Nutrition Therapy for Adults With Diabetes or Prediabetes: A Consensus Report

This Consensus Report is intended to provide clinical professionals with evidence-based guidance about individualizing nutrition therapy for adults with diabetes or prediabetes. Strong evidence supports the efficacy and cost-effectiveness of nutrition therapy as a component of quality diabetes care, including its integration into the medical management of diabetes; therefore, it is important that all members of the health care team know and champion the benefits of nutrition therapy and key nutrition messages. Nutrition counseling that works toward improving or maintaining glycemic targets, achieving weight management goals, and improving cardiovascular risk factors (e.g., blood pressure, lipids, etc.) within individualized treatment goals is recommended for all adults with diabetes and prediabetes.

Though it might simplify messaging, a "one-size-fits-all" eating plan is not evident for the prevention or management of diabetes, and it is an unrealistic expectation given the broad spectrum of people affected by diabetes and prediabetes, their cultural backgrounds, personal preferences, co-occurring conditions (often referred to as comorbidities), and socioeconomic settings in which they live. Research provides clarity on many food choices and eating patterns that can help people achieve health goals and quality of life. The American Diabetes Association (ADA) emphasizes that medical nutrition therapy (MNT) is fundamental in the overall diabetes management plan, and the need for MNT should be reassessed frequently by health care providers in collaboration with people with diabetes across the life span, with special attention during times of changing health status and life stages (1–3).

This Consensus Report now includes information on prediabetes, and previous ADA nutrition position statements, the last of which was published in 2014 (4), did not. Unless otherwise noted, the research reviewed was limited to those studies conducted in adults diagnosed with prediabetes, type 1 diabetes, and/or type 2 diabetes. Nutrition therapy for children with diabetes or women with gestational diabetes mellitus is not addressed in this review but is covered in other ADA publications, specifically *Standards of Medical Care in Diabetes* (5,6).

DATA SOURCES, SEARCHES, AND STUDY SELECTION

The authors of this report were chosen following a national call for experts to ensure diversity of the members both in professional interest and cultural background, including a person living with diabetes who served as a patient advocate. An outside market research company was used to conduct the literature search and was paid using ADA funds. The authors convened in person for one group meeting and actively participated in monthly teleconference calls between February and November 2018. Focused teleconference calls, email, and web-based collaboration were also used to reach consensus on final recommendations between November 2018 and January 2019. The 2014 position statement (4) was used as a starting point, and a search was conducted on PubMed for studies published in English between 1 January 2014 and 28 February 2018 to provide the updated evidence of nutrition therapy interventions in nonhospitalized adults with prediabetes and type 1 and type 2 diabetes. Details on the keywords and the search strategy are reported in the Supplementary Data, emphasizing randomized controlled trials (RCTs), systematic reviews, and meta-analyses of RCTs. An exception was made to the inclusion criteria for the use of meal studies for the insulin dosing section. In addition to the search results, in select cases the authors identified relevant research to include in reaching consensus. The

Alison B. Evert,[1] Michelle Dennison,[2] Christopher D. Gardner,[3] W. Timothy Garvey,[4,5] Ka Hei Karen Lau,[6] Janice MacLeod,[7] Joanna Mitri,[8] Raquel F. Pereira,[9] Kelly Rawlings,[10] Shamera Robinson,[11] Laura Saslow,[12] Sacha Uelmen,[11] Patricia B. Urbanski,[13] and William S. Yancy Jr.[14,15]

[1]UW Neighborhood Clinics, UW Medicine, University of Washington, Seattle, WA
[2]Oklahoma City Indian Clinic, Oklahoma City, OK
[3]Stanford Diabetes Research Center and Stanford Prevention Research Center, Department of Medicine, Stanford University, Stanford, CA
[4]Diabetes Research Center, Department of Nutrition Sciences, University of Alabama at Birmingham, Birmingham, AL
[5]Birmingham Veterans Affairs Medical Center, Birmingham, AL
[6]Joslin Diabetes Center, Boston, MA
[7]Companion Medical, Inc., Columbia, MD
[8]Section on Clinical, Behavioral and Outcomes Research Lipid Clinic, Adult Diabetes Section, Joslin Diabetes Center, Harvard Medical School, Boston, MA
[9]Simple Concepts Consulting, Bellevue, WA
[10]Vida Health, San Francisco, CA
[11]American Diabetes Association, Arlington, VA
[12]Department of Health Behavior and Biological Sciences, University of Michigan School of Nursing, Ann Arbor, MI
[13]St. Luke's Health Care System, Duluth, MN
[14]Duke Diet and Fitness Center, Department of Medicine, Duke University Health System, Durham, NC
[15]Durham Veterans Affairs Medical Center, Durham, NC

Corresponding author: William S. Yancy Jr., will.yancy@duke.edu

consensus report was peer reviewed (see ACKNOWLEDGMENTS) and suggestions incorporated as deemed appropriate by the authors. Though evidence-based, the recommendations presented are the informed, expert opinions of the authors after consensus was reached through presentation and discussion of the evidence.

EFFECTIVENESS OF DIABETES NUTRITION THERAPY

Consensus recommendations

- Refer adults living with type 1 or type 2 diabetes to individualized, diabetes-focused MNT at diagnosis and as needed throughout the life span and during times of changing health status to achieve treatment goals. Coordinate and align the MNT plan with the overall management strategy, including use of medications, physical activity, etc., on an ongoing basis.
- Refer adults with diabetes to comprehensive diabetes self-management education and support (DSMES) services according to national standards.
- Diabetes-focused MNT is provided by a registered dietitian nutritionist/ registered dietitian (RDN), preferably one who has comprehensive knowledge and experience in diabetes care.
- Refer people with prediabetes and overweight/obesity to an intensive lifestyle intervention program that includes individualized goal-setting components, such as the Diabetes Prevention Program (DPP) and/or to individualized MNT.
- Diabetes MNT is a covered Medicare benefit and should be adequately reimbursed by insurance and other payers or bundled in evolving value-based care and payment models.
- DPP-modeled intensive lifestyle interventions and individualized MNT for prediabetes should be covered by third-party payers or bundled in evolving value-based care and payment models.

How is diabetes nutrition therapy defined and provided?

The National Academy of Medicine (formerly the Institute of Medicine) broadly defines nutrition therapy as the treatment of a disease or condition through the modification of nutrient or whole-food intake (7). To complement diabetes nutrition therapy, members of the health care team can and should provide evidence-based guidance that allows people with diabetes to make healthy food choices that meet their individual needs and optimize their overall health. The Dietary Guidelines for Americans (DGA) 2015–2020 provide a basis for healthy eating for all Americans and recommend that people consume a healthy eating pattern that accounts for all foods and beverages within an appropriate calorie level (8). For people with diabetes, recommendations that differ from the DGA are highlighted in this report.

MNT is an evidence-based application of the nutrition care process provided by an RDN and is the legal definition of nutrition counseling by an RDN in the U.S. (9–12). Essential components of MNT are assessment, nutrition diagnosis, interventions (e.g., education and counseling), and monitoring with ongoing follow-up to support long-term lifestyle changes, evaluate outcomes, and modify interventions as needed (9,10). The goals of nutrition therapy are described in Table 1.

The unique academic preparation, training, skills, and expertise make the RDN the preferred member of the health care team to provide diabetes MNT and leadership in interprofessional team-based nutrition and diabetes care (1,9,13–18). Although certification (such as Certified Diabetes Educator, Board Certified-Advanced Diabetes Management) is not required, ideally the RDN will have comprehensive knowledge and experience in diabetes care and prevention (9,17). Detailed guidance for the RDN to obtain the expert knowledge and experience can be found in the Academy of Nutrition and Dietetics Standards of Practice and Standards of Professional Performance (12). Health care professionals can use the education algorithm suggested by ADA, the American Association of Diabetes Educators, and the Academy of Nutrition and Dietetics (1) that defines and describes the four critical times to assess, provide, and adjust care. The algorithm is intended for use by the RDN and the interprofessional team for determining how and when to deliver diabetes education and nutrition services. The number of encounters the person with diabetes might have with the RDN is described in Table 2 (9).

In addition to diabetes MNT, DSMES is important for people with diabetes to improve cardiometabolic and microvascular outcomes in a disease that is largely self-managed (1,19–23). DSMES includes the ongoing process that facilitates the knowledge, skills, and abilities necessary for diabetes self-care throughout the life span, with nutrition as one of the core curriculum topics taught in comprehensive programs (21).

Is MNT effective in improving outcomes?

Reported hemoglobin A_{1c} (A1C) reductions from MNT can be similar to or greater than what would be expected with treatment using currently available medication for type 2 diabetes (9). Strong evidence supports the effectiveness of MNT interventions provided by RDNs for improving A1C, with absolute decreases up to 2.0% (in type 2 diabetes) and up to 1.9% (in type 1 diabetes) at 3–6 months. Ongoing MNT support is helpful in maintaining glycemic improvements (9).

Table 1—Goals of nutrition therapy

- To promote and support healthful eating patterns, emphasizing a variety of nutrient-dense foods in appropriate portion sizes, in order to improve overall health and specifically to:
  - Improve A1C, blood pressure, and cholesterol levels (goals differ for individuals based on age, duration of diabetes, health history, and other present health conditions. Further recommendations for individualization of goals can be found in the ADA *Standards of Medical Care in Diabetes* [345])
  - Achieve and maintain body weight goals
  - Delay or prevent complications of diabetes
- To address individual nutrition needs based on personal and cultural preferences, health literacy and numeracy, access to healthful food choices, willingness and ability to make behavioral changes, as well as barriers to change
- To maintain the pleasure of eating by providing positive messages about food choices, while limiting food choices only when indicated by scientific evidence
- To provide the individual with diabetes with practical tools for day-to-day meal planning

Table 2—Academy of Nutrition and Dietetics evidence-based nutrition practice guidelines–recommended structure for the implementation of MNT for adults with diabetes (9)

Initial series of MNT encounters: The RDN should implement three to six MNT encounters during the first 6 months following diagnosis and determine if additional MNT encounters are needed based on an individualized assessment.

MNT follow-up encounters: The RDN should implement a minimum of one annual MNT follow-up encounter.

Cost-effectiveness of lifestyle interventions and MNT for the prevention and management of diabetes has been documented in multiple studies (12,17, 24,25). The National Academy of Medicine recommends individualized MNT, provided by an RDN upon physician referral, as part of the multidisciplinary approach to diabetes care (7). Diabetes MNT is a covered Medicare benefit and should also be adequately reimbursed by insurance and other payers, or bundled in evolving value-based care and payment models, because it can result in improved outcomes such as reduced A1C and cost savings (12,17,25).

What nutrition therapy interventions best help people with prediabetes prevent or delay the development of type 2 diabetes?

The strongest evidence for type 2 diabetes prevention comes from several studies, including the DPP (26–28). The DPP demonstrated that an intensive lifestyle intervention resulting in weight loss could reduce the incidence of type 2 diabetes for adults with overweight/obesity and impaired glucose tolerance by 58% over 3 years (26). Follow-up of three large studies of lifestyle intervention for diabetes prevention has shown sustained reduction in the rate of conversion to type 2 diabetes: 43% reduction at 20 years in the Da Qing Diabetes Prevention Study (29); 43% reduction at 7 years in the Finnish Diabetes Prevention Study (DPS) (30); and 34% reduction at 10 years (28) and 27% reduction at 15 years extended follow-up of the DPP (31) in the U.S. Diabetes Prevention Program Outcomes Study (DPPOS). The follow-up of the Da Qing study also demonstrated a reduction in cardiovascular and all-cause mortality (32).

Substantial evidence indicates that individuals with prediabetes should be referred to an intensive behavioral lifestyle intervention program modeled on the DPP and/or to individualized MNT typically provided by an RDN with the goals of improving eating habits, increasing moderate-intensity physical activity to at least 150 min per week, and achieving and maintaining 7–10% loss of initial body weight if needed (14,17,33,34). More intensive intervention programs are the most effective in decreasing diabetes incidence and improving cardiovascular disease (CVD) risk factors (35).

Both DPP-modeled intensive lifestyle interventions and individualized MNT for prediabetes have demonstrated cost-effectiveness (17,36) and therefore should be covered by third-party payers or bundled in evolving value-based care and payment models (25).

To make diabetes prevention programs more accessible, digital health tools are an area of increasing interest in the public and private sectors. Preliminary research studies support that the delivery of diabetes prevention lifestyle interventions through technology-enabled platforms and digital health tools can result in weight loss, improved glycemia, and reduced risk for diabetes and CVD, although more rigorous studies are needed (37–44).

MACRONUTRIENTS

Consensus recommendations

- Evidence suggests that there is not an ideal percentage of calories from carbohydrate, protein, and fat for all people with or at risk for diabetes; therefore, macronutrient distribution should be based on individualized assessment of current eating patterns, preferences, and metabolic goals.
- When counseling people with diabetes, a key strategy to achieve glycemic targets should include an assessment of current dietary intake followed by individualized guidance on self-monitoring carbohydrate intake to optimize meal timing and food choices and to guide medication and physical activity recommendations.
- People with diabetes and those at risk for diabetes are encouraged to consume at least the amount of dietary fiber recommended for the general public; increasing fiber intake, preferably through food (vegetables, pulses [beans, peas, and lentils], fruits, and whole intact grains) or through dietary supplement, may help in modestly lowering A1C.

Do macronutrient needs differ for people with diabetes compared with the general population?

Although numerous studies have attempted to identify the optimal mix of macronutrients for the eating plans of people with diabetes, a systematic review (45) found that there is no ideal mix that applies broadly and that macronutrient proportions should be individualized. It has been observed that people with diabetes, on average, eat about the same proportions of macronutrients as the general public: ~45% of their calories from carbohydrate (see Table 3), ~36–40% of calories from fat, and the remainder (~16–18%) from protein (46–48). Regardless of the macronutrient mix, total energy intake should be appropriate to attain weight management goals. Further, individualization of the macronutrient composition will depend on the status of the individual, including metabolic goals (glycemia, lipid profile, etc.), physical activity, food preferences, and availability.

Do carbohydrate needs differ for people with diabetes compared with the general population?

Carbohydrate is a readily used source of energy and the primary dietary influence on postprandial blood glucose (8,49). Foods containing carbohydrate—with various proportions of sugars, starches, and fiber—have a wide range of effects on the glycemic response. Some result in an extended rise and slow fall of blood glucose concentrations, while others result in a rapid rise followed by a rapid fall (50). The quality of carbohydrate foods selected—ideally rich in dietary fiber, vitamins, and minerals and low in added sugars, fats, and sodium—should be addressed as part of an

individualized eating plan that includes all components necessary for optimal nutrition (4,9).

The amount of carbohydrate intake required for optimal health in humans is unknown. Although the recommended dietary allowance for carbohydrate for adults without diabetes (19 years and older) is 130 g/day and is determined in part by the brain's requirement for glucose, this energy requirement can be fulfilled by the body's metabolic processes, which include glycogenolysis, gluconeogenesis (via metabolism of the glycerol component of fat or gluconeogenic amino acids in protein), and/or ketogenesis in the setting of very low dietary carbohydrate intake (49).

What are the dietary fiber needs of people with diabetes?

The regular intake of sufficient dietary fiber is associated with lower all-cause mortality in people with diabetes (51,52). Therefore, people with diabetes should consume at least the amount of fiber recommended by the DGA 2015–2020 (minimum of 14 g of fiber per 1,000 kcal) with at least half of grain consumption being whole intact grains (8). Other sources of dietary fiber include non-starchy vegetables, avocados, fruits, and berries, as well as pulses such as beans, peas, and lentils.

A few studies have shown modest A1C reduction (-0.2% to -0.3%) (53, 54) with intake in excess of 50 g of fiber per day. However, such very high intake of fiber may cause flatulence, bloating, and diarrhea. Meeting the recommended fiber intake through foods that are naturally high in dietary fiber, as compared with supplementation, is encouraged for the additional benefits of coexisting micronutrients and phytochemicals (55).

Does the use of glycemic index and glycemic load impact glycemia?

The use of the glycemic index (GI) and glycemic load (GL) to rank carbohydrate foods according to their effects on glycemia continues to be of interest for people with diabetes and those at risk for diabetes. As defined by Brand-Miller et al. (56), "the GI provides a good summary of postprandial glycemia. It predicts the peak (or near peak) response, the maximum glucose fluctuation, and other attributes of the response

curve." Two systematic reviews of the literature regarding GI and GL in individuals with diabetes and at risk for diabetes reported no significant impact on A1C and mixed results on fasting glucose (9,50). Further, studies have used varying definitions of low and high GI foods, leading to uncertainty in the utility of GI and GL in clinical care (45).

What are the total protein needs of people with diabetes?

There is limited research in people with diabetes or prediabetes without kidney disease on the impact of various amounts of protein consumed. Some comparisons of protein amounts have not demonstrated differences in diabetes-related outcomes (57–60). A 12-week study comparing 30% vs. 15% energy from protein noted improvements in weight, fasting glucose, and insulin requirements in the group that consumed 30% energy from protein (61). A meta-analysis from 2013 of studies ranging from 4–24 weeks in duration reported that high-protein eating plans (25–32% of total energy vs. 15–20%) resulted in 2 kg greater weight loss and 0.5% greater improvement in A1C but no statistically significant improvements in fasting serum glucose, serum lipid profiles, or blood pressure (62).

What are the dietary fat and cholesterol goals for people with diabetes?

The National Academy of Medicine has defined an acceptable macronutrient distribution for total fat for all adults to be 20–35% of total calorie intake (49). Eating patterns that replace certain carbohydrate foods with those higher in total fat, however, have demonstrated greater improvements in glycemia and certain CVD risk factors (serum HDL cholesterol [HDL-C] and triglycerides) compared with lower fat diets. The types or quality of fats in the eating plans may influence CVD outcomes beyond the total amount of fat (63). Foods containing synthetic sources of *trans* fats should be minimized to the greatest extent possible (8). Ruminant *trans* fats, occurring naturally in meat and dairy products, do not need to be eliminated because they are present in such small quantities (64).

The body makes enough cholesterol for physiological and structural functions such that people do not need to obtain cholesterol through foods. Although the

DGA concluded that available evidence does not support the recommendation to limit dietary cholesterol for the general population, exact recommendations for dietary cholesterol for other populations, such as people with diabetes, are not as clear (8). Whereas cholesterol intake has correlated with serum cholesterol levels, it has not correlated well with CVD events (65,66). More research is needed regarding the relationship among dietary cholesterol, blood cholesterol, and CVD events in people with diabetes.

What is the role of fat in the prevention of type 2 diabetes?

Large epidemiologic studies have found that consumption of polyunsaturated fat or biomarkers of polyunsaturated fatty acids are associated with lower risk of type 2 diabetes (67). Supplementation with omega-3 fatty acids in prediabetes has demonstrated some efficacy in surrogate outcomes beyond serum triglyceride levels. In a single-blinded RCT design in Asia, 107 subjects with newly diagnosed impaired glucose metabolism and coronary heart disease (CHD) supplemented with 1,800 mg/day of eicosapentaenoic acid (EPA) experienced improved postprandial triglycerides, glycemia, insulin secretion ability, and endothelial function over a 6-month period (68). Further, in a recent multisite RCT that included 57% of participants with diabetes, age 50 years or older, and with at least one additional CVD risk factor, plus elevated fasting triglycerides and low HDL-C, benefits were seen from adding 2 g of icosapent ethyl twice daily to statin therapy in terms of lower rates of a composite CVD outcome and CVD mortality, but there were also slightly higher rates of hospitalization for atrial fibrillation and serious bleeding (68a).

The intervention in the PREvención con DIeta MEDiterránea (PREDIMED) study, comparing a Mediterranean-style eating pattern supplemented either with extra-virgin olive oil or with nuts versus a control diet, reduced incidence of type 2 diabetes among people without diabetes at high cardiovascular risk at baseline (69). The Malmö Diet and Cancer cohort study examined specific food sources of saturated fat and found that intake of saturated fat from dairy products, coconut oil, and palm kernel oil were associated with lower diabetes risk (70), whereas saturated fat intake was associated with higher risk of diabetes in

Table 3—Eating patterns reviewed for this report

Type of eating pattern	Description	Potential benefits reported*
USDA Dietary Guidelines For Americans (DGA) (8)	Emphasizes a variety of vegetables from all of the subgroups; fruits, especially whole fruits; grains, at least half of which are whole intact grains; lower-fat dairy; a variety of protein foods; and oils. This eating pattern limits saturated fats and *trans* fats, added sugars, and sodium.	DGA added to the table for reference; not reviewed as part of this Consensus Report
Mediterranean-style (69,76,85–91)	Emphasizes plant-based food (vegetables, beans, nuts and seeds, fruits, and whole intact grains); fish and other seafood; olive oil as the principal source of dietary fat; dairy products (mainly yogurt and cheese) in low to moderate amounts; typically fewer than 4 eggs/week; red meat in low frequency and amounts; wine in low to moderate amounts; and concentrated sugars or honey rarely.	● Reduced risk of diabetes ● A1C reduction ● Lowered triglycerides ● Reduced risk of major cardiovascular events
Vegetarian or vegan (77–80,92–99)	The two most common approaches found in the literature emphasize plant-based vegetarian eating devoid of all flesh foods but including egg (ovo) and/or dairy (lacto) products, or vegan eating devoid of all flesh foods and animal-derived products.	● Reduced risk of diabetes ● A1C reduction ● Weight loss ● Lowered LDL-C and non–HDL-C
Low-fat (26,45,80,83,100–106)	Emphasizes vegetables, fruits, starches (e.g., breads/crackers, pasta, whole intact grains, starchy vegetables), lean protein sources (including beans), and low-fat dairy products. In this review, defined as total fat intake ≤30% of total calories and saturated fat intake ≤10%.	● Reduced risk of diabetes ● Weight loss
Very low-fat (107–109)	Emphasizes fiber-rich vegetables, beans, fruits, whole intact grains, nonfat dairy, fish, and egg whites and comprises 70–77% carbohydrate (including 30–60 g fiber), 10% fat, 13–20% protein.	● Weight loss ● Lowered blood pressure
Low-carbohydrate (110–112)	Emphasizes vegetables low in carbohydrate (such as salad greens, broccoli, cauliflower, cucumber, cabbage, and others); fat from animal foods, oils, butter, and avocado; and protein in the form of meat, poultry, fish, shellfish, eggs, cheese, nuts, and seeds. Some plans include fruit (e.g., berries) and a greater array of nonstarchy vegetables. Avoids starchy and sugary foods such as pasta, rice, potatoes, bread, and sweets. There is no consistent definition of "low" carbohydrate. In this review, a low-carbohydrate eating pattern is defined as reducing carbohydrates to 26–45% of total calories.	● A1C reduction ● Weight loss ● Lowered blood pressure ● Increased HDL-C and lowered triglycerides
Very low-carbohydrate (VLC) (110–112)	Similar to low-carbohydrate pattern but further limits carbohydrate-containing foods, and meals typically derive more than half of calories from fat. Often has a goal of 20–50 g of nonfiber carbohydrate per day to induce nutritional ketosis. In this review a VLC eating pattern is defined as reducing carbohydrate to <26% of total calories.	● A1C reduction ● Weight loss ● Lowered blood pressure ● Increased HDL-C and lowered triglycerides
Dietary Approaches to Stop Hypertension (DASH) (81,118,119)	Emphasizes vegetables, fruits, and low-fat dairy products; includes whole intact grains, poultry, fish, and nuts; reduced in saturated fat, red meat, sweets, and sugar-containing beverages. May also be reduced in sodium.	● Reduced risk of diabetes ● Weight loss ● Lowered blood pressure
Paleo (120–122)	Emphasizes foods theoretically eaten regularly during early human evolution, such as lean meat, fish, shellfish, vegetables, eggs, nuts, and berries. Avoids grains, dairy, salt, refined fats, and sugar.	● Mixed results ● Inconclusive evidence

*Source: RCTs, meta-analyses, observational studies, nonrandomized single-arm studies, cohort studies. USDA, U.S. Department of Agriculture.

the PREDIMED study (71). Other meta-analyses of observational studies have not shown an inverse relationship with full-fat dairy intake and diabetes risk (72,73). The inconsistent results in the above studies may be due to variations in food sources of fat (70) or the fact that some analyses have relied on self-reported dietary information, which can be limited by inaccuracy.

For more information on fat intake and CVD risk, see the section ROLE OF NUTRITION THERAPY IN THE PREVENTION AND MANAGEMENT OF DIABETES COMPLICATIONS (CVD, DIABETIC KIDNEY DISEASE, AND GASTROPARESIS).

EATING PATTERNS

Consensus recommendations

- A variety of eating patterns (combinations of different foods or food groups) are acceptable for the management of diabetes.
- Until the evidence surrounding comparative benefits of different eating patterns in specific individuals strengthens, health care providers should focus on the key factors that are common among the patterns:
  - Emphasize nonstarchy vegetables.
  - Minimize added sugars and refined grains.
  - Choose whole foods over highly processed foods to the extent possible.
- Reducing overall carbohydrate intake for individuals with diabetes has demonstrated the most evidence for improving glycemia and may be applied in a variety of eating patterns that meet individual needs and preferences.
- For select adults with type 2 diabetes not meeting glycemic targets or where reducing antiglycemic medications is a priority, reducing overall carbohydrate intake with low- or very low-carbohydrate eating plans is a viable approach.

An eating pattern represents the totality of all foods and beverages consumed (8) (Table 3). An eating plan is a guide to help individuals plan when, what, and how much to eat on a daily basis and applies to the foods emphasized in the individual's selected eating pattern.

This section emphasizes evidence from randomized trials of eating patterns in people with type 1 diabetes, type 2 diabetes, and prediabetes and was limited to those trials with at least 10 people in each dietary group and a retention rate of >50%. Overall, few long-term (2 years or longer) randomized trials have been conducted of any of the dietary patterns in any of the conditions examined.

What is the evidence for specific eating patterns to manage prediabetes and prevent type 2 diabetes?

The most robust research available related to eating patterns for prediabetes or type 2 diabetes prevention are Mediterranean-style, low-fat, or low-carbohydrate eating plans (26,69,74,75). The PREDIMED trial, a large RCT, compared a Mediterranean-style to a low-fat eating pattern for prevention of type 2 diabetes onset, with the Mediterranean-style eating pattern resulting in a 30% lower relative risk (69). Epidemiologic studies correlate Mediterranean-style (76), vegetarian (77–80), and Dietary Approaches to Stop Hypertension (DASH) (76,81) eating patterns with a lower risk of developing type 2 diabetes, with no effect for low-carbohydrate eating patterns (82).

Several large type 2 diabetes prevention RCTs (26,74,83,84) used low-fat eating plans to achieve weight loss and improve glucose tolerance, and some demonstrated decreased incidence of diabetes (26,74,83). Given the limited evidence, it is unclear which of the eating patterns are optimal.

What is the evidence for specific eating patterns to manage type 2 diabetes?

Mediterranean-Style Eating Pattern

The Mediterranean-style pattern has demonstrated a mixed effect on A1C, weight, and lipids in a number of RCTs (85–90). In the Dietary Intervention Randomized Controlled Trial (DIRECT), obese adults with type 2 diabetes were randomized to a calorie-restricted Mediterranean-style, a calorie-restricted lower-fat, or a low-carbohydrate eating pattern (28% of calories from carbohydrate) without emphasis on calorie restriction. A1C was lowest in the low-carbohydrate group after 2 years, whereas fasting plasma glucose was lower in the Mediterranean-style group than in the lower-fat group (90).

One of the largest and longest RCTs, the PREDIMED trial, compared a Mediterranean-style eating pattern with a low-fat eating pattern. After 4 years, glycemic management improved and the need for glucose-lowering medications was lower in the Mediterranean eating pattern group (89). In addition, the PREDIMED trial showed that a Mediterranean-style eating pattern intervention enriched with olive oil or nuts significantly reduced CVD incidence in both people with and without diabetes (91).

Vegetarian or Vegan Eating Patterns

Studies of vegetarian or vegan eating plans ranged in duration from 12 to 74 weeks and showed mixed results on glycemia and CVD risk factors. These eating plans often resulted in weight loss (92–97). Two meta-analyses of controlled trials (98,99) concluded that vegetarian and vegan eating plans can reduce A1C by an average of 0.3–0.4% in people with type 2 diabetes, and the larger meta-analysis (99) also reported that plant-based eating patterns reduced weight (weight reduction of 2 kg), waist circumference, LDL cholesterol (LDL-C), and non–HDL-C with no significant effect on fasting insulin, HDL-C, triglycerides, and blood pressure.

Low-Fat Eating Pattern

In the Look AHEAD (Action for Health in Diabetes) trial (100), individuals following a calorie-restricted low-fat eating pattern, in the context of a structured weight loss program using meal replacements, achieved moderate success compared with the control condition eating plan (101). However, lowering total fat intake did not consistently improve glycemia or CVD risk factors in people with type 2 diabetes based on a systematic review (45), several studies (102–105), and a meta-analysis (106). Benefit from a low-fat eating pattern appears to be mostly related to weight loss as opposed to the eating pattern itself (100,101). Additionally, low-fat eating patterns have commonly been used as the "control" intervention compared with other eating patterns.

Very Low-Fat: Ornish or Pritikin Eating Patterns

The Ornish and Pritikin lifestyle programs are two of the best known multicomponent very low-fat eating patterns. The Ornish program emphasizes a very low-fat, whole-foods, plant-based eating

plan (about 70% of calories from carbohydrate, 10% from fat, 20% from protein, and 60 g of fiber), predominantly from vegetables, beans, fruits, grains, nonfat dairy, and egg whites. The Pritikin intervention advises that people consume 77% of calories from carbohydrate, about 10% from fat, 13% from protein, and 30–40 g of fiber per 1,000 calories, with no calorie restriction during a 26-day stay in an in-patient treatment center. Three nonrandomized single-arm studies with 69 to 652 participants lasting between 3 weeks and 2–3 years show that these multicomponent lifestyle intervention programs may improve glucose levels, weight, blood pressure, and HDL-C, with a mixed effect on triglycerides (107–109).

Low-Carbohydrate or Very Low-Carbohydrate Eating Patterns

Low-carbohydrate eating patterns, especially very low-carbohydrate (VLC) eating patterns, have been shown to reduce A1C and the need for antihyperglycemic medications. These eating patterns are among the most studied eating patterns for type 2 diabetes. One meta-analysis of RCTs that compared low-carbohydrate eating patterns (defined as ≤45% of calories from carbohydrate) to high-carbohydrate eating patterns (defined as >45% of calories from carbohydrate) found that A1C benefits were more pronounced in the VLC interventions (where <26% of calories came from carbohydrate) at 3 and 6 months but not at 12 and 24 months (110).

Another meta-analysis of RCTs compared a low-carbohydrate eating pattern (defined as <40% of calories from carbohydrate) to a low-fat eating pattern (defined as <30% of calories from fat). In trials up to 6 months long, the low-carbohydrate eating pattern improved A1C more, and in trials of varying lengths, lowered triglycerides, raised HDL-C, lowered blood pressure, and resulted in greater reductions in diabetes medication (111). Finally, in another meta-analysis comparing low-carbohydrate to high-carbohydrate eating patterns, the larger the carbohydrate restriction, the greater the reduction in A1C, though A1C was similar at durations of 1 year and longer for both eating patterns (112). Table 4 provides a quick reference conversion of percentage of calories from carbohydrate to grams of

Table 4—Quick reference conversion of percent calories from carbohydrate shown in grams per day as reported in the research reviewed for this report

Calories	10%	20%	30%	40%	50%	60%	70%
1,200	30 g	60 g	90 g	120 g	150 g	180 g	210 g
1,500	38 g	75 g	113 g	150 g	188 g	225 g	263 g
2,000	50 g	100 g	150 g	200 g	250 g	300 g	350 g
2,500	63 g	125 g	188 g	250 g	313 g	375 g	438 g

carbohydrate based on number of calories consumed per day.

Because of theoretical concerns regarding use of VLC eating plans in people with chronic kidney disease, disordered eating patterns, and women who are pregnant, further research is needed before recommendations can be made for these subgroups. Adopting a VLC eating plan can cause diuresis and swiftly reduce blood glucose; therefore, consultation with a knowledgeable practitioner at the onset is necessary to prevent dehydration and reduce insulin and hypoglycemic medications to prevent hypoglycemia.

No randomized trials were found in people with type 2 diabetes that varied the saturated fat content of the low- or very low-carbohydrate eating patterns to examine effects on glycemia, CVD risk factors, or clinical events. Most of the trials using a carbohydrate-restricted eating pattern did not restrict saturated fat; from the current evidence, this eating pattern does not appear to increase overall cardiovascular risk, but long-term studies with clinical event outcomes are needed (113–117).

DASH Eating Pattern

One small, 8-week study comparing the DASH eating pattern with a control group in people with type 2 diabetes indicated improved A1C, blood pressure, and cholesterol levels and weight loss with the DASH eating pattern, with no difference in triglycerides (118). Another RCT compared the DASH eating pattern incorporating increased physical activity with a standard eating pattern without increased physical activity and found blood pressure was lower in the DASH and physical activity group, but A1C, weight, and lipids did not differ (119).

Paleo Eating Pattern

Research studies focused on a paleo eating pattern in adults with type 2 diabetes are small and few, ranging from 13–29 participants, lasting no longer than 3 months, and finding mixed effects on A1C, weight, and lipids (120–122).

Intermittent Fasting

While intermittent fasting is not an eating pattern by definition, it has been included in this discussion because of increased interest from the diabetes community. Fasting means to go without food, drink, or both for a period of time. People fast for reasons ranging from weight management to upcoming medical visits to religious and spiritual practice. Intermittent fasting is a way of eating that focuses more on when you eat (i.e., consuming all daily calories in set hours during the day) than what you eat. While it usually involves set times for eating and set times for fasting, people can approach intermittent fasting in many different ways.

Published intermittent fasting studies involving diabetes and diabetes prevention demonstrate a variety of approaches, including restricting food intake for 18 to 20 h per day, alternate-day fasting, and severe calorie restriction for up to 8 consecutive days or longer (123). Four fasting studies of participants with type 2 diabetes were small (≤63 participants) and of short duration (≤20 weeks). Three of the studies (124–126) demonstrated that intermittent fasting, either in consecutive days of restriction or by fasting 16 h per day or more, may result in weight loss; however, there was no improvement in A1C compared with a nonfasting eating plan. One of the studies (127) showed similar reductions in A1C, weight, and medication doses when 2 days of severe energy restriction were compared with chronic energy restriction. Another study looked at men with prediabetes and timing of food intake over a 24-h period, with the intervention group restricted to a 6-h schedule of eating (with final meal before 3 P.M.) compared with a control schedule where eating occurred over a 12-h period;

improved insulin sensitivity, β-cell responsiveness, blood pressure, oxidative stress, and appetite were shown in the intervention group (128). The safety of intermittent fasting in people with special health situations, including pregnancy and disordered eating, has not been studied.

What is the evidence to support specific eating patterns in the management of type 1 diabetes?

For adults with type 1 diabetes, no trials met the inclusion criteria for this Consensus Report related to Mediterranean-style, vegetarian or vegan, low-fat, low-carbohydrate, DASH, paleo, Ornish, or Pritikin eating patterns. We found limited evidence about the safety and/or effects of fasting on type 1 diabetes (129).

A few studies have examined the impact of a VLC eating pattern for adults with type 1 diabetes. One randomized crossover trial with 10 participants examined a VLC eating pattern aiming for 47 g carbohydrate per day without a focus on calorie restriction compared with a higher carbohydrate eating pattern aiming for 225 g carbohydrate per day for 1 week each. Participants following the VLC eating pattern had less glycemic variability, spent more time in euglycemia and less time in hypoglycemia, and required less insulin (130). A single-arm 48-person trial of a VLC eating pattern aimed at a goal of 75 g of carbohydrate or less per day found that weight, A1C, and triglycerides were reduced and HDL-C increased after 3 months, and after 4 years A1C was still lower and HDL-C was still higher than at baseline (131). This evidence suggests that a VLC eating pattern may have potential benefits for adults with type 1 diabetes, but clinical trials of sufficient size and duration are needed to confirm prior findings.

Does the current evidence support specific eating patterns for the management of diabetes?

Until the evidence surrounding comparative benefits of different eating patterns in specific individuals strengthens, health care providers should focus on the key factors that are common among the patterns: 1) emphasize nonstarchy vegetables, 2) minimize added sugars and refined grains, and 3) choose whole foods over highly processed foods to the extent possible (132).

Multiple trials and meta-analyses have been published addressing the comparative effects of specific eating patterns for diabetes. Whereas no single eating pattern has emerged as being clearly superior to all others for all diabetes-related outcomes, evidence suggests certain eating patterns are better for specific outcomes. All eating patterns include a range of more-healthy versus less-healthy options: lentils and sugar-sweetened beverages are both considered part of a vegan eating pattern; fish and processed red meats are both considered part of a low-carbohydrate eating pattern; and removing the bun from a fast food burger might make it part of a paleo eating pattern but does not necessarily make it healthier. Further, studies comparing the same two or more eating patterns could easily differ in the investigators' definition of the patterns, the effectiveness of the research team in fostering pattern adherence among study participants, the accuracy of assessing pattern adherence, study duration, and participant population characteristics.

ENERGY BALANCE AND WEIGHT MANAGEMENT

Consensus recommendations

- To support weight loss and improve A1C, CVD risk factors, and quality of life in adults with overweight/obesity and prediabetes or diabetes, MNT and DSMES services should include an individualized eating plan in a format that results in an energy deficit in combination with enhanced physical activity.
- For adults with type 2 diabetes who are not taking insulin and who have limited health literacy or numeracy, or who are older and prone to hypoglycemia, a simple and effective approach to glycemia and weight management emphasizing appropriate portion sizes and healthy eating may be considered.
- In type 2 diabetes, 5% weight loss is recommended to achieve clinical benefit, and the benefits are progressive. The goal for optimal outcomes is 15% or more when needed and can be feasibly and safely accomplished. In prediabetes, the goal

is 7–10% for preventing progression to type 2 diabetes.
- In select individuals with type 2 diabetes, an overall healthy eating plan that results in energy deficit in conjunction with weight loss medications and/or metabolic surgery should be considered to help achieve weight loss and maintenance goals, lower A1C, and reduce CVD risk.
- In conjunction with lifestyle therapy, 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.
- People with prediabetes at a healthy weight should be considered for lifestyle intervention involving both aerobic and resistance exercise and a healthy eating plan such as a Mediterranean-style eating plan.
- People with diabetes and prediabetes should be screened and evaluated during DSMES and MNT encounters for disordered eating, and nutrition therapy should accommodate these disorders.

What is the role of weight loss therapy in people with prediabetes or diabetes with overweight or obesity?

There is substantial evidence indicating that weight loss is highly effective in preventing progression from prediabetes to type 2 diabetes and in managing cardiometabolic health in type 2 diabetes. Overweight and obesity are also increasingly prevalent in people with type 1 diabetes and present clinical challenges regarding diabetes treatment and CVD risk factors (133,134). Therefore, MNT and DSMES that include an overall healthy eating plan in a format that results in an energy deficit, as well as a collaborative effort to achieve weight loss in people with type 1 diabetes, type 2 diabetes, or prediabetes and overweight/obesity, are recommended.

Eating plans that create an energy deficit and are customized to fit the person's preferences and resources can help with long-term sustainment and are the cornerstone of weight loss therapy. Regular physical activity, which can contribute to both weight loss and prevention of weight regain, and

behavioral strategies are also important components of lifestyle therapy for weight management (26,74,83,135–137). Structured weight loss programs with regular visits and use of meal replacements have been shown to enhance weight loss in people with diabetes (138–140).

The combined data do not point to a threshold of weight loss for maximal clinical benefits in people with diabetes; rather, the greater the weight loss, the greater the benefits. Previous recommendations of weight loss of 5% or ≥7% for people with overweight or obesity are based on the threshold needed for therapeutic advantages; however, weight loss targeted at ≥15%, when such can feasibly and safely be accomplished, is associated with even better outcomes in type 2 diabetes (138,141).

The UK Prospective Diabetes Study (UKPDS) demonstrated that decreases in fasting glucose were correlated with degree of weight loss (142). A meta-analysis conducted by Franz et al. (137) found that lifestyle interventions producing <5% weight loss had less effect on A1C, lipids, or blood pressure compared with studies achieving weight loss of ≥5%. Other meta-analyses focusing on nonmedicine or medicine-assisted weight loss interventions in type 2 diabetes support this finding (143–145). More recently, the Look AHEAD trial (139,141) compared standard DSMES to a more intensive lifestyle intervention and reduced-calorie eating plan. The intensive lifestyle intervention resulted in 8.6% weight loss at 1 year, and the downstream therapeutic benefits were far-ranging even though benefits were not seen for the primary cardiovascular outcomes (100).

A systematic review of the effectiveness of MNT revealed mixed weight loss outcomes in participants with type 1 and 2 diabetes (9). Similarly, while DSMES is a fundamental component of diabetes care (1), it does not consistently produce sufficient weight loss to achieve optimal therapeutic benefits in people with diabetes (136,146,147). For these reasons, diabetes MNT and DSMES should emphasize a targeted and concerted plan for weight management.

The addition of metabolic surgery (148), weight loss medications (149), and glucose-lowering agents that promote weight loss (150) can also be used as an adjunct to lifestyle interventions, resulting in greater weight loss that is maintained for a longer period of time. The data also support the position that weight loss therapy is effective at all phases of type 2 diabetes, both in individuals with recent-onset disease (1,149) and in people with longer durations of diabetes treated with multiple diabetes medications (136,149).

In the DPP, maximal prevention of diabetes over 4 years was observed at about 7–10% weight loss (151). This is consistent with the study using phentermine/topiramate ER, where weight loss of 10% reduced incident diabetes by 79% over 2 years and any further weight loss to ≥15% did not lead to additional prevention (152). For this reason, nutrition therapy to support a 7–10% weight loss is the appropriate goal in treating people with prediabetes, unless additional weight loss is desired for other purposes. Nutrition therapy can be a component of a lifestyle intervention program or used in conjunction with antiobesity medications and/or metabolic surgery (153,154) in people with prediabetes.

Regular physical activity by itself (155,156) or as part of a comprehensive lifestyle plan (26,74,83,151) can prevent progression to type 2 diabetes in high-risk individuals. Studies have demonstrated beneficial effects of both aerobic and resistance exercise and additive benefits when both forms of exercise are combined (157–159).

What is the best weight loss plan for individuals with diabetes?

For purposes of weight loss, the ability to sustain and maintain an eating plan that results in an energy deficit, irrespective of macronutrient composition or eating pattern, is critical for success (160–163). Studies investigating specific weight loss eating plans using a broad range of macronutrient composition in people with diabetes have shown mixed results regarding effects on weight, A1C, serum lipids, and blood pressure (102,103,106,164–171). As a result, the evidence does not identify one eating plan that is clearly superior to others and that can be generally recommended for weight loss for people with diabetes (172). Thus, an individualized plan for diabetes nutrition therapy is warranted, taking into account dietary preferences together with the individual's health literacy, resources, food availability, meal preparation skills, and physical activity to maximize the ability to attain and maintain the eating plan (173,174). Individualized eating plans should support calorie reduction (e.g., employing use of appropriate portion sizes, meal replacements, and/or behavioral interventions) in the context of a lifestyle program, with appropriate modifications in the medication plan to minimize associated adverse effects such as weight gain, hypoglycemia, and hypotension.

Weight loss interventions can be implemented in usual care settings and alternately in telehealth programs (175,176). In general, the intervention intensity and degree of individual participation in the program are important factors for successful weight loss (161–163,175).

What is the role of weight loss on potential for type 2 diabetes remission?

The Look AHEAD trial (177) and the Diabetes Remission Clinical Trial (DiRECT) (138) highlight the potential for type 2 diabetes remission—defined as the maintenance of euglycemia (complete remission) or prediabetes level of glycemia (partial remission) with no diabetes medication for at least 1 year (177,178)—in people undergoing weight loss treatment. In the Look AHEAD trial, when compared with the control group, the intensive lifestyle arm resulted in at least partial diabetes remission in 11.5% of participants as compared with 2% in the control group (177). The DiRECT trial showed that at 1 year, weight loss associated with the lifestyle intervention resulted in diabetes remission in 46% of participants (138). Remission rates were related to magnitude of weight loss, rising progressively from 7% to 86% as weight loss at 1 year increased from <5% to ≥15% (138). Diet composition may also play a role; in an RCT by Esposito et al. (179), despite only a 2-kg difference in weight loss, the group following a low-carbohydrate Mediterranean-style eating pattern (see Table 3) experienced greater rates of at least partial diabetes remission, with rates of 14.7% at year 1 and 5% at year 6 compared with 4.7% and 0%, respectively, in the group following a low-fat eating plan.

What is the role of eating plans that result in energy deficits and weight loss in type 1 diabetes?

Obesity prevalence among people with type 1 diabetes has been significantly increasing (180–182). Currently, over 50% of people with type 1 diabetes have overweight or obesity (180–182). A recent study suggested obesity may promote progression to overt type 1 diabetes in at-risk individuals (183), but further confirmatory studies are needed. In addition, in people with established type 1 diabetes, presence of obesity can worsen insulin resistance, glycemic variability, microvascular disease complications, and cardiovascular risk factors (184–188). Therefore, weight management has been recommended as an essential component of care for people with type 1 diabetes who have overweight or obesity (189–192).

There is a scarcity of evidence from RCTs evaluating weight loss interventions in type 1 diabetes. A retrospective nested-control study indicated that lifestyle-induced weight loss improved glycemia with a reduction in insulin doses compared with controls (193). Individuals with type 1 diabetes and obesity may benefit from eating plans that result in an energy deficit and that are lower in total carbohydrate and GI and higher in fiber and lean protein (194). Currently, adjunctive pharmacotherapy is not indicated for individuals with type 1 diabetes. However, there is preliminary evidence that in select individuals with type 1 diabetes and excess adiposity, newer pharmacotherapy (i.e., glucagon-like peptide 1 receptor agonists or sodium–glucose cotransporter 2 inhibitors) (195,196) can decrease body weight and improve glycemia, though they are currently not indicated. In addition, metabolic surgery in appropriate candidates can decrease body weight and improve glycemia (197,198).

How does disordered eating factor into weight management?

When counseling individuals with diabetes and prediabetes about weight management, special attention also must be given to prevent, diagnose, and treat disordered eating. Disordered eating can make following an eating plan challenging (199). The prevalence of disordered eating varies, affecting 18% to 40% of people with diabetes (199–205).

Health care professionals should consider screening for disordered eating, refer to a mental health professional, and individualize nutrition therapy accordingly (206).

SWEETENERS

Consensus recommendations
- Replace sugar-sweetened beverages (SSBs) with water as often as possible.
- When sugar substitutes are used to reduce overall calorie and carbohydrate intake, people should be counseled to avoid compensating with intake of additional calories from other food sources.

Does the consumption of SSBs impact risk of diabetes?

SSB consumption in the general population contributes to a significantly increased risk of type 2 diabetes, weight gain, heart disease, kidney disease, nonalcoholic liver disease, and tooth decay (207). For example, a meta-analysis reported that consumption of at least one serving of SSB per day increased risk of type 2 diabetes in adults with prediabetes by 26% (208). In a separate meta-analysis, consumption of regular soda increased type 2 diabetes risk by 13%, while consumption of diet soda increased type 2 diabetes risk by 8% (209). Conversely, the replacement of SSBs with an equal amount of water reduced the risk of type 2 diabetes by 7–8% (210).

What is the impact of sugar substitutes?

The U.S. Food and Drug Administration (FDA) has reviewed several types of sugar substitutes for safety and approved them for consumption by the general public, including people with diabetes (211). In this report, the term sugar substitutes refers to high-intensity sweeteners, artificial sweeteners, nonnutritive sweeteners, and low-calorie sweeteners. These include saccharin, neotame, acesulfame-K, aspartame, sucralose, advantame, stevia, and luo han guo (or monk fruit). Replacing added sugars with sugar substitutes could decrease daily intake of carbohydrates and calories. These dietary changes could beneficially affect glycemic, weight, and cardiometabolic control. However, an American Heart Association science advisory on the

consumption of beverages containing sugar substitutes that was supported by the ADA concluded there is not enough evidence to determine whether sugar substitute use definitively leads to long-term reduction in body weight or cardiometabolic risk factors, including glycemia (212). Using sugar substitutes does not make an unhealthy choice healthy; rather, it makes such a choice less unhealthy. If sugar substitutes are used to replace caloric sweeteners, without caloric compensation, they may be useful in reducing caloric and carbohydrate intake (213), although further research is needed to confirm these concepts (214). Multiple mechanisms have been proposed for potential adverse effects of sugar substitutes, e.g., adversely altering feelings of hunger and fullness, substituting for healthier foods, or reducing awareness of calorie intake (215). As people aim to reduce their intake of SSBs, the use of other alternatives, with a focus on water, is encouraged (212).

Sugar alcohols represent a separate category of sweeteners. Like sugar substitutes, sugar alcohols have been approved by the FDA for consumption by the general public and people with diabetes. Whereas sugar alcohols have fewer calories per gram than sugars, they are not as sweet. Therefore, a higher amount is required to match the degree of sweetness of sugars, generally bringing the calorie content to a level similar to that of sugars (216). Use of sugar alcohols needs to be balanced with their potential to cause gastrointestinal effects in sensitive individuals. Currently, there is little research on the potential benefits of sugar alcohols for people with diabetes (217).

ALCOHOL CONSUMPTION

Consensus recommendations
- It is recommended that adults with diabetes or prediabetes who drink alcohol do so in moderation (one drink or less per day for adult women and two drinks or less per day for adult men).
- Educating people with diabetes about the signs, symptoms, and self-management of delayed hypoglycemia after drinking alcohol, especially when using insulin

or insulin secretagogues, is recommended. The importance of glucose monitoring after drinking alcohol beverages to reduce hypoglycemia risk should be emphasized.

What are the effects of alcohol consumption on diabetes-related outcomes?

It is important that health care providers counsel people with diabetes about alcohol consumption and encourage moderate and sensible use for people choosing to consume alcohol. Moderate alcohol consumption has minimal acute and/or long-term detrimental effects on glycemia in people with type 1 or type 2 diabetes (218–221), with some epidemiologic data showing improved glycemia and improved insulin sensitivity with moderate intake. One alcohol-containing beverage is defined as 12-oz beer, 5-oz wine, or 1.5-oz distilled spirits, each containing approximately 15 g of alcohol (8). Excessive amounts of alcohol (>3 drinks per day or 21 drinks per week for men and >2 drinks per day or 14 drinks per week for women) consumed on a consistent basis may contribute to hyperglycemia (222). Starting with one drink per day, risk for reduced adherence to self-care and healthy lifestyle behaviors has been reported with increasing alcohol consumption (223).

What are the effects of alcohol consumption on hypoglycemia risk in people with diabetes?

Despite the potential glycemic and cardiovascular benefits of moderate alcohol consumption, alcohol intake may place people with diabetes at increased risk for delayed hypoglycemia (221,224–226). This effect may be a result of inhibition of gluconeogenesis, reduced hypoglycemia awareness due to the cerebral effects of alcohol, and/or impaired counterregulatory responses to hypoglycemia (227). This is particularly relevant for those using insulin or insulin secretagogues who can experience delayed nocturnal or fasting hypoglycemia after evening alcohol consumption. Consuming alcohol with food can minimize the risk of nocturnal hypoglycemia (227,228). It is essential that people with diabetes receive education regarding the recognition and management of delayed hypoglycemia

and the potential need for more frequent glucose monitoring after consuming alcohol (227,229).

How does alcohol consumption impact risk of developing type 2 diabetes?

Comprehensive reviews and meta-analyses suggest a protective effect of moderate alcohol intake on the risk of developing type 2 diabetes, with a higher rate of diabetes in alcohol abstainers and heavy consumers (222,230–232). Moderate alcohol intake ranging from 6–48 g/day (0.5–3.4 drinks) was associated with a 30–56% lower incidence of type 2 diabetes (9,222,230–232). Knott et al. (232) reported reduced risk of type 2 diabetes at all levels of alcohol intake <63 g per day with peak reduction at a daily alcohol intake of 10–14 g (approximately 1 drink) per day in women and non-Asian populations.

A meta-analysis and systematic review (233) that examined the effects of specific types of alcohol beverage consumption and the incidence of type 2 diabetes found that wine consumption was associated with significantly lower diabetes risk, as compared with a smaller reduction in risk with beer and spirits. A U-shaped relationship between alcohol dose and diabetes risk was found among all three types of alcohol, with lowest diabetes risk at 20–30 g of alcohol per day from wine and beer and 7–15 g of alcohol per day from spirits; the decrease in diabetes incidence was 20% for wine, 9% for beer, and 5% for spirits.

While epidemiologic evidence shows a correlation between alcohol consumption and risk of diabetes, the evidence does not suggest that providers should advise abstainers to start consuming alcohol. Ultimately, alcohol consumption is an individual's choice, but additional factors such as history of alcohol use, religion, genetic factors, and mental health, as well as medication interactions, should be considered when counseling on alcohol use.

MICRONUTRIENTS, HERBAL SUPPLEMENTS, AND RISK OF MEDICATION-ASSOCIATED DEFICIENCY

Consensus recommendations
- Without underlying deficiency, the benefits of multivitamins or mineral supplements on glycemia for people

with diabetes or prediabetes have not been supported by evidence, and therefore routine use is not recommended.
- It is recommended that MNT for people taking metformin include an annual assessment of vitamin B12 status with guidance on supplementation options if deficiency is present.
- The routine use of chromium or vitamin D micronutrient supplements or any herbal supplements, including cinnamon, curcumin, or aloe vera, for improving glycemia in people with diabetes is not supported by evidence and is therefore not recommended.

What is the effectiveness of micronutrients on diabetes-related outcomes?

Scientific evidence does not support the use of dietary supplements in the form of vitamins or minerals to meet glycemic targets or improve CVD risk factors in people with diabetes or prediabetes, in the absence of an underlying deficiency (234–236). People with diabetes not achieving glucose targets may have an increased risk of micronutrient deficiencies (237), so maintaining a balanced intake of food sources that provide at least the recommended daily allowance for nutrients and micronutrients is essential (234). For special populations, including women planning pregnancy, people with celiac disease, older adults, vegetarians, and people following an eating plan that restricts overall calories or one or more macronutrients, a multivitamin supplement may be justified (238).

A systematic review on the effect of chromium supplementation on glucose and lipid metabolism concluded that evidence is limited by poor study quality and heterogeneity in methodology and results (239,240). Evidence from clinical studies that evaluated magnesium (241,242) and vitamin D (243–253) supplementation to improve glycemia in people with diabetes is likewise conflicting. However, evidence is emerging that suggests that magnesium status may be related to diabetes risk in people with prediabetes (254).

What is the role of herbal supplementation in the management of diabetes?

It is important to consider that nutritional supplements and herbal products are not standardized or regulated (255,256). Health care providers should ask about the use of supplements and herbal products, and providers and people with or at risk for diabetes should discuss the potential benefit of these products weighed against the cost and possible adverse effects and drug interactions. The variability of herbal and micronutrient supplements makes research in this area challenging and makes it difficult to conclude effectiveness. To date, there is limited evidence supporting the addition of herbal supplements to manage glycemia. Because of public interest and the lack of conclusive data, the National Center for Complementary and Integrative Health at the National Institutes of Health aims to answer important public health and scientific questions by funding and conducting research on complementary medicine.

Does the use of metformin affect vitamin B12 status?

Metformin is associated with vitamin B12 deficiency, with a recent systematic review recommending that annual blood testing of vitamin B12 levels be considered in metformin-treated people, especially in those with anemia or peripheral neuropathy (257). This study found that even in the absence of anemia, B12 deficiency was prevalent. The exact cause of B12 deficiency in people taking metformin is not known, but some research points to malabsorption caused by metformin, with other studies suggesting improvements in B12 status with calcium supplementation (258–261). The standard of treatment has been B12 injections, but new research suggest that high-dose oral supplementation may be as effective (258,259). More research is needed in this area.

MNT AND ANTIHYPERGLYCEMIC MEDICATIONS (INCLUDING INSULIN)

Consensus recommendations

- All RDNs providing MNT in diabetes care should assess and monitor medication changes in relation to the nutrition care plan.

- For individuals with type 1 diabetes, intensive insulin therapy using the carbohydrate counting approach can result in improved glycemia and is recommended.
- For adults using fixed daily insulin doses, consistent carbohydrate intake with respect to time and amount, while considering the insulin action time, can result in improved glycemia and reduce the risk for hypoglycemia.
- When consuming a mixed meal that contains carbohydrate and is high in fat and/or protein, insulin dosing should not be based solely on carbohydrate counting. A cautious approach to increasing mealtime insulin doses is suggested; continuous glucose monitoring (CGM) or self-monitoring of blood glucose (SMBG) should guide decision-making for administration of additional insulin.

What is the role of the RDN in medication adjustment?

RDNs providing MNT in diabetes care should assess and monitor medication changes in relation to the nutrition care plan. Along with other diabetes care providers, RDNs who possess advanced practice training and clinical expertise should take an active role in facilitating and maintaining organization-approved diabetes medication protocols. Use of organization-approved protocols for insulin and other glucose-lowering medications can help reduce therapeutic inertia and/or reduce the risk of hypoglycemia and hyperglycemia (12,16–18,262,263).

How should nutrition therapy vary based on type and intensity of insulin plan?

For people with type 1 diabetes using basal-bolus insulin therapy, a primary focus for MNT should include guidance on adjusting insulin based on anticipated dietary intake, particularly carbohydrate intake (9,264–270); recent or expected physical activity; and glucose data. Intensive insulin management education programs that include nutrition therapy have been shown to improve A1C (9,264,268,271–273) and quality of life (9,274). For people using fixed daily insulin doses, carbohydrate intake on a day-to-day basis should be consistent

with respect to time and amount per meal (9,275,276).

Results from recent high-fat and/or high-protein mixed meal studies continue to support previous findings that glucose response to mixed meals high in protein and/or fat along with carbohydrate differ among individuals; therefore, 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 3 h or more after eating (277–290). If using an insulin pump, a split bolus feature (part of the bolus delivered immediately, the remainder over a programmed duration of time) may provide better insulin coverage for high-fat and/or high-protein mixed meals (278,281). Checking glucose 3 h after eating may help to determine if additional insulin adjustments (i.e., increasing or stopping bolus) are required (278,290). Because these insulin dosing algorithms require determination of anticipated nutrient intake to calculate the mealtime dose, health literacy and numeracy should be evaluated. The effectiveness of insulin dosing decisions should be confirmed with a structured approach to SMBG or CGM to evaluate individual responses and guide insulin dose adjustments.

ROLE OF NUTRITION THERAPY IN THE PREVENTION AND MANAGEMENT OF DIABETES COMPLICATIONS (CVD, DIABETIC KIDNEY DISEASE, AND GASTROPARESIS)

CVD

Consensus recommendations

- In general, replacing saturated fat with unsaturated fats reduces both total cholesterol and LDL-C and also benefits CVD risk.
- In type 2 diabetes, counseling people on eating patterns that replace foods high in carbohydrate with foods lower in carbohydrate and higher in fat may improve glycemia, triglycerides, and HDL-C; emphasizing foods higher in unsaturated fat instead of saturated fat may additionally improve LDL-C.
- People with diabetes and prediabetes are encouraged to consume less than 2,300 mg/day of sodium, the

same amount that is recommended for the general population.

- The recommendation for the general public to eat a serving of fish (particularly fatty fish) at least two times per week is also appropriate for people with diabetes.

Does comprehensive diabetes nutrition therapy support cardiovascular risk factor reduction?

Nutrition therapy that includes the development of an eating plan designed to optimize blood glucose trends, blood pressure, and lipid profiles is important in the management of diabetes and can lower the risk of CVD, CHD, and stroke (9). Findings from clinical trials support the role of nutrition therapy for achieving glycemic targets and decreasing various markers of cardiovascular and hypertension risk (9,24,291–293).

What are considerations for fat intake for people who are at risk for or have CVD and diabetes?

Total Fat
There has been increasing research examining the effects of high-fat, low-carbohydrate eating patterns on cardiometabolic risk factors, with two systematic reviews showing benefits of low-carbohydrate eating plans compared with low-fat eating plans on glycemic and CVD risk parameters in the treatment of type 2 diabetes (see the section LOW-CARBOHYDRATE OR VERY-LOW-CARBOHYDRATE EATING PATTERNS) (106,111).

Saturated Fat
The 2015–2020 DGA recommend consuming less than 10% of calories from saturated fat by replacing it with monounsaturated and polyunsaturated fatty acids (8). The scientific rationale for decreasing saturated fat in the diet is based on the effect of saturated fat in raising LDL-C, a contributing factor in atherosclerosis (294).

In a Presidential Advisory on dietary fat and CVD, the American Heart Association concluded that lowering intake of saturated fat and replacing it with unsaturated fats, especially polyunsaturated fats, will lower the incidence of CVD (295). A meta-analysis of randomized trials not focused on people with diabetes showed a 17% reduction (hazard ratio 0.83 [95% CI 0.72–0.96]) in risk of CVD

events in studies that reduced saturated fat intake from about 17% to about 9% of energy, but reductions in stroke, cardiovascular mortality, or overall mortality were not found. Subgrouping of the studies suggested that benefit occurred by replacing saturated fat with polyunsaturated fat but not with carbohydrate or protein (296). In a systematic review of observational studies, saturated fats were not associated with all-cause mortality, CVD, CHD, ischemic stroke, or type 2 diabetes, but limitations common to observational studies were noted (297). Further, in a more recent large, prospective study including 7% of participants with self-reported diabetes, higher intake of saturated fat was associated with lower risk of total mortality (hazard ratio 0.86 [0.76–0.99], P for trend = 0.0088) (298). In the PREDIMED study, which included close to 50% of people with diabetes, intakes of monounsaturated and polyunsaturated fats were associated with a lower risk of CVD and death, whereas intakes of saturated fat and *trans* fat were associated with a higher risk of CVD. The replacement of saturated fat with monounsaturated or polyunsaturated fat in food or replacement of *trans* fat with monounsaturated fat in food was inversely associated with CVD (299).

In general, replacing saturated fat with unsaturated fats, especially polyunsaturated fat, significantly reduces both total cholesterol and LDL-C, and replacement with monounsaturated fat from plant sources, such as olive oil and nuts, reduces CVD risk. Replacing saturated fat with carbohydrate also reduces total cholesterol and LDL-C, but significantly increases triglycerides and reduces HDL-C (299,300).

Monounsaturated Fats
A recent meta-analysis of nine RCTs showed that, compared with control, the Mediterranean-style eating pattern, which is high in monounsaturated fats from plant sources such as olive oil and nuts, improved outcomes of glycemia, body weight, and cardiovascular risk factors in participants with type 2 diabetes (301). A systematic review and meta-analysis of 24 studies and including 1,460 participants compared the effect of eating plans high in monounsaturated fat with that of eating plans high in carbohydrates. The eating plans high

in monounsaturated fat showed significant reductions in fasting glucose, triglycerides, body weight, and systolic blood pressure along with significant increases in HDL-C. The systematic review and meta-analysis also reviewed four studies with a total of 44 participants comparing eating plans high in monounsaturated fat with those high in polyunsaturated fat. The eating plans high in monounsaturated fat led to a significant reduction in fasting plasma glucose (63).

Polyunsaturated Fats
As is recommended for the general public, an increase in foods containing the long-chain omega-3 fatty acids EPA and docosahexaenoic acid (DHA), such as are found in fatty fish, is recommended for individuals with diabetes because of their beneficial effects on lipoproteins, prevention of heart disease, and associations with positive health outcomes in observational studies (302,303). For people following a vegetarian or vegan eating pattern, omega-3 α-linolenic acid (ALA) found in plant foods such as flax, walnuts, and soy are reasonable replacements for foods high in saturated fat and may provide some CVD benefits, though the evidence is inconclusive.

Evidence does not conclusively support recommending omega-3 (EPA and DHA) supplements for all people with diabetes for the prevention or treatment of cardiovascular events. In the most recent ASCEND (A Study of Cardiovascular Events iN Diabetes) trial, when compared with placebo, supplementation of omega-3 fatty acids at the dose of 1 g/day did not lead to cardiovascular benefit in people with diabetes without evidence of CVD (68a, 304–305). Omega-3 fatty acid supplements have not reduced CVD events or mortality in randomized trials but may have utility in people who require triglyceride reduction (304,306). The Vitamin D and Omega-3 Trial (VITAL), in which 13% of the participants had type 2 diabetes, supplementation with 1 g of omega-3 fatty acids did not result in a lower incidence of major cardiovascular events (305). However, in the Reduction of Cardiovascular Events With Icosapent Ethyl–Intervention Trial (REDUCE-IT), in which 57% of 823 participants had diabetes, 2 g of prescription icosapent ethyl twice daily (total daily dose, 4 g) significantly reduced

cardiovascular events by 25% when compared with placebo (68a).

Trans Fat
A meta-analysis of seven RCTs showed that increased *trans* fat intake did not result in changes in glucose, insulin, or triglyceride concentrations but led to an increase in total and LDL-C and a decrease in HDL-C concentrations (307). *Trans* fats also have been associated with all-cause mortality, total CHD, and CHD mortality (297).

Can lowering sodium intake reduce blood pressure and other cardiovascular risk factors in people with diabetes?
Many health groups acknowledge the current average intake of sodium, which is >3,500 mg daily (308), should be reduced (8,309–312) to prevent and manage hypertension. While reducing sodium to the general recommendation of <2,300 mg/day demonstrates beneficial effects on blood pressure (118), further reduction warrants caution. Some studies measuring urine sodium excretion in people with type 1 (313) and type 2 (314) diabetes have shown increased mortality associated with the lowest sodium intakes. A secondary analysis of data from the Ongoing Telmisartan Alone and in Combination With Ramipril Global Endpoint Trial (ONTARGET) suggests sodium excretions <3 g/day and >7 g/day were both associated with increased mortality in people with type 2 diabetes (315), leading to continued controversy over the potential benefits versus harms of lowering sodium intake below the general recommendation. In the absence of clear scientific evidence for benefit in people with combined diabetes and hypertension (313,314), sodium intake goals that are significantly lower than 2,300 mg/day should be considered only on an individual basis. When individualizing sodium intake recommendations, careful consideration must be given to issues such as food preference, palatability, availability, and additional cost of fresh or specialty low-sodium products (316).

Diabetic Kidney Disease

Consensus recommendation
- In individuals with diabetes and non–dialysis-dependent diabetic kidney disease (DKD), reducing

the amount of dietary protein below the recommended daily allowance (0.8 g/kg body weight/day) does not meaningfully alter glycemic measures, cardiovascular risk measures, or the course of glomerular filtration rate decline and may increase risk for malnutrition.

Are protein needs different for people with diabetes and kidney disease?
Historically, low-protein eating plans were advised to reduce albuminuria and progression of chronic kidney disease in people with DKD, typically with improvements in albuminuria but no clear effect on estimated glomerular filtration rate. In addition, there is some indication that a low-protein eating plan may lead to malnutrition in individuals with DKD (317–321). The average daily level of protein intake for people with diabetes without kidney disease is typically 1–1.5 g/kg body weight/day or 15–20% of total calories (45,146). Evidence does not suggest that people with DKD need to restrict protein intake to less than the average protein intake.

For people with DKD and macroalbuminuria, changing to a more soy-based source of protein may improve CVD risk factors but does not appear to alter proteinuria (322,323).

Gastroparesis

Consensus recommendations
- Selection of small-particle-size foods may improve symptoms of diabetes-related gastroparesis.
- Correcting hyperglycemia is one strategy for the management of gastroparesis, as acute hyperglycemia delays gastric emptying.
- Use of CGM and/or insulin pump therapy may aid the dosing and timing of insulin administration in people with type 1 or type 2 diabetes with gastroparesis.

How is diabetic gastroparesis best managed?
Consultation by an RDN knowledgeable in the management of gastroparesis is helpful in setting and maintaining treatment goals (324). Treatment goals include managing and reducing symptoms; correcting fluid, electrolyte, and nutritional deficiencies and glycemic

imbalances; and addressing the precipitating cause(s) with appropriate drug therapy (227). Correcting hyperglycemia is one strategy for the management of gastroparesis, as acute hyperglycemia delays gastric emptying (325,326). Modification of food and beverage intake is the primary management strategy, especially among individuals with mild symptoms.

People with gastroparesis may find it helpful to eat small, frequent meals. Replacing solid food with a greater proportion of liquid calories to meet individualized nutrition requirements may be helpful because consuming solid food in large volumes is associated with longer gastric emptying times (327,328). Large meals can also decrease the lower esophageal sphincter pressure, which may cause gastric reflux, providing further aggravation (327).

Results from an RCT demonstrated eating plans that emphasize small-particle-size (<2 mm) foods may reduce severity of gastrointestinal symptoms (329). Small-particle-size food is defined as "food easy to mash with a fork into small particle size." High-fiber foods, such as whole intact grains and foods with seeds, husks, stringy fibers, and membranes, should be excluded from the eating plan. Many of the foods typically recommended for people with diabetes, such as leafy green salads, raw vegetables, beans, and fresh fruits, and other food like fatty or tough meat, can be some of the most difficult foods for the gastroparetic stomach to grind and empty (324,329). Notably, the majority of nutrition therapy interventions for gastroparesis are based on the knowledge of the pathophysiology and clinical judgment rather than empirical research (227).

The use of an insulin pump is another option for individuals with type 1 diabetes and insulin-requiring type 2 diabetes with gastroparesis (330). A small but positive 12-month trial reported a 1.8% reduction in A1C and decreased hospitalizations with insulin pump use (331). An insulin pump can be used to provide consistent basal insulin infusion, as well as the ability to modify mealtime insulin delivery doses as needed. The variable bolus feature allows the user to administer a portion of the meal bolus in an extended fashion over a longer period of time (227). Use of this feature

may help to decrease the risk of postprandial hyperglycemia as well as hypoglycemia.

How is the risk of malnutrition in diabetic gastroparesis managed?

When an individual with gastroparesis falls below target weight, nutrition support in the form of oral (for acute exacerbation of symptoms), enteral, or parenteral nutrition should be considered (327). A 5% unintentional loss of usual body weight over 3 months or 10% loss over 6 months is indicative of severe malnutrition. Other nutritional risk parameters include weight <80% of ideal weight, BMI <20 kg/m^2, or a loss of 5 lb or 2.5% of baseline weight in 1 month.

PERSONALIZED NUTRITION

Consensus recommendation

- Studies using personalized nutrition approaches to examine genetic, metabolomic, and microbiome variations have not yet identified specific factors that consistently improve outcomes in type 1 diabetes, type 2 diabetes, or prediabetes.

Do genetic, metabolomic, or microbiome variants, or other types of personalized nutrition prescriptions, influence glycemic or other diabetes-related outcomes?

Currently, use of nutrition counseling approaches aimed at personalizing guidance based on genetic, metabolomic, and microbiome information is an area of intense research. Testing has become available commercially, with direct-to-consumer advertising. Some intriguing research has shown, for example, the wide interpersonal variability in blood glucose response to standardized meals that could be predicted by clinical and microbiome profiles (332). At this point, however, no clear conclusions can be drawn regarding their utility owing to wide variations in the markers used for predicting outcomes, in the populations and nutrients studied, and in the associations found.

Further, overall findings tend to support evidence from existing clinical trials and observational studies showing that people with markers indicating higher risk for diabetes, prediabetes, or insulin resistance have lower risk when they reduce calorie, carbohydrate, or saturated fat intake and/or increase fiber or protein intake compared with their peers (333–337).

CONCLUSIONS

Ideally, an eating plan should be developed in collaboration with the person with prediabetes or diabetes and an RDN through participation in diabetes self-management education when the diagnosis of prediabetes or diabetes is made. Nutrition therapy recommendations need to be adjusted regularly based on changes in an individual's life circumstances, preferences, and disease course (1). Regular follow-up with a diabetes health care provider is also critical to adjust other aspects of the treatment plan as indicated.

One of the most commonly asked questions upon receiving a diagnosis of diabetes is "What can I eat?" Despite widespread interest in evidence-based diabetes nutrition therapy interventions, large, well-conducted nutrition trials continue to lag far behind other areas of diabetes research. Unfortunately, national data indicate that most people with diabetes do not receive any nutrition therapy or formal diabetes education (4,9,16,20).

Strategies to improve access, clinical outcomes, and cost effectiveness include the following

- reducing barriers to referrals and allowing self-referrals to MNT and DSMES;
- providing in-person or technology-enabled diabetes nutrition therapy and education integrated with medical management (9,12,13,15,16,19,22, 291–293,338–342);
- engineering solutions that include two-way communication between the individual and his or her health care team to provide individualized feedback and tailored education based on the analyzed patient-generated health data (38,264,343);
- increasing the use of community health workers and peer coaches to provide culturally appropriate, ongoing support and clinically linked care coordination and improve the reach of MNT and DSMES (15,19,23,38, 343,344).

Evaluating nutrition evidence is complex given that multiple dietary factors influence glycemic management and CVD risk factors, and the influence of a combination of factors can be substantial. Based on a review of the evidence, it is clear that knowledge gaps continue to exist and further research on nutrition and eating patterns is needed in individuals with type 1 diabetes, type 2 diabetes, and prediabetes. Future studies should address

- the impact of different eating patterns compared with one another, controlling for supplementary advice (such as stress reduction, physical activity, or smoking cessation);
- the impact of weight loss on other outcomes (which eating plans are beneficial only with weight loss, which can show benefit regardless of weight loss);
- how cultural or personal preferences, psychological supports, co-occurring conditions, socioeconomic status, food insecurity, and other factors impact being consistent with an eating plan and its effectiveness;
- the need for increased length and size of studies, to better understand long-term impacts on clinically relevant outcomes;
- tailoring MNT and DSMES to different racial/ethnic groups and socioeconomic groups;
- comparisons of different delivery methods aided by technology (e.g., mobile technology, apps, social media, technology-enabled and internet-based tools); and
- ongoing cost-effectiveness studies that will further support coverage by third-party payers or bundling services into evolving value-based care and payment models.

References

1. Powers MA, Bardsley J, Cypress M, et al. Diabetes self-management education and support in type 2 diabetes: a joint position statement of the American Diabetes Association, the American Association of Diabetes Educators, and the Academy of Nutrition and Dietetics. Diabetes Care 2015;38:1372–1382
2. Inzucchi SE, Bergenstal RM, Buse JB, et al. Management of hyperglycemia in type 2 diabetes, 2015: a patient-centered approach: update to a position statement of the American Diabetes Association and the European Association for the Study of Diabetes. Diabetes Care 2015;38:140–149
3. American Diabetes Association. 5. Lifestyle management: *Standards of Medical Care in Diabetes—2019*. Diabetes Care 2019;42(Suppl. 1):S46–S60
4. Evert AB, Boucher JL, Cypress M, et al. Nutrition therapy recommendations for the management of adults with diabetes. Diabetes Care 2014;37(Suppl. 1):S120–S143
5. American Diabetes Association. 13. Children and adolescents: *Standards of Medical Care in Diabetes—2019*. Diabetes Care 2019;42(Suppl. 1):S148–S164
6. American Diabetes Association. 14. Management of diabetes in pregnancy: *Standards of Medical Care in Diabetes—2019*. Diabetes Care 2019;42(Suppl. 1):S165–S172
7. Institute of Medicine. The Role of Nutrition in Maintaining Health in the Nation's Elderly: Evaluating Coverage of Nutrition Services for the Medicare Population [Internet], 1999. Available from https://www.nap.edu/catalog/9741/the-role-of-nutrition-in-maintaining-health-in-the-nations-elderly. Accessed 2 October 2018
8. U.S. Department of Health and Human Service; U.S. Department of Agriculture. 2015–2020 Dietary Guidelines for Americans, 8th edition [Internet], 2015. Available from https://health.gov/dietaryguidelines/2015/guidelines/. Accessed 18 January 2019
9. 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
10. Lacey K, Pritchett E. Nutrition Care Process and Model: ADA adopts road map to quality care and outcomes management. J Am Diet Assoc 2003;103:1061–1072
11. Legal Information Institute. 42 CFR §410.132 – Medical nutrition therapy [Internet]. Available from https://www.law.cornell.edu/cfr/text/42/410.132. Accessed 2 October 2018
12. Davidson P, Ross T, Castor C. Academy of Nutrition and Dietetics: Revised 2017 Standards of Practice and Standards of Professional Performance for Registered Dietitian Nutritionists (Competent, Proficient, and Expert) in Diabetes Care. J Acad Nutr Diet 2018;118:932–946.e48
13. Andrews RC, Cooper AR, Montgomery AA, et al. Diet or diet plus physical activity versus usual care in patients with newly diagnosed type 2 diabetes: the Early ACTID randomised controlled trial. Lancet 2011;378:129–139
14. Parker AR, Byham-Gray L, Denmark R, Winkle PJ. The effect of medical nutrition therapy by a registered dietitian nutritionist in patients with prediabetes participating in a randomized controlled clinical research trial. J Acad Nutr Diet 2014;114:1739–1748
15. Berry DC, Williams W, Hall EG, Heroux R, Bennett-Lewis T. Imbedding interdisciplinary diabetes group visits into a community-based medical setting. Diabetes Educ 2016;42:96–107
16. Battista M-C, Labonté M, Ménard J, et al. Dietitian-coached management in combination with annual endocrinologist follow up improves global metabolic and cardiovascular health in diabetic participants after 24 months. Appl Physiol Nutr Metab 2012;37:610–620
17. 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
18. Møller G, Andersen HK, Snorgaard O. A systematic review and meta-analysis of nutrition therapy compared with dietary advice in patients with type 2 diabetes. Am J Clin Nutr 2017;106:1394–1400
19. Ferguson S, Swan M, Smaldone A. Does diabetes self-management education in conjunction with primary care improve glycemic control in Hispanic patients? A systematic review and meta-analysis. Diabetes Educ 2015;41:472–484
20. Lynch EB, Liebman R, Ventrelle J, Avery EF, Richardson D. A self-management intervention for African Americans with comorbid diabetes and hypertension: a pilot randomized controlled trial. Prev Chronic Dis 2014;11:130349
21. Beck J, Greenwood DA, Blanton L, et al.; 2017 Standards Revision Task Force. 2017 National Standards for Diabetes Self-Management Education and Support. Diabetes Care 2017;40:1409–1419
22. 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
23. Ku GMV, Kegels G. Effects of the First Line Diabetes Care (FiLDCare) self-management education and support project on knowledge, attitudes, perceptions, self-management practices and glycaemic control: a quasi-experimental study conducted in the Northern Philippines. BMJ Open 2014;4:e005317
24. Sun Y, You W, Almeida F, Estabrooks P, Davy B. The effectiveness and cost of lifestyle interventions including nutrition education for diabetes prevention: a systematic review and meta-analysis. J Acad Nutr Diet 2017;117:404–421.e36
25. Academy of Nutrition and Dietetics Evidence Analysis Library. MNT: cost effectiveness, cost-benefit, or economic savings of MNT (2009) [Internet]. Available from https://www.andeal.org/topic.cfm?cat=4085&conclusion_statement_id=251001. Accessed 2 October 2018
26. Knowler WC, Barrett-Connor E, Fowler SE, et al.; Diabetes Prevention Program Research Group. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. N Engl J Med 2002;346:393–403
27. Lindström J, Louheranta A, Mannelin M, et al.; Finnish Diabetes Prevention Study Group. The Finnish Diabetes Prevention Study (DPS): lifestyle intervention and 3-year results on diet and physical activity. Diabetes Care 2003;26:3230–3236
28. Knowler WC, Fowler SE, Hamman RF, et al.; Diabetes Prevention Program Research Group. 10-year follow-up of diabetes incidence and weight loss in the Diabetes Prevention Program Outcomes Study. Lancet 2009;374:1677–1686
29. Li G, Zhang P, Wang J, et al. The long-term effect of lifestyle interventions to prevent diabetes in the China Da Qing Diabetes Prevention Study: a 20-year follow-up study. Lancet 2008;371:1783–1789
30. Lindström J, Ilanne-Parikka P, Peltonen M, et al.; Finnish Diabetes Prevention Study Group. Sustained reduction in the incidence of type 2 diabetes by lifestyle intervention: follow-up of the Finnish Diabetes Prevention Study. Lancet 2006;368:1673–1679
31. Diabetes Prevention Program Research Group. Long-term effects of lifestyle intervention or metformin on diabetes development and

microvascular complications over 15-year follow-up: the Diabetes Prevention Program Outcomes Study. Lancet Diabetes Endocrinol 2015;3: 866–875

32. Li G, Zhang P, Wang J, et al. Cardiovascular mortality, all-cause mortality, and diabetes incidence after lifestyle intervention for people with impaired glucose tolerance in the Da Qing Diabetes Prevention Study: a 23-year follow-up study. Lancet Diabetes Endocrinol 2014;2:474–480

33. Raynor HA, Davidson PG, Burns H, et al. Medical nutrition therapy and weight loss questions for the Evidence Analysis Library prevention of type 2 diabetes project: systematic reviews. J Acad Nutr Diet 2017;117:1578–1611

34. Academy of Nutrition and Dietetics Evidence Analysis Library. Prevention of Type 2 Diabetes (PDM) Guideline (2014) [Internet]. Available from https://www.andeal.org/topic.cfm?menu=5344&cat=5013. Accessed 20 November 2018

35. 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

36. Diabetes Prevention Program Research Group. The 10-year cost-effectiveness of lifestyle intervention or metformin for diabetes prevention: an intent-to-treat analysis of the DPP/DPPOS. Diabetes Care 2012;35:723–730

37. Mao AY, Chen C, Magana C, Caballero Barajas K, Olayiwola JN. A mobile phone-based health coaching intervention for weight loss and blood pressure reduction in a national payer population: a retrospective study. JMIR Mhealth Uhealth 2017;5:e80

38. Sepah SC, Jiang L, Peters AL. Long-term outcomes of a Web-based diabetes prevention program: 2-year results of a single-arm longitudinal study. J Med Internet Res 2015;17:e92

39. Bian RR, Piatt GA, Sen A, et al. The effect of technology-mediated diabetes prevention interventions on weight: a meta-analysis. J Med Internet Res 2017;19:e76

40. Chen F, Su W, Becker SH, et al. Clinical and economic impact of a digital, remotely-delivered intensive behavioral counseling program on Medicare beneficiaries at risk for diabetes and cardiovascular disease. PLoS One 2016;11: e0163627

41. Azar KMJ, Aurora M, Wang EJ, Muzaffar A, Pressman A, Palaniappan LP. Virtual small groups for weight management: an innovative delivery mechanism for evidence-based lifestyle interventions among obese men. Transl Behav Med 2015;5:37–44

42. Sepah SC, Jiang L, Peters AL. Translating the Diabetes Prevention Program into an online social network: validation against CDC standards. Diabetes Educ 2014;40:435–443

43. Michaelides A, Raby C, Wood M, Farr K, Toro-Ramos T. Weight loss efficacy of a novel mobile Diabetes Prevention Program delivery platform with human coaching. BMJ Open Diabetes Res Care 2016;4:e000264

44. Block G, Azar KM, Romanelli RJ, et al. Diabetes prevention and weight loss with a fully automated behavioral intervention by email, web, and mobile phone: a randomized controlled trial among persons with prediabetes. J Med Internet Res 2015;17:e240

45. 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

46. Delahanty LM, Nathan DM, Lachin JM, et al.; Diabetes Control and Complications Trial/Epidemiology of Diabetes Interventions and Complications. 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

47. Vitolins MZ, Anderson AM, Delahanty L, et al.; Look AHEAD Research Group. Action for Health in Diabetes (Look AHEAD) trial: baseline evaluation of selected nutrients and food group intake. J Am Diet Assoc 2009;109:1367–1375

48. Oza-Frank R, Cheng YJ, Narayan KMV, Gregg EW. Trends in nutrient intake among adults with diabetes in the United States: 1988–2004. J Am Diet Assoc 2009;109:1173–1178

49. Institute of Medicine. Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids [Internet]. Washington, DC, National Academies Press, 2005 [cited 2014 Oct 1]. Available from https://www.nap.edu/catalog/10490/dietary-reference-intakes-for-energy-carbohydrate-fiber-fat-fatty-acids-cholesterol-protein-and-amino-acids. Accessed 1 October 2014

50. 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:E1361

51. He M, van Dam RM, Rimm E, Hu FB, Qi L. Whole-grain, cereal fiber, bran, and germ intake and the risks of all-cause and cardiovascular disease-specific mortality among women with type 2 diabetes mellitus. Circulation 2010;121: 2162–2168

52. Burger KNJ, Beulens JWJ, van der Schouw YT, et al. Dietary fiber, carbohydrate quality and quantity, and mortality risk of individuals with diabetes mellitus. PLoS One 2012;7:e43127

53. Jenkins DJA, Kendall CWC, Augustin LSA, et al. Effect of legumes as part of a low glycemic index diet on glycemic control and cardiovascular risk factors in type 2 diabetes mellitus: a randomized controlled trial. Arch Intern Med 2012; 172:1653–1660

54. Post RE, Mainous AG III, King DE, Simpson KN. Dietary fiber for the treatment of type 2 diabetes mellitus: a meta-analysis. J Am Board Fam Med 2012;25:16–23

55. Dahl WJ, Stewart ML. Position of the Academy of Nutrition and Dietetics: health implications of dietary fiber. J Acad Nutr Diet 2015;115: 1861–1870

56. Brand-Miller JC, Stockmann K, Atkinson F, Petocz P, Denyer G. Glycemic index, postprandial glycemia, and the shape of the curve in healthy subjects: analysis of a database of more than 1,000 foods. Am J Clin Nutr 2009;89:97–105

57. Gross JL, Zelmanovitz T, Moulin CC, et al. Effect of a chicken-based diet on renal function and lipid profile in patients with type 2 diabetes: a randomized crossover trial. Diabetes Care 2002;25:645–651

58. Fuller NR, Caterson ID, Sainsbury A, et al. The effect of a high-egg diet on cardiovascular risk factors in people with type 2 diabetes: the Diabetes and Egg (DIABEGG) study—a 3-mo randomized controlled trial. Am J Clin Nutr 2015;101:705–713

59. Qiu J, Liu Y, Yue Y, Qin Y, Li Z. Dietary tartary buckwheat intake attenuates insulin resistance and improves lipid profiles in patients with type 2 diabetes: a randomized controlled trial. Nutr Res 2016;36:1392–1401

60. Vuksan V, Jenkins AL, Brissette C, et al. Salba-chia (Salvia hispanica L.) in the treatment of overweight and obese patients with type 2 diabetes: a double-blind randomized controlled trial. Nutr Metab Cardiovasc Dis 2017;27:138–146

61. Luger M, Holstein B, Schindler K, Kruschitz R, Ludvik B. Feasibility and efficacy of an isocaloric high-protein vs. standard diet on insulin requirement, body weight and metabolic parameters in patients with type 2 diabetes on insulin therapy. Exp Clin Endocrinol Diabetes 2013; 121:286–294

62. Dong J-Y, Zhang Z-L, Wang P-Y, Qin L-Q. Effects of high-protein diets on body weight, glycaemic control, blood lipids and blood pressure in type 2 diabetes: meta-analysis of randomised controlled trials. Br J Nutr 2013;110: 781–789

63. Qian F, Korat AA, Malik V, Hu FB. Metabolic effects of monounsaturated fatty acid–enriched diets compared with carbohydrate or polyunsaturated fatty acid–enriched diets in patients with type 2 diabetes: a systematic review and meta-analysis of randomized controlled trials. Diabetes Care 2016;39:1448–1457

64. Bendsen NT, Christensen R, Bartels EM, Astrup A. Consumption of industrial and ruminant trans fatty acids and risk of coronary heart disease: a systematic review and meta-analysis of cohort studies. Eur J Clin Nutr 2011;65:773–783

65. Berger S, Raman G, Vishwanathan R, Jacques PF, Johnson EJ. Dietary cholesterol and cardiovascular disease: a systematic review and meta-analysis. Am J Clin Nutr 2015;102:276–294

66. McNamara DJ. Dietary cholesterol, heart disease risk and cognitive dissonance. Proc Nutr Soc 2014;73:161–166

67. Wu JHY, Marklund M, Imamura F, et al.; Cohorts for Heart and Aging Research in Genomic Epidemiology (CHARGE) Fatty Acids and Outcomes Research Consortium (FORCE). Omega-6 fatty acid biomarkers and incident type 2 diabetes: pooled analysis of individual-level data for 39 740 adults from 20 prospective cohort studies. Lancet Diabetes Endocrinol 2017;5:965–974

68. Sawada T, Tsubata H, Hashimoto N, et al. Effects of 6-month eicosapentaenoic acid treatment on postprandial hyperglycemia, hyperlipidemia, insulin secretion ability, and concomitant endothelial dysfunction among newly-diagnosed impaired glucose metabolism patients with coronary artery disease. An open label, single blinded, prospective randomized controlled trial. Cardiovasc Diabetol 2016;15121

68a. 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

69. Salas-Salvadó J, Bulló M, Estruch R, et al. Prevention of diabetes with Mediterranean diets: a subgroup analysis of a randomized trial. Ann Intern Med 2014;160:1–10

70. Ericson U, Hellstrand S, Brunkwall L, et al. Food sources of fat may clarify the inconsistent role of dietary fat intake for incidence of type 2 diabetes. Am J Clin Nutr 2015;101:1065–1080

71. Guasch-Ferré M, Becerra-Tomás N, Ruiz-Canela M, et al. Total and subtypes of dietary fat intake and risk of type 2 diabetes mellitus in the Prevención con Dieta Mediterránea (PREDIMED) study. Am J Clin Nutr 2017;105:723–735

72. Gijsbers L, Ding EL, Malik VS, de Goede J, Geleijnse JM, Soedamah-Muthu SS. Consumption of dairy foods and diabetes incidence: a dose-response meta-analysis of observational studies. Am J Clin Nutr 2016;103:1111–1124

73. Schwingshackl L, Chaimani A, Hoffmann G, Schwedhelm C, Boeing H. A network meta-analysis on the comparative efficacy of different dietary approaches on glycaemic control in patients with type 2 diabetes mellitus. Eur J Epidemiol 2018;33:157–170

74. Tuomilehto J, Lindström J, Eriksson JG, et al.; Finnish Diabetes Prevention Study Group. Prevention of type 2 diabetes mellitus by changes in lifestyle among subjects with impaired glucose tolerance. N Engl J Med 2001;344:1343–1350

75. Stentz FB, Brewer A, Wan J, et al. Remission of pre-diabetes to normal glucose tolerance in obese adults with high protein versus high carbohydrate diet: randomized control trial. BMJ Open Diabetes Res Care 2016;4:e000258

76. Esposito K, Chiodini P, Maiorino MI, Bellastella G, Panagiotakos D, Giugliano D. Which diet for prevention of type 2 diabetes? A meta-analysis of prospective studies. Endocrine 2014;47:107–116

77. Chiu THT, Pan W-H, Lin M-N, Lin C-L. Vegetarian diet, change in dietary patterns, and diabetes risk: a prospective study. Nutr Diabetes 2018;8:12

78. Becerra-Tomás N, Díaz-López A, Rosique-Esteban N, et al.; PREDIMED Study Investigators. Legume consumption is inversely associated with type 2 diabetes incidence in adults: a prospective assessment from the PREDIMED study. Clin Nutr 2018;37:906–913

79. Lee Y, Park K. Adherence to a vegetarian diet and diabetes risk: a systematic review and meta-analysis of observational studies. Nutrients 2017;9:603

80. Malik VS, Li Y, Tobias DK, Pan A, Hu FB. Dietary protein intake and risk of type 2 diabetes in US men and women. Am J Epidemiol 2016;183:715–728

81. Schwingshackl L, Bogensberger B, Hoffmann G. Diet quality as assessed by the Healthy Eating Index, Alternate Healthy Eating Index, Dietary Approaches to Stop Hypertension score, and health outcomes: an updated systematic review and meta-analysis of cohort studies. J Acad Nutr Diet 2018;118:74–100.e11

82. Noto H, Goto A, Tsujimoto T, Noda M. Long-term low-carbohydrate diets and type 2 diabetes risk: a systematic review and meta-analysis of observational studies. J Gen Fam Med 2016;17:60–70

83. Pan X-R, Li G-W, Hu Y-H, et al. Effects of diet and exercise in preventing NIDDM in people with impaired glucose tolerance: The Da Qing IGT and Diabetes Study. Diabetes Care 1997;20:537–544

84. Anderssen SA, Hjermann I, Urdal P, Torjesen PA, Holme I. Improved carbohydrate metabolism after physical training and dietary intervention in individuals with the 'atherothrombogenic syndrome'. Oslo Diet and Exercise Study (ODES). A randomized trial. J Intern Med 1996;240:203–209

85. Rodríguez-Villar C, Pérez-Heras A, Mercadé I, Casals E, Ros E. Comparison of a high-carbohydrate and a high-monounsaturated fat, olive oil-rich diet on the susceptibility of LDL to oxidative modification in subjects with type 2 diabetes mellitus. Diabet Med 2004;21:142–149

86. Itsiopoulos C, Brazionis L, Kaimakamis M, et al. Can the Mediterranean diet lower HbA1c in type 2 diabetes? Results from a randomized cross-over study. Nutr Metab Cardiovasc Dis 2011;21:740–747

87. Toobert DJ, Glasgow RE, Strycker LA, et al. Biologic and quality-of-life outcomes from the Mediterranean Lifestyle Program: a randomized clinical trial. Diabetes Care 2003;26:2288–2293

88. Elhayany A, Lustman A, Abel R, Attal-Singer J, Vinker S. A low carbohydrate Mediterranean diet improves cardiovascular risk factors and diabetes control among overweight patients with type 2 diabetes mellitus: a 1-year prospective randomized intervention study. Diabetes Obes Metab 2010;12:204–209

89. Esposito K, Maiorino MI, Ciotola M, et al. Effects of a Mediterranean-style diet on the need for antihyperglycemic drug therapy in patients with newly diagnosed type 2 diabetes: a randomized trial. Ann Intern Med 2009;151:306–314

90. Shai I, Schwarzfuchs D, Henkin Y, et al.; Dietary Intervention Randomized Controlled Trial (DIRECT) Group. Weight loss with a low-carbohydrate, Mediterranean, or low-fat diet. N Engl J Med 2008;359:229–241

91. 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

92. Barnard ND, Cohen J, Jenkins DJA, et al. A low-fat vegan diet improves glycemic control and cardiovascular risk factors in a randomized clinical trial in individuals with type 2 diabetes. Diabetes Care 2006;29:1777–1783

93. Nicholson AS, Sklar M, Barnard ND, Gore S, Sullivan R, Browning S. Toward improved management of NIDDM: a randomized, controlled, pilot intervention using a lowfat, vegetarian diet. Prev Med 1999;29:87–91

94. Tonstad S, Butler T, Yan R, Fraser GE. Type of vegetarian diet, body weight, and prevalence of type 2 diabetes. Diabetes Care 2009;32:791–796

95. Kahleova H, Matoulek M, Malinska H, et al. Vegetarian diet improves insulin resistance and oxidative stress markers more than conventional diet in subjects with type 2 diabetes. Diabet Med 2011;28:549–559

96. Barnard ND, Cohen J, Jenkins DJ, et al. A low-fat vegan diet and a conventional diabetes diet in the treatment of type 2 diabetes: a randomized, controlled, 74-wk clinical trial. Am J Clin Nutr 2009;89:1588S–1596S

97. Hosseinpour-Niazi S, Mirmiran P, Hedayati M, Azizi F. Substitution of red meat with legumes in the therapeutic lifestyle change diet based on dietary advice improves cardiometabolic risk factors in overweight type 2 diabetes patients: a cross-over randomized clinical trial. Eur J Clin Nutr 2015;69:592–597

98. Yokoyama Y, Barnard ND, Levin SM, Watanabe M. Vegetarian diets and glycemic control in diabetes: a systematic review and meta-analysis. Cardiovasc Diagn Ther 2014;4:373–382

99. Viguiliouk E, Kendall CW, Kahleová H, et al. Effect of vegetarian dietary patterns on cardiometabolic risk factors in diabetes: a systematic review and meta-analysis of randomized controlled trials. Clin Nutr. 13 June 2018 [Epub ahead of print]. DOI: 10.1016/j.clnu.2018.05.032

100. Wing RR, Bolin P, Brancati FL, et al.; Look AHEAD Research Group. Cardiovascular effects of intensive lifestyle intervention in type 2 diabetes. N Engl J Med 2013;369:145–154

101. Pi-Sunyer X, Blackburn G, Brancati FL, et al.; Look AHEAD Research Group. Reduction in weight and cardiovascular disease risk factors in individuals with type 2 diabetes: one-year results of the Look AHEAD trial. Diabetes Care 2007;30:1374–1383

102. Brehm BJ, Lattin BL, Summer SS, et al. One-year comparison of a high-monounsaturated fat diet with a high-carbohydrate diet in type 2 diabetes. Diabetes Care 2009;32:215–220

103. Davis NJ, Tomuta N, Schechter C, et al. Comparative study of the effects of a 1-year dietary intervention of a low-carbohydrate diet versus a low-fat diet on weight and glycemic control in type 2 diabetes. Diabetes Care 2009;32:1147–1152

104. Guldbrand H, Dizdar B, Bunjaku B, et al. In type 2 diabetes, randomisation to advice to follow a low-carbohydrate diet transiently improves glycaemic control compared with advice to follow a low-fat diet producing a similar weight loss. Diabetologia 2012;55:2118–2127

105. Papakonstantinou E, Triantafillidou D, Panagiotakos DB, et al. A high-protein low-fat diet is more effective in improving blood pressure and triglycerides in calorie-restricted obese individuals with newly diagnosed type 2 diabetes. Eur J Clin Nutr 2010;64:595–602

106. Kodama S, Saito K, Tanaka S, et al. Influence of fat and carbohydrate proportions on the metabolic profile in patients with type 2 diabetes: a meta-analysis. Diabetes Care 2009;32:959–965

107. Barnard RJ, Massey MR, Cherny S, O'Brien LT, Pritikin N. Long-term use of a high-complex-carbohydrate, high-fiber, low-fat diet and exercise in the treatment of NIDDM patients. Diabetes Care 1983;6:268–273

108. Barnard RJ, Jung T, Inkeles SB. Diet and exercise in the treatment of NIDDM. The need for early emphasis. Diabetes Care 1994;17:1469–1472

109. Pischke CR, Weidner G, Elliott-Eller M, et al. Comparison of coronary risk factors and quality of life in coronary artery disease patients with versus without diabetes mellitus. Am J Cardiol 2006;97:1267–1273

110. Sainsbury E, Kizirian NV, Partridge SR, Gill T, Colagiuri S, Gibson AA. Effect of dietary carbohydrate restriction on glycemic control in adults with diabetes: a systematic review and meta-analysis. Diabetes Res Clin Pract 2018;139:239–252

111. van Zuuren EJ, Fedorowicz Z, Kuijpers T, Pijl H. Effects of low-carbohydrate- compared with low-fat-diet interventions on metabolic control in people with type 2 diabetes: a systematic review including GRADE assessments. Am J Clin Nutr 2018;108:300–331

112. Snorgaard O, Poulsen GM, Andersen HK, Astrup A. Systematic review and meta-analysis of dietary carbohydrate restriction in patients with type 2 diabetes. BMJ Open Diabetes Res Care 2017;5:e000354

113. Bhanpuri NH, Hallberg SJ, Williams PT, et al. Cardiovascular disease risk factor responses to a type 2 diabetes care model including nutritional ketosis induced by sustained carbohydrate restriction at 1 year: an open label, non-randomized, controlled study. Cardiovasc Diabetol 2018; 17:56

114. Forsythe CE, Phinney SD, Fernandez ML, et al. Comparison of low fat and low carbohydrate diets on circulating fatty acid composition and markers of inflammation. Lipids 2008;43:65–77

115. Tay J, Luscombe-Marsh ND, Thompson CH, et al. Comparison of low- and high-carbohydrate diets for type 2 diabetes management: a randomized trial. Am J Clin Nutr 2015;102:780–790

116. Wycherley TP, Thompson CH, Buckley JD, et al. Long-term effects of weight loss with a very-low carbohydrate, low saturated fat diet on flow mediated dilatation in patients with type 2 diabetes: a randomised controlled trial. Atherosclerosis 2016;252:28–31

117. Tay J, Thompson CH, Luscombe-Marsh ND, et al. Effects of an energy-restricted low-carbohydrate, high unsaturated fat/low saturated fat diet versus a high-carbohydrate, low-fat diet in type 2 diabetes: a 2-year randomized clinical trial. Diabetes Obes Metab 2018;20:858–871

118. Azadbakht L, Fard NRP, Karimi M, et al. Effects of the Dietary Approaches to Stop Hypertension (DASH) eating plan on cardiovascular risks among type 2 diabetic patients: a randomized crossover clinical trial. Diabetes Care 2011; 34:55–57

119. Paula TP, Viana LV, Neto ATZ, Leitão CB, Gross JL, Azevedo MJ. Effects of the DASH diet and walking on blood pressure in patients with type 2 diabetes and uncontrolled hypertension: a randomized controlled trial. J Clin Hypertens (Greenwich) 2015;17:895–901

120. Jönsson T, Granfeldt Y, Ahrén B, et al. Beneficial effects of a Paleolithic diet on cardiovascular risk factors in type 2 diabetes: a randomized cross-over pilot study. Cardiovasc Diabetol 2009;8:35

121. Masharani U, Sherchan P, Schloetter M, et al. Metabolic and physiologic effects from consuming a hunter-gatherer (Paleolithic)-type diet in type 2 diabetes. Eur J Clin Nutr 2015;69: 944–948

122. Lindeberg S, Jönsson T, Granfeldt Y, et al. A Palaeolithic diet improves glucose tolerance more than a Mediterranean-like diet in individuals with ischaemic heart disease. Diabetologia 2007;50:1795–1807

123. McCue, MD (Ed.). Comparative Physiology of Fasting, Starvation, and Food Limitation [Internet]. Berlin, Springer-Verlag, 2012. Available from https://www.nhbs.com/comparative-physiology-of-fasting-starvation-and-food-limitation-book. Accessed 19 November 2018

124. Corley BT, Carroll RW, Hall RM, Weatherall M, Parry-Strong A, Krebs JD. Intermittent fasting in type 2 diabetes mellitus and the risk of hypoglycaemia: a randomized controlled trial. Diabet Med 2018;35:588–594

125. Li C, Sadraie B, Steckhan N, et al. Effects of a one-week fasting therapy in patients with type-2 diabetes mellitus and metabolic syndrome—a randomized controlled explorative study. Exp Clin Endocrinol Diabetes 2017;125:618–624

126. Williams KV, Mullen ML, Kelley DE, Wing RR. The effect of short periods of caloric restriction on weight loss and glycemic control in type 2 diabetes. Diabetes Care 1998;21:2–8

127. Carter S, Clifton PM, Keogh JB. The effects of intermittent compared to continuous energy restriction on glycaemic control in type 2 diabetes; a pragmatic pilot trial. Diabetes Res Clin Pract 2016;122:106–112

128. Sutton EF, Beyl R, Early KS, Cefalu WT, Ravussin E, Peterson CM. Early time-restricted feeding improves insulin sensitivity, blood pressure, and oxidative stress even without weight loss in men with prediabetes. Cell Metab 2018; 27:1212–1221.e3

129. Musil F, Smahelová A, Bláha V, et al. Effect of low calorie diet and controlled fasting on insulin sensitivity and glucose metabolism in obese patients with type 1 diabetes mellitus. Physiol Res 2013;62:267–276

130. Ranjan A, Schmidt S, Damm-Frydenberg C, Holst JJ, Madsbad S, Nørgaard K. Short-term effects of a low carbohydrate diet on glycaemic variables and cardiovascular risk markers in patients with type 1 diabetes: a randomized open-label crossover trial. Diabetes Obes Metab 2017;19:1479–1484

131. Nielsen JV, Gando C, Joensson E, Paulsson C. Low carbohydrate diet in type 1 diabetes, long-term improvement and adherence: a clinical audit. Diabetol Metab Syndr 2012;4:23

132. Gardner CD, Trepanowski JF, Del Gobbo LC, et al. Effect of low-fat vs low-carbohydrate diet on 12-month weight loss in overweight adults and the association with genotype pattern or insulin secretion: the DIETFITS randomized clinical trial [published corrections appear in JAMA 2018;319:1386 and 1728]. JAMA 2018;319:667–679

133. 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

134. 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

135. 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

136. Wadden TA, Neiberg RH, Wing RR, et al.; Look AHEAD Research Group. Four-year weight losses in the Look AHEAD study: factors associated with long-term success. Obesity (Silver Spring) 2011;19:1987–1998

137. 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

138. 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

139. Wing RR; Look AHEAD Research Group. Long-term effects of a lifestyle intervention on weight and cardiovascular risk factors in individuals with type 2 diabetes mellitus: four-year results of the Look AHEAD trial. Arch Intern Med 2010;170:1566–1575

140. Hamdy O, Mottalib A, Morsi A, et al. Long-term effect of intensive lifestyle intervention on cardiovascular risk factors in patients with diabetes in real-world clinical practice: a 5-year longitudinal study. BMJ Open Diabetes Res Care 2017;5:e000259

141. 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

142. UKPDS Group. UK Prospective Diabetes Study 7: response of fasting plasma glucose to diet therapy in newly presenting type II diabetic patients. Metabolism 1990;39:905–912

143. Norris SL, Zhang X, Avenell A, et al. Long-term non-pharmacologic weight loss interventions for adults with type 2 diabetes. Cochrane Database Syst Rev 2005;2:CD004095

144. Norris SL, Zhang X, Avenell A, Gregg E, Schmid CH, Lau J. Pharmacotherapy for weight loss in adults with type 2 diabetes mellitus. Cochrane Database Syst Rev 2005;1:CD004096

145. Norris SL, Zhang X, Avenell A, et al. Long-term effectiveness of lifestyle and behavioral weight loss interventions in adults with type 2 diabetes: a meta-analysis. Am J Med 2004;117: 762–774

146. American Diabetes Association. 4. Lifestyle management: *Standards of Medical Care in Diabetes—2018*. Diabetes Care 2018;41(Suppl. 1):S38–S50

147. Wennehorst K, Mildenstein K, Saliger B, et al. A comprehensive lifestyle intervention to prevent type 2 diabetes and cardiovascular diseases: the German CHIP trial. Prev Sci 2016;17: 386–397

148. Sjöström L, Peltonen M, Jacobson P, et al. Association of bariatric surgery with long-term remission of type 2 diabetes and with microvascular and macrovascular complications. JAMA 2014;311:2297–2304

149. 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

150. Cefalu WT, Leiter LA, de Bruin TWA, Gause-Nilsson I, Sugg J, Parikh SJ. Dapagliflozin's effects on glycemia and cardiovascular risk factors in high-risk patients with type 2 diabetes: a 24-week, multicenter, randomized, double-blind, placebo-controlled study with a 28-week extension. Diabetes Care 2015;38:1218–1227

151. Hamman RF, Wing RR, Edelstein SL, et al. Effect of weight loss with lifestyle intervention

on risk of diabetes. Diabetes Care 2006;29: 2102–2107

152. Garvey WT, Ryan DH, Henry R, et al. Prevention of type 2 diabetes in subjects with prediabetes and metabolic syndrome treated with phentermine and topiramate extended release. Diabetes Care 2014;37:912–921

153. Carlsson LMS, Peltonen M, Ahlin S, et al. Bariatric surgery and prevention of type 2 diabetes in Swedish obese subjects. N Engl J Med 2012;367:695–704

154. Booth H, Khan O, Prevost T, et al. Incidence of type 2 diabetes after bariatric surgery: population-based matched cohort study. Lancet Diabetes Endocrinol 2014;2:963–968

155. Jeon CY, Lokken RP, Hu FB, van Dam RM. Physical activity of moderate intensity and risk of type 2 diabetes: a systematic review. Diabetes Care 2007;30:744–752

156. Duncan GE, Perri MG, Theriaque DW, Hutson AD, Eckel RH, Stacpoole PW. Exercise training, without weight loss, increases insulin sensitivity and postheparin plasma lipase activity in previously sedentary adults. Diabetes Care 2003;26:557–562

157. Sigal RJ, Alberga AS, Goldfield GS, et al. Effects of aerobic training, resistance training, or both on percentage body fat and cardiometabolic risk markers in obese adolescents: the Healthy Eating Aerobic and Resistance Training In Youth randomized clinical trial. JAMA Pediatr 2014;168:1006–1014

158. Johannsen NM, Swift DL, Lavie CJ, Earnest CP, Blair SN, Church TS. Categorical analysis of the impact of aerobic and resistance exercise training, alone and in combination, on cardiorespiratory fitness levels in patients with type 2 diabetes: results from the HART-D study. Diabetes Care 2013;36:3305–3312

159. Snowling NJ, Hopkins WG. Effects of different modes of exercise training on glucose control and risk factors for complications in type 2 diabetic patients: a meta-analysis. Diabetes Care 2006;29:2518–2527

160. Dansinger ML, Gleason JA, Griffith JL, Selker HP, Schaefer EJ. Comparison of the Atkins, Ornish, Weight Watchers, and Zone diets for weight loss and heart disease risk reduction: a randomized trial. JAMA 2005;293:43–53

161. McClain AD, Otten JJ, Hekler EB, Gardner CD. Adherence to a low-fat vs. low-carbohydrate diet differs by insulin resistance status. Diabetes Obes Metab 2013;15:87–90

162. Thom G, Lean M. Is there an optimal diet for weight management and metabolic health? Gastroenterology 2017;152:1739–1751

163. Johnston BC, Kanters S, Bandayrel K, et al. Comparison of weight loss among named diet programs in overweight and obese adults: a meta-analysis. JAMA 2014;312:923–933

164. Look AHEAD Research Group. Effect of a long-term behavioural weight loss intervention on nephropathy in overweight or obese adults with type 2 diabetes: a secondary analysis of the Look AHEAD randomised clinical trial. Lancet Diabetes Endocrinol 2014;2:801–809

165. Vitale M, Masulli M, Rivellese AA, et al. Influence of dietary fat and carbohydrates proportions on plasma lipids, glucose control and low-grade inflammation in patients with type 2 diabetes—The TOSCA.IT Study. Eur J Nutr 2016; 55:1645–1651

166. Horikawa C, Yoshimura Y, Kamada C, et al. Is the proportion of carbohydrate intake associated with the incidence of diabetes complications?— An Analysis of the Japan Diabetes Complications Study. Nutrients 2017;9:E113

167. Garg A. High-monounsaturated-fat diets for patients with diabetes mellitus: a meta-analysis. Am J Clin Nutr 1998;67(Suppl.):577S–582S

168. Cao Y, Mauger DT, Pelkman CL, Zhao G, Townsend SM, Kris-Etherton PM. Effects of moderate (MF) versus lower fat (LF) diets on lipids and lipoproteins: a meta-analysis of clinical trials in subjects with and without diabetes. J Clin Lipidol 2009;3:19–32

169. Feinman RD, Pogozelski WK, Astrup A, et al. Dietary carbohydrate restriction as the first approach in diabetes management: critical review and evidence base. Nutrition 2015;31: 1–13

170. Noakes TD, Windt J. Evidence that supports the prescription of low-carbohydrate high-fat diets: a narrative review. Br J Sports Med 2017;51:133–139

171. Clifton PM, Keogh JB. Effects of different weight loss approaches on CVD risk. Curr Atheroscler Rep 2018;20:27

172. Nield L, Moore HJ, Hooper L, et al. Dietary advice for treatment of type 2 diabetes mellitus in adults. Cochrane Database Syst Rev 2007;3: CD004097

173. Franz MJ. Diabetes nutrition therapy: effectiveness, macronutrients, eating patterns and weight management. Am J Med Sci 2016;351: 374–379

174. Ziemer DC, Berkowitz KJ, Panayioto RM, et al. A simple meal plan emphasizing healthy food choices is as effective as an exchange-based meal plan for urban African Americans with type 2 diabetes. Diabetes Care 2003;26:1719–1724

175. Goode AD, Winkler EAH, Reeves MM, Eakin EG. Relationship between intervention dose and outcomes in living well with diabetes—a randomized trial of a telephone-delivered lifestyle-based weight loss intervention. Am J Health Promot 2015;30:120–129

176. Vadheim LM, Patch K, Brokaw SM, et al. Telehealth delivery of the Diabetes Prevention Program to rural communities. Transl Behav Med 2017;7:286–291

177. Gregg EW, Chen H, Wagenknecht LE, et al.; Look AHEAD Research Group. Association of an intensive lifestyle intervention with remission of type 2 diabetes. JAMA 2012;308:2489–2496

178. Buse JB, Caprio S, Cefalu WT, et al. How do we define cure of diabetes? Diabetes Care 2009; 32:2133–2135

179. Esposito K, Maiorino MI, Petrizzo M, Bellastella G, Giugliano D. The effects of a Mediterranean diet on the need for diabetes drugs and remission of newly diagnosed type 2 diabetes: follow-up of a randomized trial. Diabetes Care 2014;37:1824–1830

180. Szadkowska A, Madej A, Ziółkowska K, et al. Gender and age-dependent effect of type 1 diabetes on obesity and altered body composition in young adults. Ann Agric Environ Med 2015;22:124–128

181. Conway B, Miller RG, Costacou T, et al. Temporal patterns in overweight and obesity in type 1 diabetes. Diabet Med 2010;27:398–404

182. Powers MA, Gal RL, Connor CG, et al. Eating patterns and food intake of persons with type 1 diabetes within the T1D Exchange. Diabetes Res Clin Pract 2018;141:217–228

183. Ferrara CT, Geyer SM, Evans-Molina C, et al.; Type 1 Diabetes TrialNet Study Group. The role of age and excess body mass index in progression to type 1 diabetes in at-risk adults. J Clin Endocrinol Metab 2017;102:4596–4603

184. Giuffrida FM, Bulcão C, Cobas RA, Negrato CA, Gomes MB, Dib SA; Brazilian Type 1 Diabetes Study Group (BrazDiab1SG). Double-diabetes in a real-world sample of 2711 individuals: associated with insulin treatment or part of the heterogeneity of type 1 diabetes? Diabetol Metab Syndr 2016;8:28

185. Schechter R, Reutrakul S. Management of severe insulin resistance in patients with type 1 diabetes. Curr Diab Rep 2015;15:77

186. Purnell JQ, Zinman B, Brunzell JD; DCCT/ EDIC Research Group. The effect of excess weight gain with intensive diabetes mellitus treatment on cardiovascular disease risk factors and atherosclerosis in type 1 diabetes mellitus: results from the Diabetes Control and Complications Trial/Epidemiology of Diabetes Interventions and Complications Study (DCCT/EDIC) study. Circulation 2013;127:180–187

187. Rodrigues TC, Veyna AM, Haarhues MD, Kinney GL, Rewers M, Snell-Bergeon JK. Obesity and coronary artery calcium in diabetes: the Coronary Artery Calcification in Type 1 Diabetes (CACTI) study. Diabetes Technol Ther 2011;13: 991–996

188. Price SA, Gorelik A, Fourlanos S, Colman PG, Wentworth JM. Obesity is associated with retinopathy and macrovascular disease in type 1 diabetes. Obes Res Clin Pract 2014;8:e178–e182

189. Chillarón JJ, Benaiges D, Mañé L, Pedro-Botet J, Flores Le-Roux JA. Obesity and type 1 diabetes mellitus management. Minerva Endocrinol 2015;40:53–60

190. de Ferranti SD, de Boer IH, Fonseca V, et al. Type 1 diabetes mellitus and cardiovascular disease: a scientific statement from the American Heart Association and American Diabetes Association. Circulation 2014;130:1110–1130

191. Corbin KD, Driscoll KA, Pratley RE, Smith SR, Maahs DM, Mayer-Davis EJ; Advancing Care for Type 1 Diabetes and Obesity Network (ACT1ON). Obesity in type 1 diabetes: pathophysiology, clinical impact, and mechanisms. Endocr Rev 2018;39:629–663

192. Amiel SA, Pursey N, Higgins B, Dawoud D; Guideline Development Group. Diagnosis and management of type 1 diabetes in adults: summary of updated NICE guidance. BMJ 2015;351: h4188

193. Mottalib A, Tomah S, Hafida S, et al. Intensive multidisciplinary weight management in patients with type 1 diabetes and obesity: a one-year retrospective matched cohort study. Diabetes Obes Metab 2019;21:37–42

194. Mottalib A, Kasetty M, Mar JY, Elseaidy T, Ashrafzadeh S, Hamdy O. Weight management in patients with type 1 diabetes and obesity. Curr Diab Rep 2017;17:92

195. Buse JB, Garg SK, Rosenstock J, et al. Sotagliflozin in combination with optimized insulin therapy in adults with type 1 diabetes: the North American inTandem1 Study. Diabetes Care 2018;41:1970–1980

196. Kuhadiya ND, Ghanim H, Mehta A, et al. Dapagliflozin as additional treatment to liraglutide and insulin in patients with type 1 diabetes. J Clin Endocrinol Metab 2016;101:3506–3515

197. Hussain A. The effect of metabolic surgery on type 1 diabetes: meta-analysis. Arch Endocrinol Metab 2018;62:172–178

198. Kirwan JP, Aminian A, Kashyap SR, Burguera B, Brethauer SA, Schauer PR. Bariatric surgery in obese patients with type 1 diabetes. Diabetes Care 2016;39:941–948

199. Nicolau J, Simó R, Sanchís P, et al. Eating disorders are frequent among type 2 diabetic patients and are associated with worse metabolic and psychological outcomes: results from a cross-sectional study in primary and secondary care settings. Acta Diabetol 2015;52:1037–1044

200. Young-Hyman DL, Davis CL. Disordered eating behavior in individuals with diabetes: importance of context, evaluation, and classification. Diabetes Care 2010;33:683–689

201. 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

202. Papelbaum M, Appolinário JC, Moreira Rde O, Ellinger VCM, Kupfer R, Coutinho WF. Prevalence of eating disorders and psychiatric comorbidity in a clinical sample of type 2 diabetes mellitus patients. Br J Psychiatry 2005;27:135–138

203. Affenito SG, Adams CH. Are eating disorders more prevalent in females with type 1 diabetes mellitus when the impact of insulin omission is considered? Nutr Rev 2001;59:179–182

204. Clery P, Stahl D, Ismail K, Treasure J, Kan C. Systematic review and meta-analysis of the efficacy of interventions for people with type 1 diabetes mellitus and disordered eating. Diabet Med 2017;34:1667–1675

205. Doyle EA, Quinn SM, Ambrosino JM, Weyman K, Tamborlane WV, Jastreboff AM. Disordered eating behaviors in emerging adults with type 1 diabetes: a common problem for both men and women. J Pediatr Health Care 2017;31:327–333

206. 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

207. Malik VS. Sugar sweetened beverages and cardiometabolic health. Curr Opin Cardiol 2017;32:572–579

208. Malik VS, Hu FB. Fructose and cardiometabolic health: what the evidence from sugar-sweetened beverages tells us. J Am Coll Cardiol 2015;66:1615–1624

209. Imamura F, O'Connor L, Ye Z, et al. Consumption of sugar sweetened beverages, artificially sweetened beverages, and fruit juice and incidence of type 2 diabetes: systematic review, meta-analysis, and estimation of population attributable fraction. BMJ 2015;351:h3576

210. Pan A, Malik VS, Schulze MB, Manson JE, Willett WC, Hu FB. Plain-water intake and risk of type 2 diabetes in young and middle-aged women. Am J Clin Nutr 2012;95:1454–1460

211. Food & Nutrition Information Center, National Agricultural Library, U.S. Department of Agriculture. Nutritive and nonnutritive sweetener resources [Internet]. Available from https://www.nal.usda.gov/fnic/nutritive-and-nonnutritive-sweetener-resources. Accessed 20 November 2018

212. Johnson RK, Lichtenstein AH, Anderson CAM, et al.; American Heart Association Nutrition Committee of the Council on Lifestyle and Cardiometabolic Health; Council on Cardiovascular and Stroke Nursing; Council on Clinical Cardiology; Council on Quality of Care and Outcomes Research; Stroke Council. Low-calorie sweetened beverages and cardiometabolic health: a science advisory from the American Heart Association. Circulation 2018;138:e126–e140

213. Gardner C, Wylie-Rosett J, Gidding SS, et al.; American Heart Association Nutrition Committee of the Council on Nutrition, Physical Activity and Metabolism, Council on Arteriosclerosis, Thrombosis and Vascular Biology, Council on Cardiovascular Disease in the Young; American Diabetes Association. Nonnutritive sweeteners: current use and health perspectives: a scientific statement from the American Heart Association and the American Diabetes Association. Diabetes Care 2012;35:1798–1808

214. Nichol AD, Holle MJ, An R. Glycemic impact of non-nutritive sweeteners: a systematic review and meta-analysis of randomized controlled trials. Eur J Clin Nutr 2018;72:796–804

215. Sylvetsky AC, Rother KI. Nonnutritive sweeteners in weight management and chronic disease: a review. Obesity (Silver Spring) 2018;26:635–640

216. Fitch C, Keim KS; Academy of Nutrition and Dietetics. Position of the Academy of Nutrition and Dietetics: use of nutritive and nonnutritive sweeteners. J Acad Nutr Diet 2012;112:739–758

217. Wiebe N, Padwal R, Field C, Marks S, Jacobs R, Tonelli M. A systematic review on the effect of sweeteners on glycemic response and clinically relevant outcomes. BMC Med 2011;9:123

218. Shai I, Wainstein J, Harman-Boehm I, et al. Glycemic effects of moderate alcohol intake among patients with type 2 diabetes: a multicenter, randomized, clinical intervention trial. Diabetes Care 2007;30:3011–3016

219. Ahmed AT, Karter AJ, Warton EM, Doan JU, Weisner CM. The relationship between alcohol consumption and glycemic control among patients with diabetes: the Kaiser Permanente Northern California Diabetes Registry. J Gen Intern Med 2008;23:275–282

220. Bantle AE, Thomas W, Bantle JP. Metabolic effects of alcohol in the form of wine in persons with type 2 diabetes mellitus. Metabolism 2008;57:241–245

221. Schrieks IC, Heil ALJ, Hendriks HFJ, Mukamal KJ, Beulens JWJ. The effect of alcohol consumption on insulin sensitivity and glycemic status: a systematic review and meta-analysis of intervention studies. Diabetes Care 2015;38:723–732

222. Howard AA, Arnsten JH, Gourevitch MN. Effect of alcohol consumption on diabetes mellitus: a systematic review. Ann Intern Med 2004;140:211–219

223. Timko C, Kong C, Vittorio L, Cucciare MA. Screening and brief intervention for unhealthy substance use in patients with chronic medical conditions: a systematic review. J Clin Nurs 2016;25:3131–3143

224. Gepner Y, Golan R, Harman-Boehm I, et al. Effects of initiating moderate alcohol intake on cardiometabolic risk in adults with type 2 diabetes: a 2-year randomized, controlled trial. Ann Intern Med 2015;163:569–579

225. Mori TA, Burke V, Zilkens RR, Hodgson JM, Beilin LJ, Puddey IB. The effects of alcohol on ambulatory blood pressure and other cardiovascular risk factors in type 2 diabetes: a randomized intervention. J Hypertens 2016;34:421–428; discussion 428

226. Shimomura T, Wakabayashi I. Inverse associations between light-to-moderate alcohol intake and lipid-related indices in patients with diabetes. Cardiovasc Diabetol 2013;12:104

227. Franz MJ, Evert AB (Eds.). American Diabetes Association Guide to Nutrition Therapy for Diabetes. 3rd edition. Alexandria, VA, American Diabetes Association, 2017. Available from http://www.shopdiabetes.org/2283-American-Diabetes-Association-Guide-to-Nutrition-Therapy-for-Diabetes-3rd-Edition.aspx. Accessed 2 October 2018

228. Tetzschner R, Nørgaard K, Ranjan A. Effects of alcohol on plasma glucose and prevention of alcohol-induced hypoglycemia in type 1 diabetes—a systematic review with GRADE. Diabetes Metab Res Rev 2018;34:e2965

229. Barnard KD, Dyson P, Sinclair JMA, et al. Alcohol health literacy in young adults with type 1 diabetes and its impact on diabetes management. Diabet Med 2014;31:1625–1630

230. Baliunas DO, Taylor BJ, Irving H, et al. Alcohol as a risk factor for type 2 diabetes: a systematic review and meta-analysis. Diabetes Care 2009;32:2123–2132

231. Koppes LLJ, Dekker JM, Hendriks HFJ, Bouter LM, Heine RJ. Meta-analysis of the relationship between alcohol consumption and coronary heart disease and mortality in type 2 diabetic patients. Diabetologia 2006;49:648–652

232. Knott C, Bell S, Britton A. Alcohol consumption and the risk of type 2 diabetes: a systematic review and dose-response meta-analysis of more than 1.9 million individuals from 38 observational studies. Diabetes Care 2015;38:1804–1812

233. Huang J, Wang X, Zhang Y. Specific types of alcoholic beverage consumption and risk of type 2 diabetes: a systematic review and meta-analysis. J Diabetes Investig 2017;8:56–68

234. Bantle JP, Wylie-Rosett J, Albright AL, et al.; American Diabetes Association. Nutrition recommendations and interventions for diabetes: a position statement of the American Diabetes Association. Diabetes Care 2008;31(Suppl. 1):S61–S78

235. Sesso HD, Christen WG, Bubes V, et al. Multivitamins in the prevention of cardiovascular disease in men: the Physicians' Health Study II randomized controlled trial. JAMA 2012;308:1751–1760

236. Macpherson H, Pipingas A, Pase MP. Multivitamin-multimineral supplementation and mortality: a meta-analysis of randomized controlled trials. Am J Clin Nutr 2013;97:437–444

237. Mooradian AD, Morley JE. Micronutrient status in diabetes mellitus. Am J Clin Nutr 1987;45:877–895

238. Franz MJ, Bantle JP, Beebe CA, et al. Evidence-based nutrition principles and recommendations for the treatment and prevention

of diabetes and related complications. Diabetes Care 2002;25:148–198

239. Balk EM, Tatsioni A, Lichtenstein AH, Lau J, Pittas AG. Effect of chromium supplementation on glucose metabolism and lipids: a systematic review of randomized controlled trials. Diabetes Care 2007;30:2154–2163

240. Liu Y, Cotillard A, Vatier C, et al. A dietary supplement containing cinnamon, chromium and carnosine decreases fasting plasma glucose and increases lean mass in overweight or obese pre-diabetic subjects: a randomized, placebo-controlled trial. PLoS One 2015;10:e0138646

241. Rodríguez-Morán M, Guerrero-Romero F. Oral magnesium supplementation improves insulin sensitivity and metabolic control in type 2 diabetic subjects: a randomized double-blind controlled trial. Diabetes Care 2003;26:1147–1152

242. de Valk HW, Verkaaik R, van Rijn HJ, Geerdink RA, Struyvenberg A. Oral magnesium supplementation in insulin-requiring type 2 diabetic patients. Diabet Med 1998;15:503–507

243. Jorde R, Figenschau Y. Supplementation with cholecalciferol does not improve glycaemic control in diabetic subjects with normal serum 25-hydroxyvitamin D levels. Eur J Nutr 2009;48:349–354

244. Patel P, Poretsky L, Liao E. Lack of effect of subtherapeutic vitamin D treatment on glycemic and lipid parameters in type 2 diabetes: a pilot prospective randomized trial. J Diabetes 2010;2:36–40

245. Parekh D, Sarathi V, Shivane VK, Bandgar TR, Menon PS, Shah NS. Pilot study to evaluate the effect of short-term improvement in vitamin D status on glucose tolerance in patients with type 2 diabetes mellitus. Endocr Pract 2010;16:600–608

246. Nikooyeh B, Neyestani TR, Farvid M, et al. Daily consumption of vitamin D– or vitamin D + calcium–fortified yogurt drink improved glycemic control in patients with type 2 diabetes: a randomized clinical trial. Am J Clin Nutr 2011;93:764–771

247. Soric MM, Renner ET, Smith SR. Effect of daily vitamin D supplementation on HbA1c in patients with uncontrolled type 2 diabetes mellitus: a pilot study. J Diabetes 2012;4:104–105

248. Alkharfy KM, Al-Daghri NM, Sabico SB, et al. Vitamin D supplementation in patients with diabetes mellitus type 2 on different therapeutic regimens: a one-year prospective study. Cardiovasc Diabetol 2013;12:113

249. Sadiya A, Ahmed SM, Carlsson M, et al. Vitamin D₃ supplementation and body composition in persons with obesity and type 2 diabetes in the UAE: a randomized controlled double-blinded clinical trial. Clin Nutr 2016;35:77–82

250. Mousa A, Naderpoor N, de Courten MP, et al. Vitamin D supplementation has no effect on insulin sensitivity or secretion in vitamin D–deficient, overweight or obese adults: a randomized placebo-controlled trial. Am J Clin Nutr 2017;105:1372–1381

251. Moreira-Lucas TS, Duncan AM, Rabasa-Lhoret R, et al. Effect of vitamin D supplementation on oral glucose tolerance in individuals with low vitamin D status and increased risk for developing type 2 diabetes (EVIDENCE): a double-blind, randomized, placebo-controlled

clinical trial. Diabetes Obes Metab 2017;19:133–141

252. Millen AE, Sahli MW, Nie J, et al. Adequate vitamin D status is associated with the reduced odds of prevalent diabetic retinopathy in African Americans and Caucasians. Cardiovasc Diabetol 2016;15:128

253. Tabesh M, Azadbakht L, Faghihimani E, Tabesh M, Esmaillzadeh A. Effects of calcium-vitamin D co-supplementation on metabolic profiles in vitamin D insufficient people with type 2 diabetes: a randomised controlled clinical trial. Diabetologia 2014;57:2038–2047

254. Veronese N, Watutantrige-Fernando S, Luchini C, et al. Effect of magnesium supplementation on glucose metabolism in people with or at risk of diabetes: a systematic review and meta-analysis of double-blind randomized controlled trials. Eur J Clin Nutr 2016;70:1354–1359

255. Tariq SH. Herbal therapies. Clin Geriatr Med 2004;20:237–257

256. U.S. Food and Drug Administration. Dietary Supplements [Internet], 2018. Available from https://www.fda.gov/food/dietarysupplements/. Accessed 20 November 2018

257. Aroda VR, Edelstein SL, Goldberg RB, et al.; Diabetes Prevention Program Research Group. Long-term metformin use and vitamin B12 deficiency in the Diabetes Prevention Program Outcomes Study. J Clin Endocrinol Metab 2016;101:1754–1761

258. Vidal-Aballi J, Butler CC, Cannings-John R, et al. Oral vitamin B12 versus intramuscular vitamin B12 for vitamin B12 deficiency. Cochrane Database Syst Rev 2005;3:CD004655

259. Butler CC, Vidal-Aballi J, Cannings-John R, et al. Oral vitamin B12 versus intramuscular vitamin B12 for vitamin B12 deficiency: a systematic review of randomized controlled trials. Fam Pract 2006;23:279–285

260. Buvat DR. Use of metformin is a cause of vitamin B12 deficiency. Am Fam Physician 2004;69:264; author reply 264, 266

261. Bauman WA, Shaw S, Jayatilleke E, Spungen AM, Herbert V. Increased intake of calcium reverses vitamin B12 malabsorption induced by metformin. Diabetes Care 2000;23:1227–1231

262. Kim JA, Lee JS, Chung HS, et al. Impact of visit-to-visit fasting plasma glucose variability on the development of type 2 diabetes: a nationwide population-based cohort study. Diabetes Care 2018;41:2610–2616

263. Garber AJ, Abrahamson MJ, Barzilay JI, et al. Consensus statement by the American Association of Clinical Endocrinologists and American College of Endocrinology on the comprehensive type 2 diabetes management algorithm – 2017 executive summary. Endocr Pract 2017;23:207–238

264. DAFNE Study Group. Training in flexible, intensive insulin management to enable dietary freedom in people with type 1 diabetes: dose adjustment for normal eating (DAFNE) randomised controlled trial. BMJ 2002;325:746

265. Rossi MCE, Nicolucci A, Di Bartolo P, et al. Diabetes Interactive Diary: a new telemedicine system enabling flexible diet and insulin therapy while improving quality of life: an open-label, international, multicenter, randomized study. Diabetes Care 2010;33:109–115

266. Laurenzi A, Bolla AM, Panigoni G, et al. Effects of carbohydrate counting on glucose control and quality of life over 24 weeks in adult patients with type 1 diabetes on continuous subcutaneous insulin infusion: a randomized, prospective clinical trial (GIOCAR). Diabetes Care 2011;34:823–827

267. Graber AL, Elasy TA, Quinn D, Wolff K, Brown A. Improving glycemic control in adults with diabetes mellitus: shared responsibility in primary care practices. South Med J 2002;95:684–690

268. Sämann A, Mühlhauser I, Bender R, Kloos Ch, Müller UA. Glycaemic control and severe hypoglycaemia following training in flexible, intensive insulin therapy to enable dietary freedom in people with type 1 diabetes: a prospective implementation study. Diabetologia 2005;48:1965–1970

269. Lowe J, Linjawi S, Mensch M, James K, Attia J. Flexible eating and flexible insulin dosing in patients with diabetes: results of an intensive self-management course. Diabetes Res Clin Pract 2008;80:439–443

270. Scavone G, Manto A, Pitocco D, et al. Effect of carbohydrate counting and medical nutritional therapy on glycaemic control in type 1 diabetic subjects: a pilot study. Diabet Med 2010;27:477–479

271. McIntyre HD, Knight BA, Harvey DM, Noud MN, Hagger VL, Gilshenan KS. Dose adjustment for normal eating (DAFNE)—an audit of outcomes in Australia. Med J Aust 2010;192:637–640

272. Peters AL, Ahmann AJ, Battelino T, et al. Diabetes technology—continuous subcutaneous insulin infusion therapy and continuous glucose monitoring in adults: an Endocrine Society clinical practice guideline. J Clin Endocrinol Metab 2016;101:3922–3937

273. Hermanns N, Kulzer B, Ehrmann D, Bergis-Jurgan N, Haak T. The effect of a diabetes education programme (PRIMAS) for people with type 1 diabetes: results of a randomized trial. Diabetes Res Clin Pract 2013;102:149–157

274. Speight J, Amiel SA, Bradley C, et al. Long-term biomedical and psychosocial outcomes following DAFNE (Dose Adjustment For Normal Eating) structured education to promote intensive insulin therapy in adults with sub-optimally controlled type 1 diabetes. Diabetes Res Clin Pract 2010;89:22–29

275. Wolever TM, Hamad S, Chiasson JL, et al. Day-to-day consistency in amount and source of carbohydrate intake associated with improved blood glucose control in type 1 diabetes. J Am Coll Nutr 1999;18:242–247

276. Rabasa-Lhoret R, Garon J, Langelier H, Poisson D, Chiasson JL. Effects of meal carbohydrate content on insulin requirements in type 1 diabetic patients treated intensively with the basal-bolus (ultralente-regular) insulin regimen. Diabetes Care 1999;22:667–673

277. Bell KJ, Smart CE, Steil GM, Brand-Miller JC, King B, Wolpert HA. Impact of fat, protein, and glycemic index on postprandial glucose control in type 1 diabetes: implications for intensive diabetes management in the continuous glucose monitoring era. Diabetes Care 2015;38:1008–1015

278. 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

279. Lopez PE, Smart CE, McElduff P, et al. Optimizing the combination insulin bolus split for a high-fat, high-protein meal in children and adolescents using insulin pump therapy. Diabet Med 2017;34:1380–1384

280. Jabłońska K, Molęda P, Safranow K, Majkowska L. Rapid-acting and regular insulin are equal for high fat-protein meal in individuals with type 1 diabetes treated with multiple daily injections. Diabetes Ther 2018;9:339–348

281. van der Hoogt M, van Dyk JC, Dolman RC, Pieters M. Protein and fat meal content increase insulin requirement in children with type 1 diabetes—role of duration of diabetes. J Clin Transl Endocrinol 2017;10:15–21

282. Lopez PE, Evans M, King BR, et al. A randomized comparison of three prandial insulin dosing algorithms for children and adolescents with type 1 diabetes. Diabet Med 2018;35:1440–1447

283. Paterson MA, Smart CEM, Lopez PE, et al. Influence of dietary protein on postprandial blood glucose levels in individuals with type 1 diabetes mellitus using intensive insulin therapy. Diabet Med 2016;33:592–598

284. Klupa T, Benbenek-Klupa T, Matejko B, Mrozinska S, Malecki MT. The impact of a pure protein load on the glucose levels in type 1 diabetes patients treated with insulin pumps. Int J Endocrinol 2015;2015:216918

285. Borie-Swinburne C, Sola-Gazagnes A, Gonfroy-Leymarie C, Boillot J, Boitard C, Larger E. Effect of dietary protein on post-prandial glucose in patients with type 1 diabetes. J Hum Nutr Diet 2013; 26:606–611

286. Piechowiak K, Dżygało K, Szypowska A. The additional dose of insulin for high-protein mixed meal provides better glycemic control in children with type 1 diabetes on insulin pumps: randomized cross-over study. Pediatr Diabetes 2017;18:861–868

287. Paterson MA, Smart CEM, Lopez PE, et al. Increasing the protein quantity in a meal results in dose-dependent effects on postprandial glucose levels in individuals with type 1 diabetes mellitus. Diabet Med 2017;34:851–854

288. Laxminarayan S, Reifman J, Edwards SS, Wolpert H, Steil GM. Bolus estimation—rethinking the effect of meal fat content. Diabetes Technol Ther 2015;17:860–866

289. Bozzetto L, Alderisio A, Giorgini M, et al. Extra-virgin olive oil reduces glycemic response to a high-glycemic index meal in patients with type 1 diabetes: a randomized controlled trial. Diabetes Care 2016;39:518–524

290. Campbell MD, Walker M, King D, et al. Carbohydrate counting at meal time followed by a small secondary postprandial bolus injection at 3 hours prevents late hyperglycemia, without hypoglycemia, after a high-carbohydrate, high-fat meal in type 1 diabetes. Diabetes Care 2016; 39:e141–e142

291. Delahanty LM, Dalton KM, Porneala B, et al. Improving diabetes outcomes through lifestyle change—a randomized controlled trial. Obesity (Silver Spring) 2015;23:1792–1799

292. Liu H, Zhang M, Wu X, Wang C, Li Z. Effectiveness of a public dietitian-led diabetes nutrition intervention on glycemic control in a community setting in China. Asia Pac J Clin Nutr 2015;24:525–532

293. Marincic PZ, Hardin A, Salazar MV, Scott S, Fan SX, Gaillard PR. Diabetes self-management education and medical nutrition therapy improve patient outcomes: a pilot study documenting the efficacy of registered dietitian nutritionist interventions through retrospective chart review. J Acad Nutr Diet 2017;117: 1254–1264

294. Mensink RP. Effects of saturated fatty acids on serum lipids and lipoproteins: a systematic review and regression analysis [Internet], 2016. Geneva, World Health Organization. Available from http://www.who.int/nutrition/publications/nutrientrequirements/sfa_systematic_review/en/. Accessed 20 November 2018

295. 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

296. Hooper L, Martin N, Abdelhamid A, Davey Smith G. Reduction in saturated fat intake for cardiovascular disease. Cochrane Database Syst Rev 2015;6:CD011737

297. de Souza RJ, Mente A, Maroleanu A, et al. Intake of saturated and trans unsaturated fatty acids and risk of all cause mortality, cardiovascular disease, and type 2 diabetes: systematic review and meta-analysis of observational studies. BMJ 2015;351:h3978

298. Dehghan M, Mente A, Zhang X, et al.; Prospective Urban Rural Epidemiology (PURE) study investigators. Associations of fats and carbohydrate intake with cardiovascular disease and mortality in 18 countries from five continents (PURE): a prospective cohort study. Lancet 2017;390:2050–2062

299. Guasch-Ferré M, Babio N, Martínez-González MA, et al.; PREDIMED Study Investigators. Dietary fat intake and risk of cardiovascular disease and all-cause mortality in a population at high risk of cardiovascular disease. Am J Clin Nutr 2015;102:1563–1573

300. Dietary Guidelines Advisory Committee. Scientific Report of the 2015 Dietary Guidelines Advisory Committee: Advisory Report to the Secretary of Health and Human Services and the Secretary of Agriculture [Internet], 2015. Washington, DC, U.S. Department of Agriculture, Agricultural Research Service. Available from https://health.gov/dietaryguidelines/2015-scientific-report/. Accessed 25 September 2017

301. Huo R, Du T, Xu Y, et al. Effects of Mediterranean-style diet on glycemic control, weight loss and cardiovascular risk factors among type 2 diabetes individuals: a meta-analysis. Eur J Clin Nutr 2015;69:1200–1208

302. O'Mahoney LL, Matu J, Price OJ, et al. Omega-3 polyunsaturated fatty acids favourably modulate cardiometabolic biomarkers in type 2 diabetes: a meta-analysis and meta-regression of randomized controlled trials. Cardiovasc Diabetol 2018;17:98

303. 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

304. ASCEND Study Collaborative Group; Bowman L, Mafham M, Wallendszus K, et al. Effects of n-3 fatty acid supplements in diabetes mellitus. N Engl J Med 2018;379:1540–1550

305. Manson JE, Cook NR, Lee I-M, et al.; VITAL Research Group. Marine n-3 fatty acids and prevention of cardiovascular disease and cancer. N Engl J Med 2019;380:23–32

306. Chen C, Yu X, Shao S. Effects of omega-3 fatty acid supplementation on glucose control and lipid levels in type 2 diabetes: a meta-analysis. PLoS One 2015;10:e0139565

307. Aronis KN, Khan SM, Mantzoros CS. Effects of trans fatty acids on glucose homeostasis: a meta-analysis of randomized, placebo-controlled clinical trials. Am J Clin Nutr 2012; 96:1093–1099

308. Zhang Z, Cogswell ME, Gillespie C, et al. Association between usual sodium and potassium intake and blood pressure and hypertension among U.S. adults: NHANES 2005–2010. PLoS One 2013;8:e75289

309. Centers for Disease Control and Prevention (CDC). CDC grand rounds: dietary sodium reduction—time for choice. MMWR Morb Mortal Wkly Rep 2012;61:89–91

310. Appel LJ, Frohlich ED, Hall JE, et al. The importance of population-wide sodium reduction as a means to prevent cardiovascular disease and stroke: a call to action from the American Heart Association. Circulation 2011;123:1138–1143

311. World Health Organization. Guideline: Sodium Intake for Adults and Children [Internet], 2012. Available from http://www.ncbi.nlm.nih.gov/books/NBK133309/. Accessed 20 November 2018

312. Institute of Medicine Committee on Strategies to Reduce Sodium Intake. Strategies to Reduce Sodium Intake in the United States [Internet]. Henney JE, Taylor CL, Boon CS, Eds. Washington, DC, National Academies Press, 2010. Available from http://www.ncbi.nlm.nih.gov/books/NBK50956/. Accessed 20 November 2018

313. Thomas MC, Moran J, Forsblom C, et al.; FinnDiane Study Group. The association between dietary sodium intake, ESRD, and all-cause mortality in patients with type 1 diabetes. Diabetes Care 2011;34:861–866

314. Ekinci EI, Clarke S, Thomas MC, et al. Dietary salt intake and mortality in patients with type 2 diabetes. Diabetes Care 2011;34:703–709

315. Dunkler D, Dehghan M, Teo KK, et al.; ONTARGET Investigators. Diet and kidney disease in high-risk individuals with type 2 diabetes mellitus. JAMA Intern Med 2013;173:1682–1692

316. Maillot M, Drewnowski A. A conflict between nutritionally adequate diets and meeting the 2010 dietary guidelines for sodium. Am J Prev Med 2012;42:174–179

317. Pan Y, Guo LL, Jin HM. Low-protein diet for diabetic nephropathy: a meta-analysis of randomized controlled trials. Am J Clin Nutr 2008;88: 660–666

318. Meloni C, Tatangelo P, Cipriani S, et al. Adequate protein dietary restriction in diabetic and nondiabetic patients with chronic renal failure. J Ren Nutr 2004;14:208–213

319. Robertson L, Waugh N, Robertson A. Protein restriction for diabetic renal disease. Cochrane Database Syst Rev 2007;4:CD002181

320. Dussol B, Iovanna C, Raccah D, et al. A randomized trial of low-protein diet in type 1 and

in type 2 diabetes mellitus patients with incipient and overt nephropathy. J Ren Nutr 2005;15: 398–406

321. Tuttle KR, Bakris GL, Bilous RW, et al. Diabetic kidney disease: a report from an ADA Consensus Conference. Diabetes Care 2014;37: 2864–2883

322. Azadbakht L, Atabak S, Esmaillzadeh A. Soy protein intake, cardiorenal indices, and C-reactive protein in type 2 diabetes with nephropathy: a longitudinal randomized clinical trial. Diabetes Care 2008;31:648–654

323. Teixeira SR, Tappenden KA, Carson L, et al. Isolated soy protein consumption reduces urinary albumin excretion and improves the serum lipid profile in men with type 2 diabetes mellitus and nephropathy. J Nutr 2004;134:1874–1880

324. Koch KL, Calles-Escandón J. Diabetic gastroparesis. Gastroenterol Clin North Am 2015;44: 39–57

325. Coleski R, Hasler WL. Coupling and propagation of normal and dysrhythmic gastric slow waves during acute hyperglycaemia in healthy humans. Neurogastroenterol Motil 2009;21: 492–499, e1-e2

326. Horowitz M, O'Donovan D, Jones KL, Feinle C, Rayner CK, Samsom M. Gastric emptying in diabetes: clinical significance and treatment. Diabetic Med 2002;19:177–194

327. Parrish CR, Pastors JG. Nutritional management of gastroparesis in people with diabetes. Diabetes Spectr 2007;20:231–234

328. Abell TL, Bernstein RK, Cutts T, et al. Treatment of gastroparesis: a multidisciplinary clinical review. Neurogastroenterol Motil 2006;18:263–283

329. Olausson EA, Störsrud S, Grundin H, Isaksson M, Attvall S, Simrén M. A small particle size diet reduces upper gastrointestinal symptoms in patients with diabetic gastroparesis: a randomized controlled trial. Am J Gastroenterol 2014;109:375–385

330. Calles-Escandón J, Koch KL, Hasler WL, et al.; NIDDK Gastroparesis Clinical Research Consortium (GpCRC). Glucose sensor-augmented continuous subcutaneous insulin infusion in patients with diabetic gastroparesis: an open-label pilot prospective study. PLoS One 2018;13: e0194759

331. Sharma D, Morrison G, Joseph F, Purewal TS, Weston PJ. The role of continuous subcutaneous insulin infusion therapy in patients with diabetic gastroparesis. Diabetologia 2011;54: 2768–2770

332. Zeevi D, Korem T, Zmora N, et al. Personalized nutrition by prediction of glycemic responses. Cell 2015;163:1079–1094

333. Blanco-Rojo R, Delgado-Lista J, Lee Y-C, et al. Interaction of an S100A9 gene variant with saturated fat and carbohydrates to modulate insulin resistance in 3 populations of different ancestries. Am J Clin Nutr 2016;104:508–517

334. Hjorth MF, Ritz C, Blaak EE, et al. Pretreatment fasting plasma glucose and insulin modify dietary weight loss success: results from 3 randomized clinical trials. Am J Clin Nutr 2017;106:499–505

335. Dashti HS, Follis JL, Smith CE, et al.; CHARGE Nutrition Study Group. Gene-environment interactions of circadian-related genes for cardiometabolic traits. Diabetes Care 2015;38: 1456–1466

336. Huang T, Ley SH, Zheng Y, et al. Genetic susceptibility to diabetes and long-term improvement of insulin resistance and β cell function during weight loss: the Preventing Overweight Using Novel Dietary Strategies (POUNDS LOST) trial. Am J Clin Nutr 2016;104:198–204

337. Kang R, Kim M, Chae JS, Lee S-H, Lee JH. Consumption of whole grains and legumes modulates the genetic effect of the APOA5 -1131C variant on changes in triglyceride and apolipoprotein A-V concentrations in patients with impaired fasting glucose or newly diagnosed type 2 diabetes. Trials 2014;15:100

338. Rickheim PL, Weaver TW, Flader JL, Kendall DM. Assessment of group versus individual diabetes education: a randomized study. Diabetes Care 2002;25:269–274

339. Wolf AM, Conaway MR, Crowther JQ, et al.; Improving Control with Activity and Nutrition (ICAN) Study. Translating lifestyle intervention to practice in obese patients with type 2 diabetes: Improving Control with Activity and Nutrition (ICAN) study. Diabetes Care 2004;27:1570–1576

340. Coppell KJ, Kataoka M, Williams SM, Chisholm AW, Vorgers SM, Mann JI. Nutritional intervention in patients with type 2 diabetes who are hyperglycaemic despite optimised drug treatment—Lifestyle Over and Above Drugs in Diabetes (LOADD) study: randomised controlled trial. BMJ 2010;341:c3337

341. Magee MF, Nassar CM, Copeland J, et al. Synergy to reduce emergency department visits for uncontrolled hyperglycemia. Diabetes Educ 2013;39:354–364

342. 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

343. Essien O, Otu A, Umoh V, Enang O, Hicks JP, Walley J. Intensive patient education improves glycaemic control in diabetes compared to conventional education: a randomised controlled trial in a Nigerian tertiary care hospital. PLoS One 2017;12:e0168835

344. Collinsworth AW, Vulimiri M, Schmidt KL, Snead CA. Effectiveness of a community health worker-led diabetes self-management education program and implications for CHW involvement in care coordination strategies. Diabetes Educ 2013;39:792–799

345. American Diabetes Association. Standards of Medical Care in Diabetes—2019. Diabetes Care 2019;42(Suppl. 1):S1–S193