team surrounding the client to include, as needed, diabetes educators, registered dietitian nutritionists, mental health providers, and eating disorder specialists will augment the effectiveness of the primary care provider. There is no universally recommended eating pattern, and diabetes self-care requires attunement to both nutrition and physical activity. The common features of evidence-based guidelines are discussed in this review. These consistently endorse positive nutrition: a balanced eating pattern inclusive of meals and snacks, emphasizing fiber-rich plant foods (legumes, nuts, seeds, herbs), a diversity of non-starchy vegetables, nutrient-dense carbohydrate foods (whole grains), fish, and unsaturated vegetable oils. Tools including motivational interviewing and others described in this review will be useful to providers seeking to develop patient self-efficacy for diabetes self-management and health promotion.

Declaration of Competing Interest

MGS has no competing interests to report. PAQ is a Senior Consultant to Walden Behavioral Care's Department of Nutrition.

CRedit authorship contribution statement

Meg G. Salvia: Conceptualization, Data curation, Writing – original draft, Writing – review & editing. **Paula A. Quatromoni:** Conceptualization, Writing – original draft, Writing – review & editing.

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