5. Facilitating Positive Health Behaviors and Well-being to Improve Health Outcomes: Standards of Care in Diabetes—2026

Diabetes Care 2026;49(Suppl. 1):S89–S131 | https://doi.org/10.2337/dc26-S005

*American Diabetes Association Professional Practice Committee for Diabetes**

The American Diabetes Association (ADA) "Standards of Care in Diabetes" includes the ADA's current clinical practice recommendations and is intended to provide the components of diabetes care, general treatment goals and guidelines, and tools to evaluate quality of care. Members of the ADA Professional Practice Committee for Diabetes, an interprofessional expert committee, are responsible for updating the Standards of Care annually, or more frequently as warranted. For a detailed description of ADA standards, statements, and reports, as well as the evidence-grading system for ADA's clinical practice recommendations and a full list of Professional Practice Committee members, please refer to Introduction and Methodology. Readers who wish to comment on the Standards of Care are invited to do so at professional.diabetes.org/SOC.

Building positive health behaviors and maintaining psychological well-being are foundational for achieving diabetes management goals and maximizing quality of life (1,2). Essential to achieving these goals are diabetes self-management education and support (DSMES), medical nutrition therapy (MNT), routine physical activity, adequate quality sleep, support for cessation of tobacco products and vaping, health behavior counseling, and psychosocial care. Following an initial comprehensive health evaluation (see section 4, "Comprehensive Medical Evaluation and Assessment of Comorbidities"), health care professionals should engage in person-centered collaborative care with people with diabetes (3–7). Person-centered collaborative care is guided by shared decision-making in treatment plan selection; facilitating access to medical, behavioral, psychosocial, educational, and technological resources and support; and shared monitoring of agreed-upon diabetes care plans and behavioral goals (8,9). Routine care evaluations should include assessments of medical and behavioral health outcomes, particularly during periods of changes in health and well-being.

DIABETES SELF-MANAGEMENT EDUCATION AND SUPPORT

Recommendations

5.1 Advise all people with diabetes to participate in developmentally and culturally appropriate diabetes self-management education and support (DSMES) to facilitate informed decision-making, self-care behaviors, problem-solving, and active collaboration with the health care team. **A**

5.2 Provide DSMES at diagnosis, annually and/or when not meeting treatment goals, when complicating factors develop (e.g., medical, functional, and psychosocial), and when transitions in life and care occur. **E**

**A complete list of members of the American Diabetes Association Professional Practice Committee for Diabetes can be found at https://doi.org/10.2337/dc26-SINT.*

Duality of interest information for each contributor is available at https://doi.org/10.2337/dc26-SDIS.

Suggested citation: American Diabetes Association Professional Practice Committee for Diabetes. 5. Facilitating positive health behaviors and well-being to improve health outcomes: Standards of Care in Diabetes—2026. Diabetes Care 2026;49 (Suppl. 1):S89–S131

5.3 Assess clinical outcomes, health status, and well-being as key goals of DSMES on an individualized timeframe. **C**
5.4 Use behavioral strategies (e.g., motivational interviewing, goal setting, problem-solving) to support DSMES and engagement in behaviors known to optimize health-related quality of life and outcomes. **A**
5.5 Provide culturally and socially appropriate DSMES responsive to personal preferences and needs in group or individual settings. **A** Communicate DSMES participation with the diabetes care team. **E**
5.6 Offer DSMES via telehealth and/or digital interventions to meet individual preferences, reduce access barriers, and improve satisfaction. **B**
5.7 DSMES can improve outcomes and reduce costs, so reimbursement by third-party payors is recommended. **B**
5.8 Identify and address barriers to DSMES that exist at the payor, health system, clinic, health care professional, and individual levels. **E**
5.9 Assess the social determinants of health to guide and design delivery of DSMES to maximize health equity across populations. **C**

The overall objectives of DSMES are to support informed decision-making, self-care behaviors, problem-solving, and active collaboration with the health care team to improve clinical outcomes, health status, and well-being in a cost-effective manner (2). DSMES facilitates the knowledge, decision-making, and skills mastery necessary for optimal diabetes self-care and incorporates the needs, goals, and life experiences of the person with diabetes (10). When providing DSMES, health care professionals should consider a person's burden of treatment, level of self-efficacy for self-care behaviors, and degree of social and family support. Engagement in self-management behaviors and subsequent clinical outcomes, health status, and quality of life, in addition to psychosocial factors affecting the person's ability to self-manage, should be monitored on an individualized timeframe (e.g., the four critical times listed in Recommendation 5.2). A randomized controlled trial (RCT) that evaluated a decision-making education and skill-building program (11) improved health outcomes and quality of care (12).

Using judgmental words is associated with increased feelings of shame and guilt; therefore, health care professionals should consider the impact language has on building therapeutic and productive relationships. Health care professionals should use positive, strengths-based words and phrases that put people first (13). See section 4, "Comprehensive Medical Evaluation and Assessment of Comorbidities," for more on use of language.

In accordance with the "2022 National Standards for Diabetes Self-Management Education and Support" (here referred to as the National Standards for DSMES) (10), all people with diabetes should participate in developmentally appropriate and culturally sensitive DSMES, as it helps people with diabetes identify and implement effective self-management strategies and coping skills (2). DSMES includes collaborative goal setting that improves empowerment, self-management, and quality of life as the person with diabetes encounters new challenges and as advances in treatment become available (14–16). Moreover, DSMES should be thought of as an ongoing process—not a one-time occurrence. The National Standards for DSMES (10) include delivery of content addressing:

- Pathophysiology of diabetes and treatment options
- Healthy coping
- Healthy eating
- Being active
- Taking medication
- Monitoring
- Reducing risk (treating acute and chronic complications)
- Problem-solving and behavior change strategies

In addition to providing DSMES upon diagnosis, there are additional critical time points when the need for DSMES should be evaluated by the health care professional and/or interprofessional team, with referrals made as needed (2):

- Annually and/or when not meeting treatment goals, whichever is more frequent
- When complicating factors (e.g., health conditions, physical or functional limitations, emotional factors, and basic living needs) that influence self-management develop
- When transitions in life and care occur

DSMES empowers individuals with diabetes and their families by providing tools to make informed self-management decisions (10,13). DSMES should be person-centered—placing the person with diabetes and their family and/or support system at the center of the care model as they work in collaboration with health care professionals. Person-centered care is respectful of and responsive to individual and cultural preferences, needs, and values and ensures the personal values of those living with diabetes guide decision-making (17).

Evidence for the Benefits

DSMES is associated with improved diabetes knowledge and self-care behaviors (18,19), lower A1C (19–22), lower self-reported weight (23), improved quality of life (24,25), reduced all-cause mortality risk (26), positive coping behaviors (6,27), and lower health care costs (28–30). DSMES is also associated with an increased use of primary care and preventive services (28,31) and less frequent use of acute care and inpatient hospital services (23). People with diabetes who participate in DSMES are more likely to follow best practice treatment recommendations, particularly those with Medicare, and have lower Medicare and insurance claim costs (31,32). DSMES interventions have better outcomes when they are >10 h over the course of 6–12 months (20) and provide ongoing culturally (31,33,34) and age-appropriate (35,36) support (14,15,37). Additionally, DSMES is also more effective when it is tailored to individual needs and preferences, addresses psychosocial issues, and incorporates behavioral strategies (13,27,38,39). Individual and group approaches are effective (23,40), with a slight benefit realized by those who engage in both (20).

Strong evidence now exists for the benefits of telehealth, telemedicine, and telephone-based or internet-based (i.e., virtual) DSMES for diabetes prevention and management in a wide variety of populations and age-groups (10,41–43). When feasible, the best choice for delivery of DSMES is whatever approach aligns best with individual preferences. A 2023 systematic review and meta-analysis of RCTs reported moderate evidence indicating digital health technologies (e.g., mobile apps, websites, digital coaching, and SMS [i.e., texting]) can be effective modes of intervention delivery for DSMES. In fact, telehealth-based interventions have been found to produce a greater reduction in A1C (−0.30 percentage points; 95% CI −0.42 to −0.19) compared with control (42). Importantly, these digital methods provide outcomes that are comparable with or even better than those seen with traditional in-person care (42). Greater A1C reductions are demonstrated with increased virtual engagement, although data from trials are heterogeneous.

Diabetes care and education specialists (DCES) are effective providers of DSMES. Members of the DSMES team can include a variety of health care professionals such as nurses (registered nurses and nurse practitioners), registered dietitian nutritionists (RDNs), pharmacists, social workers, certified health education specialists, exercise physiologists, psychologists and behavioral health professionals, community health workers, care coordinators or navigators, and others who can tailor curricula to individual needs (44–46). Team members acting in a DCES capacity should have specialized clinical knowledge of diabetes and behavior change principles. In addition, a DCES needs to be knowledgeable about technology-enabled services and can serve as a technology champion within their practice (47). Credentials such as certified DCES (cbdce.org/) and/or board certification in advanced diabetes management (BC-ADM) (diabeteseducator.org/education/certification/bc_adm) demonstrates an individual's specialized training and expertise in diabetes management, education, and support (10), and engagement with qualified professionals has been shown to improve diabetes-related outcomes (48). There is also continued and growing evidence for the role of community health workers, peer educators, peer support, and lay leaders in providing ongoing diabetes self-management support (49,50). In locations where there are no DCES services available, other members of the diabetes care team can provide some aspects of DSMES; however, billing restrictions need to be considered (51).

Social determinants of health (SDOH) are an important aspect of diabetes care and should be assessed and weighed in guiding the design and delivery of DSMES. The DSMES team needs to consider characteristics such as racial identity, ethnic and cultural background, biological sex and gender identity, age, geographic location, technology access, education, literacy, and numeracy (13). Barriers to equitable DSMES access can be mitigated by assessing the impact of the individual's SDOH and leveraging creative delivery options (e.g., telehealth and online) that will work best for the population in need of DSMES (10). For example, a systematic review and meta-analysis of telehealth DSMES interventions with Black and Hispanic adults with diabetes showed a 0.465% decrease in A1C, demonstrating the importance of considering demographic factors in relation to DSMES interventions (43).

Despite the recognized benefits of DSMES, fewer than 10% of individuals referred for DSMES through their health insurance or Medicare receive it, while about half the participants in an analysis of Behavioral Risk Factors Surveillance System (BRFSS) data report getting diabetes education (22,52). Barriers to DSMES exist at multiple levels, including the health system, payor, clinic, health care professional, and individual, for a myriad of reasons from lack of administrative leadership support to ineffective DSMES referral processes and transportation challenges. Low participation can be due to lack of referrals, logistical issues (e.g., accessibility, timing), cost, and lack of a perceived benefit (53). Thus, in addition to educating referring health care professionals about the benefits of DSMES and the critical times to refer, efforts to identify and address potential barriers at all levels need to be made (2). This was illustrated in a multilevel diabetes care intervention that combined clinical outreach, standardized protocols, and DSMES, with SDOH screening and referrals to social needs support. A 15% increase in receipt of DSMES, including among people on Medicaid, was documented (54). Support from institutional leadership is foundational for DSMES success. Expert stakeholders, including those external to an organization, should also support DSMES by advocating for it and for people with diabetes (10).

Diabetes Technologies

Technology-enabled diabetes self-management solutions (e.g., continuous glucose monitors [CGM], automated insulin delivery [AID] systems, and connected glucose meters) improve A1C most effectively when there is two-way communication between the person with diabetes and the health care team, individualized (e.g., tailored to suit a particular person for their needs) feedback, use of person-generated health data, and education (55). Technology can facilitate self-management decisions and improve access to DSMES (55). Use of diabetes technologies warrants broader adoption because they can reduce therapeutic inertia and should be explored as part of continuous improvement (55,56). One potential model is virtual environments, which allow people with diabetes to self-represent as avatars and interact in a world with embedded informational resources accessed using principles of gamification. An example of this is from an RCT that tested DSMES in a virtual environment that demonstrated greater weight loss and similar decreases in A1C, blood pressure, cholesterol, and triglycerides compared with DSMES via a standard website (57). These nontraditional versions of DSMES may not always be reimbursed; however, adopting reimbursement policies that increase DSMES access and use will positively affect beneficiaries' clinical outcomes, quality of life, health care use, and costs (10,58).

Of all the newer diabetes technologies, CGM might be the most widely adopted. When combined with individualized DSMES or behavioral interventions, CGM demonstrated greater improvement of glycemic and psychosocial outcomes than CGM alone (59,60). Similarly, DSMES plus intermittently scanned CGM (isCGM) demonstrated increased time in range (70–180 mg/dL [3.9–10.0 mmol/L]), less time above range, and greater reduction in A1C compared with DSMES alone (61). Incorporating a systematic approach for technology assessment, adoption, and integration into the diabetes care plan could help ensure equity in access and standardized application of technology-enabled solutions (9,47,62–64).

Reimbursement

Medicare reimburses DSMES (known as diabetes self-management training [DSMT] by Medicare) when the services are provided in accordance with the National Standards for DSMES (2,10) and is recognized by the American Diabetes Association (ADA) through the Education Recognition Program (professional.diabetes.org/diabetes-education) or by the Association of Diabetes Care & Education Specialists (ADCES) (https://www.adces.org/diabetes-education-dsmes/diabetes-education-accreditation-program).

DSMES is also covered by most insurance plans. Ongoing support has been shown to be instrumental for improving outcomes when it is implemented after the completion of formal DSMES. For comprehensive information about Medicare reimbursement, readers may find the following website useful: www.cdc.gov/diabetes-toolkit/php/reimbursement/medicare-reimbursement-guidelines.html. In brief, the Medicare Part B initial DSMT is a "once-in-a-lifetime" benefit. Individual encounters are reimbursable for the first 10 h (1 h of individual training and 9 h of group training). Two hours of follow-up DSMT are allowed each year after the initial DSMT. If a person has special needs that could interfere with effective group participation, these should be identified on the referral order to allow for individual sessions. For Medicaid, DSMES coverage varies by state, but further guidance can be found at https://coveragetoolkit.org/evidence-based-programs/diabetes-self-management-education-and-support/. Additional information addressing implementation of a successful DSMES program can be found in the Centers for Disease Control and Prevention DSMES toolkit at www.cdc.gov/diabetes-toolkit/php/index.html.

Programs recognized by the ADA and accredited by the ADCES were included on the list of telehealth professionals approved by Centers for Medicare & Medicaid Services (CMS) via the Consolidated Appropriations Act of 2023 (65). However, as of 1 October 2025, Medicare recipients must be in a U.S.-based rural office or medical facility for most telehealth services (66,67).

DSMES uses an evidence-based curriculum designed to educate people with diabetes about all elements from the National Standards for DSMES, as described above, that can be delivered and billed by a variety of health care professionals on the diabetes care team. While the overarching healthy eating concepts used in DSMES can be taught by all members of the team, MNT, which is more in-depth and individualized (e.g., tailored to suit a particular person for their sociocultural preferences and needs) and derived from the evidence-based Nutrition Care Process, can only be delivered and billed by RDNs. For Medicare Part B, the MNT benefit includes individual encounters billed 3 h in the first year of the benefit. Each subsequent year can be billed up to 2 h. However, additional hours are available if a subsequent referral identifies a change in treatment. For further information on Medicare coverage of MNT, readers are encouraged to review www.cdc.gov/diabetes-toolkit/php/reimbursement/medical-nutrition-therapy.html.

MEDICAL NUTRITION THERAPY

When the first ADA Standards of Care guidelines were published in 1989, nutrition was mentioned in only two sentences of the entire 4-page document (68). Even today, the science of nutrition for diabetes continues to evolve. There has also been a change in how we talk about nutrition. We continue to encourage health care professionals to shift away from emphasizing macronutrients (i.e., carbohydrates, proteins, and fats) and micronutrients (i.e., vitamins and minerals) and to instead focus on foods. More broadly, we encourage people to think in terms of eating patterns, also known as dietary patterns or food patterns, or the totality of the foods and beverages a person consumes. Additionally, encourage nutrient-dense food choices. Nutrient dense is defined as foods high in micronutrients while being relatively low in calories (e.g., vegetables, fruits, and legumes). This integrative food-based approach aligns with numerous guidelines from multiple professional health societies (69–71) and the *Dietary Guidelines for Americans, 2020–2025* (72). Simply put, people eat food, not nutrients, and nutrition recommendations need to be applicable to what people actually eat. Additionally, macronutrients are not interchangeable entities and vary by nutrient type and quality. For example, carbohydrates include legumes, whole grains, and fruits, which are in the same category as refined grains, but their health effects are quite different (73).

MNT is effective and beneficial to people with diabetes. When delivered by an RDN, MNT is associated with A1C absolute decreases of 1.0–1.9% for people with type 1 diabetes and 0.3–2.0% for people with type 2 diabetes (74). Because diabetes is progressive, behavior modification alone may not be adequate to maintain euglycemia over time. However, even after pharmacotherapy is initiated, MNT continues to be an important component of ongoing diabetes self-management, and RDNs providing diabetes-specific MNT should assess and monitor medication changes in relation to nutrition care plans (46,75). All health care team members should be empowered to reiterate the general and evidence-based nutrition advice promoted herein—limit processed foods and foods high in added salt, sugars, and fats and, when possible, choose whole foods.

For more detailed information on nutrition therapy for people with diabetes, please refer to the ADA consensus report on nutrition therapy (46). Contained in the report is an important and often repeated tenet, i.e., there is no one-size-fits-all eating pattern for individuals with diabetes, and meal planning should be individualized. Nutrition therapy plays an integral role in overall diabetes management, and each person with diabetes should actively engage in education, self-management, and treatment planning with the health care team and participate in collaborative development of an individualized eating plan (46,75).

All people with diabetes should be referred for individualized MNT provided by an RDN who is experienced and skilled in providing diabetes-specific MNT (76–78), at diagnosis and as needed throughout the life span, like DSMES. Referrals to RDNs are particularly warranted when a person with diabetes is dealing with additional health conditions such as hypertension, dyslipidemia, heart failure, gastrointestinal disorders, chronic kidney disease (CKD), pregnancy-related nutrition concerns, pediatric growth issues, or obesity (79). See **Table 5.1** for nutrition recommendations and **Table 5.2** for nutrition behaviors that should be encouraged.

Eating Patterns and Meal Planning

To better understand the role of nutrition in diabetes, it is important to clarify terminology. Food patterns, eating plans, and approaches are terms that are often used interchangeably, but they are different and relevant in individualizing nutrition care plans (80).

- **Eating pattern, dietary pattern, or food pattern.** The totality of all foods and beverages consumed over a given period of time. An eating pattern can be ascribed to an individual, but it is also the term used in prospective cohort and observational nutrition studies to classify nutrition patterns. Examples include Mediterranean style, Dietary Approaches to Stop Hypertension (DASH), low carbohydrate, vegetarian, and plant based (80).
- **Eating/meal plan (historically referred to as a diet).** An individualized guide to plan when, what, and how much to eat on a daily basis, completed by the person with diabetes and the RDN. The eating plan could incorporate an eating pattern combined with a strategy to direct some of the choices. Eating plans are based on an individual's usual

Table 5.1—Nutrition recommendations

Recommendations
5.10 Provide individualized medical nutrition therapy by referring people with prediabetes or diabetes to a registered dietitian nutritionist, preferably one who has comprehensive experience in diabetes care. **A**
5.11 Diabetes medical nutrition therapy can result in cost savings **B** and improved cardiometabolic outcomes **A** and should be reimbursed by insurance. **E**
5.12 Provide an overweight or obesity treatment plan based on their nutrition, physical activity, and behavioral health status for all people with overweight or obesity, aiming for at least 5–7% weight loss. **A**
5.13 For diabetes prevention and management of people with prediabetes or diabetes, recommend individualized meal plans that keep nutrient quality, total calories, and metabolic goals in mind. **B**
5.14 Eating patterns should emphasize key nutrition principles (inclusion of nonstarchy vegetables, whole fruits, legumes, lean proteins, whole grains, nuts and seeds, and low-fat dairy or nondairy alternatives) and minimize consumption of red meat, sugar-sweetened beverages, sweets, refined grains, processed and ultraprocessed foods in people with prediabetes and diabetes. **B**
5.15 Consider reducing carbohydrate intake for some adults with diabetes to improve glycemia. An effective way to achieve this is by limiting consumption of processed foods. **B**
5.16 Assess intake of supplements, as supplementation with micronutrients (e.g., vitamins and minerals, such as magnesium or chromium) or herbs or spices (e.g., cinnamon and aloe vera) is not recommended for glycemic benefits. **C**
5.17 Counsel against β-carotene supplementation, as there is evidence of harm for certain individuals and it confers no benefit. **B**
5.18 Advise adults with diabetes and those at risk for diabetes who consume alcohol to not exceed the recommended daily limits. **B** Advise abstainers to not start drinking alcohol, even in moderation. **B**
5.19 Counsel people with diabetes about the signs, symptoms, and self-management of delayed hypoglycemia and the importance of monitoring glucose after drinking alcohol to reduce hypoglycemia risk, especially when using insulin or insulin secretagogues. **B**
5.20 Counsel people with diabetes to limit sodium consumption to <2,300 mg/day, as clinically appropriate, and the best way to achieve this is through limiting consumption of processed foods. **B**
5.21 Encourage people with diabetes and those at risk for diabetes to consume water over other beverages. **A**
5.22 Counsel people with diabetes and those at risk for diabetes that nonnutritive sweeteners can be used in place of sugar-sweetened products if consumed in moderation and for the short term to reduce overall calorie and carbohydrate intake. **B**
5.23 Counsel and regularly monitor individuals pursuing intentional weight loss to ensure adequate nutritional intake, with particular attention to preventing protein insufficiency and micronutrient deficiencies. **E**
5.24 Emphasize minimally processed, nutrient-dense, high-fiber sources of carbohydrate (at least 14 g fiber per 1,000 kcal). **B**
5.25 Advise people with diabetes and those at risk for diabetes to replace sugar-sweetened beverages (including any juices) with water or low-calorie or no-calorie beverages and minimize foods with added sugar to manage glycemia and reduce risk for cardiometabolic disease. **B**
5.26 Educate individuals with diabetes who are at risk for developing diabetic ketoacidosis and who are treated with sodium–glucose cotransporter inhibition on the risks and signs of ketoacidosis and methods of risk mitigation management, provide them with appropriate tools for ketone measurement (i.e., serum β-hydroxybutyrate), and discourage a ketogenic eating pattern. **E**
5.27 Provide education on the glycemic impact of carbohydrate, **A** fat, and protein **B** tailored to an individual's needs, insulin plan, and preferences for care to optimize mealtime insulin dosing.
5.28 Counsel people using fixed insulin doses about consistent patterns of carbohydrate intake with respect to time and amount while considering the insulin action time, as it can result in improved glycemia and reduce the risk for hypoglycemia. **B**
5.29 Counsel people with diabetes and those at risk for diabetes to incorporate more plant-based protein sources (e.g., nuts, seeds, and legumes) as part of an overall diverse eating pattern to reduce cardiovascular disease risk. **B**
5.30 Counsel people with diabetes and those at risk for diabetes to consider an eating plan emphasizing elements of a Mediterranean eating pattern, which is rich in fatty fish, nuts, and seeds, to reduce cardiovascular disease risk **A** and improve glucose metabolism. **B**
5.31 Counsel people with diabetes and those at risk for diabetes to limit intake of foods high in saturated fat to help reduce cardiovascular disease risk. **B**

eating style, cultural background, SDOH, and food preferences.

- **Eating/meal plan approach.** Method to individualize a desired eating pattern and provide practical tools for developing healthy eating patterns. Examples include the plate method, carbohydrate choice, carbohydrate counting, and highly individualized behavioral approaches (81).

Meal Planning

There is no ideal percentage of calories from carbohydrate, protein, or fat for people with diabetes. Therefore, macronutrient distribution should be based on an individualized assessment of current eating patterns, preferences, and metabolic goals. Members of the health care team should complement and reinforce MNT by providing evidence-based guidance to help

Table 5.2—Nutrition behaviors to encourage

• Vegetables—especially nonstarchy vegetables that are dark green, red, and orange in color; fresh, frozen, or low-sodium canned are all acceptable vegetable options.
• Legumes—dried beans, peas, and lentils.
• Fruits—especially whole fruit—fresh, frozen, or canned in own juice (or no added sugar) are all acceptable fruit options.
• Foods with at least 3 g of fiber per serving are generally considered higher fiber choices. Whole-grain foods—where culturally appropriate, whole-grain versions of commonly consumed foods, such as 100% whole-wheat breads or pastas and brown rice. When not culturally appropriate, focus more on portion control.
• Water should be the primary beverage of choice.
• For individuals who do not prefer plain water, no-calorie alternatives are the next best choice. Options include adding lemon, lime, berries, or cucumber slices to water; sparkling no-calorie water or flavored no-calorie waters; no-calorie carbonated beverages.
• Plant-based proteins can include legumes (e.g., soybeans, pinto beans, black beans, garbanzo beans, dried peas, and lentils), nuts, and seeds.
• Meats and poultry should be from fresh, frozen, or low-sodium canned and in lean forms (e.g., chicken breast and ground turkey).
• Heart-healthy wild-caught fatty fish such as salmon, tuna, sardines, and mackerel. Fresh, frozen, or low-sodium canned are all acceptable options.
• Use herbs (e.g., basil, fennel, mint, parsley, rosemary, and thyme) and spices (e.g., cinnamon, garam masala, ginger, pepper, and turmeric) to season foods instead of salt or salt-containing preparations.
• Incorporate onions, garlic, celery, carrots, and other vegetables as a base for preparing various homemade foods.
• Cook with vegetable oil (e.g., avocado, canola, and olive) in place of fats high in saturated fat (e.g., butter, coconut oil, lard, and shortening).
• Plan out meals for the week. Grocery shop using a list. Cook on a day off so there are ready-to-eat and ready-to-reheat homemade meals waiting in the fridge or freezer.
• Include family or roommates in meal preparation; share the responsibilities of grocery shopping and cooking and use time off for meal preparation in advance when possible.

people with diabetes make healthy food choices that meet their individualized needs and improve overall health. Ultimately, ongoing diabetes and nutrition education paired with appropriate support to implement and sustain health behaviors are recommended (78).

Research confirms a variety of eating patterns are acceptable for diabetes management (46,74,82,83). Evidence-based eating patterns most frequently recommended include Mediterranean, DASH, low-fat, carbohydrate-restricted, vegetarian, and vegan eating patterns. Until evidence around benefits of specific eating patterns is strengthened, health care professionals should focus on the common core characteristics among healthful patterns: inclusion of nonstarchy vegetables, whole fruits, legumes, whole grains, nuts, seeds, and low-fat dairy products or nondairy replacements and minimizing consumption of red meat, sugar-sweetened beverages, sweets, refined grains, and processed and ultraprocessed foods (84,85). The recent Dietary Approaches to Stop Hypertension for Diabetes (DASH4D) RCT further supports this guidance (86). In their randomized crossover feeding study conducted from 2021 to 2024, adults with type 2 diabetes and hypertension improved time in range (mean difference 5.2%; $P < 0.001$) and blood pressure. The intervention eating pattern was moderate in carbohydrates (45% of total calories), rich in fruits, vegetables, whole grains, lean proteins, and low-fat dairy, and low in saturated fat, sugar-sweetened beverages, and sodium.

Referral to and ongoing support from an RDN is essential to assess the overall nutrition status of the person with diabetes. RDNs work collaboratively with people to create a personalized meal plan aligned with the overall lifestyle treatment plan, including physical activity, work and life schedules, and medication use. Using shared decision-making to execute the plan is also often part of the nutrition care process.

Eating/Meal Plan Approaches and Methods

Few head-to-head studies have compared different eating approaches. The diabetes plate method (87) is a commonly used visual approach for providing basic meal planning guidance for individuals with type 1 and type 2 diabetes. One RCT found that both the diabetes plate method and carbohydrate counting were effective in helping achieve improved A1C (88). The diabetes plate method uses a simple graphic (featuring a 9-in plate) to portion foods (one-half of the plate for nonstarchy vegetables, one-quarter of the plate for protein, and one-quarter of the plate for carbohydrates).

Carbohydrate counting is a more advanced skill that helps plan for and track how much carbohydrate is consumed at meals and snacks. In a systematic review and meta-analysis of carbohydrate counting versus other forms of meal planning advice (e.g., standard education, low glycemic index [GI], and fixed carbohydrate quantities), no significant differences were seen in A1C levels compared with standard education (89). In another RCT, a simplified carbohydrate counting tool based on individual glycemic response was noninferior to conventional carbohydrate counting in 85 adults with type 1 diabetes (90). In a randomized crossover trial, carbohydrate counting and qualitative meal size (i.e., low, medium, and high carbohydrate) were compared. Time in range was 74% for carbohydrate counting and 70.5% for the quantitative meal size estimates. Noninferiority was not confirmed for the qualitative method (91). Newer technologies (e.g., smart phone apps and CGM) and

AID systems may reduce the need for precise carbohydrate counting and allow for personalized nutrition approaches (92,93).

Meal planning approaches should be customized to the individual, including their numeracy and food literacy level (88). Health numeracy refers to understanding and using numbers and numerical concepts in relation to health and self-management. Food literacy generally describes proficiency in food-related knowledge and skills that ultimately affect health, although specific definitions vary across initiatives (94,95).

Nutrition Therapy Goals for All People With Diabetes

1. To promote and support healthful eating patterns, emphasizing a variety of nutrient-dense foods in appropriate portion sizes, contributing to improved overall health, and to:
   - achieve and maintain body weight goals
   - attain individualized glycemic, blood pressure, and lipid goals
   - delay or prevent the complications of diabetes
2. To address individual nutrition needs based on personal and cultural preferences, health literacy and numeracy, access to healthful foods, willingness and ability to make behavioral changes, and existing barriers to change
3. To maintain the pleasure of eating by providing nonjudgmental messages about food choices while also reducing or limiting certain foods only when indicated by scientific evidence
4. To provide an individual with diabetes the practical tools for developing healthy eating patterns rather than focusing on individual macronutrients, micronutrients, or single foods

Carbohydrates

Studies examining the optimal amount of carbohydrate intake for people with diabetes are inconclusive, although monitoring carbohydrate intake is a key strategy in reaching glucose goals in people with type 1 and type 2 diabetes (96,97).

The amount of carbohydrate intake for people with type 2 diabetes has been a focus of research for many years. Systematic reviews and meta-analyses of RCTs report carbohydrate-restricted eating patterns, particularly those considered very low carbohydrate (<26% total energy), were effective in reducing A1C in the short term (<6 months), with less difference in eating patterns beyond 1 year (80,98,99). However, in a 12-week RCT among adults with prediabetes and type 2 diabetes, a well-formulated ketogenic eating pattern (20–50 g total carbohydrate/day and keeping protein to ∼1.5 g/kg ideal body weight/day, with the remainder of energy from fat) did not significantly improve A1C and increased LDL cholesterol compared with a low-carbohydrate Mediterranean eating pattern (99). Additionally, a systematic review and meta-analysis of six RCTs at least 12 months in duration and including a total of 524 participants with type 2 diabetes reported that a low-carbohydrate eating pattern was beneficial for lipids but not glycemic management (standardized mean difference −0.11, 95% CI −0.33 to 0.11, $P = 0.32$) (100).

Reduction in body weight and the wide range of definitions for low-carbohydrate eating plans are important challenges in interpreting carbohydrate-restricted research studies (101–103). As studies on low-carbohydrate eating plans generally indicate challenges with long-term sustainability (104), it is important to reassess and individualize meal plan guidance regularly for those interested in this approach.

Health care professionals should maintain consistent medical oversight of individuals following very-low-carbohydrate eating plans and recognize that insulin and other diabetes medications may need to be adjusted to prevent hypoglycemia, and blood pressure will need to be monitored. In addition, very-low-carbohydrate eating plans are not currently recommended for individuals who are pregnant or lactating, children, people who have kidney disease, or people with or at risk for disordered eating (46).

Very-low-carbohydrate eating plans should be avoided in those taking sodium–glucose cotransporter 2 (SGLT2) inhibitors because of the potential risk of ketoacidosis (105,106). Numerous case reports have now been published illustrating that diabetic ketoacidosis (DKA) can occur in people with type 1 and type 2 diabetes using SGLT2 inhibitors in combination with very-low-carbohydrate or ketogenic eating patterns. Additionally, excessive alcohol intake should be avoided when taking SGLT2 inhibitors (105). Maintaining adequate hydration is also very important.

Regardless of carbohydrate quantity in the meal plan, the focus should be on high-quality, minimally processed, nutrient-dense, high-fiber carbohydrate sources. Fiber modulates gut microbiota composition and increases gut microbial diversity. Although there is still much to be elucidated about the gut microbiome and chronic disease, higher-fiber eating patterns are advantageous (107). Both children and adults with diabetes are encouraged to minimize intake of refined carbohydrates with added sugars, fat, and sodium and instead focus on carbohydrates from vegetables, legumes, fruits, dairy (milk and yogurt) or fortified nondairy alternatives, and whole grains. People with diabetes and those at risk for diabetes are encouraged to consume a minimum of 14 g of fiber/1,000 kcal, with at least half of grain consumption being whole, intact grains, according to the *Dietary Guidelines for Americans, 2020–2025* (72). Regular intake of sufficient fiber is associated with lower all-cause mortality in people with diabetes, and prospective cohort studies have found fiber intake is inversely associated with risk for type 2 diabetes (108, 109). Consumption of sugar-sweetened beverages and processed food products with large amounts of refined grains and added sugars is strongly discouraged (72), as these can displace healthier, more nutrient-dense foods and increase inflammation (110).

The literature on GI and glycemic load (GL) in individuals with diabetes is complex, often with varying definitions of low- and high-GI foods (111–113). The GI ranks carbohydrate foods on their postprandial glycemic response, and GL considers both the GI of foods and the amount of carbohydrate eaten. Studies report mixed effects of GI and GL on fasting glucose levels and A1C, with one systematic review finding no significant effect on A1C (112) while others demonstrated A1C reductions of 0.15% (111) to 0.5% (114,115). More recently, however, a meta-analysis of large cohorts (≥100,000 participants) reported that when people had larger intakes of high-GI foods, there was increased incidence of type 2 diabetes (risk ratio 1.27 [95% CI 1.21–1.34]; $P < 0.0001$), total cardiovascular disease (CVD) (1.15 [1.11–1.19]; $P < 0.0001$), diabetes-related cancer (1.05 [1.02–1.08]; $P = 0.0010$), and all-cause mortality (1.08 [1.05–1.12]; $P < 0.0001$) (113). It is important to note that low GI or low GL is synonymous with higher-fiber eating patterns.

Individuals with type 1 or type 2 diabetes taking insulin at mealtime should be offered comprehensive and ongoing education about nutrition content and the need to couple insulin administration with carbohydrate intake. For people whose meal schedule or carbohydrate consumption is variable, education on the relationship between carbohydrate intake and insulin needs is important. In addition, assessing food literacy, numeracy, interest, and capability should be evaluated, especially if teaching more advanced methods of MNT diabetes management such as insulin-to-carbohydrate ratios. Teaching insulin-to-carbohydrate ratios for meal planning can assist individuals with effectively modifying insulin dosing from meal to meal to improve glycemic management (74,96). Consumption of fat and protein can affect early and delayed postprandial glycemia (116), and it appears to have a dose-dependent response (117,118). However, more research is needed to determine the optimal insulin dose and delivery strategy. A cautious approach to increasing insulin doses for high-fat and/or high-protein mixed meals is recommended to address delayed hyperglycemia that may occur after eating (46,119). For individuals using an insulin pump, a split bolus feature (part of the bolus delivered immediately and the remainder over a programmed duration of time) may provide better insulin coverage for high-fat and/or high-protein mixed meals (120,121).

Insulin dosing decisions should be confirmed with a structured approach to blood glucose monitoring or CGM to evaluate individual responses and guide insulin dose adjustments. Checking glucose 3 h after eating may help determine if additional insulin adjustments are required (i.e., increasing or stopping bolus) (120,121). For individuals on a fixed daily insulin schedule, meal planning should emphasize a relatively fixed carbohydrate consumption pattern with respect to both time and amount while considering insulin action. Attention to hunger and satiety cues also helps (46).

Most commercially available AID systems still require basic diabetes management skills, including carbohydrate counting and understanding of the effect of protein and fat on postprandial glucose response, but the algorithms included in the systems work with less accurate carbohydrate entry (122,123). The most advanced AID system provides adaptive closed-loop algorithms enabling fully autonomous insulin delivery automatically titrating all therapeutic insulins, including basal, correction, and prandial insulins. For more on AID and carbohydrates, see section 7, "Diabetes Technology."

Protein

There is no evidence that adjusting the daily protein intake above or below the recommended amount for the general public (typically 0.8–1.5 g/kg body weight/day or 15–20% of total calories) will improve health, and research is inconclusive regarding the ideal amount of dietary protein to optimize either glycemic management or CVD risk (72,124). Therefore, protein intake goals should be individualized based on current eating patterns. Some research has found successful management of type 2 diabetes with meal plans including slightly higher levels of protein (20–30%), which may contribute to increased satiety (125).

Historically, low-protein eating plans were advised for individuals with diabetes-related CKD (with albuminuria and/or reduced estimated glomerular filtration rate [eGFR]); however, current evidence does not suggest that people with CKD need to restrict protein to less than the generally recommended protein intake (126). Reducing the amount of protein below the recommended daily allowance of 0.8 g/kg is not recommended because it does not alter glycemic measures, cardiovascular risk measures, or the rate at which eGFR declines and may increase risk for malnutrition (126).

Growing evidence suggests higher plant protein intake and replacement of animal protein with plant protein is associated with lower risk of all-cause and cardiovascular mortality. A meta-analysis of 13 RCTs showed that replacing animal proteins with plant proteins leads to small improvements in A1C and fasting glucose in adults with type 2 diabetes (127). A 2023 systematic review and meta-analysis of 13 RCTs and 7 cohort studies concluded that there is limited suggestive evidence to support replacing animal protein with plant-based protein based on a moderate degree of bias in cohort studies (128). However, a prospective observational study of more than 11,000 community-dwelling adults over 22 years of follow-up reported that those with higher intakes of plant foods and lower intakes of animal foods had lower diabetes risk (129). Plant proteins are lower in saturated fat, higher in fiber, and also support planetary health (130).

Fats

There is no optimal percentage of calories from fat for people with or at risk for diabetes, and macronutrient distribution should be individualized according to the individual's eating patterns, cultural and personal preferences, and metabolic goals (46). The type of fat consumed is more important than total amount of fat when looking at metabolic goals and CVD risk, and the percentage of total calories from saturated fats should be limited (72,131–133). Multiple RCTs including people with type 2 diabetes have reported that a Mediterranean eating pattern can improve both glycemic management and blood lipids (134–136). The Mediterranean eating pattern is based on traditional eating patterns in the countries bordering the Mediterranean Sea. Although eating styles vary by country and culture (i.e., customs and behaviors of a particular group of people or other social group), they share a number of common features, including consumption of fresh fruits and vegetables, whole grains, beans, and nuts/seeds; olive oil as the primary fat source; low to moderate amounts of fish, eggs, and poultry; and limited added sugars, sugary beverages, sodium, highly processed foods, refined carbohydrates, saturated fats, and fatty or processed meats.

People with diabetes should be advised to follow the same guidelines as the general population for the recommended intakes of saturated fat, cholesterol, and *trans* fat (72). In a 12-week double-blinded randomized controlled feeding study among 61 adults with overweight and obesity, without diabetes, higher intakes of saturated fat, compared with polyunsaturated fat, were found to increase liver fat deposition (137). A 2021 systematic review and meta-analysis including over 22,500 prospective study participants followed for 9.8 years reported that replacing saturated fats with other macronutrients, such as polyunsaturated fats, was associated with reduced CVD occurrence (138). *Trans* fats should be avoided. Importantly, it should be noted that as foods high in saturated fats are progressively decreased, they should be replaced with foods high in unsaturated fats and not with refined carbohydrate foods (139).

Evidence does not conclusively support recommending n-3 (eicosapentaenoic acid and docosahexaenoic acid) supplements for people with diabetes for the prevention or treatment of cardiovascular events (46,140). In individuals with type 2 diabetes, two systematic reviews with n-3 and n-6 fatty acids concluded that the dietary supplements did not improve glycemic management (141,142). In the ASCEND (A Study of Cardiovascular Events iN Diabetes) trial, when compared with placebo, supplementation with n-3 fatty acids at a dose of 1 g/day did not lead to cardiovascular benefit in people with diabetes without evidence of CVD (143). However, results from the Reduction of Cardiovascular Events with Icosapent Ethyl-Intervention Trial (REDUCE-IT) found that supplementation with 4 g/day pure eicosapentaenoic acid significantly lowered the risk of adverse cardiovascular events. REDUCE-IT included 8,179 participants, of whom over 50% had diabetes, and found a 5% absolute reduction in cardiovascular events for individuals with established atherosclerotic CVD already treated with a statin with residual hypertriglyceridemia (135–499 mg/dL [1.52–5.63 mmol/L]) (144). See section 10, "Cardiovascular Disease and Risk Management," for more information.

Sodium

As for the general population, people with diabetes are advised to limit their sodium consumption to <2,300 mg/day (46,145). Sodium intake has been shown to mediate glucose metabolism in a number of studies and affect eGFR, so limiting sodium intake is a valuable strategy for people with diabetes with or without kidney disease (145,146). In their post hoc analysis of the DASH-sodium RCT, Morales-Alvarez et al. (147) reported that participants randomized to the low-sodium DASH eating pattern (containing ~1,150 mg sodium/day [50 mmol sodium/day]) had change in eGFR of –3.10 mL/min/1.73 m^2 (95% CI –5.46 to –0.73) after 4 weeks compared with 3,450 mg sodium/day (150 mmol sodium/day).

The DASH4D trial, which was a randomized 4-period crossover community-based feeding study, reported that in comparison with the eating pattern formulated with higher levels of sodium, the DASH4D eating pattern with lower sodium (1,500 mg/day at 2,000 kcal) resulted in improved systolic blood pressure by 4.6 mmHg (95% CI, 7.2–2.0; $P < 0.001$) and diastolic blood pressure by 2.3 mmHg (95% CI, 3.7–0.9) (86). It was noted that the largest blood pressure reduction occurred during the first 3 weeks of each treatment period, and the effect of sodium reduction appeared stronger than the effect of the DASH4D eating pattern.

Limiting sodium intake is most easily achieved through focusing on whole, fresh foods. Additionally, it is important to reduce consumption of processed and ultraprocessed foods, which are major contributors of sodium intake. Encouraging people to avoid adding salt to foods and during cooking can also help. People providing nutrition advice should consider palatability, availability, affordability, clinical appropriateness, and the difficulty of achieving low-sodium recommendations in a nutritionally adequate eating plan.

Micronutrients and Other Supplements

Despite lack of evidence of benefit from dietary supplements, consumers continue to take them. Estimates show that up to 59% of people with diabetes in the U.S. use supplements (148). Without underlying deficiency, there is no benefit from herbal or other (i.e., vitamin or mineral) supplementation for people with diabetes (46,149).

U.S. federal law broadly defines dietary supplements as products having one or more dietary ingredients, including vitamins, minerals, herbs or other botanicals, amino acids, enzymes, tissues from organs or glands, or extracts of these (150). Dietary supplements are not regulated like other over-the-counter medications or prescription drugs in the U.S. (151). In combination with the strong views on dietary supplements (both positive and negative), this can contribute to consumer confusion (152). Readers can consult the U.S. Food and Drug Administration (FDA) Dietary Supplement Ingredient Directory to locate information about ingredients used in dietary supplements and any action taken by the agency with regard to that ingredient (153).

Specific nutrient supplementation for people with diabetes is generally not recommended outside the presence of deficiencies or overt malnutrition. Routine antioxidant supplementation (such as vitamins E and C) is not recommended due to lack of evidence of efficacy and concern related to long-term safety. Based on the 2022 U.S. Preventative Services Task Force statement, the harms of β-carotene outweigh the benefits for the prevention of CVD or cancer. β-Carotene was associated with increased lung cancer and cardiovascular mortality risk (154).

Vitamin D in the context of diabetes has generated much research, but universal vitamin D supplementation for people with type 1 or type 2 diabetes without deficiency is not recommended at this time. Although post hoc analyses of the Vitamin D and Type 2 Diabetes Study (D2d) prospective RCT and Diabetes Prevention and Active Vitamin D (DPVD) and some meta-analyses suggest a potential benefit in specific populations (155–157), other studies have found no benefit or mixed results (158–160). Furthermore, adopting healthy lifestyle habits, including the eating patterns recommended herein, are strongly advised. Additional research is needed to define individual characteristics, clinical indicators, and appropriate dosages if and when vitamin D supplementation might benefit people with type 1 or type 2 diabetes.

There is also insufficient evidence to support routine use of herbal supplements and micronutrients, such as cinnamon (161), curcumin (e.g., turmeric), aloe vera, or chromium, to improve glycemia in people with type 1 or type 2 diabetes (46).

While not a dietary supplement, metformin is associated with vitamin B12 deficiency based on findings from the Diabetes Prevention Program Outcomes Study (DPPOS). Therefore, periodic testing of vitamin B12 levels should be considered in people taking metformin, particularly in those with anemia or peripheral neuropathy (162) (see section 9, "Pharmacologic Approaches to Glycemic Treatment").

For special populations, including pregnant or lactating individuals, older adults, vegetarians, vegans, and people following very-low-calorie or low-carbohydrate eating patterns, a multivitamin may be necessary (163).

Alcohol

Long-term effects of alcohol consumption for people with diabetes are unknown. The World Health Organization declared there is no safe amount of alcohol intake (164,165). Associated risks of alcohol consumption include hypoglycemia and/or delayed hypoglycemia (particularly for those using insulin or insulin secretagogue therapies), weight gain, and hyperglycemia (for those consuming excessive amounts) (46,166). People with diabetes should be educated about these risks and encouraged to monitor glucose frequently before and after drinking alcohol to minimize such risks. People with diabetes who consume alcohol can follow the same guidelines as people without diabetes consistent with the *Dietary Guidelines for Americans, 2020–2025* (72), which does not promote alcohol consumption in people who do not already drink. To reduce risk of alcohol-related harms, adults can choose not to drink or to drink in moderation by limiting intake to ≤2 drinks a day for men or ≤1 drink a day for women (one drink is equal to a 12-oz beer, a 5-oz glass of wine, or 1.5 oz of distilled spirits) (72). Recent meta-analyses have reported the previously recognized J-shaped relationship between alcohol intake and health risks likely varies by sex, obesity status, genetics, and alcohol intake behaviors (167,168).

Nonnutritive Sweeteners and Water

The FDA has approved many nonnutritive sweeteners (NNS) (containing few or no calories; commonly referred to as artificial sweeteners) for consumption by the general public, including people with diabetes (46,169). However, the safety and role of NNS continue to be sources of concern and confusion for the public.

For some people with diabetes who are accustomed to regularly consuming sugar-sweetened foods or beverages (e.g., regular soda pop, juice drinks, and other items sweetened with cane sugar or high-fructose corn syrup), NNS may be an acceptable substitute for nutritive sweeteners (those containing calories, such as sugar, honey, and agave syrup) when consumed in moderation (i.e., consuming no more than the acceptable daily intake) (170). NNS do not appear to have a significant effect on glycemic management (171,172), and they can reduce overall calorie and carbohydrate intake as long as individuals are not compensating with additional calories from other food sources (46,173). A meta-analysis and systematic review of RCTs found no evidence that NNS raise liver enzymes (174).

There is mixed evidence from systematic reviews and meta-analyses for NNS use with regard to weight management, with some finding benefit for weight loss (175–177) while other research suggests an association with weight gain (178,179). This may be explained by reverse causality and residual confounding variables (179). The addition of NNS to eating plans poses no benefit for weight loss or reduced weight gain without energy restriction (180). In a systematic review and meta-analysis using low-calorie and no-calorie sweetened beverages as an intended substitute for sugar-sweetened beverages, a small improvement in body weight and cardiometabolic risk factors was seen without evidence of harm and had a direction of benefit similar to that seen with water (181). While health care professionals should promote water as the healthiest beverage option, people with overweight or obesity and diabetes may also use a variety of no-calorie or low-calorie sweetened products so that they do not feel deprived (181).

Health care professionals should encourage reductions in foods and beverages with added sugars and promote reducing overall sugar intake and calories with or without the use of NNS. Assuring people with diabetes that NNS have undergone extensive safety evaluation by regulatory agencies and are continually monitored can allay unnecessary concern for harm. Health care professionals can regularly assess individual use of NNS based on the acceptable daily intake (amount of a substance considered safe to consume each day over a person's life) and recommend moderation. Readers are directed to the FDA for additional information on NNS including safety, graphics, and the acceptable daily intake levels for the six major ones used in the U.S. (fda.gov/food/food-additives-petitions/aspartame-and-other-sweeteners-food).

Weight Management

Management and reduction of weight is important for people with type 1 diabetes, type 2 diabetes, or prediabetes with overweight or obesity. To support weight loss and improve A1C, CVD risk factors, and well-being in adults with overweight or obesity and prediabetes or diabetes, MNT and DSMES services should include an individualized eating plan resulting in an energy deficit in combination with enhanced physical activity (46). Lifestyle intervention programs should be intensive and have frequent follow-up to achieve significant reductions in excess body weight and improve clinical indicators. Behavior modification goals should address physical activity, calorie restriction, healthy weight management strategies, and motivation. There is strong and consistent evidence that modest, sustained weight loss can delay the progression from prediabetes to type 2 diabetes (78,182,183) (see section 3, "Prevention or Delay of Diabetes and Associated Comorbidities") and is beneficial for type 2 diabetes management (see section 8, "Obesity and Weight Management for the Prevention and Treatment Diabetes").

In prediabetes, the weight loss goal is at least 5–7% from baseline body weight, and it is higher for reducing risk of progression to type 2 diabetes. Some RCTs report less than 5% weight loss in adults with diabetes and overweight or obesity following a lifestyle behavioral intervention, but this limited amount of weight loss has not been shown to improve glycemia, lipids, or blood pressure; rather, a minimum weight loss of 5% or more seems necessary to achieve metabolic improvements (184). In conjunction with support for healthy lifestyle behaviors, medication-assisted weight loss can be considered for people at risk for type 2 diabetes when needed to achieve and sustain 7–10% weight loss (185,186) (see section 8, "Obesity and Weight Management for the Prevention and Treatment of Diabetes"). People with prediabetes and healthy weight range should also be considered for behavioral interventions to help establish routine aerobic and resistance exercise (182,187,188) and healthy eating patterns. Services delivered by health care professionals familiar with diabetes and its management, such as an RDN, have been found to be effective (77).

For many individuals with overweight or obesity alongside type 2 diabetes, at least 5% weight loss is needed to achieve beneficial outcomes in glycemic management, lipids, and blood pressure (189). However, any magnitude of weight loss is recommended. It also should be noted that the clinical benefits of weight loss are progressive, and more intensive weight loss goals (i.e., 15%) may be appropriate to maximize benefit depending on need, feasibility, and safety (190,191). Long-term sustainability of weight loss remains a challenge (192). For example, in some South Asian adult populations, traditional interventions have not been as effective in prevention or remission of type 2 diabetes, so those groups will benefit from more culturally tailored interventional approaches (193).

Medications can augment MNT to support weight loss, weight loss maintenance, and improve cardiovascular outcomes. Newer medications (e.g., glucagon-like peptide 1 receptor agonists [GLP-1 RAs]) may be more viable, positively affect cardiovascular outcomes, and produce weight reduction beyond 10–15% (194–198). For more information on the nutritional considerations important for people undergoing significant weight loss, see MONITORING NUTRITION INTAKE, below.

Overweight and obesity are increasingly prevalent in people with type 1 diabetes and present clinical challenges regarding diabetes treatment and CVD risk factors (199,200). There is some evidence that GLP-1 RAs are useful in achieving weight loss among adults with type 1 diabetes, although with a higher risk of nausea and ketosis (201).

Regardless of diabetes type, weight loss maintenance is challenging (184,202) but has well-recognized long-term benefits. Weight loss maintenance physiology is complex and involves many hormonal, psychosocial, behavioral, and environmental factors. Following a weight loss of at least 8%, a subsequent "weight loss maintenance" intervention was reported to be only moderately beneficial, as it helped sustain physical health improvements but not glucose metabolism improvements (203). However, in another RCT with long-term, real-world, clinic-based follow-up of 10 years, Tomah et al. (204) reported lasting glycemic benefits in their cohort with an average weight loss of 7.7 $\pm$ 0.9 kg ($-6.9 \pm 0.8\%$) maintained for 10 years.

Starting a conversation about weight management should be based on motivational interviewing techniques (205), beginning with first asking the individual if they want to discuss their weight. Health care professionals should never assume a person with overweight or obesity wants to discuss weight at a medical appointment, especially if the appointment is for a seemingly unrelated issue (e.g., back pain, which many people do not realize is often secondary to excess body weight). Using person-centered approaches to weight management conversations involves meeting the individual where they are in their life and working with what they and their health care professional agree is the most beneficial approach. Guidance from an RDN with expertise in motivational interviewing and diabetes and weight management MNT during any comprehensive structured weight loss program is strongly recommended.

Along with routine medical management visits, people with diabetes and prediabetes should be screened during DSMES and MNT encounters for a history of dieting and past or current disordered eating behaviors. Characterizing an individual's past efforts with weight loss and their body weight history can also be very useful. Nutrition therapy should be individualized to help address maladaptive eating behavior (e.g., purging) or compensatory changes in medical treatment plan (e.g., overtreatment of hypoglycemic episodes and reduction in medication dosing to reduce hunger) (46) (see DISORDERED EATING BEHAVIOR, below). Caloric restriction may be necessary for glycemic and weight management, but rigid meal plans and strict tracking of food intake and/or body weight can be contraindicated for individuals at increased risk of significant maladaptive eating behaviors (206). If eating disorders are identified during screening with diabetes-specific questionnaires, individuals should be referred to a qualified behavioral health professional (1).

Meal Replacements

Use of partial or total meal replacements is an additional strategy for energy restriction. Meal replacements are prepackaged foods (bars, shakes, and soups) that contain fixed amounts of macronutrients and micronutrients. They can improve nutrient quality and glycemic management and, consequently, reduce portion size and energy intake. In a meta-analysis involving 17 studies incorporating both partial and total meal replacements, greater weight loss and improvements in A1C and fasting blood glucose were demonstrated compared with conventional meal plans (207). Furthermore, meal replacements have been used in several landmark clinical trials, including Look AHEAD (Action for Health in Diabetes) (208), DiRECT (Diabetes Remission Clinical Trial) (209), and PREVIEW (Prevention of Diabetes Through Lifestyle Intervention and Population Studies in Europe and Around the World) (210). Results of these trials showed that partial or total meal replacements can be a potential short-term (i.e., <6 months) strategy for weight loss. Regardless of the specific eating pattern or meal plan selected, long-term follow-up and support from members of the diabetes care team are needed to optimize self-efficacy and maintain behavioral changes (211).

Fasting and Timing of Food Intake

Chrononutrition is an emerging nutrition and biology subspecialty aimed toward increasing the understanding of how the timing of food ingestion affects metabolic health (212). Glucose metabolism follows a circadian rhythm through diurnal variation of glucose tolerance and peaks during daylight hours when food is consumed. Some preliminary studies show cardiometabolic benefits when food is consumed earlier (213). Similarly, circadian disruptions found in shift workers increase risk of type 2 diabetes (214). This evolving area of research currently lacks conclusive evidence, but future studies are anticipated.

Nonreligious Fasting

The primary forms of nonreligious fasting are intermittent fasting or time-restricted eating. These are popular strategies for weight and glucose management. One of the key distinctions between nonreligious and religious fasting is water intake. See **Fig. 5.1** for further details on how religious and nonreligious fasting practices compare.

Intermittent fasting is an umbrella term that includes three main forms of restricted eating: alternate-day fasting (energy restriction of 500–600 calories on alternate days), the 5:2 eating pattern (energy restriction of 500–600 calories on consecutive or nonconsecutive days with usual intake the other five), and time-restricted eating (daily calorie restriction based on window of time of 8–15 h). Each produces mild to moderate weight loss (3–8% loss from baseline) over short durations (8–12 weeks) with no significant differences in weight loss when compared with continuous calorie restriction (215,216). A 2024 systematic review and meta-analysis of RCTs examined the most common types of fasting in studies lasting 2–52 weeks. The authors concluded that intermittent energy restriction produces small but significant reductions in waist circumference and fat-free mass but were otherwise not superior to continuous energy restriction eating patterns (217). Generally, time-restricted eating or shortening the eating window can be adapted to any

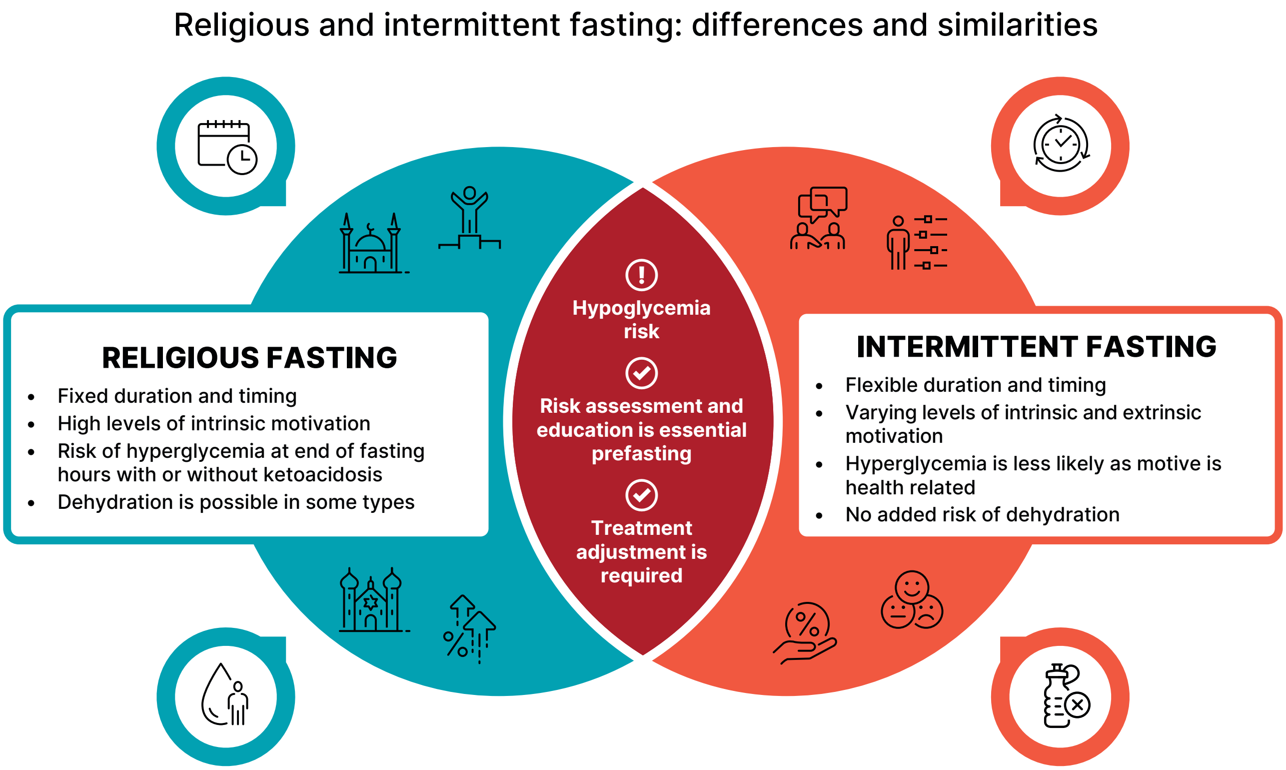


Figure 5.1—Differences and similarities between religious and intermittent fasting for people with diabetes.

eating pattern and has been shown to be safe for adults with type 1 or type 2 diabetes (218). People with diabetes who are taking insulin and/or secretagogues should be medically monitored during the fasting period (219). Because of the simplicity of intermittent fasting and time-restricted eating, these may be useful strategies for people with diabetes who are looking for practical eating management tools. It should also be noted that the principles of healthy eating still apply during non-fasting times.

Religious Fasting

Recommendations

5.32 Use the updated International Diabetes Federation along with Diabetes and Ramadan International Alliance comprehensive prefasting risk assessment to generate a risk score for the safety of religious fasting. Provide fasting-focused education to minimize risks. **B**

5.33 Assess and optimize treatment plan, dose, and timing for people with diabetes well in advance of religious fasting to reduce risk of hypoglycemia, dehydration, hyperglycemia, and/or ketoacidosis. **B**

Although intermittent fasting and time-restricted eating are specific dietary strategies for energy restriction, religious fasting has been practiced for thousands of years and is part of many faith-based traditions. Duration, frequency, and type of fast vary among different religions (220). For example, Jewish people abstain from any intake for ∼25 h during Yom Kippur (221,222). For Muslims, Ramadan fasting lasts for a full month, when abstinence from any food or drink is required from dawn to dusk (223). Individuals with diabetes who fast have an increased risk for hypoglycemia, dehydration, hyperglycemia, and ketoacidosis (224,225).

Prefasting risk assessment is essential to increase level of safety (224,225). Various risk factors need to be considered for every individual wishing to fast. Some of these factors are related to the type of fast, type of diabetes, and/or the individual. Indeed, health care professionals should inquire about any religious fasting for people with diabetes and provide education and support to accommodate their choice. The number of fasting days is an important factor to consider. In Ramadan fasting, a person fasts from dawn to dusk for a lunar month (29–30 days). It is important for the health care professional to comprehensively assess these risk factors well in advance of the planned fasting date, as some of them are modifiable. Some of these factors are related to the nature of the fasting practice, others are related to diabetes, and others might be due to individual factors such as the physical intensity of their work and/or the nutrition choices when they break their fast. The International Diabetes Federation along with Diabetes and Ramadan International Alliance adopted a risk calculator for the various risk factors (224,226). Several clinical studies from different countries have been published that assess the validity of the fasting risk score and the ease of use of it (226–229). The accumulation of these risk factors provides a risk score as low, moderate, or high (**Table 5.3**) (224). While the risks of different religious fasting practices may vary, this risk calculator provides some useful guidance for other types of religious fasting.

Prefasting education regarding the importance of increasing the frequency of glucose monitoring for people wishing to fast is very important. Timing of glucose monitoring is also especially important,

Table 5.3—Elements for risk calculation and suggested risk score for people with diabetes who seek to fast during Ramadan

Fasting risk element	Risk score
1. Pregnancy with any type of diabetes	
• Yes	6.5
2. Diabetes type	
• Type 1 diabetes or LADA	1
• Type 2 diabetes or any other type of diabetes	0
3. Duration of diabetes (years)	
• >20 years	1
• 10–20 years	0.5
• <10 years	0
4. Type of diabetes treatment (select all that are relevant)	
• Multiple daily premixed insulin injections	2
• Once-daily premixed insulin	1.5
• Open-loop insulin pump	1.5
• Automated insulin delivery system	1
• Standard basal insulin (NPH, detemir, or glargine 100)	1
• Ultra-long-acting basal insulin (glargine 300 or degludec)	0.75
• Short-acting insulin	0.75
• Glibenclamide or glipizide	0.75
• Modern sulfonylurea (gliclazide, gliclazide MR, glimepride) or repeglanide	0.5
• ≥2 glucose-lowering medications excluding insulin or sulfonylurea	0.25
• Nutrition modification only or monotherapy (excluding insulin or sulfonylurea)	0
5. Presence of hypoglycemia	
• Impaired hypoglycemia awareness	6.5
• Severe* hypoglycemia during last 4 weeks	5
• Hypoglycemia more than once daily	4
• 6–7 episodes of hypoglycemia/week	3
• 3–5 episodes of hypoglycemia/week	2
• 1–2 episodes of hypoglycemia/week	1
• Hypoglycemia <1 time per week	0.5
• No hypoglycemia in last 4 weeks	0
6. Level of A1C	
• >9% (>75 mmol/mol)	1
• 7.5–9% (58–75 mmol/mol)	0.5
• <7.5% (<58 mmol/mol)	0
7. Glucose monitoring	
• Not done	2
• Done suboptimally	1
• Done as indicated	0
• Any type of CGM	−0.5
8. Hyperglycemic emergencies	
• DKA or HHS in the last month	3.5
• DKA or HHS in last 2–3 months	2
• DKA or HHS in last 4–6 months	1
• No DKA or HHS in last 6 months	0
9. Macrovascular** complications	
• Unstable macrovascular disease	6.5
• Stable macrovascular disease	2
• No macrovascular disease	0
10. Microvascular complications	
a. Nephropathy	
• eGFR <30 mL/min	6.5
• eGFR 30–45 mL/min	4
• eGFR 45–60 mL/min	2
• eGFR >60 mL/min	0
b. Neuropathy, foot complications, or diabetic retinopathy	
• 3 microvascular complications	3
• 2 microvascular complications	2
• 1 microvascular complication	1
• 0 microvascular complications	0

Continued on p. S102

as the last few hours of fasting are frequently associated with approximately 50% of hypoglycemic events (230). Consequently, avoiding intense physical activity during the last few hours of fasting seems to be a sensible approach.

During religious fasting, some people change their nutrition habits and overindulge after fasting concludes. In many communities, the meal consumed to break the fast is rich in carbohydrates and includes foods and beverages high in added sugars and fat (224). Indeed, in one recent study 16.5% of people with type 2 diabetes who fasted for Ramadan reported high blood glucose of >300 mg/dL (>16.6 mmol/L) during fasting days (230). Individualized fluid adjustment and meal advice should be provided with emphasis on higher intake of fiber and replacing added sugars with complex carbohydrates to minimize hypoglycemia and hyperglycemia and emphasis on sustaining adequate daily fluid intake (231).

Treatment before and after fasting should be culturally sensitive and individualized. Specific recommendations for diabetes management during religious fasting in different faiths are available (224,225). In general, for people planning to fast for long hours and multiple consecutive days, choice of treatment should prioritize drugs with low hypoglycemia risk. Hypoglycemia risk while fasting in people using insulin, sulfonylureas, and other insulin secretagogues is higher than that for individuals treated with other types of diabetes medications (224). The safety of SGLT2 inhibitors was assessed in several studies during Ramadan fasting. These studies did not show significant change in kidney function, dehydration rates, or ketosis (232). Guidelines do not advise any change in SGLT2 inhibitor dose during fasting; however, they advise against initiating SGLT2 inhibitors close to the start of fasting days to avoid excessive thirst (224). **Table 5.4** summarizes the effect of fasting on different treatment options and the possible change in doses or timing for people with diabetes.

Technology could be an important tool to enhance safety during fasting. Several studies have investigated the use of monitoring technology during Ramadan fasting (e.g., flash glucose monitoring and CGM) and confirmed that these tools are able to support high-risk groups wishing to fast, especially if combined with Ramadan-focused education (232–234). Meanwhile, the use of insulin pumps

Table 5.3—Continued

Fasting risk element	Risk score
11. Cognitive function, frailty, and age	
• Impaired cognitive function	6.5
• Advanced frailty	6.5
• Mild to moderate frailty	4
• Age >70 years with no home support	1
• Normal cognitive function and no frailty	0
12. Physical labor	
• High intensity	4
• Moderate intensity	2
• Low intensity	0
13. Fasting-focused education	
• Yes	0
• No	1
14. Fasting hours	
• ≥16 h	1
• <16 h	0

Based on risk scoring, people with diabetes can be categorized as having:
- Score 0–3.0: low risk, fasting is probably safe
- Score 3.5–6.0: moderate risk, fasting safety is uncertain
- Score >6.0: high risk, fasting is probably unsafe

AID, automated insulin delivery; CGM, continuous glucose monitoring; DKA, diabetic ketoacidosis; eGFR, estimated glomerular filtration rate; HHS, hyperglycemic hyperosmolar state; LADA, latent autoimmune diabetes in adults (type 1 diabetes). *Hypoglycemia requiring assistance for treatment. **Macrovascular disease includes cardiac, cerebral, or peripheral. Adapted from Hassanein et al. (224).

has been associated with low rates of hypoglycemia during fasting in people with type 1 diabetes. Diabetes technologies should be considered as a useful adjunct to risk calculation and/or nutrition planning and education during religious fasting for people with diabetes (224).

Monitoring Nutrition Intake

It is important to monitor for adequate nutritional intake to prevent nutrient deficiencies, especially in people with diabetes who are seeking intentional weight loss. Health care professionals should advise a healthy, whole foods–based eating pattern with sufficient micro- and macronutrients, protein, fiber, and fluid intake alongside regular resistance training to maintain lean body mass and prevent nutritional deficiencies (235,236). Referral to an RDN is also important to optimize nutrition status, especially if they have experience conducting a nutrition-focused physical exam (235,237) (see section 8, "Obesity and Weight Management for the Prevention and Treatment of Diabetes").

Food Insecurity and Access

Food insecurity is a household-level economic and social condition of limited or uncertain access to adequate food (238). In 2023, 13.5% of Americans were food insecure (238), and food insecurity affects 16% of adults with diabetes compared with 9% of adults without diabetes (239). There is a complex bidirectional association between food insecurity and co-occurring diabetes. Food security screening should happen at all levels of the health care system. Any member of the health care team can screen for food insecurity using the Hunger Vital Sign. Households are considered at risk if they answer either or both of the following statements as "often true" or "sometimes true" (compared with "never true") (240):

- "Within the past 12 months, we worried whether our food would run out before we got money to buy more."
- "Within the past 12 months, the food we bought just didn't last, and we didn't have money to get more."

If screening is positive for food insecurity, efforts should be made to refer to appropriate programs and resources. See section 1, "Improving Care and Promoting Health in Populations," for more information concerning the social determinants of health and related issues like food insecurity and access.

PHYSICAL ACTIVITY

Recommendations

5.34 Evaluate baseline physical activity and sedentary time for all people with diabetes and those at risk for diabetes. For people who do not meet activity guidelines, encourage an increase in physical activities above baseline with the goal of meeting activity guidelines. **B** Counsel that prolonged sitting should be interrupted at least every 30 min for blood glucose and other benefits. **C**

5.35 Counsel children and adolescents with type 1 diabetes **C** or type 2 diabetes **B** to engage in 60 min/day or more of moderate- or vigorous-intensity aerobic activity, with muscle-strengthening and bone-strengthening activities at least 3 days/week, and to limit the amount of time being spent sedentary, including recreational screen time. **C**

5.36 Counsel most adults with type 1 diabetes **C** and type 2 diabetes **B** to engage in 150 min or more of moderate- to vigorous-intensity aerobic activity per week, spread over at least 3 days/week, with no more than 2 consecutive days without activity. Shorter durations (minimum 75 min/week) of vigorous-intensity or interval training may be sufficient for more physically fit individuals.

5.37 Counsel adults with type 1 diabetes **C** and type 2 diabetes **B** to engage in 2–3 sessions/week of resistance exercise on nonconsecutive days.

5.38 Counsel most older adults with diabetes to engage in flexibility training and balance training 2–3 times/week. **C**

5.39 Counsel all people with diabetes who are treated with obesity pharmacotherapy or metabolic surgery that meeting physical activity recommendations, in particular muscle-strengthening exercises, may be beneficial for maintaining lean body mass. **C**

Physical activity includes all movement that increases energy use, and exercise is a more specific form of physical activity that is structured and designed to improve physical fitness. Both physical activity and exercise demonstrate numerous benefits for people with and at

Table 5.4—Changes in medications during fasting

Medication name	Risk of hypoglycemia	Timing	Total daily dose
Metformin, SGLT2 inhibitor, DPP-4 inhibitor, GLP-1 receptor agonist, acarbose, or pioglitazone	Low	• If once daily, then take at main mealtime. • If twice daily, then split dose between the two meals. • If once weekly, no change of time.	• No change
New generation of sulfonylurea (glimepiride and gliclazide)	Low to moderate	• If once daily, then take at main mealtime. • If twice daily, then split dose between the two meals.	• Reduce dose if glucose levels are within individualized goal range and if no hypoglycemia or hyperglycemia is present at baseline.
Older generation of sulfonylurea (glyburide)	Moderate to high	• Take at time of main meal	• Replace with newer-generation sulfonylurea or reduce dose by 50%.
Basal insulin	Moderate to high	• For longer-acting basal analogs (glargine 300 or degludec), no need to change timing. • For other basal insulins, take at beginning of breaking fast meal.	• Choose the insulin with lower risk of hypoglycemia among the class. • Reduce dose by 25–35% if not well managed.
Prandial insulin	High	• At mealtime	• Reduce dose of insulin for the meal followed by fasting (35–50%). • For other meals, insulin dose should match carbohydrate intake.
Mixed insulin and insulin coformulations	High	• If once daily, then take at main mealtime. • If twice daily, then split dose between the two meals	• Reduce dose of insulin for the meal followed by fasting (35–50%). • For other meals, no change of dose.

DPP-4, dipeptidyl peptidase 4; GLP-1, glucagon-like peptide 1; SGLT2, sodium–glucose cotransporter 2.

risk for diabetes and are important for the diabetes management plan. Higher levels of total and leisure-time physical activity are associated with a lower risk of cardiovascular and overall mortality in people with diabetes (241,242). Leisure-time activity may also help prevent type 2 diabetes (243) and reduce A1C in those with diabetes (244). Moreover, data from the DPPOS noted that self-reported habitual physical activity is positively associated with 6-min walking distance, which suggests long-term benefits of regular physical activity engagement (245). Exercise and physical activity have favorable effects on glycemia, cardiovascular risk factors, weight loss, body composition, mobility, mortality, psychosocial well-being, and physical function in people with diabetes (242,246–254).

Given the benefits of physical activity and exercise for people with diabetes, they should be recommended and prescribed to all individuals who are at risk for or have diabetes as part of the diabetes care plan, unless otherwise contraindicated. Specific recommendations and precautions on the type of activity will vary by diabetes type, age, and presence of complications. Health care professionals should support people with diabetes to set stepwise goals toward meeting the recommended exercise volume. As individuals intensify their exercise program, medical monitoring may be indicated to ensure safety and evaluate the effects on glycemic management. Exercise and activity plans should be tailored to meet the specific needs of each individual (255), and different strategies can be used to increase engagement (256,257). Individuals with diabetes may experience obstacles to exercise, such as not having enough time or inadequate access to equipment or education for safe participation. The care team should help identify these obstacles and individualize approaches to improve long-term adoption of physical activity and exercise as a key part of the diabetes care plan.

Furthermore, activity plans can be modified to best suit the fitness level of the individual, which may vary due to ability level or complications. The plan might also need to be modified over time due to changes in health status, goals, or preferences or if the therapeutic response reaches a plateau. For this reason, individuals with diabetes benefit from a team-based approach, including working with an exercise physiologist, physical therapist, or personal trainer, among others, where available and affordable (258). The ADA position statement "Physical Activity/Exercise and Diabetes" reviews the evidence for the benefits of exercise in people with type 1 and type 2 diabetes and offers more specific guidance (255).

Physical Activity and Glycemic Management

In people with type 2 diabetes, exercise training has demonstrated multiple cardiometabolic improvements, including but not limited to improved glycemia, cardiovascular function, and lipid profiles (259,260). A meta-analysis primarily consisting of aerobic training studies revealed that structured exercise interventions of at least 8 weeks have been shown to lower A1C by 0.66% in people with type 2 diabetes, even without a significant change in BMI (247). Data also suggest that combining aerobic and resistance exercise may provide greater glycemic benefits compared with performing either mode of exercise alone (260).

In people with type 1 diabetes, the data for improving A1C are somewhat unclear (261,262). Interestingly, adding resistance training to an exercise plan for adults with type 1 diabetes who were already aerobically active did not impact glycemia, even with improvements in waist circumference and strength (263). Real-world data from the Type 1 Diabetes and Exercise Initiative (T1DEXI) show that aerobic exercise reduces glycemia after an acute exercise session compared with high-intensity interval exercise and resistance exercise; however, all three modes of exercise improve time in range over a 24-h period (264). Furthermore, meeting daily step count of ∼7,000–10,000 steps/day may support marginal improvements in time in range and reduced insulin requirements (265). Though there may be some benefits in glycemic response to exercise, this variability should be taken into consideration when recommending the type, intensity, and duration of exercise and insulin adjustments for a given individual with type 1 diabetes to prevent hypoglycemia and hyperglycemia (266,267).

Individuals of childbearing potential with preexisting diabetes, particularly type 2 diabetes, and those at risk for or presenting with gestational diabetes mellitus should be encouraged to engage in regular moderate-intensity physical activity prior to and during their pregnancies, as tolerated (255). Regular exercise can reduce the odds of developing gestational diabetes mellitus by nearly 40% (268), and acute and long-term prenatal exercise can positively impact glycemia, with a larger effect noted in people with diabetes (269). For more information, see section 15, "Management of Diabetes in Pregnancy."

Evaluating Pre-exercise Risk and Baseline Physical Activity

As discussed more fully in section 10, "Cardiovascular Disease and Risk Management," the best protocol for assessing asymptomatic people with diabetes for coronary artery disease remains unclear. The ADA consensus report "Screening for Coronary Artery Disease in Patients With Diabetes" (270) concluded that routine testing is not recommended. However, health care professionals should perform a careful history prior to exercise engagement, assess cardiovascular risk factors, be aware of the atypical presentation of coronary artery disease, such as a recently reported or measured decrease in exercise tolerance, and determine if testing for cardiac abnormality (e.g., arrhythmia) is warranted. Certainly, those with high risk should be encouraged to start with short periods of low-intensity exercise and slowly increase the duration and intensity as tolerated. Additionally, individuals with complications may warrant a more thorough evaluation prior to engaging in a physical activity or exercise plan to ensure the plan is safe and appropriate. Health care professionals should assess for conditions that might contraindicate certain types of exercise or predispose to injury, such as inadequately managed hypertension, untreated proliferative retinopathy, autonomic neuropathy, orthostatic hypotension, peripheral neuropathy, balance impairment, and a history of foot ulcers or Charcot foot.

An evaluation of baseline physical activity and time spent in sedentary behavior is recommended to help guide initial increases in physical activity levels. When discussing physical activity, health care professionals should consider inquiring about motivators (e.g., health benefits, enjoyable activities with family) and potential barriers (e.g., lack of time, fear of hypoglycemia, no safe place to perform activity) to exercise and activity participation (271,272). Understanding these barriers may help with devising practical solutions for sustainable exercise participation, as complete uptake of the recommended total exercise volume may be initially challenging for some people with diabetes (273,274). People who do not meet activity guidelines should be encouraged to increase physical activity levels above baseline by performing activities such as walking, yoga, housework, gardening, swimming, and dancing (275). Sedentary behaviors (e.g., time seated at work, on a computer, tablet, smartphone, or watching television) should be discussed regularly. People with diabetes should be counseled to reduce sedentary time and break up sedentary activities at least every 30 min by briefly standing, walking, or performing other light physical activities to support glycemic and other cardiometabolic benefits, such as vascular function (276–279).

Exercise for Children and Adolescents

Similar to children and adolescents in general, children and adolescents with diabetes or who are at risk for diabetes should be encouraged to engage in regular physical activity, including at least 60 min of moderate-to-vigorous aerobic activity every day and muscle- and bone-strengthening activities at least 3 days per week to support development and health benefits (254,280). Exercise programs promoting nutrition modification, increasing physical activity levels, and reducing sedentary time in children and adolescents at risk for type 2 diabetes have been shown to reduce risk of type 2 diabetes development (281–283), and vigorous-intensity physical activity participation is associated with lower CVD risk in youth with type 2 diabetes (284). In general, children and adolescents with type 1 diabetes benefit from being physically active, with meta-analyses reporting significant associations between physical activity and lower A1C (285) and an absolute A1C reduction of nearly 0.8% (286). Thus, an active lifestyle should be recommended to all children and adolescents with diabetes to support health outcomes and health-related quality of life (287,288). Children and adolescents are recommended to limit sedentary time, including recreational screen time, to less than 2 h per day (289–291). See section 14, "Children and Adolescents," for details.

Frequency and Type of Physical Activity

A comprehensive physical activity and exercise plan should encompass multiple modes of activities, including aerobic, resistance, flexibility, balance, and leisure-time activities. Each activity type offers unique benefits for diabetes management, overall health, and quality of life. Age, previous physical activity experiences, fitness level, and goals should be considered when discussing physical activity and exercise plans. For more specific guidance, see the ADA position statement "Physical Activity/Exercise and Diabetes" (255).

Aerobic Activity

Aerobic activities encompass prolonged rhythmic activities using large muscle groups, such as walking, running, and cycling (255), and provide multiple cardiometabolic benefits for people with diabetes (241,247,259,260,292). Adults with diabetes are encouraged to engage in 150 min or more of moderate- to vigorous-intensity aerobic activity weekly (254,255). Aerobic activity bouts should last at least 10 min, with the goal of ∼30 min/day or more most days of the week to accumulate at least 150 min per week (e.g., 30 min/day, 5 days per week). Daily exercise, or at least not allowing more than 2 days to elapse between exercise sessions, is recommended to decrease insulin resistance, regardless of diabetes type (293,294). Over time, aerobic activities should progress in intensity, frequency, and/or duration to meet the recommended exercise volume. Though exercise at higher intensities can facilitate greater reductions in A1C (295), many adults may be unable or unwilling to participate in high-intensity exercise. In those cases, diabetes care professionals should encourage engagement in moderate exercise for the recommended duration for A1C reduction and other cardiometabolic benefits (241,259,292).

Resistance Activity

Resistance activity refers to movements working against an external force for the purpose of improving skeletal muscle strength and size, which typically includes free weight, weight machine, body weight, or resistance band movements to target the major muscle groups. Resistance training can improve glycemia, strength, hypertrophy, bone mineral density, and cardiometabolic health (296–298), and higher relative muscle mass is associated with better insulin sensitivity and lower diabetes risk (298). Adults with diabetes are encouraged to participate in 2–3 sessions/week of resistance exercise on nonconsecutive days (254,255). Although it has been suggested that high-intensity resistance exercise training provides a greater benefit for glycemic management when compared with lower intensities (299), resistance training of any intensity is recommended to improve strength, balance, and the ability to engage in activities of daily living throughout the lifespan.

Flexibility and Balance Activities

Flexibility and balance activities serve to improve the range of motion around joints and reduce the risk of falls, respectively (254,255). Older adults with diabetes are encouraged to participate in flexibility and balance training 2–3 times/week. A variety of activities, including yoga, tai chi, and resistance training, can significantly improve A1C, flexibility, muscle strength, balance, and gait (254,300–304). Older adults in particular can benefit from flexibility and resistance training for maintenance of range of motion, strength, and balance (255,305,306) (**Fig. 5.2**).

High-Intensity Interval Training

High-intensity interval training (HIIT) involves short bursts of aerobic training performed between 65% and 90% VO_{2peak} (a measure of maximal aerobic capacity) or 75% and 95% heart rate peak for 10 s to 4 min with 12 s to 5 min of active or passive recovery. HIIT is a potentially time-efficient modality that can elicit significant physiologic and metabolic adaptations for individuals with type 1 and type 2 diabetes, including improvements in glycemia, β-cell function, central adiposity, and cardiac function (307–310).

When matched for energy expenditure, a 4-month HIIT-style walking program provided greater improvement in glycemia, physical fitness, and body composition compared with a continuous-walking program in people with type 2 diabetes (311). In contrast, a 12-week study in people with type 2 diabetes noted that HIIT cycling and continuous cycling programs, matched for energy expenditure, were not different in efficacy compared with each other or with a nonexercise control group (312). Both cycling protocols demonstrated improvements in aerobic capacity and A1C compared with baseline, but only continuous cycling showed improvements in cardiovascular response and visceral adiposity compared with baseline (312).

Because an acute bout of HIIT can lead to transient increases in postexercise hyperglycemia, individuals with type 1 diabetes may need to use bolus correction (313) and individuals with type 2 diabetes are encouraged to monitor blood glucose when starting HIIT (314). In type 1 diabetes, weeks of HIIT reduce A1C and insulin requirements and improve cardiometabolic risk profiles (310). Variability in glucose may occur with an increased risk in delayed hypoglycemia, so careful monitoring of glucose during and after HIIT is advised (310). Though HIIT may be an attractive mode of activity due to lowered required time commitment, individuals may be unable or unwilling to participate in activity at a high intensity. It may be of interest to intersperse HIIT within the broader activity plan with considerations for adequate recovery to prevent potential exercise-related injury (293).

Other Considerations

Exercise During Obesity Treatment

As many people with diabetes and obesity are often treated with obesity pharmacotherapy or metabolic surgery, additional emphasis on meeting physical activity guidelines, particularly muscle-strengthening activities, is warranted. Both obesity pharmacotherapy and metabolic surgery lead to reductions in body weight, which often induces loss of both fat mass (adipose tissue) and fat-free mass (nonadipose tissues). This has raised concern about the loss of fat-free mass (particularly skeletal muscle and bone) and its potential long-term consequences on strength, physical function, resting energy expenditure, and the potential development or worsening of frailty, sarcopenia, and sarcopenic obesity. Engagement in exercise programs prior to and after metabolic surgery may support muscle mass and strength (315,316), reduce weight recurrence and promote better weight maintenance (317,318), and improve insulin sensitivity (319). Even modest increases in physical activity after metabolic surgery may contribute to greater fat mass loss and better retention of skeletal muscle mass (320). Though aerobic exercise may be beneficial, combined aerobic and resistance training may produce greater weight loss and better improvements in functional capacity, muscle mass, and strength compared with aerobic exercise alone (316). In addition to metabolic surgery, combining obesity pharmacotherapy with exercise programs may lead to some synergistic benefits. Combination of structured exercise training plus a GLP-1 RA has demonstrated improvements in β-cell function, glucose tolerance, and insulin sensitivity (321,322), reductions in abdominal adiposity and inflammation (323), and more favorable effects on body composition such as fat mass loss, fat-free mass maintenance, and reduced waist circumference (321–324). Conversely, a 16-week RCT reported that combined exercise training and GLP-1 RA therapy did not show synergistic benefits on cardiac function but rather showed potential inhibitory effects on left ventricular diastolic function in people with type 2 diabetes (325). However, this was a predefined substudy that was not designed to detect changes in myocardial function. As data in this area for people with diabetes are emerging, more studies of longer duration and with newer-generation medications are needed.

Hypoglycemia

For individuals taking insulin and/or insulin secretagogues, physical activity may cause hypoglycemia if the medication dose or carbohydrate consumption is not adjusted for the exercise session and postbout effect on glucose. Individuals on these therapies may need to ingest carbohydrates if

Importance of 24-hour physical behaviors for type 2 diabetes

SITTING/BREAKING UP PROLONGED SITTING

- Limit sitting. Breaking up prolonged sitting (at least every 30 min) with short regular bouts of slow walking or simple resistance exercises can improve glucose metabolism.

STEPPING

- An increase of only 500 steps/day is associated with 2-9% decreased risk of cardiovascular morbidity and all-cause mortality.
- A 5- to 6-min brisk-intensity walk per day equates to ~4 years' greater life expectancy.

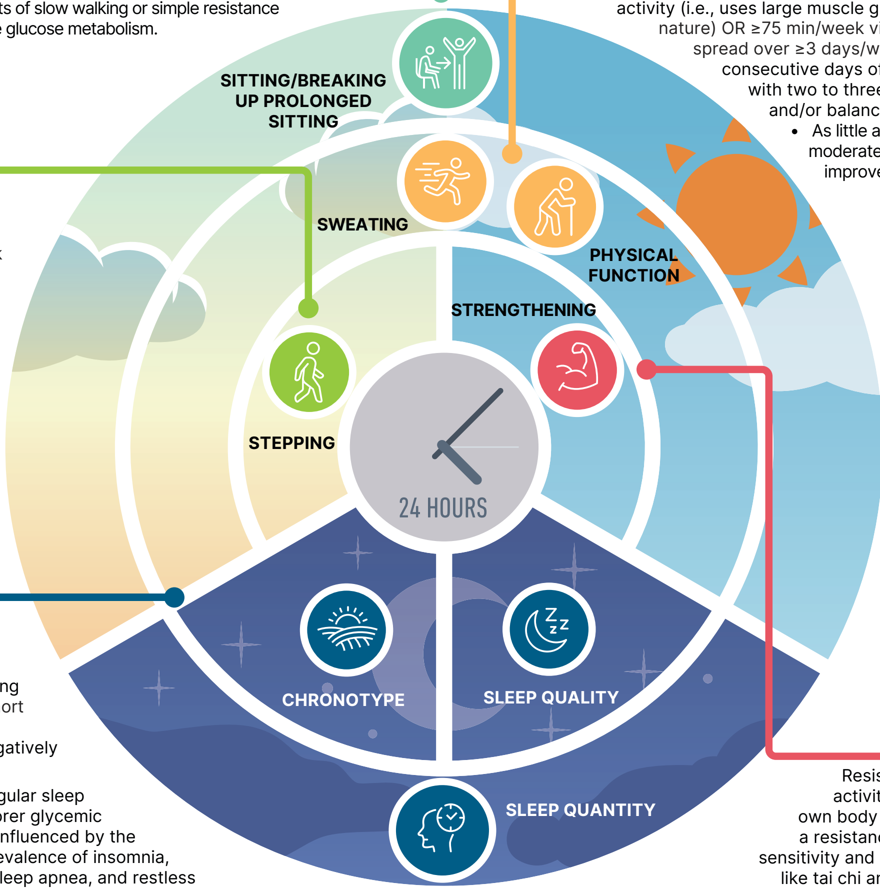
SLEEP

Aim for consistent, uninterrupted sleep, even on weekends.

Quantity - Long (>8 h) and short (<6 h) sleep durations negatively impact A1C.

Quality - Irregular sleep results in poorer glycemic levels, likely influenced by the increased prevalence of insomnia, obstructive sleep apnea, and restless leg syndrome in people with type 2 diabetes.

Chronotype - Evening chronotypes (i.e., night owl: go to bed late and get up late) may be more susceptible to inactivity and poorer glycemic levels than morning chronotypes (i.e., early bird: go to bed early and get up early).



SWEATING (MODERATE-TO-VIGOROUS ACTIVITY)

- Encourage ≥150 min/week of moderate-intensity physical activity (i.e., uses large muscle groups, rhythmic in nature) OR ≥75 min/week vigorous-intensity activity spread over ≥3 days/week, with no more than 2 consecutive days of inactivity. Supplement with two to three resistance, flexibility, and/or balance sessions.
- As little as 30 min/week of moderate-intensity physical activity improves metabolic profiles.

Physical function/ frailty/sarcopenia

- The frailty phenotype in type 2 diabetes is unique, often encompassing obesity alongside physical frailty, at an earlier age. The ability of people with type 2 diabetes to undertake simple functional exercises in middle-age is similar to that in those over a decade older.

STRENGTHENING

Resistance exercise (i.e., any activity that uses the person's own body weight or works against a resistance) also improves insulin sensitivity and glucose levels; activities like tai chi and yoga also encompass elements of flexibility and balance.

	Glucose/ insulin	Blood pressure	A1C	Lipids	Physical function	Depression	Quality of life
SITTING/BREAKING UP PROLONGED SITTING	↓ (green)	↓ (yellow)	↓ (red)	↓ (red)	↑ (red)	↓ (red)	↑ (red)
STEPPING	↓ (green)	↓ (yellow)	↓ (yellow)	↓ (yellow)	↑ (red)	↓ (green)	↑ (green)
SWEATING (MODERATE-TO-VIGOROUS ACTIVITY)	↓ (green)	↓ (green)	↓ (green)	↓ (green)	↑ (green)	↓ (green)	↑ (green)
STRENGTHENING	↓ (green)	↓ (yellow)	↓ (green)	↓ (yellow)	↑ (green)	↓ (red)	↑ (yellow)
ADEQUATE SLEEP DURATION	↓ (green)	↓ (red)	↓ (green)	↓ (red)	?	↓ (yellow)	↑ (yellow)
GOOD SLEEP QUALITY	↓ (green)	↓ (green)	↓ (green)	↓ (green)	?	↓ (yellow)	↑ (green)
CHRONOTYPE/CONSISTENT TIMING	↓ (yellow)	?	↓ (yellow)	?	?	↓ (yellow)	?

IMPACT OF PHYSICAL BEHAVIORS ON CARDIOMETABOLIC HEALTH IN PEOPLE WITH TYPE 2 DIABETES

↑ **Higher levels of improvement** (physical function, quality of life) ↓ **Lower levels of improvement** (glucose/insulin, blood pressure, A1C, lipids, depression)
? No data available
↑ Green arrows = strong evidence ↑ Yellow arrows = medium-strength evidence ↑ Red arrows = limited evidence

Figure 5.2—Importance of 24-h physical behaviors for type 2 diabetes. Adapted from Davies et al. (633).

pre-exercise glucose levels are <90 mg/dL (<5.0 mmol/L), depending on whether they are able to lower insulin doses during the workout (such as with an insulin pump or reduced pre-exercise insulin dosage), the time of day exercise is done, and the intensity and duration of the activity (267). Due to heterogeneity of glycemic responses to physical activity, the approach to carbohydrate intake and medication adjustments around the activity or exercise session should be individualized. More guidance on carbohydrate intake and medication considerations can be found in the ADA position statement "Physical Activity/Exercise and Diabetes" (255). In some people with diabetes, hypoglycemia after exercise may occur and last for several hours due to increased insulin sensitivity. Hypoglycemia is not common in those who are not treated with insulin or insulin secretagogues, and no routine preventive measures for hypoglycemia are usually advised in these cases. Intense activities, such as HIIT, may actually raise glucose levels instead of lowering them, especially if pre-exercise glucose is elevated (267). Because of variation in glycemic response to exercise, people with diabetes should be taught to check blood glucose levels and/or monitor CGM values during and after exercise, how to understand the effect of exercise on glucose, about the potential prolonged effects (depending on intensity and duration), and how to manage and use AID technology around and during the time of exercise (266,326). See section 6, "Glycemic Goals, Hypoglycemia, and Hyperglycemic Crises," for more information on hypoglycemia prevention and management.

Exercise in the Presence of Complications

See section 11, "Chronic Kidney Disease and Risk Management," and section 12, "Retinopathy, Neuropathy, and Foot Care," for more information on these long-term complications. A meta-analysis demonstrated that high versus low levels of physical activity were associated with lower CVD incidence and mortality (summary risk ratio 0.84 [95% CI 0.77–0.92], n = 7, and 0.62 [0.55–0.69], n = 11) and fewer microvascular complications (0.76 [0.67–0.86], n = 8). Dose-response meta-analyses showed that physical activity was associated with lower risk of diabetes-related complications even at lower activity levels (327).

Retinopathy

If proliferative diabetic retinopathy or severe nonproliferative diabetic retinopathy is present, then vigorous-intensity aerobic or resistance exercise may be contraindicated because of the risk of triggering vitreous hemorrhage or retinal detachment (328). Consultation with an ophthalmologist prior to engaging in an intense exercise plan may be appropriate.

Peripheral Neuropathy

Decreased pain sensation and a higher pain threshold in the extremities can result in an increased risk of skin breakdown, infection, and Charcot joint destruction with some forms of exercise. Therefore, a thorough assessment should be done to ensure that neuropathy does not alter kinesthetic or proprioceptive sensation during physical activity, particularly in those with more severe neuropathy. Moderate-intensity walking may not lead to an increased risk of foot ulcers or reulceration in those with peripheral neuropathy who use proper footwear (329,330). In addition, 150 min/week of moderate exercise improved outcomes in people with prediabetic neuropathy (331). All individuals with peripheral neuropathy should wear proper footwear and examine their feet daily to detect lesions early. Anyone with a foot injury or open sore should be restricted to non–weight-bearing activities.

Autonomic Neuropathy

Autonomic neuropathy can increase the risk of exercise-induced injury or adverse events through decreased cardiac responsiveness to exercise, postural hypotension, impaired thermoregulation, impaired night vision due to impaired papillary reaction, and greater susceptibility to hypoglycemia (332). Cardiovascular autonomic neuropathy is also an independent risk factor for cardiovascular death and silent myocardial ischemia (333). Therefore, individuals with diabetic autonomic neuropathy should undergo cardiac investigation before beginning physical activity more intense than that to which they are accustomed.

Chronic Kidney Disease

Physical activity can acutely increase urinary albumin excretion. However, there is no evidence that vigorous-intensity exercise accelerates the rate of progression of CKD, and there appears to be no need for specific exercise restrictions for people with CKD in general (328).

SMOKING CESSATION: TOBACCO, E-CIGARETTES, AND CANNABIS

Recommendations

5.40 Ask people with diabetes routinely about the use of tobacco or vape products. **A** Advise complete avoidance of tobacco and vaping. **A** For individuals who use these products, provide or refer for combination treatment consisting of tobacco and/or vape product(s) cessation counseling and pharmacologic therapy. **A**

5.41 Advise people with type 1 diabetes **C** and those with other forms of diabetes at risk for diabetic ketoacidosis not to use recreational cannabis in any form. **E**

A causal link between cigarette smoking and diabetes has been well established for over a decade (334). Results from epidemiologic, case-control, and cohort studies support the causal link between cigarette smoking and multiple health risks that profoundly affect the morbidity and mortality of people with diabetes (334). People with diabetes who smoke and are exposed to second-hand smoke have a heightened risk of macrovascular complications (e.g., cardiovascular and peripheral vascular disease), microvascular complications (e.g., kidney disease and visual impairment), elevated A1C, and premature death compared with those who do not smoke and are not exposed to second-hand smoke (335,336). Findings from a systematic review and meta-analysis show a dose-response relation for current smoking and the risk for type 2 diabetes; this risk decreases as the time since quitting increases (337).

Routine (every visit with every person), thorough assessment of all types of tobacco use is essential to prevent tobacco product initiation and promote cessation. Evidence demonstrates quitting smoking reduces or reverses adverse health effects in addition to increasing life expectancy by up to 10 years (338). However, tobacco use among adults with chronic conditions remains higher than the general population, despite recent declines in smoking among middle-aged and older adults with diabetes (339). Numerous RCTs demonstrate the efficacy and cost-effectiveness of both intensive and brief counseling on smoking cessation, including the use of telephone quit lines and web-based interventions, in reducing tobacco use and maintaining abstinence from smoking (338,340). The World Health Organization recommends both counseling and pharmacologic therapy to assist with smoking cessation in nonpregnant adults (341). A secondary data analysis of the Evaluating Adverse Events in a Global Smoking Cessation Study (EAGLES), a randomized, double-blind, triple-dummy, placebo-controlled and active-controlled trial, found varenicline to be the most efficacious pharmacotherapy for people with diabetes compared with placebo (342). These findings support the American Thoracic Society 2020 guideline recommending varenicline as a first-line pharmacotherapy for tobacco dependence (343). However, despite the effectiveness of pharmacologic therapy and counseling, more than two-thirds of people trying to quit do not receive treatment following evidence-based guidelines (338).

Weight gain after smoking cessation is a concern for diabetes management and risk for new onset of disease (344). While postcessation weight gain is an identified issue, studies have found that an average weight gain of 3–5 kg does not necessarily persist long term or diminish the substantial cardiovascular benefit realized from smoking cessation (337). A systematic review and meta-analysis comparing those who quit smoking to those who smoke stratified by postcessation weight gain found smoking cessation lowered the risk of CVD and all-cause mortality regardless of postcessation weight gain (345). Another systematic review and meta-analysis of interventions to prevent weight gain following smoking cessation identified several approaches that may modestly reduce weight gain, including personalized weight management programs, exercise programs, nicotine replacement therapy, and fluoxetine (346). Emerging research suggests GLP-1 RAs may improve smoking cessation, reduce cravings and withdrawal symptoms, and decrease weight gain in adults with overweight and/or prediabetes (347). More clinical trials are needed to examine the efficacy of GLP-1 RAs and other incretin pharmacotherapies as a possible treatment for tobacco use disorders and preventing weight gain postcessation.

In recent years, there has been an increase in the use and availability of multiple noncigarette nicotine products. The impact of these products on diabetes is less well established than that of combustible cigarettes. Smokeless tobacco products, such as dip and chew, pose an increased risk for CVD and oral cancer (348,349). Vaping with e-cigarettes and related devices has become more popular due to perceptions that e-cigarette use is less harmful than combustible cigarettes (350). While combustible tobacco products are the most harmful, e-cigarettes pose significant health risks to the cardiovascular and respiratory systems (351,352). Findings from the Population Assessment of Tobacco and Health (PATH) Study suggest e-cigarettes contribute to nicotine dependence, confirming that there is no safe tobacco product (353,354). Individuals with diabetes should be advised to avoid vaping and using e-cigarettes, either as an approach to stop smoking combustible cigarettes or as a recreational drug. If people are using e-cigarettes for cessation, they should be advised to avoid using both combustible and electronic cigarettes, and if only using only e-cigarettes, they should be advised to discontinue those too (340). Diabetes education programs provide an opportunity to systematically reach and engage individuals with diabetes in smoking cessation efforts. A cluster randomized trial demonstrated statistically significant increases in quit rates and long-term abstinence rates (>6 months) when cessation interventions were delivered through diabetes education clinics, regardless of motivation to quit at baseline (355).

Increased legalization and multiple formulations of cannabis products have resulted in increased prevalence in the use of these products in all age-groups (356,357). Cannabidiol (CBD), which in its pure form has no psychoactive effect, has received attention for its potential therapeutic benefits in diabetes management. However, research shows no noticeable effect on glucose or insulin levels in adults with type 2 diabetes who use CBD (358). Significant increases in tetrahydrocannabinol (THC) concentrations in CBD products and use of additional psychoactive cannabinoid products, such as delta-8 THC, are of specific concern (359). Most of these products are currently unregulated by the FDA, and public health warnings regarding use have been issued (360). The FDA reports adverse effects related to delta-8 THC, some of which may have health implications for people with diabetes (e.g., vomiting) (360). Evidence of specific increased risk of hyperglycemic ketosis associated with cannabis use has been reported in adults with type 1 diabetes (361–363). Hyperglycemic ketosis in individuals with type 1 diabetes using cannabis is associated with cannabis hyperemesis syndrome, which is marked by severe nausea, abdominal pain, and vomiting (361–363). Recommended diagnostic criteria for hyperglycemic ketosis cannabis hyperemesis syndrome include a blood glucose of ≥250 mg/dL, an anion gap of >10, a serum β-hydroxybutyrate level of >0.6 mmol/L, a pH level of ≥7.4, and a bicarbonate level of ≥15 mmol/L (363). Health care professionals should consider hyperglycemic ketosis cannabis hyperemesis syndrome in people with type 1 diabetes with pH ≥7.4 and bicarbonate >15 mmol/L in the presence of ketosis (363).

The increased availability and use of tobacco and cannabis products highlights the importance of assessing use, educating individuals about the associated risks, and providing support for cessation.

SUPPORTING POSITIVE HEALTH BEHAVIORS

Given the impact on glycemic outcomes and risk for future complications (364,365), diabetes care professionals should support health-promoting behaviors (preventive, treatment, and maintenance), including glucose monitoring, taking medications, using diabetes technologies, engaging in physical activity, and healthy eating. Evidence-based behavioral strategies and multicomponent interventions, including motivational interviewing (366,367), activation (368), goal setting and action planning (367,369,370), problem-solving (8,369), tracking or self-monitoring health behaviors with or without feedback from a health care professional (367,369,370), and facilitating opportunities for social support (367,369,370), help people with diabetes and their caregivers develop health behavior routines and overcome barriers to self-management. While behavioral economics approaches (e.g., financial incentives, social norms messaging) show mixed results, they tend to enhance motivation and demonstrate short-term (i.e., <6 months) benefits for behavior change (371). Multicomponent interventions are the most effective for improving behavior and glycemic outcomes (370,372), particularly in children and adolescents with diabetes, when delivered as family-based or multisystem behavioral interventions (373). Adapting and tailoring behavior change strategies to the characteristics and needs of individuals and populations is essential (374,375). These health behavior change strategies can be delivered by behavioral health professionals, certified DCES, qualified community health workers (369), or other trained health care professionals (376,377). They can also be implemented via digital health tools (370,377,378). To deliver these strategies effectively, diabetes care professionals should receive training in evidence-based methods such as motivational interviewing (379).

PSYCHOSOCIAL CARE

Recommendations

5.42 Provide psychosocial care to all people with diabetes as part of routine medical care delivered by trained health care professionals using a collaborative, person-centered, culturally informed approach. **A**

5.43 Implement screening protocols for psychosocial concerns, preferably using age-appropriate standardized and validated tools. Screen at least annually or when there is a change in health status, treatment, or life circumstances. **C**

5.44 Refer to behavioral health professionals or other trained health care professionals, ideally those with experience in diabetes, for further assessment and treatment of psychosocial concerns as indicated. **B**

Please refer to the ADA position statement "Psychosocial Care for People With Diabetes" for a list of assessment tools and additional details (1) and the ADA Behavioral Health Toolkit for assessment questionnaires and surveys (professional.diabetes.org/meetings/behavioral-health-toolkit). Throughout the Standards of Care, the broad term "behavioral health" is used to encompass both *1*) health behavior engagement and relevant factors and *2*) behavioral health concerns and care related to living with diabetes.

Psychosocial well-being is a critical component of diabetes care and self-management. Psychosocial factors, including environmental, social, family, behavioral, emotional, religious, and SDOH factors, influence living with diabetes and the ability to achieve optimal health outcomes. People with diabetes and their families or caregivers face complex, multifaceted challenges integrating diabetes care into daily life (380). Clinically significant behavioral health diagnoses are considerably more prevalent in people with diabetes than in those without diabetes (381,382). Psychological and social problems can interfere with a person's (383–385) or family's (385) ability to perform diabetes care tasks and negatively affect health status. Furthermore, these conditions are associated with reduced short-term (i.e., <6 months) glycemic stability and increased mortality risk (382,386). Therefore, addressing both clinical and subclinical psychological symptoms is essential to comprehensive care.

Diabetes health care professionals should routinely monitor and screen for psychosocial concerns in a timely and efficient manner and refer to appropriate services (387,388). Psychosocial care can be provided by various health care professionals based on training, experience, need, and availability (377,389,390). Health care professionals can integrate brief, person-centered psychosocial interventions into routine diabetes care by creating a supportive environment for emotional disclosure. Validating an individual's experiences, asking open-ended questions, and employing empathetic listening can foster trust and increase engagement in treatment decisions (391). Furthermore, health care professionals can implement brief counseling strategies to address psychosocial concerns and promote adaptive coping, including motivational interviewing, collaborative goal setting, cognitive behavioral techniques to reframe negative thoughts, structured problem-solving, and emotion regulation strategies (8,366,367,369,370,392,393). Practical examples include using "importance" and "confidence" rulers, conducting week-long behavioral experiments within a cognitive behavioral therapy (CBT) framework, demonstrating breathing exercises to promote mindfulness, setting SMART goals to facilitate problem-solving, and teaching grounding techniques to support emotion regulation.

When psychosocial concerns cannot be addressed adequately in routine diabetes care, referral to a behavioral health professional is necessary. Ideally, qualified behavioral health professionals with specialized training and experience in diabetes should be integrated with or provide collaborative care as part of diabetes care teams (394,395). A behavioral health professional should conduct a comprehensive assessment and deliver evidence-based treatment (396,397).

Screening

Health care teams and clinical practices should develop and implement psychosocial screening protocols to ensure routine monitoring of psychosocial well-being and to identify potential concerns among people with diabetes, following published guidance and recommendations (398,399). Topics to screen for may include, but are not limited to, attitudes about diabetes, expectations for treatment and outcomes (especially related to starting a new treatment or technology), general and diabetes-related mood, stress, and/or quality of life (e.g., diabetes distress, depressive symptoms, anxiety symptoms, and fear of hypoglycemia), available resources (financial, social, family, and emotional), and/or psychiatric history. Given elevated rates of suicidality among people with diabetes (400,401), screening for suicidality may also be appropriate (402–404). A list of age-appropriate screening and evaluation measures is provided in the ADA position statement "Psychosocial Care for People with Diabetes" (1), and guidance has been published about selection of screening tools, clinical thresholds, and frequency of screening (405,406).

Key opportunities for psychosocial screening include diagnosis, routine visits, hospitalizations, new onset of complications, transitions in care (e.g., pediatric to adult care teams [407]), changes in medical treatment, and when problems with achieving A1C goals, quality of life, or self-management arise. Additionally, changes in life circumstances and SDOH affect a person's ability to self-manage their diabetes. Thus, screening for SDOH should also be incorporated into routine care (408). When caregivers or family members play a significant role in diabetes care, their psychosocial concerns should be assessed and addressed by appropriate professionals (407,409).

Standardized, validated, age-appropriate tools for psychosocial monitoring and screening can also be used (1). The ADA provides access to tools for screening specific psychosocial topics, such as diabetes distress, fear of hypoglycemia, and other relevant psychological symptoms, at professional.diabetes.org/sites/default/files/media/ada_mental_health_toolkit_questionnaires.pdf. Additional information about developmentally specific psychosocial screening topics is available in section 14, "Children and Adolescents," and section 13, "Older Adults." Health care professionals may also use informal verbal inquiries, for example, by asking whether there have been persistent changes in mood during the past 2 weeks or since the individual's last appointment and whether the person can identify a triggering event or change in circumstances. Diabetes care professionals should also ask whether there are new or different barriers to treatment and self-management, such as feeling overwhelmed or stressed by having diabetes (see DIABETES DISTRESS, below), changes in finances, or competing medical demands (e.g., the diagnosis of a co-occurring condition).

Psychological Assessment and Treatment

When psychosocial concerns are identified and cannot be addressed adequately in routine diabetes care, referral to a qualified behavioral health professional, preferably one specializing in diabetes, should be made for comprehensive evaluation, diagnosis, and treatment (377,396,397). Indications for referrals may include positive screening for diabetes distress, depression, anxiety, disordered eating, or cognitive dysfunction (see **Table 5.5** for a complete list). Incorporating psychosocial assessment and treatment into routine care is preferable to waiting for a specific problem or deterioration in glycemic or psychological status to occur (38,385). Health care professionals should identify and refer to behavioral health professionals knowledgeable about diabetes and psychosocial care. The ADA provides a list of behavioral health professionals who have specialized expertise or who have received education about psychosocial and behavioral issues related to diabetes in the ADA Mental Health Professional Directory (professional.diabetes.org/ada-mental-health-provider-directory). Ideally, behavioral health professionals should be embedded in diabetes care settings. Given limited behavioral health resources, other trained health care professionals may also provide this specialized psychosocial care (389,394,410). Although some health care professionals may not feel qualified to treat psychosocial concerns (411), strengthening the relationship between a person with diabetes and the health care professional may increase referral acceptance. Collaborative care interventions and a team approach have demonstrated efficacy in diabetes self-management, depression outcomes, and psychosocial functioning (6,7). The ADA provides resources for a range of health professionals to support behavioral health in people with diabetes at professional.diabetes.org/meetings/behavioral-health-toolkit.

Successful evidence-based approaches include cognitive behavioral (392,396,412) and mindfulness-based therapies (413). See the sections below for details about interventions for specific psychosocial concerns. Behavioral interventions may also be indicated in a preventive manner even in the absence of positive psychosocial screeners, such as resilience-promoting interventions to prevent diabetes distress in adolescence (414,415) and behavioral family interventions to promote collaborative family diabetes management in early adolescence (416,417) or to support adjustment to a new treatment plan or technology (60). Psychosocial interventions can be delivered via digital health platforms (418,419) or integrated into group-based or shared diabetes appointments that address both medical and psychosocial concerns relevant to living with diabetes (390,420).

Although psychosocial interventions have demonstrated short-term (i.e., <6 months) efficacy, their success in sustained engagement in health behaviors and improved glycemic outcomes has varied. Thus, health care professionals should systematically monitor these outcomes to assess ongoing needs following implementation of current evidence-based psychosocial treatments.

Diabetes Distress

Recommendation

5.45 Screen for diabetes distress at least annually in people with diabetes, caregivers, and family members, and repeat screening when treatment goals are not met, at transitional times, and/or in the presence of diabetes complications. Health care professionals should consider referral to a qualified behavioral health professional, ideally one with experience in diabetes, for further assessment and treatment if not adequately addressed during medical appointments. **B**

Diabetes distress is common and refers to the emotional burdens and worries associated with living with and managing a demanding chronic condition (421,422). Diabetes distress is distinct from depression and anxiety and has unique relationships with glycemia and other outcomes (423,424) (**Tables 5.6** and **5.7**). The constant behavioral demands of diabetes self-management (taking medications, monitoring glucose levels, moderating food intake, and participating in physical activity) and the potential or actual disease progression are associated with increased diabetes distress (425,426). In individuals with type 2 diabetes, prevalence rates of diabetes distress exceed 60% (425,427), whereas in those with type 1 diabetes, rates surpass 70% (426). Parents of children and adolescents with type 1 diabetes also experience diabetes distress, which is associated with greater family conflict and reduced self-management behaviors (428). Among adults, diabetes distress negatively affects medication-taking behaviors and is linked to elevated A1C, lower self-efficacy, and less optimal eating and exercise behaviors (429). In addition, diabetes distress frequently co-occurs with symptoms of anxiety, depression, and reduced health-related quality of life (430). Importantly, the experience of stigma related to living with diabetes may further exacerbate diabetes distress (431,432).

Diabetes distress should be routinely monitored (433) using diabetes-specific validated measures appropriate for each person or population (e.g., age and diabetes type) (1). Once diabetes distress is identified, it should be acknowledged and addressed (434). Addressing diabetes distress in routine diabetes care involves initiating a conversation about feelings and beliefs in a respectful, sensitive, and direct manner (421). In practice, this involves creating a space for emotional disclosure, validating the emotional aspects of diabetes, and linking emotions to self-management behaviors. Health care professionals can introduce brief coping strategies (e.g., values affirmation, mindful breathing, cognitive reframing) and highlight past successes to reinforce resilience. When diabetes distress cannot be addressed in routine diabetes care, referral for follow-up care is recommended (397), such as DSMES, to address distressing areas of diabetes management that may also be affecting self-care; a behavioral intervention from a qualified behavioral health professional, ideally one with expertise in diabetes; and/or an intervention from another trained health care professional (421).

Several intervention strategies have been shown to reduce diabetes distress and, to a lesser degree, improve glycemic outcomes. These include educational, psychological, and health behavior change approaches such as DSMES, CBT, mindfulness-based therapies, motivational interviewing, and others (392,412,435–439). In addition, interventions delivered via telephone, smartphone applications, video visits, and/or self-help modalities can be effective in reducing diabetes distress (416,440–442). DSMES has been shown to reduce diabetes distress (6,443) and may benefit A1C

Table 5.5—Situations that warrant referral of a person with diabetes to a qualified behavioral health professional for evaluation and treatment

- A positive screen on a validated screening tool for depressive symptoms, diabetes distress, anxiety, fear of hypoglycemia, suicidality, or cognitive impairment
- The presence of symptoms or suspicions of disordered eating behavior, an eating disorder, or disrupted patterns of eating
- Intentional omission or underdosing of insulin or noninsulin medication to cause weight loss
- A serious mental illness is suspected
- In children and adolescents and families with behavioral self-care difficulties, repeated hospitalizations for diabetic ketoacidosis, failure to achieve expected developmental milestones, or significant distress
- Low engagement in diabetes self-management behaviors, including declining or impaired ability to perform diabetes self-management behaviors
- Before undergoing metabolic surgery and after surgery, if assessment reveals an ongoing need for adjustment support

when combined with peer support (444). Counseling about expected diabetes distress may be helpful in several contexts, including new diagnosis, changes in treatment, life context, presence of complications, and other stressors (421). A multisite RCT with adults with type 1 diabetes, elevated diabetes distress, and elevated A1C demonstrated clinically meaningful improvements in both outcomes using a combination of group-based diabetes self-management education and emotion-focused skills (441). In adults with type 2 diabetes in the Veterans Affairs system, an RCT found that integrating a single session of mindfulness into DSMES, followed by a booster session and mobile app practice over 24 weeks, significantly reduced diabetes distress compared with DSMES alone (445). An RCT of CBT in adults with type 2 diabetes and elevated symptoms of distress or depression demonstrated improvements in diabetes distress, A1C, and depressive symptoms for up to 1 year (446). Another RCT among individuals with type 1 and type 2 diabetes found mindful self-compassion training increased self-compassion, reduced depression and diabetes distress, and improved A1C (447). In teens with type 1 diabetes, an RCT of a resilience-focused cognitive behavioral and social problem-solving intervention reduced diabetes distress and depressive symptoms for up to 3 years compared with diabetes education, although neither A1C nor self-management behaviors improved over time (415). Lastly, the use of AID systems can also contribute to decreases in diabetes distress among adults with type 1 diabetes and caregivers of children and adolescents; however, evidence of benefit among children and adolescents remains mixed (448,449).

A combination of educational, behavioral, and psychological approaches is needed to address distress, depression, and A1C. There are few outcome data on long-term systematic treatment of diabetes distress integrated into routine care. As the burden of diabetes management can vary over time, diabetes distress may fluctuate and may need varying treatment approaches at different life stages and at different levels of diabetes progression.

Anxiety

Recommendations

5.46 Screen for anxiety symptoms at least annually in people with diabetes. Health care professionals can address anxiety symptoms within the scope of their practice. Consider referral to a qualified behavioral health professional for further assessment and treatment if anxiety symptoms interfere with diabetes self-management behaviors or quality of life, if not adequately addressed during medical appointments. **B**

5.47 Screen individuals at high risk for hypoglycemia or with severe and/or frequent hypoglycemia for fear of hypoglycemia at least annually and when clinically appropriate. **E** Refer to a trained health care professional for evidence-based intervention. **A**

Anxiety symptoms are common in people with diabetes and significantly affect clinical outcomes and self-management (450) (**Tables 5.6** and **5.7**). Rates of generalized anxiety disorder, agoraphobia, panic disorder, social phobia, and posttraumatic stress disorder are higher in people with diabetes than in those without diabetes (450). A systematic review and meta-analysis found that the pooled prevalence of anxiety disorders among individuals with diabetes was 28% (451). This systematic review and meta-analysis also reported that individuals with anxiety disorders had a 19% higher risk for type 2 diabetes, while those with type 2 diabetes had a 41% greater risk of developing anxiety disorders (451). It is important to note that anxiety symptoms may overlap with diabetes distress and/or hyperglycemia symptoms, which can complicate screening practices (434). This highlights the importance of conducting screening for both diabetes distress and anxiety at least annually in people with diabetes, followed by further clinical assessment to ensure accurate identification.

Fear of hypoglycemia is a common diabetes-specific concern (452–454) that can lead to avoidance of glucose-lowering behaviors, such as increasing insulin doses or monitoring frequency. Factors contributing to fear of hypoglycemia in people with diabetes and family members include history of nocturnal hypoglycemia, co-occurring psychological concerns, and sleep disturbances (455). See section 6, "Glycemic Goals, Hypoglycemia, and Hyperglycemic Crises," for more information about impaired awareness of hypoglycemia and related fear of hypoglycemia. Other common sources of diabetes-related anxiety include not meeting glycemic goals (456), insulin injections or infusion (457), and onset of complications (1). People with diabetes who exhibit excessive diabetes self-management behaviors well beyond what is prescribed or needed to achieve glycemic goals may be experiencing

Table 5.6—Psychosocial concerns and their association with diabetes-related outcomes in adults with type 1 diabetes

	Increased A1C	Increased blood pressure	Increased cholesterol	Increased macrovascular complications	Increased microvascular complications	Decreased self-care behaviors	Comorbid psychosocial concerns	Decreased quality of life	Increased mortality
Diabetes distress (576–579)	+++	?	+	+++	+++	+++	+++	+++	?
Depression and depressive symptoms (577,578,580,581)	+++	?	+++	+++	+++	+++	+++	+++	+++
Anxiety (383,582,583)	+++	?	?	?	?	+++	+++	+++	?
Disordered eating behaviors (insulin omission) (495,584)	+++	?	?	?	+++	+++	+++	+++	+++
Serious mental illness (schizophrenia, personality disorders) (585–587)	+++	?	+	+++	+++	?	+++	?	+++
Cognitive impairment (588–592)	+++	+++	+++	+++	+++	++	+++	?	+++

+++, strong evidence (consistent findings in multiple studies of good methodological quality or one study of excellent methodological quality); ++, moderate evidence (consistent findings in multiple studies of fair methodological quality or one study of good methodological quality); +, limited evidence (evidence from one study of fair methodological quality); ?, no data available.

symptoms of obsessive-compulsive disorder (458). General anxiety is also associated with injection-related anxiety and fear of hypoglycemia (459).

Evidence-based psychosocial interventions for anxiety include collaborative care and CBT. An RCT in adults with type 2 diabetes, depression, and anxiety showed that those randomized to collaborative care were more likely to achieve a clinically significant reduction in anxiety symptoms at 6 and 12 months compared with those receiving usual care (460). Another RCT of CBT with adults with type 2 diabetes showed a reduction in health anxiety, with CBT accounting for 77% of the reduction in health anxiety at 16 weeks of follow-up; this trial also found decreased depressive symptoms and diabetes distress (461). For individuals with type 1 diabetes, a systematic review and meta-analysis found that using diabetes technologies, specifically real-time CGM, sensor-augmented pumps, and AID, reduced fear of hypoglycemia independent of the reduction of hypoglycemia frequency (462). Another RCT for young adults with type 1 diabetes found that a CBT-based intervention reduced fear of hypoglycemia by 8.5% compared with control participants and led to increased time in range and improved self-management behaviors over an 8-week period (463). These findings highlight the need for specialized behavioral interventions with a positive adjunct of diabetes technology delivered by qualified professionals to effectively address hypoglycemia-related anxiety.

Depression

Recommendations

5.48 Screen for depressive symptoms in all people with diabetes at least annually and more frequently among those with a history of depression. **B** Refer to qualified behavioral health professionals or other health care professionals with experience using evidence-based treatment approaches for depression in collaboration with the diabetes care team. **A**

5.49 Rescreen for depression at diagnosis of complications or when there are significant changes in medical status. **B**

Elevated depressive symptoms and depressive disorders are common among people with diabetes (381,454) (**Tables 5.6**

Table 5.7—Psychosocial concerns and their association with diabetes-related outcomes in adults with type 2 diabetes

	Increased A1C	Increased blood pressure	Increased dyslipidemia	Increased macrovascular complications	Increased microvascular complications	Decreased self-care behaviors	Comorbid psychosocial concerns	Decreased quality of life	Increased mortality
Diabetes distress (593–599)	+++	+	+	+++	+++	+++	+++	+++	+++
Depression and depressive symptoms (600–607)	+++	++	+++	+++	+++	+++	+++	+++	+++
Anxiety (382,430,601,608–611)	+++	++	+	+++	+	+++	+++	+++	+++
Disordered eating behaviors (binge eating disorder, night eating syndrome) (492,496,612–615)	+/−	+	?	?	+	+	+++	+++	?
Serious mental illness (schizophrenia, bipolar disorder) (616–624)	+/−	++	++	+++	+++	+++	+++	+++	+++
Cognitive impairment (625–632)	+++	+++	+++	+++	+++	+++	+++	+++	+++

+++, strong evidence (consistent findings in multiple studies of good methodological quality or one study of excellent methodological quality); ++, moderate evidence (consistent findings in multiple studies of fair methodological quality or one study of good methodological quality); +, limited evidence (evidence from one study of fair methodological quality); +/−, inconclusive evidence; ?, no data available.

and **5.7**), affecting approximately one in four people with type 1 or type 2 diabetes (384,464), and parents of children and adolescents with diabetes (465). Co-occurring depressive symptoms and diabetes are associated with reduced self-management, elevated A1C (466), and increased CVD and mortality risk (423,467). History of depression, current depression, and antidepressant medication use are also risk factors for the development of type 2 diabetes, particularly in individuals with other risk factors, such as overweight, obesity, and family history of type 2 diabetes (468–470). At least annual depression screening, and more frequent screening for those with a history of depression, is indicated for people with type 1 or type 2 diabetes and gestational diabetes mellitus. Screening is particularly important given that women report higher rates of depression than men (471). For individuals with type 2 diabetes, the experience of diabetes-related stigma is associated with increased depressive symptoms (432). Importantly, depressive symptoms often overlap with diabetes distress, anxiety symptoms, and hyperglycemia, complicating screening and increasing the risk for false positives (434). Conducting annual screening for depression, anxiety, and diabetes distress will help distinguish overlapping symptoms. Positive findings should be followed by a comprehensive clinical assessment to ensure an accurate diagnosis. In practice, routine monitoring with age-appropriate validated measures (1) can help to identify if referral is warranted (397). Multisite studies have demonstrated the feasibility of implementing depressive symptom screening protocols in diabetes clinics and have published practical guides for implementation (405,472).

Person-centered integrated care approaches have been shown to improve both depression and glycemic outcomes (5). The behavioral health professional providing treatment for depression should be incorporated into, or collaborate closely with, the diabetes treatment team (473). Because depressive symptoms may also indicate reduced quality of life due to diabetes burden (also see DIABETES DISTRESS, above), it is important to query origins and exacerbating factors for those symptoms to distinguish between diabetes distress and depression. RCTs examining pharmacologic treatment, group therapy, psychotherapy, parenting interventions, mindfulness-based approaches, or collaborative care have consistently shown improvements in depressive symptoms, with mixed effects on A1C when depression is treated simultaneously with diabetes (5,7,392,474–478). Additionally, psychological interventions, such as CBT, delivered via internet, phone, and self-guided interventions have improved depressive symptoms (475,479,480). Lifestyle interventions targeting nutrition and/or physical activity also demonstrate benefits for depressive symptoms and A1C (251) on their own and when combined with CBT (481–483). Finally, one meta-analysis found that use of GLP-1 RAs led to improvement in depressive symptoms among adults with type 2 diabetes (484), while another meta-analysis did not find significant change in depressive symptoms (485). It is important to note that the medical treatment plan should also be monitored and potentially adjusted in response to reduction in depressive symptoms.

Disordered Eating Behavior

Recommendations

5.50 Screen for disordered or disrupted eating using validated screening measures. Review the medical treatment plan to identify potential treatment-related effects on hunger/caloric intake. **B**

5.51 Reevaluate the treatment plan of people with diabetes who present with symptoms of disordered eating behaviors, an eating disorder, or disrupted patterns of eating, ideally in consultation with a qualified professional. **B**

The estimated prevalence of disordered eating behaviors and diagnosable eating disorders in people with diabetes varies (486–488) (see **Tables 5.6** and **5.7**). People with type 1 diabetes are at increased risk for eating disorders compared with people without diabetes (489). The median prevalence of insulin restriction for weight control is 15%, with mixed findings on whether the behavior is more prevalent among women than men (489–491). In people with type 2 diabetes, binge eating (excessive food intake with an accompanying sense of loss of control) and night eating syndrome are commonly reported (492). Among those with type 2 diabetes treated with insulin, intentional omission is also frequently reported (493). People with diabetes and diagnosable eating disorders have high rates of co-occurring psychosocial concerns, including diabetes distress, depression, fear of hypoglycemia, and anxiety (494). Eating disorders and disordered eating behaviors are also associated with elevated A1C (495–497). Among individuals with type 1 diabetes, body image concerns and emotional distress are common and associated with disordered eating behavior (491,494,498). A systematic review with limited available studies found a higher prevalence of disordered eating behaviors among children and adolescents with type 2 diabetes compared with children and adolescents with type 1 diabetes (499). Data from the SEARCH for Diabetes in Youth study showed that children and adolescents with type 1 and type 2 diabetes and household food insecurity reported more disordered eating behaviors than those with high food security (500).

Diabetes care professionals should monitor for disordered eating behaviors using validated measures. Diabetes-specific measures are recommended to assess for intentional insulin omission and, according to a meta-analysis, show strong associations with A1C (498). For individuals with type 1 diabetes, the Diabetes Eating Problem Survey–Revised (DEPS-R) (501) is recommended to screen for disordered eating behaviors, while the mSCOFF (502), a five-item screening questionnaire, is for eating disorders and includes a question on insulin omission. Any "yes" response should prompt a comprehensive evaluation. For type 2 diabetes, recommended screening measures include the Questionnaire on Eating and Weight Patterns-5 (QEWP-5) (503), the Binge Eating Scale (504), and the Night Eating Questionnaire (505).

Given the complexities of treating disordered eating behaviors and disrupted eating patterns in people with diabetes, interprofessional care teams should include, or closely collaborate with, a health professional trained to identify and treat eating behaviors in individuals with diabetes (506). Key qualifications for such professionals include familiarity with diabetes physiology, weight-related and psychological risk factors for disordered eating behaviors, and treatments for diabetes and disordered eating behaviors. Caution should be taken in labeling individuals with diabetes as having a diagnosable eating disorder, as disordered or disrupted eating patterns are frequently found to be associated with diabetes and its treatment. Maladaptive food intake patterns that appear to have a psychological origin may be driven by physiologic disruption in hunger and satiety cues, metabolic perturbations, and/or secondary distress because of the individual's inability to control their hunger and satiety (507). More rigorous methods to identify underlying mechanisms of action that drive change in eating and treatment behaviors, as well as associated emotional distress, are needed (508).

Reevaluating the treatment plan for people with diabetes in consultation with trained professionals is essential to ensure safety (avoid stigmatizing language, do not focus solely on A1C), to minimize harm (risk of DKA, severe hypoglycemia, complications), and to avoid reinforcing maladaptive patterns (avoid rigid carbohydrate counting and intensive weight monitoring). Inconsistent intervention findings highlight the importance of addressing eating disorders and disordered eating behaviors in the context of the condition and its treatment. Additionally, health care teams may consider the appropriateness of technology use among people with diabetes and disordered eating behaviors, although more research on the risks and benefits is needed (509). Some efforts have focused on preventing disordered eating behaviors among individuals with type 1 diabetes and on supporting parents of children and adolescents with type 1 diabetes who are at risk for disordered eating; however, more RCTs with longer-term follow-up are needed (510,511). A feasibility study of a 12-session CBT and diabetes education program for individuals with type 1 diabetes and disordered eating found that participants reported improvements in disordered eating, diabetes distress, anxiety, and depressive symptoms (512). A 12-week pilot self-guided online program for individuals with type 2 diabetes and binge eating disorder showed promise in benefiting eating behaviors, depression, and anxiety (513).

The use of incretin therapies, specifically GLP-1 RAs and potentially dual glucose-dependent insulinotropic polypeptide (GIP) and GLP-1 RAs, may have relevance to the treatment of disrupted or disordered eating (see section 8, "Obesity and Weight Management for the Prevention and Treatment of Diabetes"). These therapies work in the appetite and reward circuitries to modulate food intake, reducing uncontrollable hunger and overeating (514). A systematic review found early evidence for GLP-1 RAs being effective in reducing binge-eating behaviors, and a meta-analysis found GLP-1 RAs are associated with decreases in emotional eating (485,515).

Serious Mental Illness

Recommendations

5.52 Provide an increased level of support for people with diabetes and serious mental illness through enhanced monitoring of and assistance with diabetes self-management behaviors. **B**

5.53 Monitor changes in body weight, glycemia, and lipids in adolescents and adults with diabetes who are prescribed second-generation antipsychotic medications; adjust the treatment plan accordingly, if needed. **C**

Type 2 diabetes incidence is 1.5- to 2.5-fold higher in individuals with serious mental illness, particularly schizophrenia and other thought disorders, compared with those without a major mental disorder (516,517) (see **Tables 5.6** and **5.7**). People with serious mental illness who are treated with antipsychotics and other psychotropic medications should be monitored routinely for prediabetes and type 2 diabetes, as these medications are associated with metabolic dysregulation, including elevated glucose levels, increased weight, BMI, total cholesterol, and LDL cholesterol, as well as decreased HDL cholesterol (518,519). Changes in glycemia, body weight, and lipids should be monitored every 12–16 weeks, unless clinically indicated to be monitored sooner (520). Disordered thinking and judgment can make it difficult to engage in behaviors that reduce risk factors for type 2 diabetes, such as restrained eating for weight management. Further, people with serious mental illness and diabetes frequently experience moderate psychological distress, indicating pervasive intrusion of behavioral health issues into daily functioning (521). Serious mental illness is often associated with the inability to evaluate and apply information to make judgments about treatment options. For a person with an established diagnosis of a serious mental illness affecting judgment, activities of daily living, and the ability to collaborate with care professionals, the inclusion of a nonmedical caretaker in treatment decision-making is beneficial. This caretaker can assist with care coordination, engagement with self-management behaviors, and participation in social activities to improve the well-being of people with diabetes and serious mental illness (522).

Coordinated management of prediabetes or diabetes and serious mental illness is recommended to achieve diabetes treatment goals. The diabetes care team, in collaboration with other care professionals, should work to provide an enhanced level of care and self-management support for people with diabetes and serious mental illness based on individual capacity and needs. Such care may include remote monitoring, health care aides, and diabetes training for family members, community support personnel, and other caregivers. A systematic review and meta-analysis of nonpharmacologic interventions for people with type 2 diabetes and serious mental illness showed significant reductions in psychiatric symptoms, total cholesterol, and LDL cholesterol but not improvements in A1C, triglycerides, or BMI (523). Qualitative research suggests that educational and behavioral interventions provide benefit via group support, accountability, and assistance with applying diabetes knowledge (524).

Cognitive Capacity and Impairment

Recommendations

5.54 Monitor cognitive capacity throughout the life span for all individuals with diabetes, particularly in those who have documented cognitive disabilities, those who experience severe hypoglycemia, very young children, and older adults. **B**

5.55 Consider referral for a formal assessment if cognitive capacity changes or appears to be suboptimal for decision-making and/or behavioral self-management. **E**

Cognitive capacity refers to attention, memory, logic and reasoning, and auditory and visual processing, all of which are involved in diabetes self-management (525) (see **Tables 5.6** and **5.7**). Long-term diabetes (type 1 or type 2) is associated with cognitive decline (526,527). In people with type 1 diabetes, cognitive impairment is associated with diabetes-specific factors (e.g., younger age at diagnosis, longer disease duration, more time in glycemic extremes, recurrent DKA, elevated A1C, and presence of microvascular complications), other medical factors (e.g., dyslipidemia, intestinal flora, and poorer sleep quality), and sociodemographic factors (e.g., female sex, lower educational level) (528). Similarly, in people with type 2 diabetes, cognitive decline is associated with diabetes-specific factors (e.g., longer duration, elevated A1C, higher fasting blood glucose, microvascular complications, macrovascular complications), other medical factors (e.g., hypertension, depression, physical inactivity), and sociodemographic factors (e.g., older age, male sex, lower education) (529–531). Diagnosis of dementia is more prevalent among people with diabetes, both type 1 and type 2 (532).

Executive functioning is an aspect of cognitive capacity that has relevance to diabetes management. Executive functions refer to a set of cognitive processes that enable a person to plan, organize, and execute tasks; regulate emotions; and control impulses. Declines in cognitive capacity affect executive functioning and information processing speed; they are not consistent between people, and evidence is lacking regarding a known course of decline (533). Attention deficit hyperactivity disorder, which involves deficits in executive functions, is associated with a twofold increased risk of type 2 diabetes (534). Among children, adolescents, and young adults with type 1 diabetes, lower executive functioning is linked with more self-management difficulties and elevated A1C (535). Conversely, higher self-regulation is associated with improved emotional and diabetes-related functioning (536). Thus, monitoring cognitive capacity among individuals with or at risk for diabetes is recommended, particularly their self-monitoring, symptom recognition, and decision-making, all of which are mediated by executive function (532).

As with other conditions affecting mental capacity (e.g., major psychiatric disorders), the key concern is whether the person can collaborate with the care team to achieve metabolic goals and prevent both short-term and long-term complications (521). When cognitive ability is altered, declining, or absent, a lay care professional should be introduced into the care team to serve as a daily monitor and liaison to the care team (1). Individuals with cognitive impairment may require tailored approaches to DSMES that simplify self-management behaviors and introduce remote monitoring. Children and adolescents will need second-party monitoring (e.g., parents and adult caregivers) until they are developmentally able to evaluate information and make appropriate self-management decisions.

Episodes of severe hypoglycemia are independently associated with cognitive decline and are a risk factor for accelerated decline (537). Early-onset type 1 diabetes is associated with long-term deficits in intellectual abilities, especially when accompanied by repeated episodes of severe hypoglycemia (538), and is correlated with elevated A1C and sensor glucose values (539) (see section 14, "Children and Adolescents," for information on early-onset diabetes and cognitive abilities and the effects of severe hypoglycemia on children's cognitive and academic performance). For this reason, cognitive capacity should be routinely assessed to determine a person's ability to maintain and adjust self-management behaviors (e.g., dosing of medications, corrections) and to evaluate the need for caregiver support. If concerns arise, an age-appropriate test of cognitive capacity is recommended (1), with consideration given to the developmental stage; for example, young children who are not expected to self-manage independently or older adults who may require ongoing monitoring.

Importantly, the risk of cognitive decline can be reduced through improved A1C (540). A systematic review and meta-analysis comparing cardioprotective glucose-lowering therapy with control therapy found GLP-1 RAs were associated with a statistically significant reduction in dementia but not SGLT2 inhibitors or pioglitazone (541). Additionally, exercise may be a potential nonpharmacologic treatment pathway for cognitive impairment in older adults with type 2 diabetes (542).

Sleep Health

Recommendations

5.56 Screen for sleep health in people with prediabetes or diabetes and in those at risk for diabetes, including screening for sleep disorders and diabetes-related sleep disruptions. Refer to sleep medicine specialists and/or qualified behavioral health professionals or diabetes care team as indicated. **B**

5.57 Counsel people with diabetes to practice sleep-promoting routines and habits. **A**

The associations between sleep problems and diabetes are complex: sleep disorders are a risk factor for developing type 2 diabetes (543,544) and possibly gestational diabetes mellitus (545). Across the life span, people with diabetes experience sleep disruptions and reduced sleep quality (546,547). Sleep problems are also common in parents of children and adolescents with diabetes, especially after diagnosis (548,549). Disrupted sleep and sleep disorders, including obstructive sleep apnea (OSA) (550), insomnia, and restless leg syndrome (551), are common among people with diabetes. In people with type 1 diabetes, estimates of poor sleep range from 30% to 50% (552), and estimates of moderate to severe OSA are >50% (550). In type 2 diabetes, 55% of people are estimated to have OSA (553), 39% to have insomnia, and 8–45% to have restless leg syndrome (i.e., an uncontrollable urge to move legs) (554). Furthermore, people with type 2 diabetes and restless leg syndrome are more likely to experience microvascular and macrovascular complications (555) as well as depression (556). Additionally, people with diabetes who perform shift work increase their risk for circadian rhythm disorders, which are associated with elevated A1C (557), neuropathy (558), and decreased psychological well-being (558). Health care professionals should consider a comprehensive evaluation of the daily lifestyles of people with diabetes, including sleep duration, shift work schedules, and actual days taken off work, given their associations with hyperglycemia, hypertension, dyslipidemia, and weight gain (559).

The high prevalence of OSA in people with diabetes poses significant clinical implications for diabetes management. Sleep fragmentation and hypoxemia activate the sympathetic nervous system, contributing to hyperglycemia, insulin resistance, increased circulating free fatty acids, impaired microcirculation, oxidative stress, and psychological stress (560). A systematic review and meta-analysis found that continuous positive airway pressure (CPAP) significantly reduced A1C by 0.24% (561). Another systematic review and meta-analysis compared GLP-1 RAs alone or combined with the same interventions in the control group in adults with obesity, prediabetes, and/or type 2 diabetes. Findings showed that the GLP-1 RAs were more effective in reducing apnea-hypopnea index compared with the control group in the population with type 2 diabetes (562). Two phase 3, double-blind RCTs in adults with OSA and obesity showed that a dual GIP and GLP-1 RA significantly reduced sleep apnea severity and body weight compared with placebo after 52 weeks (563). More RCTs with people with diabetes are needed to determine the effectiveness of GLP-1 RAs and dual GIP and GLP-1 RAs as potential treatments for OSA.

Sleep disturbances are associated with less engagement in diabetes self-management and can interfere with achieving and maintaining glucose levels within the goal range (547,550). In type 1 diabetes, risk of hypoglycemia poses specific sleep challenges and may require detailed assessment and treatment approaches (564). People with type 1 diabetes and their family members report worries about poor sleep and diabetes self-management needs interfering with sleep (565). Diabetes technology has been described as both helpful and challenging for sleep (565), with the greatest perceived benefits attributed to AID systems (566–568). Given these challenges, screening and treatment of sleep disorders should be considered a part of standardized care for people with type 1 and type 2 diabetes.

Importantly, nonpharmacological evidence-based strategies are available to improve sleep in people with diabetes. CBT, including CBT for insomnia (392), has been shown to improve sleep outcomes, A1C (569), fasting glucose (569), and depressive symptoms (570). Evidence also suggests sleep extension and pharmacologic treatments can improve sleep outcomes and possibly insulin resistance (564,569). Three RCTs have evaluated insomnia in people with diabetes. Suvorexant improved total sleep time and sleep efficiency, ramelteon improved sleep quality and sleep latency, and lemborexant improved sleep onset and sleep maintenance (571–573). Finally, sleep education, or sleep hygiene, has been shown to improve sleep quality, reduce A1C, and decrease insulin resistance in adults with type 2 diabetes (574). Diabetes care professionals are encouraged to counsel people with diabetes to use sleep-promoting routines and practices, such as establishing a regular bedtime and rise time, creating a dark, quiet area for sleep with temperature and humidity control, establishing a pre-sleep routine, putting electronic devices (except diabetes management devices) in silent/off mode, exercising during the day, avoiding daytime naps, limiting caffeine and nicotine in the evening, avoiding spicy foods at night, and avoiding alcohol before bedtime (575). For people with diabetes who have significant sleep difficulties, referral to sleep specialists to address the medical and behavioral aspects of sleep is recommended, ideally in collaboration with the diabetes care team (**Fig. 5.2**).

References

1. Young-Hyman D, de Groot M, Hill-Briggs F, Gonzalez JS, Hood K, Peyrot M. Psychosocial care for people with diabetes: a position statement of the American Diabetes Association. Diabetes Care 2016;39:2126–2140
2. Powers MA, Bardsley JK, Cypress M, et al. Diabetes self-management education and support in adults with type 2 diabetes: a consensus report of the American Diabetes Association, the Association of Diabetes Care & Education Specialists, the Academy of Nutrition and Dietetics, the American Academy of Family Physicians, the American Academy of PAs, the American Association of Nurse Practitioners, and the American Pharmacists Association. Diabetes Care 2020;43:1636–1649
3. Speight J, Holmes-Truscott E, Garza M, et al. Bringing an end to diabetes stigma and discrimination: an international consensus statement on evidence and recommendations. Lancet Diabetes Endocrinol 2024;12:61–82
4. Asmat K, Dhamani K, Gul R, Froelicher ES. The effectiveness of patient-centered care vs. usual care in type 2 diabetes self-management: a systematic review and meta-analysis. Front Public Health 2022;10:994766
5. Cooper ZW, O'Shields J, Ali MK, Chwastiak L, Johnson LCM. Effects of integrated care approaches to address co-occurring depression and diabetes: a systematic review and meta-analysis. Diabetes Care 2024;47:2291–2304
6. Fisher L, Hessler D, Polonsky WH, et al. T1-REDEEM: a randomized controlled trial to reduce diabetes distress among adults with type 1 diabetes. Diabetes Care 2018;41:1862–1869
7. van der Feltz-Cornelis C, Allen SF, Holt RIG, Roberts R, Nouwen A, Sartorius N. Treatment for comorbid depressive disorder or subthreshold depression in diabetes mellitus: systematic review and meta-analysis. Brain Behav 2021;11:e01981
8. Fitzpatrick SL, Schumann KP, Hill-Briggs F. Problem solving interventions for diabetes self-management and control: a systematic review of the literature. Diabetes Res Clin Pract 2013;100:145–161
9. Greenwood DA, Howell F, Scher L, et al. A framework for optimizing technology-enabled diabetes and cardiometabolic care and education: the role of the diabetes care and education specialist. Diabetes Educ 2020;46:315–322
10. Davis J, Fischl AH, Beck J, et al. 2022 National standards for diabetes self-management education and support. Diabetes Care 2022;45:484–494
11. Fitzpatrick SL, Golden SH, Stewart K, et al. Effect of DECIDE (Decision-making Education for Choices In Diabetes Everyday) program delivery modalities on clinical and behavioral outcomes in urban african americans with type 2 diabetes: a randomized trial. Diabetes Care 2016;39:2149–2157
12. Brunisholz KD, Briot P, Hamilton S, et al. Diabetes self-management education improves quality of care and clinical outcomes determined by a diabetes bundle measure. J Multidiscip Healthc 2014;7:533–542
13. Dickinson JK, Guzman SJ, Maryniuk MD, et al. The use of language in diabetes care and education. Diabetes Care 2017;40:1790–1799
14. Woodard L, Amspoker AB, Hundt NE, et al. Comparison of collaborative goal setting with enhanced education for managing diabetes-associated distress and hemoglobin A1c levels: a randomized clinical trial. JAMA Netw Open 2022;5:e229975
15. Cheng L, Sit JWH, Choi K-C, et al. The effects of an empowerment-based self-management intervention on empowerment level, psychological distress, and quality of life in patients with poorly controlled type 2 diabetes: a randomized controlled trial. Int J Nurs Stud 2021;116:103407
16. Okeyo HM, Biddle M, Williams LB. Impact of diabetes self-management education on A1C levels among Black/African Americans: a systematic review. Sci Diabetes Self Manag Care 2024;50:87–95
17. Rutten GEHM, Van Vugt H, de Koning E. Person-centered diabetes care and patient activation in people with type 2 diabetes. BMJ Open Diabetes Res Care 2020;8:e001926
18. Li R, Shrestha SS, Lipman R, et al.; Centers for Disease Control and Prevention (CDC). Diabetes self-management education and training among privately insured persons with newly diagnosed diabetes–United States, 2011–2012. MMWR Morb Mortal Wkly Rep 2014;63:1045–1049
19. Hildebrand JA, Billimek J, Lee J-A, et al. Effect of diabetes self-management education on glycemic control in Latino adults with type 2 diabetes: a systematic review and meta-analysis. Patient Educ Couns 2020;103:266–275
20. Chrvala CA, Sherr D, Lipman RD. Diabetes self-management education for adults with type 2 diabetes mellitus: a systematic review of the effect on glycemic control. Patient Educ Couns 2016;99:926–943
21. Bekele BB, Negash S, Bogale B, et al. Effect of diabetes self-management education (DSME) on glycated hemoglobin (HbA1c) level among patients with T2DM: systematic review and meta-analysis of randomized controlled trials. Diabetes Metab Syndr 2021;15:177–185
22. Mendez I, Lundeen EA, Saunders M, Williams A, Saaddine J, Albright A. Diabetes self-management education and association with diabetes self-care and clinical preventive care practices. Sci Diabetes Self Manag Care 2022;48:23–34
23. Odgers-Jewell K, Ball LE, Kelly JT, Isenring EA, Reidlinger DP, Thomas R. Effectiveness of group-based self-management education for individuals with type 2 diabetes: a systematic review with meta-analyses and meta-regression. Diabet Med 2017;34:1027–1039
24. Winkley K, Upsher R, Stahl D, et al. Psychological interventions to improve self-management of type 1 and type 2 diabetes: a systematic review. Health Technol Assess 2020;24:1–232
25. Davidson P, LaManna J, Davis J, et al. The effects of diabetes self-management education on quality of life for persons with type 1 diabetes: a systematic review of randomized controlled trials. Sci Diabetes Self Manag Care 2022;48:111–135
26. He X, Li J, Wang B, et al. Diabetes self-management education reduces risk of all-cause mortality in type 2 diabetes patients: a systematic review and meta-analysis. Endocrine 2017;55:712–731
27. Thorpe CT, Fahey LE, Johnson H, Deshpande M, Thorpe JM, Fisher EB. Facilitating healthy coping in patients with diabetes: a systematic review. Diabetes Educ 2013;39:33–52
28. Robbins JM, Thatcher GE, Webb DA, Valdmanis VG. Nutritionist visits, diabetes classes, and hospitalization rates and charges: the Urban Diabetes Study. Diabetes Care 2008;31:655–660
29. Strawbridge LM, Lloyd JT, Meadow A, Riley GF, Howell BL. One-year outcomes of diabetes self-management training among medicare beneficiaries newly diagnosed with diabetes. Med Care 2017;55:391–397
30. Ye W, Kuo S, Kieffer EC, et al. Cost-effectiveness of a diabetes self-management education and support intervention led by community health workers and peer leaders: projections from the Racial and Ethnic Approaches to Community Health Detroit Trial. Diabetes Care 2021;44:1108–1115
31. Al Harbi SS, Alajmi MM, Algabbas SM, Alharbi MS. The comparison of self-management group education and the standard care for patients with type 2 diabetes mellitus: an updated systematic review and meta-analysis. J Family Med Prim Care 2022;11:4299–4309
32. Duncan I, Ahmed T, Li QE, et al. Assessing the value of the diabetes educator. Diabetes Educ 2011;37:638–657
33. Dallosso H, Mandalia P, Gray LJ, et al. The effectiveness of a structured group education programme for people with established type 2 diabetes in a multi-ethnic population in primary care: a cluster randomised trial. Nutr Metab Cardiovasc Dis 2022;32:1549–1559
34. Attridge M, Creamer J, Ramsden M, Cannings-John R, Hawthorne K. Culturally appropriate health education for people in ethnic minority groups with type 2 diabetes mellitus. Cochrane Database Syst Rev 2014;2014:CD006424
35. Chodosh J, Morton SC, Mojica W, et al. Meta-analysis: chronic disease self-management programs for older adults. Ann Intern Med 2005;143:427–438
36. Sarkisian CA, Brown AF, Norris KC, Wintz RL, Mangione CM. A systematic review of diabetes self-care interventions for older, African American, or Latino adults. Diabetes Educ 2003;29:467–479
37. Cruz-Cobo C, Santi-Cano MJ. Efficacy of diabetes education in adults with diabetes mellitus type 2 in primary care: a systematic review. J Nurs Scholarsh 2020;52:155–163
38. Peyrot M, Rubin RR. Behavioral and psychosocial interventions in diabetes: a conceptual review. Diabetes Care 2007;30:2433–2440
39. Naik AD, Palmer N, Petersen NJ, et al. Comparative effectiveness of goal setting in diabetes mellitus group clinics: randomized clinical trial. Arch Intern Med 2011;171:453–459
40. Mannucci E, Giaccari A, Gallo M, et al. Self-management in patients with type 2 diabetes: group-based versus individual education. A

systematic review with meta-analysis of randomized trails. Nutr Metab Cardiovasc Dis 2022;32:330–336
41. Eberle C, Stichling S. Clinical improvements by telemedicine interventions managing type 1 and type 2 diabetes: systematic meta-review. J Med Internet Res 2021;23:e23244
42. Moschonis G, Siopis G, Jung J, et al.; DigiCare4You Consortium. Effectiveness, reach, uptake, and feasibility of digital health interventions for adults with type 2 diabetes: a systematic review and meta-analysis of randomised controlled trials. Lancet Digit Health 2023;5:e125–e143
43. Anderson A, O'Connell SS, Thomas C, Chimmanamada R. Telehealth Interventions to Improve Diabetes Management Among Black and Hispanic Patients: a Systematic Review and Meta-Analysis. J Racial Ethn Health Disparities 2022;9: 2375–2386
44. van Eikenhorst L, Taxis K, van Dijk L, de Gier H. Pharmacist-led self-management interventions to improve diabetes outcomes. A systematic literature review and meta-analysis. Front Pharmacol 2017;8:891
45. Tshiananga JKT, Kocher S, Weber C, Erny-Albrecht K, Berndt K, Neeser K. The effect of nurse-led diabetes self-management education on glycosylated hemoglobin and cardiovascular risk factors: a meta-analysis. Diabetes Educ 2012;38: 108–123
46. Evert AB, Dennison M, Gardner CD, et al. Nutrition therapy for adults with diabetes or prediabetes: a consensus report. Diabetes Care 2019;42:731–754
47. Scalzo P. From the Association of Diabetes Care & Education Specialists: the role of the diabetes care and education specialist as a champion of technology integration. Sci Diabetes Self Manag Care 2021;47:120–123
48. Rodriguez K, Ryan D, Dickinson JK, Phan V. Improving quality outcomes: the value of diabetes care and education specialists. Clin Diabetes 2022; 40:356–365
49. Litchman ML, Oser TK, Hodgson L, et al. In-person and technology-mediated peer support in diabetes care: a systematic review of reviews and gap analysis. Diabetes Educ 2020;46:230–241
50. Evans J, White P, Ha H. Evaluating the effectiveness of community health worker interventions on glycaemic control in type 2 diabetes: a systematic review and meta-analysis. Lancet 2023;402(Suppl 1):S40
51. Centers for Disease Control and Prevention. Diabetes Self-Management Education and Support (DSMES) Toolkit. The Multidisciplinary DSMES Team. Accessed 6 August 2025. Available from https://www.cdc.gov/diabetes-toolkit/php/staffing-models/multidiscipline-team.html
52. Tharakan A, McPeek Hinz E, Zhu E, et al. Accessibility of diabetes education in the United States: barriers, policy implications, and the road ahead. Health Aff Sch 2024;2:qxae097
53. Arena L, Austin R, Esquivel N, Vigil T, Kaelin-Kee J, Millstein S. Understanding barriers and facilitators to participating in diabetes self-management education and support services from multiple perspectives: results of a mixed-methods study of Medicaid members, Medicaid managed care organizations, and providers in New York State. Clin Diabetes 2024;42:505–514
54. Roth SE, Gronowski B, Jones KG, et al. Evaluation of an integrated intervention to address clinical care and social needs among patients with type 2 diabetes. J Gen Intern Med 2023;38:38–44
55. Greenwood DA, Gee PM, Fatkin KJ, Peeples M. A systematic review of reviews evaluating technology-enabled diabetes self-management education and support. J Diabetes Sci Technol 2017;11:1015–1027
56. Powell RE, Zaccardi F, Beebe C, et al. Strategies for overcoming therapeutic inertia in type 2 diabetes: a systematic review and meta-analysis. Diabetes Obes Metab 2021;23:2137–2154
57. Johnson CM, D'Eramo Melkus G, Reagan L, et al. Learning in a virtual environment to improve type 2 diabetes outcomes: randomized controlled trial. JMIR Form Res 2023;7:e40359
58. Center For Health Law and Policy Innovation. Reconsidering cost-sharing for diabetes self-management education: recommendations for policy reform. Accessed 6 August 2025. Available from https://chlpi.org/wp-content/uploads/2015/07/6.11.15-Reconsidering-Cost-Sharing-for-DSME-cover.jpg
59. Lee M-K, Lee DY, Ahn H-Y, Park C-Y. A novel user utility score for diabetes management using tailored mobile coaching: secondary analysis of a randomized controlled trial. JMIR Mhealth Uhealth 2021;9:e17573
60. Strategies to Enhance New CGM Use in Early Childhood (SENCE) Study Group. A randomized clinical trial assessing continuous glucose monitoring (CGM) use with standardized education with or without a family behavioral intervention compared with fingerstick blood glucose monitoring in very young children with type 1 diabetes. Diabetes Care 2021;44:464–472
61. Aronson R, Brown RE, Chu L, et al. IMpact of flash glucose Monitoring in pEople with type 2 Diabetes Inadequately controlled with non-insulin Antihyperglycaemic ThErapy (IMMEDIATE): a randomized controlled trial. Diabetes Obes Metab 2023;25:1024–1031
62. Patil SP, Albanese-O'Neill A, Yehl K, Seley JJ, Hughes AS. Professional competencies for diabetes technology use in the care setting. Sci Diabetes Self Manag Care 2022;48:437–445
63. Greenwood DA, Litchman ML, Isaacs D, et al. A new taxonomy for technology-enabled diabetes self-management interventions: results of an umbrella review. J Diabetes Sci Technol 2022;16: 812–824
64. Association for Diabetes Care & Education Specialists. Diabetes Technology Resources for Healthcare Professionals. Accessed 6 August 2025. Available from https://www.adces.org/education/danatech/home
65. H.R.2617 - 117th Congress (2021-2022): Consolidated Appropriations Act, 2023. (29 December 2022). Accessed 6 August 2025. Available from https://www.congress.gov/bill/117th-congress/house-bill/2617/text
66. Health and Human Services. Telehealth policy updates. Accessed 6 August 2025. Available from https://telehealth.hhs.gov/providers/telehealth-policy/telehealth-policy-updates?utm_medium=share+button&utm_source=mail
67. Medicare. Telehealth. Accessed 6 August 2025. Available from https://www.medicare.gov/coverage/telehealth
68. American Diabetes Association. Standards of medical care for patients with diabetes mellitus. Diabetes Care 1989;12:365–368
69. Lichtenstein AH, Appel LJ, Vadiveloo M, et al. 2021 Dietary guidance to improve cardiovascular health: a scientific statement from the American Heart Association. Circulation 2021;144:e472–e487
70. Levin A, Ahmed SB, Carrero JJ, et al. Executive summary of the KDIGO 2024 Clinical Practice Guideline for the Evaluation and Management of Chronic Kidney Disease: known knowns and known unknowns. Kidney Int 2024;105:684–701
71. Holt RIG, DeVries JH, Hess-Fischl A, et al. The management of type 1 diabetes in adults. A consensus report by the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). Diabetes Care 2021;44: 2589–2625
72. U.S. Department of Agriculture and U.S. Department of Health and Human Services. *Dietary Guidelines for Americans, 2020–2025.* 9th ed. 2020. Accessed 6 August 2025. Available from https://www.dietaryguidelines.gov/sites/default/files/2021-03/Dietary_Guidelines_for_Americans-2020-2025.pdf
73. Forouhi NG. Embracing complexity: making sense of diet, nutrition, obesity and type 2 diabetes. Diabetologia 2023;66:786–799
74. Franz MJ, MacLeod J, Evert A, et al. Academy of Nutrition and Dietetics Nutrition Practice guideline for type 1 and type 2 diabetes in adults: systematic review of evidence for medical nutrition therapy effectiveness and recommendations for integration into the nutrition care process. J Acad Nutr Diet 2017;117:1659–1679
75. Davies MJ, D'Alessio DA, Fradkin J, et al. Management of hyperglycemia in type 2 diabetes, 2018. A consensus report by the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). Diabetes Care 2018;41:2669–2701
76. Marincic PZ, Salazar MV, Hardin A, et al. Diabetes self-management education and medical nutrition therapy: a multisite study documenting the efficacy of registered dietitian nutritionist interventions in the management of glycemic control and diabetic dyslipidemia through retrospective chart review. J Acad Nutr Diet 2019;119: 449–463
77. Briggs Early K, Stanley K. Position of the Academy of Nutrition and Dietetics: the role of medical nutrition therapy and registered dietitian nutritionists in the prevention and treatment of prediabetes and type 2 diabetes. J Acad Nutr Diet 2018;118:343–353
78. Dobrow L, Estrada I, Burkholder-Cooley N, Miklavcic J. Potential effectiveness of registered dietitian nutritionists in healthy behavior interventions for managing type 2 diabetes in older adults: a systematic review. Front Nutr 2021;8: 737410
79. Academy of Nutrition and Dietetics. Eat right PRO. Referrals to an RDN: Primary Care Provider Toolkit. Accessed 5 August 2025. Available from https://www.eatrightpro.org/referrals-to-an-rdn-primary-care-provider-toolkit
80. Evert Ab, Chomko M. Nutrition Therapy. In *The Art and Science of Diabetes Care and Education.* 6th ed. Cornell S, Miller K, Urbanski P, Eds. Association of Diabetes Care & Education Specialists, 2023, p. 455–484
81. Zeng B-T, Pan H-Q, Li F-D, Ye Z-Y, Liu Y, Du J-W. Comparative efficacy of different eating patterns in the management of type 2 diabetes and predia-

betes: an arm-based Bayesian network meta-analysis. J Diabetes Investig 2023;14:263–288
82. Benson G, Hayes J. An update on the mediterranean, vegetarian, and DASH eating patterns in people with type 2 diabetes. Diabetes Spectr 2020; 33:125–132
83. English LK, Ard JD, Bailey RL, et al. Evaluation of dietary patterns and all-cause mortality: a systematic review. JAMA Netw Open 2021;4: e2122277
84. Ge L, Sadeghirad B, Ball GDC, et al. Comparison of dietary macronutrient patterns of 14 popular named dietary programmes for weight and cardiovascular risk factor reduction in adults: systematic review and network meta-analysis of randomised trials. BMJ 2020;369:m696
85. Bonekamp NE, van Damme I, Geleijnse JM, et al. Effect of dietary patterns on cardiovascular risk factors in people with type 2 diabetes. A systematic review and network meta-analysis. Diabetes Res Clin Pract 2023;195:110207
86. Pilla SJ, Yeh H-C, Mitchell CM, et al.; DASH4D Collaborative Research Group. Dietary patterns, sodium reduction, and blood pressure in type 2 diabetes: the DASH4D randomized clinical trial. JAMA Intern Med 2025;185:937–946
87. American Diabetes Association. Nutrition for Life: Diabetes Plate Method. Accessed 6 August 2025. Available from https://professional.diabetes.org/sites/dpro/files/2023-12/plan_your_plate.pdf
88. Bowen ME, Cavanaugh KL, Wolff K, et al. The diabetes nutrition education study randomized controlled trial: a comparative effectiveness study of approaches to nutrition in diabetes self-management education. Patient Educ Couns 2016; 99:1368–1376
89. Builes-Montaño CE, Ortiz-Cano NA, Ramirez-Rincón A, Rojas-Henao NA. Efficacy and safety of carbohydrate counting versus other forms of dietary advice in patients with type 1 diabetes mellitus: a systematic review and meta-analysis of randomised clinical trials. J Hum Nutr Diet 2022; 35:1030–1042
90. Witkow S, Liberty IF, Goloub I, et al. Simplifying carb counting: a randomized controlled study—feasibility and efficacy of an individualized, simple, patient-centred carb counting tool. Endocrinol Diabetes Metab 2023;6:e411
91. Haidar A, Legault L, Raffray M, et al. A randomized crossover trial to compare automated insulin delivery (the artificial pancreas) with carbohydrate counting or simplified qualitative meal-size estimation in type 1 diabetes. Diabetes Care 2023;46:1372–1378
92. Joubert M, Meyer L, Doriot A, Dreves B, Jeandidier N, Reznik Y. Prospective independent evaluation of the carbohydrate counting accuracy of two smartphone applications. Diabetes Ther 2021;12:1809–1820
93. Vasiloglou MF, Mougiakakou S, Aubry E, et al. A comparative study on carbohydrate estimation: GoCARB vs. dietitians. Nutrients 2018;10:741
94. Krause C, Sommerhalder K, Beer-Borst S, Abel T. Just a subtle difference? Findings from a systematic review on definitions of nutrition literacy and food literacy. Health Promot Int 2018;33: 378–389
95. Food Literacy Center. What is food literacy? Accessed 6 August 2025. Available from https://www.foodliteracycenter.org/about
96. Walker GS, Chen JY, Hopkinson H, Sainsbury CAR, Jones GC. Structured education using Dose Adjustment for Normal Eating (DAFNE) reduces long-term HbA1c and HbA1c variability. Diabet Med 2018;35:745–749
97. Delahanty LM, Nathan DM, Lachin JM, et al.; Diabetes Control and Complications Trial/Epidemiology of Diabetes. Association of diet with glycated hemoglobin during intensive treatment of type 1 diabetes in the Diabetes Control and Complications Trial. Am J Clin Nutr 2009;89: 518–524
98. Sacks FM, Bray GA, Carey VJ, et al. Comparison of weight-loss diets with different compositions of fat, protein, and carbohydrates. N Engl J Med 2009;360:859–873
99. Gardner CD, Landry MJ, Perelman D, et al. Effect of a ketogenic diet versus Mediterranean diet on glycated hemoglobin in individuals with prediabetes and type 2 diabetes mellitus: the interventional Keto-Med randomized crossover trial. Am J Clin Nutr 2022;116:640–652
100. Ichikawa T, Okada H, Hironaka J, et al. Efficacy of long-term low carbohydrate diets for patients with type 2 diabetes: a systematic review and meta-analysis. J Diabetes Investig 2024;15: 1410–1421
101. Garbutt J, England C, Jones AG, Andrews RC, Salway R, Johnson L. Is glycaemic control associated with dietary patterns independent of weight change in people newly diagnosed with type 2 diabetes? Prospective analysis of the Early-ACTivity-In-Diabetes trial. BMC Med 2022;20:161
102. Saslow LR, Daubenmier JJ, Moskowitz JT, et al. Twelve-month outcomes of a randomized trial of a moderate-carbohydrate versus very low-carbohydrate diet in overweight adults with type 2 diabetes mellitus or prediabetes. Nutr Diabetes 2017;7:304
103. Korsmo-Haugen H-K, Brurberg KG, Mann J, Aas A-M. Carbohydrate quantity in the dietary management of type 2 diabetes: a systematic review and meta-analysis. Diabetes Obes Metab 2019;21:15–27
104. Tian W, Cao S, Guan Y, et al. The effects of low-carbohydrate diet on glucose and lipid metabolism in overweight or obese patients with T2DM: a meta-analysis of randomized controlled trials. Front Nutr 2024;11:1516086
105. U.S. Food and Drug Administration. FDA revises labels of SGLT2 inhibitors for diabetes to include warnings about too much acid in the blood and serious urinary tract infections. Accessed 6 August 2025. Available from https://www.fda.gov/drugs/drug-safety-and-availability/fda-revises-labels-sglt2-inhibitors-diabetes-include-warnings-about-too-much-acid-blood-and-serious#:∼:text=To%20lessen%20the%20risk%20of,issued%20on%20May%2015%2C%202015%20
106. Ozoran H, Matheou M, Dyson P, Karpe F, Tan GD. Type 1 diabetes and low carbohydrate diets—defining the degree of nutritional ketosis. Diabet Med 2023;40:e15178
107. Attaye I, Warmbrunn MV, Boot ANAF, et al. A systematic review and meta-analysis of dietary interventions modulating gut microbiota and cardiometabolic diseases-striving for new standards in microbiome studies. Gastroenterology 2022; 162:1911–1932
108. Partula V, Deschasaux M, Druesne-Pecollo N, et al.; Milieu Intérieur Consortium. Associations between consumption of dietary fibers and the risk of cardiovascular diseases, cancers, type 2 diabetes, and mortality in the prospective NutriNet-Santé cohort. Am J Clin Nutr 2020;112: 195–207
109. Reynolds AN, Akerman AP, Mann J. Dietary fibre and whole grains in diabetes management: systematic review and meta-analyses. PLoS Med 2020;17:e1003053
110. Qi X, Chiavaroli L, Lee D, et al. Effect of important food sources of fructose-containing sugars on inflammatory biomarkers: a systematic review and meta-analysis of controlled feeding trials. Nutrients 2022;14:3986
111. Zafar MI, Mills KE, Zheng J, et al. Low-glycemic index diets as an intervention for diabetes: a systematic review and meta-analysis. Am J Clin Nutr 2019;110:891–902
112. Vega-López S, Venn BJ, Slavin JL. Relevance of the glycemic index and glycemic load for body weight, diabetes, and cardiovascular disease. Nutrients 2018;10:1361
113. Jenkins DJA, Willett WC, Yusuf S, et al.; Clinical Nutrition & Risk Factor Modification Centre Collaborators. Association of glycaemic index and glycaemic load with type 2 diabetes, cardiovascular disease, cancer, and all-cause mortality: a meta-analysis of mega cohorts of more than 100000 participants. Lancet Diabetes Endocrinol 2024;12:107–118
114. Chiavaroli L, Lee D, Ahmed A, et al. Effect of low glycaemic index or load dietary patterns on glycaemic control and cardiometabolic risk factors in diabetes: systematic review and meta-analysis of randomised controlled trials. BMJ 2021;374: n1651
115. Thomas D, Elliott EJ. Low glycaemic index, or low glycaemic load, diets for diabetes mellitus. Cochrane Database Syst Rev 2009;2009:CD006296
116. Smith TA, Smart CE, Howley PP, Lopez PE, King BR. For a high fat, high protein breakfast, preprandial administration of 125% of the insulin dose improves postprandial glycaemic excursions in people with type 1 diabetes using multiple daily injections: a cross-over trial. Diabet Med 2021;38: e14512
117. Bell KJ, Fio CZ, Twigg S, et al. Amount and type of dietary fat, postprandial glycemia, and insulin requirements in type 1 diabetes: a randomized within-subject trial. Diabetes Care 2020;43: 59–66
118. Furthner D, Lukas A, Schneider AM, et al. The role of protein and fat intake on insulin therapy in glycaemic control of paediatric type 1 diabetes: a systematic review and research gaps. Nutrients 2021;13:3558
119. Al Balwi R, Al Madani W, Al Ghamdi A. Efficacy of insulin dosing algorithms for high-fat high-protein mixed meals to control postprandial glycemic excursions in people living with type 1 diabetes: a systematic review and meta-analysis. Pediatr Diabetes 2022;23:1635–1646
120. Bell KJ, Toschi E, Steil GM, Wolpert HA. Optimized mealtime insulin dosing for fat and protein in type 1 diabetes: application of a model-based approach to derive insulin doses for open-loop diabetes management. Diabetes Care 2016; 39:1631–1634
121. Metwally M, Cheung TO, Smith R, Bell KJ. Insulin pump dosing strategies for meals varying in fat, protein or glycaemic index or grazing-style meals in type 1 diabetes: a systematic review. Diabetes Res Clin Pract 2021;172:108516
122. Petrovski G, Campbell J, Pasha M, et al. Simplified meal announcement versus precise

carbohydrate counting in adolescents with type 1 diabetes using the MiniMed 780G advanced hybrid closed loop system: a randomized controlled trial comparing glucose control. Diabetes Care 2023;46:544–550
123. Phillip M, Nimri R, Bergenstal RM, et al. Consensus recommendations for the use of automated insulin delivery technologies in clinical practice. Endocr Rev 2023;44:254–280
124. Lesser LI. In adults at CV risk, Mediterranean-style or low-fat dietary programs vs. minimal interventions reduce all-cause mortality. Ann Intern Med 2023;176:JC78
125. Ley SH, Hamdy O, Mohan V, Hu FB. Prevention and management of type 2 diabetes: dietary components and nutritional strategies. Lancet 2014;383:1999–2007
126. Jiang S, Fang J, Li W. Protein restriction for diabetic kidney disease. Cochrane Database Syst Rev 2023;1:CD014906
127. Viguiliouk E, Stewart SE, Jayalath VH, et al. Effect of replacing animal protein with plant protein on glycemic control in diabetes: a systematic review and meta-analysis of randomized controlled trials. Nutrients 2015;7:9804–9824
128. Lamberg-Allardt C, Bärebring L, Arnesen EK, et al. Animal versus plant-based protein and risk of cardiovascular disease and type 2 diabetes: a systematic review of randomized controlled trials and prospective cohort studies. Food Nutr Res 2023;67:10.29219/fnr.v67.9003
129. Sullivan VK, Kim H, Caulfield LE, Steffen LM, Selvin E, Rebholz CM. Plant-based dietary patterns and incident diabetes in the Atherosclerosis Risk in Communities (ARIC) study. Diabetes Care 2024;47:803–809
130. Willett W, Rockström J, Loken B, et al. Food in the Anthropocene: the EAT-Lancet Commission on healthy diets from sustainable food systems. Lancet 2019;393:447–492
131. Estruch R, Ros E, Salas-Salvadó J, et al.; PREDIMED Study Investigators. Primary prevention of cardiovascular disease with a Mediterranean diet supplemented with extra-virgin olive oil or nuts. N Engl J Med 2018;378:e34
132. Forouhi NG, Imamura F, Sharp SJ, et al. Association of plasma phospholipid n-3 and n-6 polyunsaturated fatty acids with type 2 diabetes: the EPIC-InterAct case-cohort study. PLoS Med 2016;13:e1002094
133. Wang DD, Li Y, Chiuve SE, et al. Association of specific dietary fats with total and cause-specific mortality. JAMA Intern Med 2016;176:1134–1145
134. Sebastian SA, Padda I, Johal G. Long-term impact of Mediterranean diet on cardiovascular disease prevention: a systematic review and meta-analysis of randomized controlled trials. Curr Probl Cardiol 2024;49:102509
135. Kirkpatrick CF, Sikand G, Petersen KS, et al. Nutrition interventions for adults with dyslipidemia: a clinical perspective from the National Lipid Association. J Clin Lipidol 2023;17:428–451
136. Karam G, Agarwal A, Sadeghirad B, et al. Comparison of seven popular structured dietary programmes and risk of mortality and major cardiovascular events in patients at increased cardiovascular risk: systematic review and network meta-analysis. BMJ 2023;380:e072003
137. Rosqvist F, Kullberg J, Ståhlman M, et al. Overeating saturated fat promotes fatty liver and ceramides compared with polyunsaturated fat: a randomized trial. J Clin Endocrinol Metab 2019;104:6207–6219
138. Schwab U, Reynolds AN, Sallinen T, Rivellese AA, Risérus U. Dietary fat intakes and cardiovascular disease risk in adults with type 2 diabetes: a systematic review and meta-analysis. Eur J Nutr 2021;60:3355–3363
139. Sacks FM, Lichtenstein AH, Wu JHY, et al.; American Heart Association. Dietary fats and cardiovascular disease: a presidential advisory from the American Heart Association. Circulation 2017;136:e1–e23
140. Bosch J, Gerstein HC, Dagenais GR, et al.; ORIGIN Trial Investigators. n-3 fatty acids and cardiovascular outcomes in patients with dysglycemia. N Engl J Med 2012;367:309–318
141. Wheeler ML, Dunbar SA, Jaacks LM, et al. Macronutrients, food groups, and eating patterns in the management of diabetes: a systematic review of the literature, 2010. Diabetes Care 2012;35:434–445
142. Brown TJ, Brainard J, Song F, Wang X, Abdelhamid A, Hooper L; PUFAH Group. Omega-3, omega-6, and total dietary polyunsaturated fat for prevention and treatment of type 2 diabetes mellitus: systematic review and meta-analysis of randomised controlled trials. BMJ 2019;366:l4697
143. Bowman L, Mafham M, Wallendszus K, et al.; ASCEND Study Collaborative Group. Effects of n-3 fatty acid supplements in diabetes mellitus. N Engl J Med 2018;379:1540–1550
144. Bhatt DL, Steg PG, Miller M, et al.; REDUCE-IT Investigators. Cardiovascular risk reduction with icosapent ethyl for hypertriglyceridemia. N Engl J Med 2019;380:11–22
145. Hodson EM, Cooper TE. Altered dietary salt intake for preventing diabetic kidney disease and its progression. Cochrane Database Syst Rev 2023;1:CD006763
146. Han S, Cheng D, Liu N, Kuang H. The relationship between diabetic risk factors, diabetic complications and salt intake. J Diabetes Complications 2018;32:531–537
147. Morales-Alvarez MC, Nissaisorakarn V, Appel LJ, et al. Effects of reduced dietary sodium and the DASH diet on GFR: the DASH-sodium trial. Kidney360 2024;5:569–576
148. Hannon BA, Fairfield WD, Adams B, Kyle T, Crow M, Thomas DM. Use and abuse of dietary supplements in persons with diabetes. Nutr Diabetes 2020;10:14
149. Kazemi A, Ryul Shim S, Jamali N, et al. Comparison of nutritional supplements for glycemic control in type 2 diabetes: a systematic review and network meta-analysis of randomized trials. Diabetes Res Clin Pract 2022;191:110037
150. National Center for Complementary and Integrative Health. Dietary and Herbal Supplements. Accessed 6 August 2025. Available from https://www.nccih.nih.gov/health/dietary-and-herbal-supplements
151. U.S. Food and Drug Administration. Dietary Supplements. Accessed 6 August 2025. Available from https://www.fda.gov/food/dietary-supplements
152. Dwyer JT, Coates PM, Smith MJ. Dietary supplements: regulatory challenges and research resources. Nutrients 2018;10:41
153. U.S. Food and Drug Administration. Dietary Supplement Ingredient Directory. Accessed 6 August 2025. Available from https://www.fda.gov/food/dietary-supplements/dietary-supplement-ingredient-directory
154. Mangione CM, Barry MJ, Nicholson WK, et al.; US Preventive Services Task Force. Vitamin, mineral, and multivitamin supplementation to prevent cardiovascular disease and cancer: US Preventive Services Task Force recommendation statement. JAMA 2022;327:2326–2333
155. Pittas AG, Kawahara T, Jorde R, et al. Vitamin D and risk for type 2 diabetes in people with prediabetes: a systematic review and meta-analysis of individual participant data from 3 randomized clinical trials. Ann Intern Med 2023;176:355–363
156. Dawson-Hughes B, Nelson J, Pittas AG, et al. Intratrial exposure to vitamin D and new-onset diabetes among adults with prediabetes: a secondary analysis from the Vitamin D and Type 2 Diabetes (D2d) Study. Diabetes Care 2021;43:2916–2922
157. Barbarawi M, Zayed Y, Barbarawi O, et al. Effect of vitamin D supplementation on the incidence of diabetes mellitus. J Clin Endocrinol Metab 2020;105:dgaa335
158. Barbarawi M, Kheiri B, Zayed Y, et al. Vitamin D supplementation and cardiovascular disease risks in more than 83 000 individuals in 21 randomized clinical trials: a meta-analysis. JAMA Cardiol 2019;4:765–776
159. Jayedi A, Daneshvar M, Jibril AT, et al. Serum 25(OH)D concentration, vitamin D supplementation, and risk of cardiovascular disease and mortality in patients with type 2 diabetes or prediabetes: a systematic review and dose-response meta-analysis. Am J Clin Nutr 2023;118:697–707
160. Dadon Y, Hecht Sagie L, Mimouni FB, Arad I, Mendlovic J. Vitamin D and insulin-dependent diabetes: a systematic review of clinical trials. Nutrients 2024;16:1042
161. Moridpour AH, Kavyani Z, Khosravi S, et al. The effect of cinnamon supplementation on glycemic control in patients with type 2 diabetes mellitus: an updated systematic review and dose-response meta-analysis of randomized controlled trials. Phytother Res 2024;38:117–130
162. Khattab R, Albannawi M, Alhajjmohammed D, et al. Metformin-induced vitamin B12 deficiency among type 2 diabetes mellitus' patients: a systematic review. Curr Diabetes Rev 2023;19:e180422203716
163. National Institutes of Health. Office of Dietary Supplements. Multivitamin/mineral Supplements. Fact Sheet for Health Professionals. Accessed 6 August 2025. Available from https://ods.od.nih.gov/factsheets/MVMS-HealthProfessional/
164. World Health Organization. No level of alcohol consumption is safe for our health. Accessed 6 August 2025. Available from https://www.who.int/europe/news/item/04-01-2023-no-level-of-alcohol-consumption-is-safe-for-our-health
165. Anderson BO, Berdzuli N, Ilbawi A, et al. Health and cancer risks associated with low levels of alcohol consumption. Lancet Public Health 2023;8:e6–e7
166. de Souza ABC, Correa-Giannella MLC, Gomes MB, Negrato CA, Nery M. Epidemiology and risk factors of hypoglycemia in subjects with type 1 diabetes in Brazil: a cross-sectional, multicenter study. Arch Endocrinol Metab 2022;66:784–791

167. Llamosas-Falcón L, Rehm J, Bright S, et al. The relationship between alcohol consumption, BMI, and type 2 diabetes: a systematic review and dose-response meta-analysis. Diabetes Care 2023;46:2076–2083
168. Krittanawong C, Isath A, Rosenson RS, et al. Alcohol consumption and cardiovascular health. Am J Med 2022;135:1213–1230.e3
169. National Agricultural Library, U.S. Department of Agriculture. Nutritive and nonnutritive sweetener resources. Accessed 6 August 2025. Available from https://www.nal.usda.gov/human-nutrition-and-food-safety/food-composition/sweeteners
170. U.S. Food and Drug Administration. Food Additives & Petitions. Aspartame and Other Sweeteners in Food. Accessed 8 September 2025. Available from https://www.fda.gov/food/food-additives-petitions/aspartame-and-other-sweeteners-food#:~:text=Text%20Version%20of%20Safe%20Levels%20of%20Sweeteners&text=The%20ADI%20in%20milligrams%20per,5%20mg/kg%20bw/d
171. Lohner S, Kuellenberg de Gaudry D, Toews I, Ferenci T, Meerpohl JJ. Non-nutritive sweeteners for diabetes mellitus. Cochrane Database Syst Rev 2020;5:CD012885
172. Zhang R, Noronha JC, Khan TA, et al. The effect of non-nutritive sweetened beverages on postprandial glycemic and endocrine responses: a systematic review and network meta-analysis. Nutrients 2023;15:1050
173. Sylvetsky AC, Chandran A, Talegawkar SA, Welsh JA, Drews K, El Ghormli L. Consumption of beverages containing low-calorie sweeteners, diet, and cardiometabolic health in youth with type 2 diabetes. J Acad Nutr Diet 2020;120:1348–1358.e6
174. Golzan SA, Movahedian M, Haghighat N, Asbaghi O, Hekmatdoost A. Association between non-nutritive sweetener consumption and liver enzyme levels in adults: a systematic review and meta-analysis of randomized clinical trials. Nutr Rev 2023;81:1105–1117
175. Miller PE, Perez V. Low-calorie sweeteners and body weight and composition: a meta-analysis of randomized controlled trials and prospective cohort studies. Am J Clin Nutr 2014;100:765–777
176. Rogers PJ, Hogenkamp PS, de Graaf C, et al. Does low-energy sweetener consumption affect energy intake and body weight? A systematic review, including meta-analyses, of the evidence from human and animal studies. Int J Obes (Lond) 2016;40:381–394
177. Laviada-Molina H, Molina-Segui F, Pérez-Gaxiola G, et al. Effects of nonnutritive sweeteners on body weight and BMI in diverse clinical contexts: systematic review and meta-analysis. Obes Rev 2020;21:e13020
178. Azad MB, Abou-Setta AM, Chauhan BF, et al. Nonnutritive sweeteners and cardiometabolic health: a systematic review and meta-analysis of randomized controlled trials and prospective cohort studies. CMAJ 2017;189:e929–e939
179. Lee JJ, Khan TA, McGlynn N, et al. Relation of change or substitution of low- and no-calorie sweetened beverages with cardiometabolic outcomes: a systematic review and meta-analysis of prospective cohort studies. Diabetes Care 2022;45:1917–1930
180. Mattes RD, Popkin BM. Nonnutritive sweetener consumption in humans: effects on appetite and food intake and their putative mechanisms. Am J Clin Nutr 2009;89:1–14
181. McGlynn ND, Khan TA, Wang L, et al. Association of low- and no-calorie sweetened beverages as a replacement for sugar-sweetened beverages with body weight and cardiometabolic risk: a systematic review and meta-analysis. JAMA Netw Open 2022;5:e222092
182. Gostoli S, Raimondi G, Popa AP, Giovannini M, Benasi G, Rafanelli C. Behavioral lifestyle interventions for weight loss in overweight or obese patients with type 2 diabetes: a systematic review of the literature. Curr Obes Rep 2024;13:224–241
183. Balk EM, Earley A, Raman G, Avendano EA, Pittas AG, Remington PL. Combined diet and physical activity promotion programs to prevent type 2 diabetes among persons at increased risk: a systematic review for the Community Preventive Services Task Force. Ann Intern Med 2015;163:437–451
184. Franz MJ, Boucher JL, Rutten-Ramos S, VanWormer JJ. Lifestyle weight-loss intervention outcomes in overweight and obese adults with type 2 diabetes: a systematic review and meta-analysis of randomized clinical trials. J Acad Nutr Diet 2015;115:1447–1463
185. Garvey WT, Ryan DH, Bohannon NJV, et al. Weight-loss therapy in type 2 diabetes: effects of phentermine and topiramate extended release. Diabetes Care 2014;37:3309–3316
186. Kahan S, Fujioka K. Obesity pharmacotherapy in patients with type 2 diabetes. Diabetes Spectr 2017;30:250–257
187. Hemmingsen B, Gimenez-Perez G, Mauricio D, Roque IFM, Metzendorf MI, Richter B. Diet, physical activity or both for prevention or delay of type 2 diabetes mellitus and its associated complications in people at increased risk of developing type 2 diabetes mellitus. Cochrane Database Syst Rev 2017;12:CD003054
188. Rebello CJ, Zhang D, Kirwan JP, et al. Effect of exercise training on insulin-stimulated glucose disposal: a systematic review and meta-analysis of randomized controlled trials. Int J Obes (Lond) 2023;47:348–357
189. Singh N, Stewart RAH, Benatar JR. Intensity and duration of lifestyle interventions for long-term weight loss and association with mortality: a meta-analysis of randomised trials. BMJ Open 2019;9:e029966
190. Lean ME, Leslie WS, Barnes AC, et al. Primary care-led weight management for remission of type 2 diabetes (DiRECT): an open-label, cluster-randomised trial. Lancet 2018;391:541–551
191. Wing RR, Lang W, Wadden TA, et al.; Look AHEAD Research Group. Benefits of modest weight loss in improving cardiovascular risk factors in overweight and obese individuals with type 2 diabetes. Diabetes Care 2011;34:1481–1486
192. Aukan MI, Coutinho S, Pedersen SA, Simpson MR, Martins C. Differences in gastrointestinal hormones and appetite ratings between individuals with and without obesity—a systematic review and meta-analysis. Obes Rev 2023;24:e13531
193. Farhat G, Mellor DD, Sattar N, Harvie M, Issa B, Rutter MK. Effectiveness of lifestyle interventions/culturally bespoke programmes in South Asian ethnic groups targeting weight loss for prevention and/or remission of type 2 diabetes: a systematic review and meta-analysis of intervention trials. J Hum Nutr Diet 2024;37:550–563
194. Wing RR; Look AHEAD Research Group. Does lifestyle intervention improve health of adults with overweight/obesity and type 2 diabetes? Findings from the Look AHEAD randomized trial. Obesity (Silver Spring) 2021;29:1246–1258
195. Garvey WT. Long-term health benefits of intensive lifestyle intervention in the Look AHEAD study. Obesity (Silver Spring) 2021;29:1242–1243
196. Davies M, Færch L, Jeppesen OK, et al.; STEP 2 Study Group. Semaglutide 2·4 mg once a week in adults with overweight or obesity, and type 2 diabetes (STEP 2): a randomised, double-blind, double-dummy, placebo-controlled, phase 3 trial. Lancet 2021;397:971–984
197. Jastreboff AM, Aronne LJ, Ahmad NN, et al.; SURMOUNT-1 Investigators. Tirzepatide once weekly for the treatment of obesity. N Engl J Med 2022;387:205–216
198. Garvey WT, Frias JP, Jastreboff AM, et al.; SURMOUNT-2 investigators. Tirzepatide once weekly for the treatment of obesity in people with type 2 diabetes (SURMOUNT-2): a double-blind, randomised, multicentre, placebo-controlled, phase 3 trial. Lancet 2023;402:613–626
199. Prinz N, Schwandt A, Becker M, et al. Trajectories of body mass index from childhood to young adulthood among patients with type 1 diabetes—a longitudinal group-based modeling approach based on the DPV Registry. J Pediatr 2018;201:78–85.e4
200. Lipman TH, Levitt Katz LE, Ratcliffe SJ, et al. Increasing incidence of type 1 diabetes in youth: twenty years of the Philadelphia Pediatric Diabetes Registry. Diabetes Care 2013;36:1597–1603
201. Park J, Ntelis S, Yunasan E, et al. Glucagon-like peptide 1 analogues as adjunctive therapy for patients with type 1 diabetes: an updated systematic review and meta-analysis. J Clin Endocrinol Metab 2023;109:279–292
202. Sumithran P, Prendergast LA, Delbridge E, et al. Long-term persistence of hormonal adaptations to weight loss. N Engl J Med 2011;365:1597–1604
203. Li L, Soll D, Leupelt V, Spranger J, Mai K. Weight loss-induced improvement of body weight and insulin sensitivity is not amplified by a subsequent 12-month weight maintenance intervention but is predicted by adaption of adipose atrial natriuretic peptide system: 48-month results of a randomized controlled trial. BMC Med 2022;20:238
204. Tomah S, Zhang H, Al-Badri M, et al. Long-term effect of intensive lifestyle intervention on cardiometabolic risk factors and microvascular complications in patients with diabetes in real-world clinical practice: a 10-year longitudinal study. BMJ Open Diabetes Res Care 2023;11:e003179
205. Ekong G, Kavookjian J. Motivational interviewing and outcomes in adults with type 2 diabetes: a systematic review. Patient Educ Couns 2016;99:944–952
206. Nip ASY, Reboussin BA, Dabelea D, et al.; SEARCH for Diabetes in Youth Study Group. Disordered eating behaviors in youth and young adults with type 1 or type 2 diabetes receiving insulin therapy: the SEARCH for Diabetes in Youth Study. Diabetes Care 2019;42:859–866
207. Ye W, Xu L, Ye Y, et al. The efficacy and safety of meal replacement in patients with type 2 diabetes: a systematic review and meta-analysis. J Clin Endocrinol Metab 2023;108:3041–3049

208. Murphy E, Finucane FM. Structured lifestyle modification as an adjunct to obesity pharmacotherapy: there is much to learn. Int J Obes (Lond) 2025;49:427–432
209. Lean MEJ, Leslie WS, Barnes AC, et al. Durability of a primary care-led weight-management intervention for remission of type 2 diabetes: 2-year results of the DiRECT open-label, cluster-randomised trial. Lancet Diabetes Endocrinol 2019;7:344–355
210. Raben A, Vestentoft PS, Brand-Miller J, et al. The PREVIEW intervention study: results from a 3-year randomized 2 x 2 factorial multinational trial investigating the role of protein, glycaemic index and physical activity for prevention of type 2 diabetes. Diabetes Obes Metab 2021;23:324–337
211. Salvia MG, Quatromoni PA. Behavioral approaches to nutrition and eating patterns for managing type 2 diabetes: a review. Am J Med Open 2023;9:100034
212. Henry CJ, Kaur B, Quek RYC. Chrononutrition in the management of diabetes. Nutr Diabetes 2020;10:6
213. Liu J, Yi P, Liu F. The effect of early time-restricted eating vs later time-restricted eating on weight loss and metabolic health. J Clin Endocrinol Metab 2023;108:1824–1834
214. Wang L, Ma Q, Fang B, et al. Shift work is associated with an increased risk of type 2 diabetes and elevated RBP4 level: cross sectional analysis from the OHSPIW cohort study. BMC Public Health 2023;23:1139
215. Jamshed H, Steger FL, Bryan DR, et al. Effectiveness of early time-restricted eating for weight loss, fat loss, and cardiometabolic health in adults with obesity: a randomized clinical trial. JAMA Intern Med 2022;182:953–962
216. Lowe DA, Wu N, Rohdin-Bibby L, et al. Effects of time-restricted eating on weight loss and other metabolic parameters in women and men with overweight and obesity: the TREAT randomized clinical trial. JAMA Intern Med 2020;180:1491–1499
217. Schroor MM, Joris PJ, Plat J, Mensink RP. Effects of intermittent energy restriction compared with those of continuous energy restriction on body composition and cardiometabolic risk markers—a systematic review and meta-analysis of randomized controlled trials in adults. Adv Nutr 2024;15:100130
218. Pappachan JM. In T2DM with obesity, time-restricted eating increased weight loss and reduced HbA1c level at 6 mo. Ann Intern Med 2024;177:JC16
219. Varady KA, Cienfuegos S, Ezpeleta M, Gabel K. Clinical application of intermittent fasting for weight loss: progress and future directions. Nat Rev Endocrinol 2022;18:309–321
220. Al-Arouj M, Assaad-Khalil S, Buse J, et al. Recommendations for management of diabetes during Ramadan: update 2010. Diabetes Care 2010;33:1895–1902
221. Grajower MM. Management of diabetes mellitus on Yom Kippur and other Jewish fast days. Endocr Pract 2008;14:305–311
222. Gupta N, Gusdorf J. Guidance for physicians on the Yom Kippur fast. Georgetown Medical Review 2023;7
223. Saboo B, Joshi S, Shah SN, et al. Management of diabetes during fasting and feasting in India. J Assoc Physicians India 2019;67:70–77
224. Hassanein M, Afandi B, Yakoob Ahmedani M, et al. Diabetes and Ramadan: practical guidelines 2021. Diabetes Res Clin Pract 2022;185:109185
225. Deeb A, Babiker A, Sedaghat S, et al. ISPAD Clinical Practice Consensus Guidelines 2022: Ramadan and other religious fasting by young people with diabetes. Pediatr Diabetes 2022;23:1512–1528
226. Noor SK, Alutol MT, FadAllah FSA, et al. Risk factors associated with fasting during Ramadan among individuals with diabetes according to IDF-DAR risk score in Atbara city, Sudan: cross-sectional hospital-based study. Diabetes Metab Syndr 2023;17:102743
227. Mohammed N, Buckley A, Siddiqui M, et al. Validation of the new IDF-DAR risk assessment tool for Ramadan fasting in patients with diabetes. Diabetes Metab Syndr 2023;17:102754
228. Alfadhli EM, Alharbi TS, Alrotoie AM, et al. Validity of the International Diabetes Federation risk stratification score of Ramadan fasting in individuals with diabetes mellitus. Saudi Med J 2024;45:86–92
229. Shamsi N, Naser J, Humaidan H, et al. Verification of 2021 IDF-DAR risk assessment tool for fasting Ramadan in patients with diabetes attending primary health care in The Kingdom of Bahrain: the DAR-BAH study. Diabetes Res Clin Pract 2024;211:111661
230. Hassanein M, Hussein Z, Shaltout I, et al. The DAR 2020 global survey: Ramadan fasting during COVID 19 pandemic and the impact of older age on fasting among adults with type 2 diabetes. Diabetes Res Clin Pract 2021;173:108674
231. Yousuf S, Syed A, Ahmedani MY. To explore the association of Ramadan fasting with symptoms of depression, anxiety, and stress in people with diabetes. Diabetes Res Clin Pract 2021;172:108545
232. Hassanein M, Bashier A, Randeree H, et al. Use of SGLT2 inhibitors during Ramadan: an expert panel statement. Diabetes Res Clin Pract 2020;169:108465
233. Hassanein M, Abdelgadir E, Bashier A, et al. The role of optimum diabetes care in form of Ramadan focused diabetes education, flash glucose monitoring system and pre-Ramadan dose adjustments in the safety of Ramadan fasting in high risk patients with diabetes. Diabetes Res Clin Pract 2019;150:288–295
234. Afandi B, Hassanein M, Roubi S, Nagelkerke N. The value of continuous glucose monitoring and self-monitoring of blood glucose in patients with gestational diabetes mellitus during Ramadan fasting. Diabetes Res Clin Pract 2019;151:260–264
235. Gigliotti L, Warshaw H, Evert A, et al. Incretin-based therapies and lifestyle interventions: the evolving role of registered dietitian nutritionists in obesity care. J Acad Nutr Diet 2025;125:408–421
236. Mozaffarian D, Agarwal M, Aggarwal M, et al. Nutritional priorities to support GLP-1 therapy for obesity: a joint advisory from the American College of Lifestyle Medicine, the American Society for Nutrition, the Obesity Medicine Association, and the Obesity Society. Am J Lifestyle Med 2025:15598276251344827
237. Hummell AC, Cummings M. Role of the nutrition-focused physical examination in identifying malnutrition and its effectiveness. Nutr Clin Pract 2022;37:41–49
238. U.S. Department of Agriculture. Economic Research Service. Household Food Security in the United States in 2023. Accessed 6 August 2025. Available from https://www.ers.usda.gov/publications/pub-details?pubid=109895
239. Whitehouse CR, Akyirem S, Petoskey C, et al. A systematic review of interventions that address food insecurity for persons with prediabetes or diabetes using the RE-AIM Framework. Sci Diabetes Self Manag Care 2024;50:141–166
240. Hager ER, Quigg AM, Black MM, et al. Development and validity of a 2-item screen to identify families at risk for food insecurity. Pediatrics 2010;126:e26–e32
241. Sluik D, Buijsse B, Muckelbauer R, et al. Physical activity and mortality in individuals with diabetes mellitus: a prospective study and meta-analysis. Arch Intern Med 2012;172:1285–1295
242. Tikkanen-Dolenc H, Wadén J, Forsblom C, et al.; FinnDiane Study Group. Physical activity reduces risk of premature mortality in patients with type 1 diabetes with and without kidney disease. Diabetes Care 2017;40:1727–1732
243. Wang Y, Lee D-C, Brellenthin AG, et al. Leisure-time running reduces the risk of incident type 2 diabetes. Am J Med 2019;132:1225–1232
244. Pai L-W, Li T-C, Hwu Y-J, Chang S-C, Chen L-L, Chang P-Y. The effectiveness of regular leisure-time physical activities on long-term glycemic control in people with type 2 diabetes: a systematic review and meta-analysis. Diabetes Res Clin Pract 2016;113:77–85
245. Munshi MN, Venditti EM, Tjaden AH, et al. Long-term impact of Diabetes Prevention Program interventions on walking endurance. Front Public Health 2024;12:1470035
246. Ostman C, Jewiss D, King N, Smart NA. Clinical outcomes to exercise training in type 1 diabetes: a systematic review and meta-analysis. Diabetes Res Clin Pract 2018;139:380–391
247. Boulé NG, Haddad E, Kenny GP, Wells GA, Sigal RJ. Effects of exercise on glycemic control and body mass in type 2 diabetes mellitus: a meta-analysis of controlled clinical trials. JAMA 2001;286:1218–1227
248. Martland R, Mondelli V, Gaughran F, Stubbs B. Can high-intensity interval training improve physical and mental health outcomes? A meta-review of 33 systematic reviews across the lifespan. J Sports Sci 2020;38:430–469
249. Pandey A, Patel KV, Bahnson JL, et al.; Look AHEAD Research Group. Association of intensive lifestyle intervention, fitness, and body mass index with risk of heart failure in overweight or obese adults with type 2 diabetes mellitus: an analysis from the Look AHEAD trial. Circulation 2020;141:1295–1306
250. Rejeski WJ, Ip EH, Bertoni AG, et al.; Look AHEAD Research Group. Lifestyle change and mobility in obese adults with type 2 diabetes. N Engl J Med 2012;366:1209–1217
251. Mohammad Rahimi GR, Aminzadeh R, Azimkhani A, Saatchian V. The effect of exercise interventions to improve psychosocial aspects and glycemic control in type 2 diabetic patients: a systematic review and meta-analysis of randomized controlled trials. Biol Res Nurs 2022;24:10–23
252. Laosa O, Topinkova E, Bourdel-Marchasson I, et al.; MIDFRAIL Consortium. Long-term frailty and physical performance transitions in older people with type-2 diabetes. The MIDFRAIL randomized clinical study. J Nutr Health Aging 2025;29:100512
253. Arsh A, Afaq S, Carswell C, Bhatti MM, Ullah I, Siddiqi N. Effectiveness of physical activity in

managing co-morbid depression in adults with type 2 diabetes mellitus: a systematic review and meta-analysis. J Affect Disord 2023;329:448–459
254. U.S. Department of Health and Human Services. *Physical Activity Guidelines for Americans*, 2nd ed. Accessed 5 August 2025. Available from https://health.gov/sites/default/files/2019-09/Physical_Activity_Guidelines_2nd_edition.pdf
255. Colberg SR, Sigal RJ, Yardley JE, et al. Physical activity/exercise and diabetes: a position statement of the American Diabetes Association. Diabetes Care 2016;39:2065–2079
256. Nelson KM, Reiber G, Boyko EJ. Diet and exercise among adults with type 2 diabetes: findings from the third national health and nutrition examination survey (NHANES III). Diabetes Care 2002;25:1722–1728
257. Frediani JK, Bienvenida AF, Li J, Higgins MK, Lobelo F. Physical fitness and activity changes after a 24-week soccer-based adaptation of the U.S diabetes prevention program intervention in Hispanic men. Prog Cardiovasc Dis 2020;63:775–785
258. Taylor JD, Fletcher JP, Tiarks J. Impact of physical therapist-directed exercise counseling combined with fitness center-based exercise training on muscular strength and exercise capacity in people with type 2 diabetes: a randomized clinical trial. Phys Ther 2009;89:884–892
259. Umpierre D, Ribeiro PAB, Kramer CK, et al. Physical activity advice only or structured exercise training and association with HbA1c levels in type 2 diabetes: a systematic review and meta-analysis. JAMA 2011;305:1790–1799
260. Schwingshackl L, Missbach B, Dias S, König J, Hoffmann G. Impact of different training modalities on glycaemic control and blood lipids in patients with type 2 diabetes: a systematic review and network meta-analysis. Diabetologia 2014;57:1789–1797
261. Yardley JE, Hay J, Abou-Setta AM, Marks SD, McGavock J. A systematic review and meta-analysis of exercise interventions in adults with type 1 diabetes. Diabetes Res Clin Pract 2014;106:393–400
262. Kennedy A, Nirantharakumar K, Chimen M, et al. Does exercise improve glycaemic control in type 1 diabetes? A systematic review and meta-analysis. PLoS One 2013;8:e58861
263. Sigal RJ, Yardley JE, Perkins BA, et al.; READI Trial Investigators. The Resistance Exercise in Already Active Diabetic Individuals (READI) randomized clinical trial. J Clin Endocrinol Metab 2023;108:e63–e75
264. Riddell MC, Li Z, Gal RL, et al.; T1DEXI Study Group. Examining the acute glycemic effects of different types of structured exercise sessions in type 1 diabetes in a real-world setting: the Type 1 Diabetes and Exercise Initiative (T1DEXI). Diabetes Care 2023;46:704–713
265. Turner LV, Marak MC, Gal RL, et al.; T1DEXI Study Group. Associations between daily step count classifications and continuous glucose monitoring metrics in adults with type 1 diabetes: analysis of the Type 1 Diabetes Exercise Initiative (T1DEXI) cohort. Diabetologia 2024;67:1009–1022
266. Moser O, Zaharieva DP, Adolfsson P, et al. The use of automated insulin delivery around physical activity and exercise in type 1 diabetes: a position statement of the European Association for the Study of Diabetes (EASD) and the International Society for Pediatric and Adolescent Diabetes (ISPAD). Diabetologia 2025;68:255–280
267. Peters AI, Laffel L. *The American Diabetes Association/JDRF Type 1 Diabetes Sourcebook.* Arlington, VA, American Diabetes Association, 2013
268. Davenport MH, Ruchat S-M, Poitras VJ, et al. Prenatal exercise for the prevention of gestational diabetes mellitus and hypertensive disorders of pregnancy: a systematic review and meta-analysis. Br J Sports Med 2018;52:1367–1375
269. Davenport MH, Sobierajski F, Mottola MF, et al. Glucose responses to acute and chronic exercise during pregnancy: a systematic review and meta-analysis. Br J Sports Med 2018;52:1357–1366
270. Bax JJ, Young LH, Frye RL, Bonow RO, Steinberg HO, Barrett EJ. Screening for coronary artery disease in patients with diabetes. Diabetes Care 2007;30:2729–2736
271. Finn M, Sherlock M, Feehan S, Guinan EM, Moore KB. Adherence to physical activity recommendations and barriers to physical activity participation among adults with type 1 diabetes. Ir J Med Sci 2022;191:1639–1646
272. Reynolds AN, Moodie I, Venn B, Mann J. How do we support walking prescriptions for type 2 diabetes management? Facilitators and barriers following a 3-month prescription. J Prim Health Care 2020;12:173–180
273. Zhao G, Ford ES, Li C, Mokdad AH. Compliance with physical activity recommendations in US adults with diabetes. Diabet Med 2008;25:221–227
274. Jarvie JL, Pandey A, Ayers CR, et al. Aerobic fitness and adherence to guideline-recommended minimum physical activity among ambulatory patients with type 2 diabetes mellitus. Diabetes Care 2019;42:1333–1339
275. Armstrong M, Colberg SR, Sigal RJ. Where to start? Physical assessment, readiness, and exercise recommendations for people with type 1 or type 2 diabetes. Diabetes Spectr 2023;36:105–113
276. Katzmarzyk PT, Church TS, Craig CL, Bouchard C. Sitting time and mortality from all causes, cardiovascular disease, and cancer. Med Sci Sports Exerc 2009;41:998–1005
277. Dempsey PC, Larsen RN, Sethi P, et al. Benefits for type 2 diabetes of interrupting prolonged sitting with brief bouts of light walking or simple resistance activities. Diabetes Care 2016;39:964–972
278. Campbell MD, Alobaid AM, Hopkins M, et al. Interrupting prolonged sitting with frequent short bouts of light-intensity activity in people with type 1 diabetes improves glycaemic control without increasing hypoglycaemia: the SIT-LESS randomised controlled trial. Diabetes Obes Metab 2023;25:3589–3598
279. Taylor FC, Dunstan DW, Homer AR, et al. Acute effects of interrupting prolonged sitting on vascular function in type 2 diabetes. Am J Physiol Heart Circ Physiol 2021;320:H393–H403
280. Janssen I, Leblanc AG. Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. Int J Behav Nutr Phys Act 2010;7:40
281. Savoye M, Caprio S, Dziura J, et al. Reversal of early abnormalities in glucose metabolism in obese youth: results of an intensive lifestyle randomized controlled trial. Diabetes Care 2014;37:317–324
282. Harnois-Leblanc S, Sylvestre M-P, Van Hulst A, et al. Estimating causal effects of physical activity and sedentary behaviours on the development of type 2 diabetes in at-risk children from childhood to late adolescence: an analysis of the QUALITY cohort. Lancet Child Adolesc Health 2023;7:37–46
283. García-Hermoso A, López-Gil JF, Ezzatvar Y, Ramírez-Vélez R, Izquierdo M. Twenty-four-hour movement guidelines during middle adolescence and their association with glucose outcomes and type 2 diabetes mellitus in adulthood. J Sport Health Sci 2023;12:167–174
284. Slaght JL, Wicklow BA, Dart AB, et al. Physical activity and cardiometabolic health in adolescents with type 2 diabetes: a cross-sectional study. BMJ Open Diabetes Res Care 2021;9:e002134
285. Huerta-Uribe N, Ramírez-Vélez R, Izquierdo M, García-Hermoso A. Association between physical activity, sedentary behavior and physical fitness and glycated hemoglobin in youth with type 1 diabetes: a systematic review and meta-analysis. Sports Med 2023;53:111–123
286. Quirk H, Blake H, Tennyson R, Randell TL, Glazebrook C. Physical activity interventions in children and young people with Type 1 diabetes mellitus: a systematic review with meta-analysis. Diabet Med 2014;31:1163–1173
287. Adolfsson P, Taplin CE, Zaharieva DP, et al. ISPAD Clinical Practice Consensus Guidelines 2022: exercise in children and adolescents with diabetes. Pediatr Diabetes 2022;23:1341–1372
288. Anderson BJ, Laffel LM, Domenger C, et al. Factors associated with diabetes-specific health-related quality of life in youth with type 1 diabetes: the Global TEENs Study. Diabetes Care 2017;40:1002–1009
289. Gortmaker SL, Must A, Sobol AM, Peterson K, Colditz GA, Dietz WH. Television viewing as a cause of increasing obesity among children in the United States, 1986-1990. Arch Pediatr Adolesc Med 1996;150:356–362
290. de Jong E, Visscher TLS, HiraSing RA, Heymans MW, Seidell JC, Renders CM. Association between TV viewing, computer use and overweight, determinants and competing activities of screen time in 4- to 13-year-old children. Int J Obes (Lond) 2013;37:47–53
291. Hardy LL, Denney-Wilson E, Thrift AP, Okely AD, Baur LA. Screen time and metabolic risk factors among adolescents. Arch Pediatr Adolesc Med 2010;164:643–649
292. Chimen M, Kennedy A, Nirantharakumar K, Pang TT, Andrews R, Narendran P. What are the health benefits of physical activity in type 1 diabetes mellitus? A literature review. Diabetologia 2012;55:542–551
293. Jelleyman C, Yates T, O'Donovan G, et al. The effects of high-intensity interval training on glucose regulation and insulin resistance: a meta-analysis. Obes Rev 2015;16:942–961
294. Little JP, Gillen JB, Percival ME, et al. Low-volume high-intensity interval training reduces hyperglycemia and increases muscle mitochondrial capacity in patients with type 2 diabetes. J Appl Physiol (1985) 2011;111:1554–1560
295. Grace A, Chan E, Giallauria F, Graham PL, Smart NA. Clinical outcomes and glycaemic responses to different aerobic exercise training intensities in type II diabetes: a systematic review and meta-analysis. Cardiovasc Diabetol 2017;16:37

296. Al-Mhanna SB, Franklin BA, Jakicic JM, et al. Impact of resistance training on cardiometabolic health-related indices in patients with type 2 diabetes and overweight/obesity: a systematic review and meta-analysis of randomised controlled trials. Br J Sports Med 2025;59:733–746
297. Wan Y, Su Z. The impact of resistance exercise training on glycemic control among adults with type 2 diabetes: a systematic review and meta-analysis of randomized controlled trials. Biol Res Nurs 2024;26:597–623
298. Gordon BA, Benson AC, Bird SR, Fraser SF. Resistance training improves metabolic health in type 2 diabetes: a systematic review. Diabetes Res Clin Pract 2009;83:157–175
299. Liu Y, Ye W, Chen Q, Zhang Y, Kuo C-H, Korivi M. Resistance exercise intensity is correlated with attenuation of HbA1c and insulin in patients with type 2 diabetes: a systematic review and meta-analysis. Int J Environ Res Public Health 2019; 16:140
300. Cui J, Yan J-H, Yan L-M, Pan L, Le J-J, Guo Y-Z. Effects of yoga in adults with type 2 diabetes mellitus: a meta-analysis. J Diabetes Investig 2017; 8:201–209
301. Lee MS, Jun JH, Lim H-J, Lim H-S. A systematic review and meta-analysis of tai chi for treating type 2 diabetes. Maturitas 2015;80:14–23
302. Rees JL, Johnson ST, Boulé NG. Aquatic exercise for adults with type 2 diabetes: a meta-analysis. Acta Diabetol 2017;54:895–904
303. Chapman A, Meyer C, Renehan E, Hill KD, Browning CJ. Exercise interventions for the improvement of falls-related outcomes among older adults with diabetes mellitus: a systematic review and meta-analyses. J Diabetes Complications 2017;31:631–645
304. Pfeifer LO, Botton CE, Diefenthaeler F, Umpierre D, Pinto RS. Effects of a power training program in the functional capacity, on body balance and lower limb muscle strength of elderly with type 2 diabetes mellitus. J Sports Med Phys Fitness 2021;61:1529–1537
305. Lee J, Kim D, Kim C. Resistance training for glycemic control, muscular strength, and lean body mass in old type 2 diabetic patients: a meta-analysis. Diabetes Ther 2017;8:459–473
306. Herriott MT, Colberg SR, Parson HK, Nunnold T, Vinik AI. Effects of 8 weeks of flexibility and resistance training in older adults with type 2 diabetes. Diabetes Care 2004;27:2988–2989
307. Hollekim-Strand SM, Bjørgaas MR, Albrektsen G, Tjønna AE, Wisløff U, Ingul CB. High-intensity interval exercise effectively improves cardiac function in patients with type 2 diabetes mellitus and diastolic dysfunction: a randomized controlled trial. J Am Coll Cardiol 2014;64:1758–1760
308. Madsen SM, Thorup AC, Overgaard K, Jeppesen PB. High intensity interval training improves glycaemic control and pancreatic β cell function of type 2 diabetes patients. PLoS One 2015;10:e0133286
309. Nieuwoudt S, Fealy CE, Foucher JA, et al. Functional high-intensity training improves pancreatic β-cell function in adults with type 2 diabetes. Am J Physiol Endocrinol Metab 2017; 313:E314–E320
310. Riddell MC, Peters AL. Exercise in adults with type 1 diabetes mellitus. Nat Rev Endocrinol 2023; 19:98–111
311. Karstoft K, Winding K, Knudsen SH, et al. The effects of free-living interval-walking training on glycemic control, body composition, and physical fitness in type 2 diabetic patients: a randomized, controlled trial. Diabetes Care 2013;36:228–236
312. Findikoglu G, Altinkapak A, Yaylali GF. Is isoenergetic high-intensity interval exercise superior to moderate-intensity continuous exercise for cardiometabolic risk factors in individuals with type 2 diabetes mellitus? A single-blinded randomized controlled study. Eur J Sport Sci 2023;23: 2086–2097
313. Aronson R, Brown RE, Li A, Riddell MC. Optimal insulin correction factor in post-high-intensity exercise hyperglycemia in adults with type 1 diabetes: the FIT study. Diabetes Care 2019; 42:10–16
314. Kanaley JA, Colberg SR, Corcoran MH, et al. Exercise/physical activity in individuals with type 2 diabetes: a consensus statement from the American College of Sports Medicine. Med Sci Sports Exerc 2022;54:353–368
315. Boppre G, Diniz-Sousa F, Veras L, et al. Impact of a multicomponent exercise training program on muscle strength after bariatric surgery: a randomized controlled trial. Obes Surg 2024;34:1704–1716
316. In G, Taskin HE, Al M, et al. Comparison of 12-week fitness protocols following bariatric surgery: aerobic exercise versus aerobic exercise and progressive resistance. Obes Surg 2021;31:1475–1484
317. Herring LY, Stevinson C, Carter P, et al. The effects of supervised exercise training 12-24 months after bariatric surgery on physical function and body composition: a randomised controlled trial. Int J Obes (Lond) 2017;41:909–916
318. Bellicha A, Ciangura C, Roda C, et al. Effect of exercise training after bariatric surgery: a 5-year follow-up study of a randomized controlled trial. PLoS One 2022;17:e0271561
319. Coen PM, Tanner CJ, Helbling NL, et al. Clinical trial demonstrates exercise following bariatric surgery improves insulin sensitivity. J Clin Invest 2015;125:248–257
320. Carnero EA, Dubis GS, Hames KC, et al. Randomized trial reveals that physical activity and energy expenditure are associated with weight and body composition after RYGB. Obesity (Silver Spring) 2017;25:1206–1216
321. Ingersen A, Schmücker M, Alexandersen C, et al. Effects of aerobic training and semaglutide treatment on pancreatic β-cell secretory function in patients with type 2 diabetes. J Clin Endocrinol Metab 2023;108:2798–2811
322. Jensen SBK, Juhl CR, Janus C, et al. Weight loss maintenance with exercise and liraglutide improves glucose tolerance, glucagon response, and beta cell function. Obesity (Silver Spring) 2023; 31:977–989
323. Sandsdal RM, Juhl CR, Jensen SBK, et al. Combination of exercise and GLP-1 receptor agonist treatment reduces severity of metabolic syndrome, abdominal obesity, and inflammation: a randomized controlled trial. Cardiovasc Diabetol 2023;22:41
324. Lundgren JR, Janus C, Jensen SBK, et al. Healthy weight loss maintenance with exercise, liraglutide, or both combined. N Engl J Med 2021; 384:1719–1730
325. Jorgensen PG, Jensen MT, Mensberg P, et al. Effect of exercise combined with glucagon-like peptide-1 receptor agonist treatment on cardiac function: a randomized double-blind placebo-controlled clinical trial. Diabetes Obes Metab 2017;19:1040–1044
326. Moser O, Riddell MC, Eckstein ML, et al. Glucose management for exercise using continuous glucose monitoring (CGM) and intermittently scanned CGM (isCGM) systems in type 1 diabetes: position statement of the European Association for the Study of Diabetes (EASD) and of the International Society for Pediatric and Adolescent Diabetes (ISPAD) endorsed by JDRF and supported by the American Diabetes Association (ADA). Diabetologia 2020;63:2501–2520
327. Rietz M, Lehr A, Mino E, et al. Physical activity and risk of major diabetes-related complications in individuals with diabetes: a systematic review and meta-analysis of observational studies. Diabetes Care 2022;45:3101–3111
328. Colberg SR. *Exercise and Diabetes: a Clinician's Guide to Prescribing Physical Activity.* Arlington, VA, American Diabetes Association, 2013
329. Hulshof CM, van Netten JJ, Pijnappels M, Bus SA. The role of foot-loading factors and their associations with ulcer development and ulcer healing in people with diabetes: a systematic review. J Clin Med 2020;9:3591
330. Lemaster JW, Reiber GE, Smith DG, Heagerty PJ, Wallace C. Daily weight-bearing activity does not increase the risk of diabetic foot ulcers. Med Sci Sports Exerc 2003;35:1093–1099
331. Smith AG, Russell J, Feldman EL, et al. Lifestyle intervention for pre-diabetic neuropathy. Diabetes Care 2006;29:1294–1299
332. Spallone V, Ziegler D, Freeman R, et al.; Toronto Consensus Panel on Diabetic Neuropathy. Cardiovascular autonomic neuropathy in diabetes: clinical impact, assessment, diagnosis, and management. Diabetes Metab Res Rev 2011;27: 639–653
333. Pop-Busui R, Evans GW, Gerstein HC, et al.; Action to Control Cardiovascular Risk in Diabetes Study Group. Effects of cardiac autonomic dysfunction on mortality risk in the Action to Control Cardiovascular Risk in Diabetes (ACCORD) trial. Diabetes Care 2010;33:1578–1584
334. U.S. Department of Health and Human Services. Eliminating Tobacco-Related Disease and Death: Addressing Disparities. A Report of the Surgeon General. Accessed 6 August 2025. Available from https://www.hhs.gov/sites/default/files/2024-sgr-tobacco-related-health-disparities-full-report.pdf
335. Śliwińska-Mossoń M, Milnerowicz H. The impact of smoking on the development of diabetes and its complications. Diab Vasc Dis Res 2017;14: 265–276
336. Pan A, Wang Y, Talaei M, Hu FB. Relation of smoking with total mortality and cardiovascular events among patients with diabetes mellitus: a meta-analysis and systematic review. Circulation 2015;132:1795–1804
337. Pan A, Wang Y, Talaei M, Hu FB, Wu T. Relation of active, passive, and quitting smoking with incident type 2 diabetes: a systematic review and meta-analysis. Lancet Diabetes Endocrinol 2015;3:958–967
338. U.S. Department of Health and Human Services. Smoking Cessation. A Report of the Surgeon General, 2020. Accessed 13 August

2024. Available from https://www.hhs.gov/sites/default/files/2020-cessation-sgr-full-report.pdf
339. Loretan CG, Cornelius ME, Jamal A, Cheng YJ, Homa DM. Cigarette smoking among US adults with selected chronic diseases associated with smoking, 2010-2019. Prev Chronic Dis 2022;19:E62
340. Rigotti NA, Kruse GR, Livingstone-Banks J, Hartmann-Boyce J. Treatment of tobacco smoking: a review. JAMA 2022;327:566–577
341. World Health Organization. WHO clinical treatment guideline for tobacco cessation in adults. Accessed 8 September 2025. Available from https://www.who.int/publications/i/item/9789240096431
342. Rojewski AM, Palmer AM, Baker NL, Toll BA. Smoking cessation pharmacotherapy efficacy in comorbid medical populations: secondary analysis of the Evaluating Adverse Events in a Global Smoking Cessation Study (EAGLES) randomized clinical trial. Nicotine Tob Res 2024;26:31–38
343. Leone FT, Zhang Y, Evers-Casey S, et al. Initiating pharmacologic treatment in tobacco-dependent adults. An official American Thoracic Society clinical practice guideline. Am J Respir Crit Care Med 2020;202:e5–e31
344. Tian J, Venn A, Otahal P, Gall S. The association between quitting smoking and weight gain: a systematic review and meta-analysis of prospective cohort studies. Obes Rev 2015;16:883–901
345. Wang X, Qin L-Q, Arafa A, Eshak ES, Hu Y, Dong J-Y. Smoking cessation, weight gain, cardiovascular risk, and all-cause mortality: a meta-analysis. Nicotine Tob Res 2021;23:1987–1994
346. Hartmann-Boyce J, Theodoulou A, Farley A, et al. Interventions for preventing weight gain after smoking cessation. Cochrane Database Syst Rev 2021;10:CD006219
347. Yammine L, Green CE, Kosten TR, et al. Exenatide adjunct to nicotine patch facilitates smoking cessation and may reduce post-cessation weight gain: a pilot randomized controlled trial. Nicotine Tob Res 2021;23:1682–1690
348. Asthana S, Labani S, Kailash U, Sinha DN, Mehrotra R. Association of smokeless tobacco use and oral cancer: a systematic global review and meta-analysis. Nicotine Tob Res 2019;21:1162–1171
349. Dennison Himmelfarb CR, Benowitz NL, Blank MD, et al.; American Heart Association Advocacy Coordinating Committee. Impact of smokeless oral nicotine products on cardiovascular disease: implications for policy, prevention, and treatment: a policy statement from the American Heart Association. Circulation 2025;151:e1–e21
350. Huerta TR, Walker DM, Mullen D, Johnson TJ, Ford EW. Trends in e-cigarette awareness and perceived harmfulness in the U.S. Am J Prev Med 2017;52:339–346
351. Kiernan E, Click ES, Melstrom P, et al.; Lung Injury Response Clinical Task Force; Lung Injury Response Clinical Working Group. A brief overview of the national outbreak of e-cigarette, or vaping, product use-associated lung injury and the primary causes. Chest 2021;159:426–431
352. Darville A, Hahn EJ. E-cigarettes and atherosclerotic cardiovascular disease: what clinicians and researchers need to know. Curr Atheroscler Rep 2019;21:15
353. Pierce JP, Benmarhnia T, Chen R, et al. Role of e-cigarettes and pharmacotherapy during attempts to quit cigarette smoking: the PATH Study 2013-16. PLoS One 2020;15:e0237938
354. Chen R, Pierce JP, Leas EC, et al. Use of electronic cigarettes to aid long-term smoking cessation in the United States: prospective evidence from the PATH cohort study. Am J Epidemiol 2020;189:1529–1537
355. Reid RD, Malcolm J, Wooding E, et al. Prospective, cluster-randomized trial to implement the Ottawa model for smoking cessation in diabetes education programs in Ontario, Canada. Diabetes Care 2018;41:406–412
356. Assaf RD, Gorbach PM, Cooper ZD. Changes in medical and non-medical cannabis use among United States adults before and during the COVID-19 pandemic. Am J Drug Alcohol Abuse 2022;48:321–327
357. Hasin D, Walsh C. Trends over time in adult cannabis use: a review of recent findings. Curr Opin Psychol 2021;38:80–85
358. Jadoon KA, Ratcliffe SH, Barrett DA, et al. Efficacy and safety of cannabidiol and tetrahydrocannabivarin on glycemic and lipid parameters in patients with type 2 diabetes: a randomized, double-blind, placebo-controlled, parallel group pilot study. Diabetes Care 2016;39:1777–1786
359. Freeman TP, Craft S, Wilson J, et al. Changes in delta-9-tetrahydrocannabinol (THC) and cannabidiol (CBD) concentrations in cannabis over time: systematic review and meta-analysis. Addiction 2021;116:1000–1010
360. U.S. Food and Drug Administration. 5 Things to Know about Delta-8 Tetrahydrocannabinol-Delta-8 THC, 2022. Accessed 6 August 2025. Available from https://www.fda.gov/consumers/consumer-updates/5-things-know-about-delta-8-tetrahydrocannabinol-delta-8-thc
361. Akturk HK, Taylor DD, Camsari UM, Rewers A, Kinney GL, Shah VN. Association between cannabis use and risk for diabetic ketoacidosis in adults with type 1 diabetes. JAMA Intern Med 2019;179:115–118
362. Kinney GL, Akturk HK, Taylor DD, Foster NC, Shah VN. Cannabis use is associated with increased risk for diabetic ketoacidosis in adults with type 1 diabetes: findings from the T1D Exchange Clinic Registry. Diabetes Care 2020;43:247–249
363. Akturk HK, Snell-Bergeon J, Kinney GL, Champakanath A, Monte A, Shah VN. Differentiating diabetic ketoacidosis and hyperglycemic ketosis due to cannabis hyperemesis syndrome in adults with type 1 diabetes. Diabetes Care 2022;45:481–483
364. Hood KK, Rohan JM, Peterson CM, Drotar D. Interventions with adherence-promoting components in pediatric type 1 diabetes: meta-analysis of their impact on glycemic control. Diabetes Care 2010;33:1658–1664
365. Asche C, LaFleur J, Conner C. A review of diabetes treatment adherence and the association with clinical and economic outcomes. Clin Ther 2011;33:74–109
366. Berhe KK, Gebru HB, Kahsay HB. Effect of motivational interviewing intervention on HgbA1C and depression in people with type 2 diabetes mellitus (systematic review and meta-analysis). PLoS One 2020;15:e0240839
367. Liang W, Lo SHS, Tola YO, Chow KM. The effectiveness of self-management programmes for people with type 2 diabetes receiving insulin injection: a systematic review and meta-analysis. Int J Clin Pract 2021;75:e14636
368. Almutairi N, Hosseinzadeh H, Gopaldasani V. The effectiveness of patient activation intervention on type 2 diabetes mellitus glycemic control and self-management behaviors: a systematic review of RCTs. Prim Care Diabetes 2020;14:12–20
369. Gray KE, Hoerster KD, Taylor L, Krieger J, Nelson KM. Improvements in physical activity and some dietary behaviors in a community health worker-led diabetes self-management intervention for adults with low incomes: results from a randomized controlled trial. Transl Behav Med 2021;11:2144–2154
370. Van Rhoon L, Byrne M, Morrissey E, Murphy J, McSharry J. A systematic review of the behaviour change techniques and digital features in technology-driven type 2 diabetes prevention interventions. Digit Health 2020;6:2055207620914427
371. Patton SR, Cushing CC, Lansing AH. Applying behavioral economics theories to interventions for persons with diabetes. Curr Diab Rep 2022;22:219–226
372. Avery L, Flynn D, van Wersch A, Sniehotta FF, Trenell MI. Changing physical activity behavior in type 2 diabetes: a systematic review and meta-analysis of behavioral interventions. Diabetes Care 2012;35:2681–2689
373. Hilliard ME, Powell PW, Anderson BJ. Evidence-based behavioral interventions to promote diabetes management in children, adolescents, and families. Am Psychol 2016;71:590–601
374. Lake AJ, Bo A, Hadjiconstantinou M. Developing and evaluating behaviour change interventions for people with younger-onset type 2 diabetes: lessons and recommendations from existing programmes. Curr Diab Rep 2021;21:59
375. Berlin KS, Klages KL, Banks GG, et al. Toward the development of a culturally humble intervention to improve glycemic control and quality of life among adolescents with type-1 diabetes and their families. Behav Med 2021;47:99–110
376. Nicolucci A, Haxhi J, D'Errico V, et al.; Italian Diabetes and Exercise Study 2 (IDES_2) Investigators. Effect of a behavioural intervention for adoption and maintenance of a physically active lifestyle on psychological well-being and quality of life in patients with type 2 diabetes: the IDES_2 randomized clinical trial. Sports Med 2022;52:643–654
377. Crowley MJ, Tarkington PE, Bosworth HB, et al. Effect of a comprehensive telehealth intervention vs telemonitoring and care coordination in patients with persistently poor type 2 diabetes control: a randomized clinical trial. JAMA Intern Med 2022;182:943–952
378. Harris MA, Freeman KA, Duke DC. Seeing is believing: using skype to improve diabetes outcomes in youth. Diabetes Care 2015;38:1427–1434
379. Kaczmarek T, Kavanagh DJ, Lazzarini PA, Warnock J, Van Netten JJ. Training diabetes healthcare practitioners in motivational interviewing: a systematic review. Health Psychol Rev 2022;16:430–449
380. Bell KJ, Barclay AW, Petocz P, Colagiuri S, Brand-Miller JC. Efficacy of carbohydrate counting in type 1 diabetes: a systematic review and meta-

analysis. Lancet Diabetes Endocrinol 2014;2:133–140
381. McVoy M, Hardin H, Fulchiero E, et al. Mental health comorbidity and youth onset type 2 diabetes: a systematic review of the literature. Int J Psychiatry Med 2023;58:37–55
382. Naicker K, Johnson JA, Skogen JC, et al. Type 2 diabetes and comorbid symptoms of depression and anxiety: longitudinal associations with mortality risk. Diabetes Care 2017;40:352–358
383. Anderson RJ, Grigsby AB, Freedland KE, et al. Anxiety and poor glycemic control: a meta-analytic review of the literature. Int J Psychiatry Med 2002;32:235–247
384. Anderson RJ, Freedland KE, Clouse RE, Lustman PJ. The prevalence of comorbid depression in adults with diabetes: a meta-analysis. Diabetes Care 2001;24:1069–1078
385. Nicolucci A, Kovacs Burns K, Holt RIG, et al.; DAWN2 Study Group. Diabetes Attitudes, Wishes and Needs second study (DAWN2): cross-national benchmarking of diabetes-related psychosocial outcomes for people with diabetes. Diabet Med 2013;30:767–777
386. Guerrero Fernández de Alba I, Gimeno-Miguel A, Poblador-Plou B, et al. Association between mental health comorbidity and health outcomes in type 2 diabetes mellitus patients. Sci Rep 2020;10:19583
387. Gonzalvo JD, Hamm J, Eaves S, et al. A practical approach to mental health for the diabetes educator. AADE Pract 2019;7:29–44
388. Robinson DJ, Coons M, Haensel H, Vallis M, Yale J-F; Diabetes Canada Clinical Practice Guidelines Expert Committee. Diabetes and mental health. Can J Diabetes 2018;42(Suppl 1):S130–S141
389. Cho M-K, Kim MY. Self-management nursing intervention for controlling glucose among diabetes: a systematic review and meta-analysis. Int J Environ Res Public Health 2021;18:12750
390. Majidi S, Reid MW, Fogel J, et al. Psychosocial outcomes in young adolescents with type 1 diabetes participating in shared medical appointments. Pediatr Diabetes 2021;22:787–795
391. Jiang S, Wu Z, Zhang X, et al. How does patient-centered communication influence patient trust?: the roles of patient participation and patient preference. Patient Educ Couns 2024;122:108161
392. Li Y, Storch EA, Ferguson S, Li L, Buys N, Sun J. The efficacy of cognitive behavioral therapy-based intervention on patients with diabetes: a meta-analysis. Diabetes Res Clin Pract 2022;189:109965
393. Fisher L, Guzman S, Polonsky WH, Strycker L, Greenberg K, Hessler DM. How does addressing diabetes distress lead to positive glycemic change? Results from the EMBARK trial. Patient Educ Couns 2025:108748
394. Phillips S, Culpepper J, Welch M, et al. A multidisciplinary diabetes clinic improves clinical and behavioral outcomes in a primary care setting. J Am Board Fam Med 2021;34:579–589
395. Ali MK, Chwastiak L, Poongothai S, et al.; INDEPENDENT Study Group. Effect of a collaborative care model on depressive symptoms and glycated hemoglobin, blood pressure, and serum cholesterol among patients with depression and diabetes in India: the INDEPENDENT randomized clinical trial. JAMA 2020;324:651–662
396. Rechenberg K, Koerner R. Cognitive behavioral therapy in adolescents with type 1 diabetes: an integrative review. J Pediatr Nurs 2021;60:190–197
397. McMorrow R, Hunter B, Hendrieckx C, et al. Effect of routinely assessing and addressing depression and diabetes distress on clinical outcomes among adults with type 2 diabetes: a systematic review. BMJ Open 2022;12:e054650
398. Corathers S, Williford DN, Kichler J, et al. Implementation of psychosocial screening into diabetes clinics: experience from the Type 1 Diabetes Exchange Quality Improvement Network. Curr Diab Rep 2023;23:19–28
399. Brodar KE, Davis EM, Lynn C, et al. Comprehensive psychosocial screening in a pediatric diabetes clinic. Pediatr Diabetes 2021;22:656–666
400. Myers AK, Grannemann BD, Lingvay I, Trivedi MH. Brief report: depression and history of suicide attempts in adults with new-onset type 2 diabetes. Psychoneuroendocrinology 2013;38:2810–2814
401. Majidi S, O'Donnell HK, Stanek K, Youngkin E, Gomer T, Driscoll KA. Suicide risk assessment in youth and young adults with type 1 diabetes. Diabetes Care 2020;43:343–348
402. Barnard-Kelly KD, Naranjo D, Majidi S, et al. Suicide and self-inflicted injury in diabetes: a balancing act. J Diabetes Sci Technol 2020;14:1010–1016
403. Hill RM, Gallagher KAS, Eshtehardi SS, Uysal S, Hilliard ME. Suicide risk in youth and young adults with type 1 diabetes: a review of the literature and clinical recommendations for prevention. Curr Diab Rep 2021;21:51
404. Huang C-J, Huang Y-T, Lin P-C, Hsieh H-M, Yang Y-H. Mortality and suicide related to major depressive disorder before and after type 2 diabetes mellitus. J Clin Psychiatry 2022;83:20m13692
405. Mulvaney SA, Mara CA, Kichler JC, et al. A retrospective multisite examination of depression screening practices, scores, and correlates in pediatric diabetes care. Transl Behav Med 2021;11:122–131
406. Marker AM, Patton SR, Clements MA, Egan AE, McDonough RJ. Adjusted cutoff scores increase sensitivity of depression screening measures in adolescents with type 1 diabetes. Diabetes Care 2022;45:2501–2508
407. Weissberg-Benchell J, Shapiro JB. A review of interventions aimed at facilitating successful transition planning and transfer to adult care among youth with chronic illness. Pediatr Ann 2017;46:e182–e187
408. O'Gurek DT, Henke C. A practical approach to screening for social determinants of health. Fam Pract Manag 2018;25:7–12
409. Zhang H, Zhang Q, Luo D, et al. The effect of family-based intervention for adults with diabetes on HbA1c and other health-related outcomes: systematic review and meta-analysis. J Clin Nurs 2022;31:1488–1501
410. Oyedeji AD, Ullah I, Weich S, Bentall R, Booth A. Effectiveness of non-specialist delivered psychological interventions on glycemic control and mental health problems in individuals with type 2 diabetes: a systematic review and meta-analysis. Int J Ment Health Syst 2022;16:9
411. Beverly EA, Hultgren BA, Brooks KM, Ritholz MD, Abrahamson MJ, Weinger K. Understanding physicians' challenges when treating type 2 diabetic patients' social and emotional difficulties: a qualitative study. Diabetes Care 2011;34:1086–1088
412. Vlachou E, Ntikoudi A, Owens DA, Nikolakopoulou M, Chalimourdas T, Cauli O. Effectiveness of cognitive behavioral therapy-based interventions on psychological symptoms in adults with type 2 diabetes mellitus: an update review of randomized controlled trials. J Diabetes Complications 2022;36:108185
413. Ni Y-X, Ma L, Li J-P. Effects of mindfulness-based intervention on glycemic control and psychological outcomes in people with diabetes: a systematic review and meta-analysis. J Diabetes Investig 2021;12:1092–1103
414. Hood KK, Iturralde E, Rausch J, Weissberg-Benchell J. Preventing diabetes distress in adolescents with type 1 diabetes: results 1 year after participation in the STePS program. Diabetes Care 2018;41:1623–1630
415. Weissberg-Benchell J, Shapiro JB, Bryant FB, Hood KK. Supporting Teen Problem-Solving (STEPS) 3 year outcomes: preventing diabetes-specific emotional distress and depressive symptoms in adolescents with type 1 diabetes. J Consult Clin Psychol 2020;88:1019–1031
416. Laffel LMB, Vangsness L, Connell A, Goebel-Fabbri A, Butler D, Anderson BJ. Impact of ambulatory, family-focused teamwork intervention on glycemic control in youth with type 1 diabetes. J Pediatr 2003;142:409–416
417. Wysocki T, Harris MA, Buckloh LM, et al. Effects of behavioral family systems therapy for diabetes on adolescents' family relationships, treatment adherence, and metabolic control. J Pediatr Psychol 2006;31:928–938
418. Yakubu TI, Pawer S, West NC, Tang TS, Görges M. Impact of digitally enabled peer support interventions on diabetes distress and depressive symptoms in people living with type 1 diabetes: a systematic review. Curr Diab Rep 2024;25:1
419. Yap JM, Tantono N, Wu VX, Klainin-Yobas P. Effectiveness of technology-based psychosocial interventions on diabetes distress and health-relevant outcomes among type 2 diabetes mellitus: a systematic review and meta-analysis. J Telemed Telecare 2024;30:262–284
420. Bisno DI, Reid MW, Fogel JL, Pyatak EA, Majidi S, Raymond JK. Virtual group appointments reduce distress and improve care management in young adults with type 1 diabetes. J Diabetes Sci Technol 2022;16:1419–1427
421. Fisher L, Guzman S, Polonsky W, Hessler D. Bringing the assessment and treatment of diabetes distress into the real world of clinical care: time for a shift in perspective. Diabet Med 2024;41:e15446
422. Hagger V, Hendrieckx C, Sturt J, Skinner TC, Speight J. Diabetes distress among adolescents with type 1 diabetes: a systematic review. Curr Diab Rep 2016;16:9
423. Wojujutari Ajele K, Sunday Idemudia E. The role of depression and diabetes distress in glycemic control: a meta-analysis. Diabetes Res Clin Pract 2025;221:112014
424. Dalsgaard E-M, Graversen SB, Bjerg L, Sandbaek A, Laurberg T. Diabetes distress and depression in type 2 diabetes. A cross-sectional study in 18,000 individuals in the Central Denmark region. Diabet Med 2025;42:e15463
425. Fisher L, Polonsky WH, Perez-Nieves M, Desai U, Strycker L, Hessler D. A new perspective on diabetes distress using the Type 2 Diabetes Distress Assessment System (T2-DDAS): prevalence

and change over time. J Diabetes Complications 2022;36:108256
426. Hessler DM, Polonsky WH, Strycker L, Naranjo D, Greenberg K, Fisher L. Stability and impact of diabetes distress over time: the potential value and uses of the Type 1 Diabetes Distress Assessment System (T1-DDAS). Diabet Med 2025; 42:e70066
427. Aikens JE. Prospective associations between emotional distress and poor outcomes in type 2 diabetes. Diabetes Care 2012;35:2472–2478
428. McCarty T, Inverso H, Streisand R, et al. Diabetes distress among caregivers of adolescents with type 1 diabetes. J Pediatr Psychol. 11 July 2025 [Epub ahead of print].
429. Gonzalez JS, Krause-Steinrauf H, Bebu I, et al.; GRADE Research Group. Emotional distress, self-management, and glycemic control among participants enrolled in the Glycemia Reduction Approaches in Diabetes: a Comparative Effectiveness (GRADE) study. Diabetes Res Clin Pract 2023; 196:110229
430. Liu X, Haagsma J, Sijbrands E, et al. Anxiety and depression in diabetes care: longitudinal associations with health-related quality of life. Sci Rep 2020;10:8307
431. Guo X, Wu S, Tang H, et al. The relationship between stigma and psychological distress among people with diabetes: a meta-analysis. BMC Psychol 2023;11:242
432. Akyirem S, Ekpor E, Namumbejja Abwoye D, Batten J, Nelson LE. Type 2 diabetes stigma and its association with clinical, psychological, and behavioral outcomes: a systematic review and meta-analysis. Diabetes Res Clin Pract 2023;202: 110774
433. Hamilton K, Forde R, Due-Christensen M, et al. Which diabetes specific patient reported outcomes should be measured in routine care? A systematic review to inform a core outcome set for adults with type 1 and 2 diabetes mellitus: the European Health Outcomes Observatory (H2O) programme. Patient Educ Couns 2023;116:107933
434. Michot AP, Evans TL, Vasudevan MM, et al. The case for screening for diabetes distress, depression, and anxiety. J Health Psychol 2024;29: 1608–1613
435. Franc S, Charpentier G. Emotional distress as a therapeutic target against persistent poor glycaemic control in subjects with type 1 diabetes: a systematic review. Diabetes Obes Metab 2025; 27:4662–4673
436. Hu H, Kuang L, Dai H, Sheng Y. Effectiveness of nurse-led psychological interventions on diabetes distress, depression, and glycemic control in individuals with type 2 diabetes mellitus: a systematic review and meta-analysis. J Psychosoc Nurs Ment Health Serv 2025;63:11–18
437. Zu W, Zhang S, Du L, Huang X, Nie W, Wang L. The effectiveness of psychological interventions on diabetes distress and glycemic level in adults with type 2 diabetes: a systematic review and meta-analysis. BMC Psychiatry 2024;24:660
438. Gutiérrez-Domingo T, Farhane-Medina NZ, Villaécija J, et al. Effectiveness of mindfulness-based interventions with respect to psychological and biomedical outcomes in young people with type 1 diabetes: a systematic review. Healthcare (Basel) 2024;12:1876
439. Ngan HY, Chong YY, Chien WT. Effects of mindfulness- and acceptance-based interventions on diabetes distress and glycaemic level in people with type 2 diabetes: systematic review and meta-analysis. Diabet Med 2021;38:e14525
440. Roddy MK, Spieker AJ, Nelson LA, et al. Well-being outcomes of a family-focused intervention for persons with type 2 diabetes and support persons: main, mediated, and subgroup effects from the FAMS 2.0 RCT. Diabetes Res Clin Pract 2023;204:110921
441. Hessler DM, Fisher L, Guzman S, et al. EMBARK: a randomized, controlled trial comparing three approaches to reducing diabetes distress and improving HbA1c in adults with type 1 diabetes. Diabetes Care 2024;47:1370–1378
442. Wicaksana AL, Apriliyasari RW, Tsai P-S. Effect of self-help interventions on psychological, glycemic, and behavioral outcomes in patients with diabetes: a meta-analysis of randomized controlled trials. Int J Nurs Stud 2024;149:104626
443. Fisher L, Hessler D, Glasgow RE, et al. REDEEM: a pragmatic trial to reduce diabetes distress. Diabetes Care 2013;36:2551–2558
444. Tay JHT, Jiang Y, Hong J, He H, Wang W. Effectiveness of lay-led, group-based self-management interventions to improve glycated hemoglobin (HbA1c), self-efficacy, and emergency visit rates among adults with type 2 diabetes: a systematic review and meta-analysis. Int J Nurs Stud 2021;113:103779
445. DiNardo MM, Greco C, Phares AD, et al. Effects of an integrated mindfulness intervention for veterans with diabetes distress: a randomized controlled trial. BMJ Open Diabetes Res Care 2022; 10:e002631
446. Lutes LD, Cummings DM, Littlewood K, et al. A tailored cognitive-behavioural intervention produces comparable reductions in regimen-related distress in adults with type 2 diabetes regardless of insulin use: 12-month outcomes from the COMRADE trial. Can J Diabetes 2020;44: 530–536
447. Friis AM, Johnson MH, Cutfield RG, Consedine NS. Kindness Matters: a randomized controlled trial of a mindful self-compassion intervention improves depression, distress, and HbA1c among patients with diabetes. Diabetes Care 2016;39:1963–1971
448. Canha D, McMahon V, Schmitz S, et al. The effect of automated insulin delivery system use on diabetes distress in people with type 1 diabetes and their caregivers: a systematic review and meta-analysis. Diabet Med 2025;42:e15503
449. Roos T, Hermanns N, Groß C, Kulzer B, Haak T, Ehrmann D. Effect of automated insulin delivery systems on person-reported outcomes in people with diabetes: a systematic review and meta-analysis. EClinicalMedicine 2024;76:102852
450. Lin EHB, Von Korff M, Alonso J, et al. Mental disorders among persons with diabetes-results from the World Mental Health Surveys. J Psychosom Res 2008;65:571–580
451. Mersha AG, Tollosa DN, Bagade T, Eftekhari P. A bidirectional relationship between diabetes mellitus and anxiety: a systematic review and meta-analysis. J Psychosom Res 2022;162:110991
452. Gonder-Frederick LA, Schmidt KM, Vajda KA, et al. Psychometric properties of the hypoglycemia fear survey-ii for adults with type 1 diabetes. Diabetes Care 2011;34:801–806
453. Wild D, von Maltzahn R, Brohan E, Christensen T, Clauson P, Gonder-Frederick L. A critical review of the literature on fear of hypoglycemia in diabetes: implications for diabetes management and patient education. Patient Educ Couns 2007;68:10–15
454. Alazmi A, Bashiru MB, Viktor S, Erjavec M. Psychological variables and lifestyle in children with type1 diabetes and their parents: a systematic review. Clin Child Psychol Psychiatry 2024; 29:1174–1194
455. Zhang L, Xu H, Liu L, et al. Related factors associated with fear of hypoglycemia in parents of children and adolescents with type 1 diabetes—a systematic review. J Pediatr Nurs 2022;66:125–135
456. Smith KJ, Béland M, Clyde M, et al. Association of diabetes with anxiety: a systematic review and meta-analysis. J Psychosom Res 2013; 74:89–99
457. Zambanini A, Newson RB, Maisey M, Feher MD. Injection related anxiety in insulin-treated diabetes. Diabetes Res Clin Pract 1999;46:239–246
458. American Psychiatric Association. *Diagnostic and statistical manual of mental disorders: DSM-5*. Washington, DC, American Psychiatric Association, 2013
459. Mollema ED, Snoek FJ, Adèr HJ, Heine RJ, van der Ploeg HM. Insulin-treated diabetes patients with fear of self-injecting or fear of self-testing: psychological comorbidity and general well-being. J Psychosom Res 2001;51:665–672
460. Kemp CG, Johnson LCM, Sagar R, et al. Effect of a collaborative care model on anxiety symptoms among patients with depression and diabetes in India: the INDEPENDENT randomized clinical trial. Gen Hosp Psychiatry 2022;74:39–45
461. Abbas Q, Latif S, Ayaz Habib H, et al. Cognitive behavior therapy for diabetes distress, depression, health anxiety, quality of life and treatment adherence among patients with type-II diabetes mellitus: a randomized control trial. BMC Psychiatry 2023;23:86
462. Talbo MK, Katz A, Hill L, Peters TM, Yale J-F, Brazeau A-S. Effect of diabetes technologies on the fear of hypoglycaemia among people living with type 1 diabetes: a systematic review and meta-analysis. EClinicalMedicine 2023;62:102119
463. Martyn-Nemeth P, Duffecy J, Quinn L, et al. FREE: a randomized controlled feasibility trial of a cognitive behavioral therapy and technology-assisted intervention to reduce fear of hypoglycemia in young adults with type 1 diabetes. J Psychosom Res 2024;181:111679
464. Wulandari N, Lamuri A, van Hasselt F, Feenstra T, Taxis K. The burden of depression among patients with type 2 diabetes: an umbrella review of systematic reviews. J Diabetes Complications 2025;39:109004
465. Chen Z, Wang J, Carru C, Coradduzza D, Li Z. The prevalence of depression among parents of children/adolescents with type 1 diabetes: a systematic review and meta-analysis. Front Endocrinol (Lausanne) 2023;14:1095729
466. Damilano CP, Hong KMC, Glick BA, Kamboj MK, Hoffman RP. Diabetes distress, depression, and future glycemic control among adolescents with type 1 diabetes. J Pediatr Endocrinol Metab 2025;38:311–317
467. Tu Q, Hyun K, Lin S, et al. Individual and joint effects of diabetes and depression on incident cardiovascular diseases and all-cause mortality: results from a population-based cohort study. J Diabetes Complications 2024;38:108878
468. de Groot M, Crick KA, Long M, Saha C, Shubrook JH. Lifetime duration of depressive

disorders in patients with type 2 diabetes. Diabetes Care 2016;39:2174–2181
469. Rubin RR, Ma Y, Marrero DG, et al.; Diabetes Prevention Program Research Group. Elevated depression symptoms, antidepressant medicine use, and risk of developing diabetes during the diabetes prevention program. Diabetes Care 2008; 31:420–426
470. Zheng C, Yin J, Wu L, et al. Association between depression and diabetes among American adults using NHANES data from 2005 to 2020. Sci Rep 2024;14:27735
471. Farooqi A, Gillies C, Sathanapally H, et al. A systematic review and meta-analysis to compare the prevalence of depression between people with and without type 1 and type 2 diabetes. Prim Care Diabetes 2022;16:1–10
472. Monaghan M, Mara CA, Kichler JC, et al. Multisite examination of depression screening scores and correlates among adolescents and young adults with type 2 diabetes. Can J Diabetes 2021;45:411–416
473. Rosas CE, Talavera GA, Roesch SC, et al. Randomized trial of an integrated care intervention among Latino adults: sustained effects on diabetes management. Transl Behav Med 2024;14: 310–318
474. Lu X, Yang D, Liang J, et al. Effectiveness of intervention program on the change of glycaemic control in diabetes with depression patients: a meta-analysis of randomized controlled studies. Prim Care Diabetes 2021;15:428–434
475. Ellis D, Carcone AI, Templin T, et al. Moderating effect of depression on glycemic control in an ehealth intervention among black youth with type 1 diabetes: findings from a multicenter randomized controlled trial. JMIR Diabetes 2024;9:e55165
476. Li Y, Buys N, Ferguson S, et al. The evaluation of cognitive-behavioral therapy-based intervention on type 2 diabetes patients with comorbid metabolic syndrome: a randomized controlled trial. Diabetol Metab Syndr 2023;15:158
477. Fisher V, Li WW, Malabu U. The effectiveness of mindfulness-based stress reduction (MBSR) on the mental health, HbA1C, and mindfulness of diabetes patients: a systematic review and meta-analysis of randomised controlled trials. Appl Psychol Health Well Being 2023;15:1733–1749
478. Ajele KW, Deacon E. Targeting depression and diabetes comorbidity: a generalization meta-analysis of randomized controlled trials on cognitive-behavioural therapy efficacy. Prim Care Diabetes 2025;19:93–102
479. Varela-Moreno E, Carreira Soler M, Guzmán-Parra J, Jódar-Sánchez F, Mayoral-Cleries F, Anarte-Ortíz MT. Effectiveness of eHealth-based psychological interventions for depression treatment in patients with type 1 or type 2 diabetes mellitus: a systematic review. Front Psychol 2021;12:746217
480. Tavares Franquez R, Del Grossi Moura M, Cristina Ferreira McClung D, et al. E-Health technologies for treatment of depression, anxiety and emotional distress in person with diabetes mellitus: a systematic review and meta-analysis. Diabetes Res Clin Pract 2023;203:110854
481. Koning E, Grigolon RB, Breda V, et al. The effect of lifestyle interventions on depressive symptom severity in individuals with type-2 diabetes: a meta-analysis of randomized controlled trials. J Psychosom Res 2023;173:111445
482. Seddigh S, Bagheri S, Sharifi N, Moravej H, Hadian Shirazi Z. The effect of yoga therapy directed by virtual training on depression of adolescent girls with type 1 diabetes: a randomized controlled trial. J Diabetes Metab Disord 2023;22:1273–1281
483. Saha CK, Shubrook JH, Guyton Hornsby W, et al. Program ACTIVE II: 6- and 12-month outcomes of a treatment approach for major depressive disorder in adults with type 2 diabetes. J Diabetes Complications 2024;38:108666
484. Chen X, Zhao P, Wang W, Guo L, Pan Q. The antidepressant effects of GLP-1 receptor agonists: a systematic review and meta-analysis. Am J Geriatr Psychiatry 2024;32:117–127
485. Pierret ACS, Mizuno Y, Saunders P, et al. Glucagon-like peptide 1 receptor agonists and mental health: a systematic review and meta-analysis. JAMA Psychiatry 2025;82:643–653
486. Pinhas-Hamiel O, Hamiel U, Levy-Shraga Y. Eating disorders in adolescents with type 1 diabetes: challenges in diagnosis and treatment. World J Diabetes 2015;6:517–526
487. Niemelä PE, Leppänen HA, Voutilainen A, et al. Prevalence of eating disorder symptoms in people with insulin-dependent-diabetes: a systematic review and meta-analysis. Eat Behav 2024; 53:101863
488. Dziewa M, Bańka B, Herbet M, Piątkowska-Chmiel I. Eating disorders and diabetes: facing the dual challenge. Nutrients 2023;15:3955
489. Dean YE, Motawea KR, Aslam M, et al. Association between type 1 diabetes mellitus and eating disorders: a systematic review and meta-analysis. Endocrinol Diabetes Metab 2024;7:e473
490. Beam AB, Wiebe DJ. Subtypes of insulin restriction in diabetes management: a systematic review. Curr Diab Rep 2025;25:20
491. Garrido-Bueno M, Núñez-Sánchez M, García-Lozano MS, Fagundo-Rivera J, Romero-Alvero A, Fernández-León P. Effects of body image and self-concept on the management of type 1 diabetes mellitus in adolescents and young adults: a systematic review. Healthcare (Basel) 2025;13: 1425
492. Abbott S, Dindol N, Tahrani AA, Piya MK. Binge eating disorder and night eating syndrome in adults with type 2 diabetes: a systematic review. J Eat Disord 2018;6:36
493. Weinger K, Beverly EA. Barriers to achieving glycemic targets: who omits insulin and why? Diabetes Care 2010;33:450–452
494. Priesterroth L-S, Grammes J, Kubiak T. Subtypes of disordered eating and their diabetes-related and psychosocial concomitants in adults with type 1 diabetes. J Diabetes Complications 2025;39:109067
495. Araia E, King RM, Pouwer F, Speight J, Hendrieckx C. Psychological correlates of disordered eating in youth with type 1 diabetes: results from diabetes MILES Youth-Australia. Pediatr Diabetes 2020;21:664–672
496. Pekin C, McHale M, Seymour M, et al. Psychopathology and eating behaviour in people with type 2 diabetes referred for bariatric surgery. Eat Weight Disord 2022;27:3627–3635
497. Freitag AC, Koller OG, Menezes VM, Luft VC, de Almeida JC. Emotional and uncontrolled eating behaviors are associated with poorer glycemic control in patients with type 2 diabetes. Nutr Res 2025;140:93–101
498. Garcia-Poblet M, Sospedra I, Martinez-Sanz JM. The association between psychological distress and disordered eating behavior in young people with type 1 diabetes: a systematic review. Nutr Rev. 16 June 2025 [Epub ahead of print]. DOI: 10.1093/nutrit/nuaf072
499. Mateo K, Greenberg B, Valenzuela J. Disordered eating behaviors and eating disorders in youth with type 2 diabetes: a systematic review. Diabetes Spectr 2024;37:342–348
500. Julceus EF, Liese AD, Alfalki AM, et al. The association of levels of food insecurity and disordered eating behaviors among youth and young adults with diabetes: the SEARCH for Diabetes in Youth Study. Int J Eat Disord 2025;58: 1039–1047
501. Markowitz JT, Butler DA, Volkening LK, Antisdel JE, Anderson BJ, Laffel LMB. Brief screening tool for disordered eating in diabetes: internal consistency and external validity in a contemporary sample of pediatric patients with type 1 diabetes. Diabetes Care 2010;33:495–500
502. Zuijdwijk CS, Pardy SA, Dowden JJ, Dominic AM, Bridger T, Newhook LA. The mSCOFF for screening disordered eating in pediatric type 1 diabetes. Diabetes Care 2014;37:e26-27–e27
503. Yanovski SZ, Marcus MD, Wadden TA, Walsh BT. The Questionnaire on Eating and Weight Patterns-5: an updated screening instrument for binge eating disorder. Int J Eat Disord 2015;48: 259–261
504. Gormally J, Black S, Daston S, Rardin D. Binge Eating Scale [PsychTESTS dataset]. APA PsycTests. Accessed 8 September 2025. Available from https://psycnet.apa.org/doiLanding?doi=10.1037%2Ft08303-000
505. Allison KC, Stunkard AJ. (2006). Night Eating Questionnaire. (NEQ) [Database record]. APA PsycTests. Accessed 8 September 2025. Available from https://psycnet.apa.org/doiLanding?doi=10.1037%2Ft62905-000
506. Zaremba N, Watson A, Kan C, et al. Multidisciplinary healthcare teams' challenges and strategies in supporting people with type 1 diabetes to recover from disordered eating. Diabet Med 2020;37:1992–2000
507. Peterson CM, Fischer S, Young-Hyman D. Topical review: a comprehensive risk model for disordered eating in youth with type 1 diabetes. J Pediatr Psychol 2015;40:385–390
508. Banting R, Randle-Phillips C. A systematic review of psychological interventions for comorbid type 1 diabetes mellitus and eating disorders. Diabetes Management 2018;8:1–18
509. Priesterroth L, Grammes J, Clauter M, Kubiak T. Diabetes technologies in people with type 1 diabetes mellitus and disordered eating: a systematic review on continuous subcutaneous insulin infusion, continuous glucose monitoring and automated insulin delivery. Diabet Med 2021; 38:e14581
510. Hennekes MHCL, Haugvik S, de Wit M, et al. Diabetes Body Project: acute effects of an eating disorder prevention program for young women with type 1 diabetes. A multinational randomized controlled trial. Diabetes Care 2025;48:220–225
511. Jones CJ, Read R, O'Donnell N, et al. PRIORITY Trial: results from a feasibility randomised controlled trial of a psychoeducational intervention for parents to prevent disordered eating in children and young people with type 1 diabetes. Diabet Med 2024;41:e15263

512. Stadler M, Zaremba N, Harrison A, et al. Safety of a co-designed cognitive behavioural therapy intervention for people with type 1 diabetes and eating disorders (STEADY): a feasibility randomised controlled trial. Lancet Reg Health Eur 2025;50:101205
513. Traviss-Turner G, Bowes E, Hill A, et al. Providing online guided self-help for the management of binge eating in adults with type 2 diabetes: the POSE-D pilot study and process evaluation. Br J Nutr 2024;132:1542–1552
514. van Bloemendaal L, IJzerman RG, Ten Kulve JS, et al. GLP-1 receptor activation modulates appetite- and reward-related brain areas in humans. Diabetes 2014;63:4186–4196
515. Aoun L, Almardini S, Saliba F, et al. GLP-1 receptor agonists: a novel pharmacotherapy for binge eating (binge eating disorder and bulimia nervosa)? A systematic review. J Clin Transl Endocrinol 2024;35:100333
516. Jackson CA, Fleetwood K, Kerssens J, Smith DJ, Mercer S, Wild SH. Incidence of type 2 diabetes in people with a history of hospitalization for major mental illness in Scotland, 2001-2015: a retrospective cohort study. Diabetes Care 2019;42: 1879–1885
517. Fleetwood KJ, Wild SH, Licence KAM, et al.; Scottish Diabetes Research Network Epidemiology Group. Severe mental illness and type 2 diabetes outcomes and complications: a nationwide cohort study. Diabetes Care 2023;46:1363–1371
518. Pillinger T, McCutcheon RA, Vano L, et al. Comparative effects of 18 antipsychotics on metabolic function in patients with schizophrenia, predictors of metabolic dysregulation, and association with psychopathology: a systematic review and network meta-analysis. Lancet Psychiatry 2020;7:64–77
519. Zhang Y, Liu Y, Su Y, et al. The metabolic side effects of 12 antipsychotic drugs used for the treatment of schizophrenia on glucose: a network meta-analysis. BMC Psychiatry 2017;17:373
520. American Diabetes Association; American Psychiatric Association; American Association of Clinical Endocrinologists; North American Association for the Study of Obesity. Consensus development conference on antipsychotic drugs and obesity and diabetes. Diabetes Care 2004;27: 596–601
521. Mulligan K, McBain H, Lamontagne-Godwin F, et al. Barriers to effective diabetes management—a survey of people with severe mental illness. BMC Psychiatry 2018;18:165
522. Nadal IP, Cliffton C, Tolani E, et al. Eliciting the mechanisms of action of care navigators in the management of type 2 diabetes in people with severe mental illness: a qualitative study. Diabet Med 2022;39:e14894
523. Ojo O, Kalocsányiová E, McCrone P, Elliott H, Milligan W, Gkaintatzi E. Non-pharmacological interventions for type 2 diabetes in people living with severe mental illness: results of a systematic review and meta-analysis. Int J Environ Res Public Health 2024;21:423
524. Schnitzer K, Cather C, Zvonar V, et al. Patient experience and predictors of improvement in a group behavioral and educational intervention for individuals with diabetes and serious mental illness: mixed methods case study. J Particip Med 2021;13:e21934
525. Biessels GJ, Whitmer RA. Cognitive dysfunction in diabetes: how to implement emerging guidelines. Diabetologia 2020;63:3–9
526. Brands AMA, Biessels GJ, de Haan EHF, Kappelle LJ, Kessels RPC. The effects of type 1 diabetes on cognitive performance: a meta-analysis. Diabetes Care 2005;28:726–735
527. Carmichael OT, Neiberg RH, Dutton GR, et al. Long-term change in physiological markers and cognitive performance in type 2 diabetes: the Look AHEAD study. J Clin Endocrinol Metab 2020;105: e4778–e4791
528. Jin C-Y, Yu S-W, Yin J-T, Yuan X-Y, Wang X-G. Corresponding risk factors between cognitive impairment and type 1 diabetes mellitus: a narrative review. Heliyon 2022;8:e10073
529. Mao S, Wang Y. Risk factors for cognitive decline in type 2 diabetes mellitus adults: a systematic review and meta-analysis. Mol Cell Biochem 2025:10.1007/s11010
530. Chi H, Song M, Zhang J, Zhou J, Liu D. Relationship between acute glucose variability and cognitive decline in type 2 diabetes: a systematic review and meta-analysis. PLoS One 2023;18: e0289782
531. Jacobson AM, Ryan CM, Cleary PA, et al.; Diabetes Control and Complications Trial/EDIC Research Group. Biomedical risk factors for decreased cognitive functioning in type 1 diabetes: an 18 year follow-up of the Diabetes Control and Complications Trial (DCCT) cohort. Diabetologia 2011;54:245–255
532. Biessels GJ, Despa F. Cognitive decline and dementia in diabetes mellitus: mechanisms and clinical implications. Nat Rev Endocrinol 2018;14: 591–604
533. Munshi MN. Cognitive dysfunction in older adults with diabetes: what a clinician needs to know. Diabetes Care 2017;40:461–467
534. Garcia-Argibay M, Li L, Du Rietz E, et al. The association between type 2 diabetes and attention-deficit/hyperactivity disorder: a systematic review, meta-analysis, and population-based sibling study. Neurosci Biobehav Rev 2023; 147:105076
535. Ding K, Reynolds CM, Driscoll KA, Janicke DM. The relationship between executive functioning, type 1 diabetes self-management behaviors, and glycemic control in adolescents and young adults. Curr Diab Rep 2021;21:10
536. Miller AL, Albright D, Bauer KW, et al. Self-regulation as a protective factor for diabetes distress and adherence in youth with type 1 diabetes during the COVID-19 pandemic. J Pediatr Psychol 2022;47:873–882
537. Feinkohl I, Aung PP, Keller M, et al.; Edinburgh Type 2 Diabetes Study (ET2DS) Investigators. Severe hypoglycemia and cognitive decline in older people with type 2 diabetes: the Edinburgh type 2 diabetes study. Diabetes Care 2014;37:507–515
538. Strudwick SK, Carne C, Gardiner J, Foster JK, Davis EA, Jones TW. Cognitive functioning in children with early onset type 1 diabetes and severe hypoglycemia. J Pediatr 2005;147:680–685
539. Mauras N, Buckingham B, White NH, et al.; Diabetes Research in Children Network (DirecNet). Impact of type 1 diabetes in the developing brain in children: a longitudinal study. Diabetes Care 2021;44:983–992
540. West RK, Ravona-Springer R, Schmeidler J, et al. The association of duration of type 2 diabetes with cognitive performance is modulated by long-term glycemic control. Am J Geriatr Psychiatry 2014;22:1055–1059
541. Seminer A, Mulihano A, O'Brien C, et al. Cardioprotective glucose-lowering agents and dementia risk: a systematic review and meta-analysis. JAMA Neurol 2025;82:450–460
542. Cai Y-H, Wang Z, Feng L-Y, Ni G-X. Effect of exercise on the cognitive function of older patients with type 2 diabetes mellitus: a systematic review and meta-analysis. Front Hum Neurosci 2022; 16:876935
543. Anothaisintawee T, Reutrakul S, Van Cauter E, Thakkinstian A. Sleep disturbances compared to traditional risk factors for diabetes development: systematic review and meta-analysis. Sleep Med Rev 2016;30:11–24
544. Liu H, Zhu H, Lu Q, et al. Sleep features and the risk of type 2 diabetes mellitus: a systematic review and meta-analysis. Ann Med 2025;57: 2447422
545. Zhang X, Zhang R, Cheng L, et al. The effect of sleep impairment on gestational diabetes mellitus: a systematic review and meta-analysis of cohort studies. Sleep Med 2020;74:267–277
546. Monzon AD, Patton SR, Koren D. Childhood diabetes and sleep. Pediatr Pulmonol 2022;57: 1835–1850
547. Lee SWH, Ng KY, Chin WK. The impact of sleep amount and sleep quality on glycemic control in type 2 diabetes: a systematic review and meta-analysis. Sleep Med Rev 2017;31 :91–101
548. Al-Gadi IS, Streisand R, Tully C, et al. Up all night? Sleep disruption in parents of young children newly diagnosed with type 1 diabetes. Pediatr Diabetes 2022;23:815–819
549. Macaulay GC, Boucher SE, Yogarajah A, Galland BC, Wheeler BJ. Sleep and night-time caregiving in parents of children and adolescents with type 1 diabetes mellitus—a qualitative study. Behav Sleep Med 2020;18:622–636
550. Reutrakul S, Thakkinstian A, Anothaisintawee T, et al. Sleep characteristics in type 1 diabetes and associations with glycemic control: systematic review and meta-analysis. Sleep Med 2016;23: 26–45
551. Khalil M, Power N, Graham E, Deschênes SS, Schmitz N. The association between sleep and diabetes outcomes —a systematic review. Diabetes Res Clin Pract 2020;161:108035
552. Denic-Roberts H, Costacou T, Orchard TJ. Subjective sleep disturbances and glycemic control in adults with long-standing type 1 diabetes: the Pittsburgh's Epidemiology of Diabetes Complications study. Diabetes Res Clin Pract 2016;119:1–12
553. Fallahi A, Jamil DI, Karimi EB, Baghi V, Gheshlagh RG. Prevalence of obstructive sleep apnea in patients with type 2 diabetes: a systematic review and meta-analysis. Diabetes Metab Syndr 2019;13:2463–2468
554. Schipper SBJ, Van Veen MM, Elders PJM, et al. Sleep disorders in people with type 2 diabetes and associated health outcomes: a review of the literature. Diabetologia 2021;64:2367–2377
555. Bener A, Al-Hamaq AOAA, Ağan AF, Öztürk M, Ömer A. The prevalence of restless legs syndrome and comorbid condition among patient with type 2 diabetic mellitus visiting primary healthcare. J Family Med Prim Care 2019;8:3814–3820

556. Modarresnia L, Golgiri F, Madani NH, Emami Z, Tanha K. Restless legs syndrome in Iranian people with type 2 diabetes mellitus: the role in quality of life and quality of sleep. J Clin Sleep Med 2018;14:223–228
557. Manodpitipong A, Saetung S, Nimitphong H, et al. Night-shift work is associated with poorer glycaemic control in patients with type 2 diabetes. J Sleep Res 2017;26:764–772
558. El Tayeb I, El Saghier E, Ramadan B. Impact of shift work on glycemic control in insulin treated diabetics Dar El Chefa Hospital, Egypt 2014. Int J Diabetes Res 2014;3:15–21
559. Itani O, Kaneita Y, Tokiya M, et al. Short sleep duration, shift work, and actual days taken off work are predictive life-style risk factors for new-onset metabolic syndrome: a seven-year cohort study of 40,000 male workers. Sleep Med 2017;39: 87–94
560. Lecube A, Simó R, Pallayova M, et al. Pulmonary function and sleep breathing: two new targets for type 2 diabetes care. Endocr Rev 2017; 38:550–573
561. Herth J, Sievi NA, Schmidt F, Kohler M. Effects of continuous positive airway pressure therapy on glucose metabolism in patients with obstructive sleep apnoea and type 2 diabetes: a systematic review and meta-analysis. Eur Respir Rev 2023;32:230083
562. Yang R, Zhang L, Guo J, et al. Glucagon-like peptide-1 receptor agonists for obstructive sleep apnea in patients with obesity and type 2 diabetes mellitus: a systematic review and meta-analysis. J Transl Med 2025;23:389
563. Malhotra A, Grunstein RR, Fietze I, et al.; SURMOUNT-OSA Investigators. Tirzepatide for the treatment of obstructive sleep apnea and obesity. N Engl J Med 2024;391:1193–1205
564. Tan X, van Egmond L, Chapman CD, Cedernaes J, Benedict C. Aiding sleep in type 2 diabetes: therapeutic considerations. Lancet Diabetes Endocrinol 2018;6:60–68
565. Carreon SA, Cao VT, Anderson BJ, Thompson DI, Marrero DG, Hilliard ME. 'I don't sleep through the night': qualitative study of sleep in type 1 diabetes. Diabet Med 2022;39:e14763
566. Hood KK, Schneider-Utaka AK, Reed ZW, et al.; PEDAP Trial Study Group. Patient reported outcomes (PROs) and user experiences of young children with type 1 diabetes using t:slim X2 insulin pump with control-IQ technology. Diabetes Res Clin Pract 2024;208:111114
567. Cobry EC, Hamburger E, Jaser SS. Impact of the hybrid closed-loop system on sleep and quality of life in youth with type 1 diabetes and their parents. Diabetes Technol Ther 2020;22:794–800
568. Franceschi R, Mozzillo E, Di Candia F, et al. A systematic review on the impact of commercially available hybrid closed loop systems on psychological outcomes in youths with type 1 diabetes and their parents. Diabet Med 2023;40:e15099
569. Kothari V, Cardona Z, Chirakalwasan N, Anothaisintawee T, Reutrakul S. Sleep interventions and glucose metabolism: systematic review and meta-analysis. Sleep Med 2021;78: 24–35
570. Groeneveld L, Beulens JW, Blom MT, et al. The effect of cognitive behavioral therapy for insomnia on sleep and glycemic outcomes in people with type 2 diabetes: a randomized controlled trial. Sleep Med 2024;120:44–52
571. Kärppä M, Yardley J, Pinner K, et al. Long-term efficacy and tolerability of lemborexant compared with placebo in adults with insomnia disorder: results from the phase 3 randomized clinical trial SUNRISE 2. Sleep 2020;43:zsaa123
572. Tsunoda T, Yamada M, Akiyama T, et al. The effects of ramelteon on glucose metabolism and sleep quality in type 2 diabetic patients with insomnia: a pilot prospective randomized controlled trial. J Clin Med Res 2016;8:878–887
573. Toi N, Inaba M, Kurajoh M, et al. Improvement of glycemic control by treatment for insomnia with suvorexant in type 2 diabetes mellitus. J Clin Transl Endocrinol 2019;15:37–44
574. Li M, Li D, Tang Y, et al. Effect of diabetes sleep education for T2DM who sleep after midnight: a pilot study from China. Metab Syndr Relat Disord 2018;16:13–19
575. Khandelwal D, Dutta D, Chittawar S, Kalra S. Sleep disorders in type 2 diabetes. Indian J Endocrinol Metab 2017;21:758–761
576. Hernar I, Cooper JG, Nilsen RM, et al. Diabetes distress and associations with demographic and clinical variables: a nationwide population-based registry study of 10,186 adults with type 1 diabetes in Norway. Diabetes Care 2024;47:126–131
577. McCarthy MM, Whittemore R, Gholson G, Grey M. Diabetes distress, depressive symptoms, and cardiovascular health in adults with type 1 diabetes. Nurs Res 2019;68:445–452
578. Lloyd CE, Pambianco G, Orchard TJ. Does diabetes-related distress explain the presence of depressive symptoms and/or poor self-care in individuals with type 1 diabetes? Diabet Med 2010;27:234–237
579. Chatwin H, Broadley M, Hendrieckx C, et al.; Hypo-RESOLVE Consortium. The impact of hypoglycaemia on quality of life among adults with type 1 diabetes: results from "YourSAY: hypoglycaemia." J Diabetes Complications 2023;37: 108232
580. Trief PM, Xing D, Foster NC, et al.; T1D Exchange Clinic Network. Depression in adults in the T1D Exchange Clinic Registry. Diabetes Care 2014;37:1563–1572
581. Schram MT, Baan CA, Pouwer F. Depression and quality of life in patients with diabetes: a systematic review from the European Depression in Diabetes (EDID) research consortium. Curr Diabetes Rev 2009;5:112–119
582. Schmitt A, McSharry J, Speight J, et al. Symptoms of depression and anxiety in adults with type 1 diabetes: associations with self-care behaviour, glycaemia and incident complications over four years—results from diabetes MILES-Australia. J Affect Disord 2021;282:803–811
583. Stahl-Pehe A, Selinski S, Bächle C, et al. Screening for generalized anxiety disorder (GAD) and associated factors in adolescents and young adults with type 1 diabetes: cross-sectional results of a Germany-wide population-based study. Diabetes Res Clin Pract 2022;184:109197
584. Goebel-Fabbri AE, Fikkan J, Franko DL, Pearson K, Anderson BJ, Weinger K. Insulin restriction and associated morbidity and mortality in women with type 1 diabetes. Diabetes Care 2008;31:415–419
585. Galler A, Bollow E, Meusers M, et al.; German Federal Ministry of Education and Research (BMBF) Competence Network Diabetes Mellitus. Comparison of glycemic and metabolic control in youth with type 1 diabetes with and without antipsychotic medication: analysis from the nationwide German/Austrian Diabetes Survey (DPV). Diabetes Care 2015;38:1051–1057
586. Cooper MN, Lin A, Alvares GA, de Klerk NH, Jones TW, Davis EA. Psychiatric disorders during early adulthood in those with childhood onset type 1 diabetes: rates and clinical risk factors from population-based follow-up. Pediatr Diabetes 2017;18:599–606
587. Chan JKN, Wong CSM, Or PCF, Chen EYH, Chang WC. Risk of mortality and complications in patients with schizophrenia and diabetes mellitus: population-based cohort study. Br J Psychiatry 2021;219:375–382
588. Jacobson AM, Ryan CM, Braffett BH, et al.; DCCT/EDIC Research Group. Cognitive performance declines in older adults with type 1 diabetes: results from 32 years of follow-up in the DCCT and EDIC Study. Lancet Diabetes Endocrinol 2021;9: 436–445
589. Ryan CM, Geckle MO, Orchard TJ. Cognitive efficiency declines over time in adults with type 1 diabetes: effects of micro- and macrovascular complications. Diabetologia 2003;46:940–948
590. Chaytor NS, Riddlesworth TD, Bzdick S, et al.; T1D Exchange Severe Hypoglycemia in Older Adults with Type 1 Diabetes Study Group. The relationship between neuropsychological assessment, numeracy, and functional status in older adults with type 1 diabetes. Neuropsychol Rehabil 2017;27:507–521
591. Chow YY, Verdonschot M, McEvoy CT, Peeters G. Associations between depression and cognition, mild cognitive impairment and dementia in persons with diabetes mellitus: a systematic review and meta-analysis. Diabetes Res Clin Pract 2022;185:109227
592. Matsunaga M, Tanihara S, He Y, Yatsuya H, Ota A. Impact of diabetes on mortality and hospitalization after dementia diagnosis: health insurance claims data analysis. Geriatr Gerontol Int 2024;24:773–781
593. Fisher L, Mullan JT, Arean P, Glasgow RE, Hessler D, Masharani U. Diabetes distress but not clinical depression or depressive symptoms is associated with glycemic control in both cross-sectional and longitudinal analyses. Diabetes Care 2010;33:23–28
594. Khashayar P, Shirzad N, Zarbini A, Esteghamati A, Hemmatabadi M, Sharafi E. Diabetes-related distress and its association with the complications of diabetes in Iran. J Diabetes Metab Disord 2022;21:1569–1575
595. Park H-S, Cho Y, Seo DH, et al. Impact of diabetes distress on glycemic control and diabetic complications in type 2 diabetes mellitus. Sci Rep 2024;14:5568
596. Hayashino Y, Okamura S, Tsujii S, Ishii H; Care Registry at Tenri Study Group. Diabetes distress is associated with future risk of progression of diabetic nephropathy in adults with type 2 diabetes: a prospective cohort study (Diabetes Distress and Care Registry at Tenri [DDCRT23]). Can J Diabetes 2023;47:519–524
597. Young CF, Mullin R, Moverley JA, Shubrook JH. Associations between diabetes-related distress and predicted cardiovascular complication risks in patients with type 2 diabetes. J Osteopath Med 2022;122:319–326
598. Bruno BA, Choi D, Thorpe KE, Yu CH. Relationship among diabetes distress, decisional

conflict, quality of life, and patient perception of chronic illness care in a cohort of patients with type 2 diabetes and other comorbidities. Diabetes Care 2019;42:1170–1177
599. Hayashino Y, Okamura S, Tsujii S, Ishii H; Care Registry at Tenri Study Group. Association between diabetes distress and all-cause mortality in Japanese individuals with type 2 diabetes: a prospective cohort study (Diabetes Distress and Care Registry in Tenri [DDCRT 18]). Diabetologia 2018;61:1978–1984
600. Lustman PJ, Anderson RJ, Freedland KE, de Groot M, Carney RM, Clouse RE. Depression and poor glycemic control: a meta-analytic review of the literature. Diabetes Care 2000;23:934–942
601. Khuwaja AK, Lalani S, Dhanani R, Azam IS, Rafique G, White F. Anxiety and depression among outpatients with type 2 diabetes: a multi-centre study of prevalence and associated factors. Diabetol Metab Syndr 2010;2:72
602. Chourpiliadis C, Zeng Y, Lovik A, et al. Metabolic profile and long-term risk of depression, anxiety, and stress-related disorders. JAMA Netw Open 2024;7:e244525
603. Lin EHB, Rutter CM, Katon W, et al. Depression and advanced complications of diabetes: a prospective cohort study. Diabetes Care 2010;33:264–269
604. Gonzalez JS, Peyrot M, McCarl LA, et al. Depression and diabetes treatment nonadherence: a meta-analysis. Diabetes Care 2008; 31:2398–2403
605. Fisher L, Glasgow RE, Strycker LA. The relationship between diabetes distress and clinical depression with glycemic control among patients with type 2 diabetes. Diabetes Care 2010;33: 1034–1036
606. Ali S, Stone M, Skinner TC, Robertson N, Davies M, Khunti K. The association between depression and health-related quality of life in people with type 2 diabetes: a systematic literature review. Diabetes Metab Res Rev 2010; 26:75–89
607. Park M, Katon WJ, Wolf FM. Depression and risk of mortality in individuals with diabetes: a meta-analysis and systematic review. Gen Hosp Psychiatry 2013;35:217–225
608. Lee LO, Grimm KJ, Spiro A, 3rd, Kubzansky LD. Neuroticism, worry, and cardiometabolic risk trajectories: findings from a 40-year study of men. J Am Heart Assoc 2022;11:e022006
609. Deschênes SS, Burns RJ, Schmitz N. Trajectories of anxiety symptoms and associations with incident cardiovascular disease in adults with type 2 diabetes. J Psychosom Res 2018;104: 95–100
610. Karpha K, Biswas J, Nath S, Dhali A, Sarkhel S, Dhali GK. Factors affecting depression and anxiety in diabetic patients: a cross sectional study from a tertiary care hospital in Eastern India. Ann Med Surg (Lond) 2022;84:104945
611. Deschênes SS, Burns RJ, Schmitz N. Associations between diabetes, major depressive disorder and generalized anxiety disorder comorbidity, and disability: findings from the 2012 Canadian Community Health Survey—Mental Health (CCHS-MH). J Psychosom Res 2015; 78:137–142
612. Papelbaum M, de Oliveira Moreira R, Coutinho WF, et al. Does binge-eating matter for glycemic control in type 2 diabetes patients? J Eat Disord 2019;7:30
613. TODAY Study Group. Longitudinal association of depressive symptoms, binge eating, and quality of life with cardiovascular risk factors in young adults with youth-onset type 2 diabetes: the TODAY2 study. Diabetes Care 2022;45:1073–1081
614. Meneghini LF, Spadola J, Florez H. Prevalence and associations of binge eating disorder in a multiethnic population with type 2 diabetes. Diabetes Care 2006;29:2760
615. Trott M, Driscoll R, Iraldo E, Pardhan S. Pathological eating behaviours and risk of retinopathy in diabetes: a systematic review and meta-analysis. J Diabetes Metab Disord 2022;21:1047–1054
616. Wykes TL, Lee AA, McKibbin CL, Laurent SM. Self-efficacy and hemoglobin A1C among adults with serious mental illness and type 2 diabetes: the roles of cognitive functioning and psychiatric symptom severity. Psychosom Med 2016;78: 263–270
617. Dixon LB, Kreyenbuhl JA, Dickerson FB, et al. A comparison of type 2 diabetes outcomes among persons with and without severe mental illnesses. Psychiatr Serv 2004;55:892–900
618. McEvoy JP, Meyer JM, Goff DC, et al. Prevalence of the metabolic syndrome in patients with schizophrenia: baseline results from the Clinical Antipsychotic Trials of Intervention Effectiveness (CATIE) schizophrenia trial and comparison with national estimates from NHANES III. Schizophr Res 2005;80:19–32
619. Kim H, Lee K-N, Shin DW, Han K, Jeon HJ. Association of comorbid mental disorders with cardiovascular disease risk in patients with type 2 diabetes: a nationwide cohort study. Gen Hosp Psychiatry 2022;79:33–41
620. Scheuer SH, Kosjerina V, Lindekilde N, et al. Severe mental illness and the risk of diabetes complications: a nationwide, register-based cohort study. J Clin Endocrinol Metab 2022;107:e3504–e3514
621. Tzeng W-C, Tai Y-M, Feng H-P, Lin C-H, Chang Y-C. Diabetes self-care behaviours among people diagnosed with serious mental illness: a cross-sectional correlational study. J Psychiatr Ment Health Nurs 2024;31:364–375
622. Bajor LA, Gunzler D, Einstadter D, et al. Associations between comorbid anxiety, diabetes control, and overall medical burden in patients with serious mental illness and diabetes. Int J Psychiatry Med 2015;49:309–320
623. Dickerson F, Brown CH, Fang L, et al. Quality of life in individuals with serious mental illness and type 2 diabetes. Psychosomatics 2008;49: 109–114
624. Ter Braake JG, Fleetwood KJ, Vos RC, et al.; Scottish Diabetes Research Network Epidemiology Group. Cardiovascular risk management among individuals with type 2 diabetes and severe mental illness: a cohort study. Diabetologia 2024;67: 1029–1039
625. Munshi M, Grande L, Hayes M, et al. Cognitive dysfunction is associated with poor diabetes control in older adults. Diabetes Care 2006;29:1794–1799
626. Lee S-H, Han K, Cho H, et al. Variability in metabolic parameters and risk of dementia: a nationwide population-based study. Alzheimers Res Ther 2018;10:110
627. Olesen KKW, Thrane PG, Gyldenkerne C, et al. Diabetes and coronary artery disease as risk factors for dementia. Eur J Prev Cardiol 2024;32: 477–484
628. Cheng D, Zhao X, Yang S, Wang G, Ning G. Association between diabetic retinopathy and cognitive impairment: a systematic review and meta-analysis. Front Aging Neurosci 2021;13: 692911
629. Sinclair AJ, Girling AJ, Bayer AJ. Cognitive dysfunction in older subjects with diabetes mellitus: impact on diabetes self-management and use of care services. All Wales Research into Elderly (AWARE) Study. Diabetes Res Clin Pract 2000; 50:203–212
630. Katon W, Lyles CR, Parker MM, Karter AJ, Huang ES, Whitmer RA. Association of depression with increased risk of dementia in patients with type 2 diabetes: the Diabetes and Aging Study. Arch Gen Psychiatry 2012;69:410–417
631. Janssen J, Koekkoek PS, Biessels G-J, Kappelle JL, Rutten GEHM; Cog-ID study group. Depressive symptoms and quality of life after screening for cognitive impairment in patients with type 2 diabetes: observations from the Cog-ID cohort study. BMJ Open 2019;9:e024696
632. Titcomb TJ, Richey P, Casanova R, et al. Association of type 2 diabetes mellitus with dementia-related and non-dementia-related mortality among postmenopausal women: a secondary competing risks analysis of the women's health initiative. Alzheimers Dement 2024;20:234–242
633. Davies MJ, Aroda VR, Collins BS, et al. Management of hyperglycemia in type 2 diabetes, 2022. A consensus report by the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). Diabetes Care 2022;45:2753–2786