Nutrition and Dietary Factors in Type 2 Diabetes: Current Evidence and Clinical Implications

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ABSTRACT

Background: Type 2 diabetes (T2D) affects an estimated 589 million adults worldwide, and diet is central to both its prevention and management. The evidence base has expanded rapidly since the 2019 American Diabetes Association nutrition consensus.

Objective: To review current evidence on nutrition and dietary factors in the prevention and management of T2D in adults, emphasising literature published from 2022 onward.

Methods: Structured narrative review of guidelines, meta-analyses, randomised controlled trials and large prospective cohort studies identified through PubMed/MEDLINE, Embase and the Cochrane Library (2015 to September 2026).

Findings: Intensive energy restriction with total diet replacement achieves remission in 36–46% of people with recent-onset T2D at 1–2 years in trials and about 27–32% in a national real-world programme, but only 13% remain in remission at 5 years. An energy-reduced Mediterranean diet with physical activity reduced T2D incidence by 31% over 6 years in PREDIMED-Plus. Low-carbohydrate diets improve short-term glycaemia, with benefits attenuating by 12 months. Pooled data from 1.97 million adults link processed and red meat to higher T2D risk, and ultra-processed foods, sugar-sweetened beverages and French fries show consistent adverse associations. Time-restricted eating and 5:2 intermittent fasting perform comparably to daily energy restriction. Incretin-based therapies shift nutritional priorities toward protein adequacy, lean-mass preservation and micronutrient sufficiency.

Conclusions: Weight reduction and high-quality dietary patterns remain the foundation of T2D nutrition care. Individualised, culturally appropriate and sustainable approaches should be prioritised, and long-term trials in diverse populations are needed.

Key points

- Structured energy restriction with total diet replacement can put recent-onset type 2 diabetes into remission, but relapse is common without long-term weight-maintenance support.
- Mediterranean, DASH, healthful plant-based and quality-focused lower-carbohydrate patterns all improve cardiometabolic risk; long-term adherence matters more than the specific pattern.
- Processed and red meat, sugar-sweetened beverages, French fries and specific ultra-processed food subgroups are consistently associated with higher diabetes risk.
- Time-restricted eating and 5:2 intermittent fasting are effective alternatives to daily energy restriction when medication is adjusted.
- With GLP-1-based therapies, nutrition care should prioritise protein adequacy, lean-mass preservation, micronutrient sufficiency and weight maintenance after treatment.

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INTRODUCTION

Type 2 diabetes (T2D) now affects an estimated 589 million adults aged 20–79 years worldwide, roughly one in nine, and this figure is projected to reach 853 million by 2050 [1]. More than 90% of cases are T2D, three in four affected adults live in low- and middle-income countries, and global diabetes-related health expenditure exceeded one trillion US dollars for the first time in 2024 [1]. The epidemic is driven largely by modifiable factors, of which excess adiposity and diet quality are the most important.

Nutrition operates at every stage of the disease. In prevention, the Finnish Diabetes Prevention Study and the US Diabetes Prevention Program showed that modest weight loss through diet and activity reduced progression from impaired glucose tolerance to T2D by about 58% [2,3]. In established disease, medical nutrition therapy (MNT) lowers HbA1c by amounts comparable to a single glucose-lowering drug, and intensive energy restriction can induce remission in a substantial minority of people with recent-onset disease [4,5].

The field has changed considerably since the 2019 American Diabetes Association (ADA) nutrition consensus report [4] and the 2023 European Association for the Study of Diabetes (EASD) recommendations [6]. Long-term follow-up of remission trials, large pooled cohort analyses of meat and ultra-processed food, randomised trials of time-restricted eating, and the rapid uptake of glucagon-like peptide-1 receptor agonists (GLP-1 RAs) and dual incretin agonists have all reshaped the evidence base. The ADA Standards of Care in Diabetes—2026 continue to position MNT, delivered in a person-centred way, as foundational to management [7].

Existing reviews and guidelines each cover part of this picture but not its integration. The ADA and EASD statements set normative recommendations rather than critically appraising the underlying trial and cohort evidence; prior narrative reviews of dietary patterns in T2D generally predate the 5-year DiRECT extension, the 2024 pooled meat and individual-participant cohort analyses, and the 2025 GLP-1 nutritional advisories; and reviews focused on diabetes remission do not typically extend to food-level evidence, ultra-processed food, or the nutritional implications of incretin-based therapy. No recent single source brings together remission, food- and pattern-level evidence, meal timing, precision nutrition and the practical consequences of GLP-1-era pharmacotherapy for nutrition care; this integration, applied to the needs of practising clinicians and dietitians, is the distinct contribution of the present review.

This narrative review summarises current evidence on nutrition and dietary factors in the prevention and management of T2D in adults. It emphasises literature published from 2022 onward, identifies where recommendations are well supported and where uncertainty remains, and considers practical implications for clinicians and dietitians.

METHODS

We conducted a structured narrative review. PubMed/MEDLINE, Embase and the Cochrane Library were each searched from inception (1 January 2015) to the same cut-off date, 30 September 2026, for English-language publications, with emphasis on work published from 2022 onward. Search terms combined "type 2 diabetes" or "prediabetes" with terms for dietary patterns, macronutrients, specific foods and beverages, energy restriction, remission, meal timing, intermittent fasting, sweeteners, alcohol, GLP-1 receptor agonists and precision nutrition. The full PubMed strategy is given in Supplementary Table S1; the same concept blocks were translated into Embase subject headings (Emtree) and free-text terms and into the Cochrane Library's controlled-vocabulary and free-text syntax, and are available from the corresponding author on request.

Eligible sources were current clinical practice guidelines and consensus statements; systematic reviews and meta-analyses of randomised controlled trials (RCTs); large RCTs with clinical or glycaemic outcomes; and meta-analyses or pooled analyses of prospective cohort studies, all in adults (aged 18 years or older) and published in English. We excluded case reports, narrative commentaries without primary data, studies restricted to children, type 1 or gestational diabetes, animal or in vitro studies, and conference abstracts without a peer-reviewed full text. Reference lists of key papers were hand-searched for additional eligible studies. One author (RM) screened titles, abstracts and full texts against these criteria; the second author (AR) independently checked all included studies, and disagreements on eligibility were resolved by discussion. We prioritised sources in the

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order listed above when evidence conflicted. Because this is a narrative rather than a systematic review, no formal risk-of-bias tool or quantitative synthesis was applied. Strength of evidence is instead described qualitatively using consistent terms: findings are described as "established" or "well supported" where multiple RCTs or meta-analyses of RCTs agree; as "probable" or "associated with" where the evidence is from prospective cohort studies, which show correlation rather than proof of causation; and as "expert consensus" or "advisory" where a recommendation rests on professional-society opinion rather than primary trial data specific to the claim. Observational findings are flagged as such at first mention in each section.

Energy restriction, weight loss and diabetes remission

Weight loss is the single most powerful dietary lever in T2D, and substantial, sustained loss can return glycaemia to the non-diabetic range. An international consensus defines remission as HbA1c below 6.5% (48 mmol/mol) measured at least 3 months after stopping glucose-lowering medication [8].

Evidence from randomised trials

In the Diabetes Remission Clinical Trial (DiRECT), 306 adults with T2D of less than 6 years' duration received a 12-week total diet replacement (TDR) of about 830 kcal/day, followed by structured food reintroduction and maintenance support in primary care. Remission was achieved by 46% at 1 year and 36% at 2 years, compared with 4% of controls at 1 year, and was closely tied to the magnitude of weight loss [5]. Among participants losing at least 15 kg, 86% were in remission at 1 year [5].

The DiRECT extension offered low-intensity maintenance support for a further 3 years to 85 intervention participants. At 5 years, 13% remained in remission and mean weight loss was 6.1 kg; among those in remission at year 2, 26% were still in remission at year 5 [9]. Serious adverse events requiring hospitalisation were roughly halved in the intervention arm compared with the original controls, suggesting benefit even among those who relapsed [9].

The DIADEM-I trial extended this approach to younger adults of predominantly Middle Eastern and North African origin with early T2D, reporting remission in 61% of the intervention group at 12 months versus 12% of controls [10]. In Look AHEAD, an intensive lifestyle intervention produced partial or complete remission in 11.5% of participants at 1 year versus 2.0% with usual care [11], although it did not reduce cardiovascular events over a median of 9.6 years [12].

Real-world implementation

NHS England scaled the DiRECT model through the Type 2 Diabetes Path to Remission Programme, which uses 800–900 kcal/day TDR for 12 weeks within a 12-month programme. In the first evaluation, 27% of all starters with complete HbA1c data achieved remission at 12 months, rising to 32% among programme completers, whose mean weight loss was 15.9 kg (14.4%) [13]. Only 55% of starters completed the programme, however, and data completeness was lower than in trials [13].

Mechanisms and clinical implications

Remission appears to depend on reducing ectopic fat in the liver and pancreas below an individual threshold, allowing recovery of first-phase insulin secretion. Shorter diabetes duration and larger weight loss predict success, while longer duration and insulin use predict failure [5,9]. Weight regain is the main reason for relapse, so long-term maintenance support is as important as the initial phase.

Clinically, remission should be offered as an option to people with recent-onset T2D and overweight or obesity, with explicit discussion of the effort involved and the likelihood of relapse. Continued retinal screening and cardiovascular risk management remain necessary after remission is achieved [8].

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Macronutrient composition

There is no single ideal macronutrient distribution for people with T2D. Both the ADA and EASD recommend individualising proportions around total energy needs, food quality and personal preference [4,6,7]. The quality of carbohydrate, fat and protein sources matters at least as much as their quantity.

Carbohydrate quantity: low- and very-low-carbohydrate diets

Reducing overall carbohydrate intake has the most consistent evidence among macronutrient strategies for lowering glycaemia. A systematic review of 23 RCTs (1,357 participants) defined low-carbohydrate diets (LCDs) as below 130 g/day and very-low-carbohydrate diets (VLCDs) as below 10% of energy [14]. At 6 months, LCDs increased the proportion achieving HbA1c below 6.5% from 31% to 57% (risk difference 0.32; 95% CI 0.17–0.47) [14]. However, when remission required HbA1c below 6.5% without glucose-lowering medication, the effect was small and not statistically significant, and most benefits diminished by 12 months [14].

The Keto-Med randomised crossover trial compared a well-formulated ketogenic diet with a Mediterranean-plant diet, both low in added sugars and refined grains, over 12 weeks each in adults with prediabetes or T2D [15]. HbA1c fell similarly on both diets. The ketogenic diet produced greater triglyceride reduction, while the Mediterranean diet produced lower LDL cholesterol and higher fibre intake and was easier to sustain [15]. This suggests that eliminating refined carbohydrates and added sugars may account for much of the benefit attributed to carbohydrate restriction.

Carbohydrate restriction requires medical supervision and medication review before and during the diet, not self-directed adjustment by the patient. People taking insulin or sulfonylureas face hypoglycaemia risk and need their doses reviewed by their prescriber in advance, and those on sodium-glucose cotransporter-2 (SGLT2) inhibitors face a risk of euglycaemic ketoacidosis on very-low-carbohydrate or ketogenic diets and should discuss this risk with their clinician before starting [7].

Carbohydrate quality, fibre and glycaemic index

A series of meta-analyses commissioned by the World Health Organization found that higher intakes of dietary fibre and whole grains were associated with 15–30% lower all-cause and cardiovascular mortality, and incidence of T2D, in the general population [16]. In people with diabetes, increasing fibre intake improved HbA1c, fasting glucose, insulin resistance, lipids and body weight in RCTs; benefits were seen up to about 35 g/day [17]. Low-glycaemic-index diets produce modest additional HbA1c reductions, although much of this effect overlaps with higher fibre content [6,17].

Observational data from people with incident T2D support prioritising quality within a lower-carbohydrate pattern. In the Nurses' Health Study and Health Professionals Follow-up Study, higher scores on a low-carbohydrate pattern emphasising plant proteins, unsaturated fats and high-quality carbohydrates were associated with lower all-cause, cardiovascular and cancer mortality among 10,101 adults with incident T2D (hazard ratio for all-cause mortality 0.78 per 10-point increase in a healthy low-carbohydrate score; 95% CI 0.73–0.84), whereas this was not true of patterns emphasising animal protein and refined carbohydrates [18].

Protein

There is no evidence that people with T2D and normal kidney function need to alter usual protein intake of roughly 1–1.5 g/kg/day, or 15–20% of energy [4]. For people with diabetic kidney disease not on dialysis, intake of about 0.8 g/kg/day is recommended; further restriction is not advised because it does not alter glycaemia, cardiovascular risk or rate of kidney function decline [7]. Protein source matters: plant proteins, fish and poultry are preferred over red and processed meat (section 6.2). Adequate protein is particularly important during substantial weight loss and in older adults to limit loss of lean mass (section 9).

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Dietary fat

The type of fat is more important than total fat. Replacing saturated and trans fats with unsaturated fats, particularly from nuts, seeds, olive oil and fish, improves lipid profiles and is associated with lower cardiovascular risk [4,6]. Current guidelines advise limiting saturated fat to less than 10% of energy and avoiding industrially produced trans fats [6,7]. Omega-3 supplementation is not recommended for glycaemic control, and the evidence does not support routine supplementation for cardiovascular prevention in T2D except in selected high-risk individuals [7].

Dietary patterns

Guidelines have shifted from single-nutrient targets to whole dietary patterns, which better reflect how people eat and capture interactions between foods [4,6,7]. Several patterns have good evidence in T2D; common features include abundant vegetables, legumes, fruits, whole grains, nuts and unsaturated oils, with limited refined grains, added sugars, and red and processed meat.

Mediterranean diet

The Mediterranean diet has the strongest trial evidence for both prevention and cardiovascular outcomes, though the two findings come from different analyses of the same high-cardiovascular-risk trial population. In a subgroup of the PREDIMED trial without diabetes at baseline, an ad libitum Mediterranean diet supplemented with extra-virgin olive oil reduced diabetes incidence (prevention) by about 30% compared with a low-fat control diet, with little change in body weight [19]. Separately, across the full PREDIMED cohort, in which roughly half of participants already had T2D at enrolment, the same dietary intervention reduced major cardiovascular events, a secondary-prevention/long-term-prognosis outcome rather than a glycaemic management outcome [20].

PREDIMED-Plus tested whether adding energy restriction and physical activity improved on this. In 4,746 adults aged 55–75 years with overweight or obesity and metabolic syndrome, an energy-reduced Mediterranean diet (about 600 kcal/day deficit) plus physical activity and weight-loss support reduced T2D incidence by 31% over 6 years compared with an ad libitum Mediterranean diet alone [21]. Cumulative incidence was 9.5% versus 12.0%, an absolute reduction of about 2.6 cases per 1,000 person-years, and the intervention group also achieved greater reductions in body weight and waist circumference [21]. In people with newly diagnosed T2D, a low-carbohydrate Mediterranean diet delayed the need for glucose-lowering medication compared with a low-fat diet over 4 years [22].

DASH and other healthy patterns

The Dietary Approaches to Stop Hypertension (DASH) pattern, rich in fruits, vegetables, low-fat dairy and whole grains and low in sodium, lowers blood pressure and LDL cholesterol and is associated with lower incidence of T2D and cardiovascular disease in cohort studies [23]. Its blood-pressure benefit is particularly relevant given that most people with T2D also have hypertension. Consistent with this, the ADA advises people with diabetes to limit sodium intake to less than 2,300 mg/day, as recommended for the general population [7].

Plant-based and vegetarian diets

In a meta-analysis of nine prospective cohorts including more than 300,000 participants, higher adherence to plant-based dietary patterns was associated with about 23% lower T2D risk [24]. The association was stronger for "healthful" plant-based indices that favour whole grains, fruits, vegetables, nuts and legumes, and was absent or reversed for "unhealthful" indices that include refined grains, potatoes and sugary drinks [24,25]. Randomised trials of vegan and vegetarian diets in people with T2D report modest improvements in HbA1c, weight and LDL cholesterol, but are mostly small and short [6].

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Summary

These patterns are not directly comparable: the Mediterranean evidence above comes mainly from large primary-prevention and secondary cardiovascular-prevention RCTs in mixed populations with and without T2D; the DASH evidence is predominantly observational; and the plant-based and lower-carbohydrate evidence mixes prospective cohorts with small, short RCTs in people who already have T2D. Differences in population, intervention intensity, comparator diet and outcome definition mean that reported effect sizes should not be ranked against one another directly. Within those limits, no single pattern is clearly superior for glycaemic control when energy intake is matched. The ADA and EASD both endorse Mediterranean, DASH, plant-based and lower-carbohydrate patterns as acceptable options, selected according to personal preference, culture and cardiometabolic goals [6,7]. Long-term adherence, rather than the specific pattern, is the main determinant of benefit.

Foods and beverages

Most evidence on individual foods comes from prospective cohorts and concerns prevention — that is, the risk of developing T2D — rather than the management of established disease; where a food has also been tested in people who already have T2D, this is stated explicitly. Causal inference is therefore limited, but consistency across large, diverse cohorts, dose–response relationships and supportive feeding studies strengthen several associations. Unless stated otherwise, the percentages below are relative risks or hazard ratios from these cohorts; because baseline risk varies between populations, the same relative risk corresponds to a larger absolute risk difference in groups who already have more risk factors for T2D. Table 1 summarises the direction and strength of the main findings.

Whole grains, legumes and fibre

Whole grains and cereal fibre are among the most consistently protective foods for T2D risk, and increasing fibre improves glycaemic and lipid outcomes in people with diabetes (section 4.2) [16,17]. Legumes add fibre and plant protein with a low glycaemic response and are a core component of Mediterranean and plant-based patterns.

Red and processed meat

The largest analysis to date, an individual-participant federated meta-analysis of 31 cohorts in 20 countries (1.97 million adults, 107,271 incident cases, median follow-up 10 years), found that 50 g/day of processed meat was associated with a 15% higher risk of T2D and 100 g/day of unprocessed red meat with a 10% higher risk [26]. Poultry showed a weaker positive association, which the authors considered uncertain [26]. In substitution analyses, replacing processed meat with unprocessed red meat or poultry was associated with lower T2D incidence [26]. Associations were somewhat weaker than in earlier published meta-analyses, possibly reflecting publication bias in prior work [26]. Plausible mechanisms include haem iron, nitrites and nitrosamines, advanced glycation end-products and saturated fat.

Ultra-processed foods

An umbrella review of 45 pooled analyses graded the evidence linking greater ultra-processed food (UPF) exposure with higher T2D risk as among the most robust of all UPF–health associations [27]. In the European EPIC cohort (311,892 adults, 14,236 incident cases over a mean of 10.9 years), each 10% increment in the proportion of daily food intake from UPF was associated with 17% higher T2D risk, and replacing UPF with unprocessed or minimally processed foods was associated with lower risk [28]. However, UPF is heterogeneous. In three large US cohorts, refined breads, sauces and condiments, sugar- and artificially sweetened beverages, animal-based products and ready-to-eat mixed dishes were associated with higher risk, whereas cereals, dark and whole-grain breads, and yoghurt and dairy-based desserts were associated with lower risk [29]. EPIC showed similar heterogeneity across UPF subgroups [28]. In a tightly controlled inpatient feeding trial, a UPF diet caused spontaneous excess intake of about 500 kcal/day and weight gain compared with an unprocessed diet matched

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for presented macronutrients [30]. Guidance should therefore focus on limiting specific UPF categories rather than on processing level alone.

Sugar-sweetened beverages and fruit juice

Each daily serving of sugar-sweetened beverages is associated with roughly 13–18% higher T2D incidence, depending on adjustment for adiposity [31]. Water is the preferred replacement. The ADA recommends that people with diabetes replace sugar-sweetened beverages, including fruit juices, with water or low-calorie options as often as possible [7].

Potatoes and refined starches

In three US cohorts (205,107 participants, 22,299 incident cases), each additional three servings per week of French fries was associated with 20% higher T2D risk, whereas baked, boiled or mashed potatoes were not significantly associated with risk [32]. Replacing three weekly servings of French fries with whole grains was associated with 19% lower risk, while replacing potatoes with white rice was associated with higher risk [32]. Replacing total potatoes with whole grains was associated with 8% lower risk, and replacing baked, boiled or mashed potatoes with 4% lower risk [32]. This illustrates that the preparation method and the replacement food both determine the net effect.

Dairy, nuts and coffee

Yoghurt intake is consistently associated with lower T2D risk. In 2024 the US Food and Drug Administration allowed a qualified health claim that regular yoghurt consumption (at least 2 cups per week) may reduce the risk of T2D, while noting that the evidence is limited [33]. Nut consumption improves lipids and modestly improves glycaemia in trials and is a component of the PREDIMED intervention [6,19]. Habitual coffee drinking, caffeinated or decaffeinated, is associated with about 6% lower T2D risk per daily cup in cohort studies [34]. None of these foods should be presented as treatments, but they can be included within a healthy pattern.

Table 1. Summary of evidence for selected foods and beverages and type 2 diabetes

Food or beverage	Direction of association with T2D risk	Main evidence type	Certainty
Whole grains, cereal fibre	Lower risk; improves HbA1c in T2D	Cohorts, RCTs	High
Processed meat	Higher risk (15% per 50 g/day)	Pooled cohorts	Moderate
Unprocessed red meat	Higher risk (10% per 100 g/day)	Pooled cohorts	Moderate
Ultra-processed foods (overall)	Higher risk; heterogeneous by subgroup	Cohorts, one feeding RCT	Moderate
Sugar-sweetened beverages	Higher risk (13–18% per serving/day)	Cohorts	Moderate–high
French fries	Higher risk (20% per 3 servings/week)	Cohorts	Low–moderate
Boiled, baked or mashed potatoes	No significant association	Cohorts	Low
Yoghurt	Lower risk	Cohorts	Low–moderate
Coffee	Lower risk (about 6% per cup/day)	Cohorts	Moderate
Nuts	Neutral to lower risk; improves lipids	Cohorts, RCTs	Moderate

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Certainty reflects our informal, narrative-review judgement of confidence in the direction of the association — based on study design (randomised evidence weighted above cohort evidence), consistency across independent cohorts or trials, and directness of the outcome — and is not a formal GRADE assessment. Certainty describes confidence in the estimate, not the size of the association: a food can carry a small but highly certain effect, or a large but uncertain one.

Meal timing, time-restricted eating and intermittent fasting

Intermittent fasting and time-restricted eating (TRE) improve glycaemia in T2D mainly by reducing energy intake, and current trials show them to be comparable, but not superior, to conventional energy restriction. They are reasonable options for people who find them easier to follow.

Time-restricted eating

In a 6-month RCT of 75 adults with obesity and T2D, 8-hour TRE (eating between noon and 8 pm) produced greater weight loss than daily calorie restriction, and HbA1c fell to a similar extent in both intervention groups compared with controls [35]. In an Australian RCT of 51 adults with T2D and overweight, TRE from 10:00 to 19:00 was non-inferior to individualised dietitian-led advice for HbA1c over 6 months, with reductions of 0.4 and 0.3 percentage points respectively [36]. Neither trial reported excess hypoglycaemia, but both excluded or carefully adjusted high-risk medications.

Intermittent energy restriction

A 12-month RCT in people with T2D found that intermittent energy restriction on 2 days per week (the 5:2 approach) was non-inferior to continuous energy restriction for HbA1c reduction [37]. The EARLY trial randomised 405 Chinese adults with early T2D and overweight or obesity to a 16-week 5:2 meal-replacement programme, metformin or empagliflozin [38]. The 5:2 meal-replacement group achieved greater HbA1c reduction and weight loss than either drug group at 16 weeks, with mean reductions of 1.9 percentage points in HbA1c and 9.7 kg in body weight [38]. Durability beyond the intervention period and applicability to other populations remain uncertain.

Clinical considerations

Fasting regimens require medication adjustment by the prescribing clinician, not independent dose changes by the patient, in people using insulin or sulfonylureas, because of hypoglycaemia risk on fasting days, and caution in those taking SGLT2 inhibitors. Earlier eating windows may offer additional benefit through alignment with circadian variation in insulin sensitivity, but trial evidence in T2D is limited. The same considerations apply to religious fasting such as Ramadan, for which structured pre-fast education and medication review with the clinical team are recommended [7].

Non-nutritive sweeteners, alcohol and dietary supplements

Non-nutritive sweeteners

Non-nutritive sweeteners (NNS) are best viewed as a transitional tool for replacing sugar-sweetened products, not as a health-promoting food. In 2023 the World Health Organization issued a conditional recommendation against using non-sugar sweeteners for weight control or reducing noncommunicable disease risk, citing no long-term benefit for body fat and possible associations with higher T2D and cardiovascular risk in observational studies [39]. Importantly, the recommendation explicitly excludes people with pre-existing diabetes, and the observational associations are vulnerable to reverse causation, since people at higher metabolic risk are more likely to choose sweetened products [39].

For people who habitually drink sugar-sweetened beverages, a meta-analysis of RCTs found that substituting low- or no-calorie sweetened beverages produced small improvements in body weight and cardiometabolic risk factors, similar to substituting water [40]. The ADA supports NNS as a short-term replacement for sugar-sweetened products while encouraging water as the long-term goal [7]. Emerging data linking the sugar alcohol

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erythritol to platelet reactivity and cardiovascular events are mechanistic and observational and require confirmation [41].

Alcohol

Alcohol provides energy without nutritional benefit, can cause delayed hypoglycaemia in people using insulin or sulfonylureas, and raises triglycerides and blood pressure at higher intakes. Earlier observational findings suggesting cardiometabolic benefit from light drinking have been weakened by analyses that account for "sick quitter" bias; a meta-analysis of 107 cohorts found no significant reduction in all-cause mortality with low-volume drinking compared with lifelong abstention [42]. Current guidance is that adults with diabetes who drink should limit intake to no more than one drink per day for women and two for men, and should not be encouraged to start drinking for health reasons [4,7].

Dietary supplements

There is no clear evidence that vitamin, mineral or herbal supplements improve glycaemia in people with T2D who are not deficient, and routine use is not recommended [7]. Vitamin D is the most thoroughly tested. In the D2d trial of 2,423 adults with prediabetes, 4,000 IU/day of vitamin D3 did not significantly reduce progression to diabetes over a median of 2.5 years [43]. An individual-participant meta-analysis of three trials in prediabetes, however, found a 15% relative reduction in new-onset diabetes with vitamin D supplementation, suggesting a modest benefit that may not justify population-wide use [44]. Evidence for chromium, magnesium, cinnamon and other botanicals is inconsistent and generally of low quality [4,6]. One supplement-related issue is clinically important: long-term metformin use is associated with vitamin B12 deficiency, and periodic B12 measurement is recommended, particularly in people with peripheral neuropathy [7].

Nutrition in the era of GLP-1 receptor agonists and incretin therapies

GLP-1 RAs and dual glucose-dependent insulinotropic polypeptide (GIP)/GLP-1 agonists have changed what is achievable in T2D, but they make nutrition care more important, not less. Much of the quantitative evidence on their nutritional effects comes from trials conducted in people with obesity, who may or may not have had T2D; where a finding has not been separately confirmed in T2D-specific trials, it is presented below as extrapolated rather than as direct T2D evidence. In these obesity trials, placebo-adjusted weight reductions of about 5–18% were produced largely by reducing appetite and energy intake [45]. That reduced intake raises new nutritional risks that dietitians and clinicians need to manage in people with T2D as well.

In 2025, four professional societies (the American College of Lifestyle Medicine, the American Society for Nutrition, the Obesity Medicine Association and The Obesity Society) published a joint advisory on nutritional priorities for people receiving GLP-1-based therapy [45]. This is an expert-consensus advisory rather than a synthesis of T2D-specific trial data. Its eight priorities include baseline nutritional assessment, management of gastrointestinal side effects, a personalised nutrient-dense and minimally processed diet, prevention of micronutrient deficiencies, adequate protein intake combined with resistance training to preserve lean mass, and wider lifestyle support covering activity, sleep and stress [45]. The advisory itself addresses obesity rather than T2D specifically; people with T2D were well represented in the underlying trials, so we judge its principles to be reasonably extrapolated to T2D nutrition care, but we are not aware of a T2D-specific advisory or trial that tests these priorities as a bundle in people with T2D.

Three issues deserve particular attention in T2D. First, rapid weight loss includes a meaningful proportion of lean tissue — an observation again drawn mainly from obesity trials and body-composition substudies — which is a particular concern in older adults and those with sarcopenia; prioritising protein at each meal and resistance exercise can help mitigate this [45]. Second, when intake falls sharply, diet quality determines whether micronutrient needs are met, so energy-dense, nutrient-poor foods should be the first to be reduced. Third, weight is largely regained after stopping treatment: in the STEP 1 extension, a trial in adults with overweight or obesity (not specifically T2D), participants regained about two-thirds of the weight they had lost within 1 year of stopping semaglutide, with parallel reversal of cardiometabolic improvements [46]. Dietary habits established

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during treatment may therefore be critical for long-term outcomes, but this has not yet been tested in adequately powered trials in people with T2D specifically.

Finally, incretin therapy does not remove the need for sulfonylurea or insulin dose adjustment when intake falls, and gastrointestinal effects can be reduced by smaller meals, stopping eating at satiety, and limiting high-fat and very sweet foods.

Precision nutrition, glycaemic variability and the microbiome

Personalised approaches to diet are promising but not yet ready to replace pattern-based advice. The strongest rationale is the large variation between individuals in postprandial glucose response to identical foods. In a landmark study of 800 people using continuous glucose monitoring (CGM), responses to standardised meals varied widely, and an algorithm incorporating gut microbiome, anthropometric and blood data predicted responses better than carbohydrate content alone [47]. The PREDICT 1 study later showed that genetic factors explained only a modest share of the variation in postprandial glucose, triglyceride and insulin responses, with meal timing, sleep, activity and microbiome contributing substantially [48].

In a 6-month RCT in adults with prediabetes, a diet personalised by predicted postprandial response improved time in glycaemic range and HbA1c more than a Mediterranean diet [49]. Evidence in established T2D is limited, and long-term outcome data are absent. By contrast, tailoring diets to genotype has not proved useful: in the DIETFITS trial, neither a genotype pattern nor baseline insulin secretion modified weight loss on healthy low-fat versus healthy low-carbohydrate diets [50].

The gut microbiome is a plausible mediator of dietary effects. In a trial in people with T2D, a high-fibre diet selectively promoted short-chain fatty acid–producing bacteria and improved HbA1c more than a control diet [51]. Microbiome-targeted therapies such as specific probiotics remain experimental.

CGM is increasingly used by people with T2D who are not taking insulin, and it can be a useful educational tool for showing the glycaemic effects of meals, food order and post-meal activity [7]. Its value for guiding dietary change in this population is still being evaluated, and interpretation should emphasise overall patterns rather than avoidance of individual nutritious foods.

Implementation: medical nutrition therapy, guidelines and food insecurity

The evidence reviewed above only benefits patients if it is delivered in a way people can sustain. The ADA recommends that all people with diabetes be referred for individualised MNT, preferably from a registered dietitian nutritionist, at diagnosis and as needed thereafter [7]. MNT delivered by dietitians has been associated with absolute HbA1c reductions of roughly 0.3–2.0 percentage points in T2D, alongside improvements in weight and cardiovascular risk factors [4,7].

Practical approaches

For many people, simple tools are more effective than detailed nutrient targets. The diabetes plate method (half the plate non-starchy vegetables, one-quarter lean protein, one-quarter high-fibre carbohydrate, with water to drink) is easy to teach and suitable for those with limited health literacy [4]. Carbohydrate counting remains essential for people using flexible insulin regimens. Advice should respect cultural food traditions; culturally adapted interventions improve engagement and outcomes compared with generic advice, and traditional diets can usually be adapted rather than replaced. None of the dietary approaches discussed in this review, including carbohydrate restriction, total diet replacement, time-restricted eating and intermittent fasting, should prompt patients to adjust glucose-lowering medication on their own; medication changes should always be made or supervised by the treating clinician.

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Table 2. Key nutrition recommendations for adults with or at risk of type 2 diabetes

Area	Recommendation	Strength of supporting evidence
Weight management	Aim for at least 5–7% weight loss if overweight; offer intensive energy restriction (for example, TDR) to motivated people with recent-onset T2D seeking remission	High
Dietary pattern	Choose a sustainable healthy pattern: Mediterranean, DASH, healthful plant-based or lower-carbohydrate	High (Mediterranean); moderate (others)
Carbohydrate	Prioritise whole grains, legumes, vegetables and fruit; minimise refined grains and added sugars; lower-carbohydrate intake is an option with medication review	Moderate–high
Fibre	Aim for at least 25–35 g/day, mainly from foods	Moderate–high
Fat	Replace saturated and trans fats with unsaturated fats	Moderate
Protein	Maintain usual intake; favour plant, fish and poultry sources over red and processed meat; ensure adequacy during weight loss	Moderate
Beverages	Replace sugar-sweetened beverages with water; NNS acceptable as a transitional substitute	Moderate
Meal timing	TRE and intermittent energy restriction are acceptable alternatives to daily restriction with medication adjustment	Low–moderate
Incretin therapy	Pair with nutrient-dense diet, adequate protein and resistance exercise	Low–moderate (expert consensus)

Strength of supporting evidence follows the same informal, narrative-review judgement described for Table 1 (study design, consistency and directness), not a formal GRADE assessment, and reflects confidence in the recommendation rather than the magnitude of expected benefit.

Food insecurity and social determinants

Food insecurity is common among people with T2D and is associated with worse glycaemic control and higher rates of hypoglycaemia. The ADA recommends screening for food insecurity and linking affected people to community resources [7]. However, rigorous evidence on "food-as-medicine" interventions is mixed. In a randomised trial of 500 adults with T2D, HbA1c of at least 8% and food insecurity, an intensive 1-year programme at one rural and one urban site, providing groceries for 10 meals per week for the household, plus dietitian, nursing and coaching support, increased engagement with preventive care but did not improve HbA1c at 6 months compared with a wait-list control [52]. HbA1c improved substantially in both groups, underlining the need for randomised controls when evaluating such programmes [52].

Research gaps and future directions

Several important questions remain unresolved:

- **Durability.** Most dietary RCTs in T2D last 6–24 months. Trials with 5-year or longer follow-up and hard outcomes (cardiovascular events, microvascular complications, mortality) are needed, particularly for low-carbohydrate diets, TRE and remission programmes.

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- **Diet and incretin therapy together.** The contribution of diet quality to lean-mass preservation, micronutrient status and weight maintenance during and after GLP-1 RA or dual agonist treatment has not been tested in adequately powered trials.

- **Diverse populations.** Evidence is concentrated in European, North American and East Asian populations. South Asian, African and Latin American populations, who carry a large and rising share of the T2D burden, are under-represented, as are people with T2D at a lower body mass index.

- **Ultra-processed foods.** Mechanistic trials are needed to separate the effects of processing, additives and food matrix from nutrient composition, and to identify which UPF subgroups drive risk.

- **Precision nutrition.** Personalised response-based diets need testing in people with established T2D, over longer periods and against strong comparator diets, with attention to cost and equity.

- **Implementation.** Effective, scalable models for delivering MNT, addressing food insecurity and supporting weight maintenance in routine care remain a priority.

CONCLUSIONS

Nutrition remains a cornerstone of T2D prevention and management, and the evidence base has strengthened considerably since 2019. Substantial weight loss through structured energy restriction can induce remission in a meaningful proportion of people with recent-onset T2D, although sustaining it requires long-term support. Several dietary patterns, particularly Mediterranean, healthful plant-based and lower-carbohydrate approaches that prioritise food quality, improve glycaemia and cardiometabolic risk, and no single pattern is universally superior. Large pooled cohort analyses reinforce advice to limit processed and red meat, sugar-sweetened beverages, fried potatoes and specific categories of ultra-processed food, while favouring whole grains, legumes, fibre, nuts, yoghurt and coffee within a healthy pattern. Time-restricted eating and intermittent fasting are effective alternatives to daily restriction for those who prefer them. In the era of incretin therapies, nutrition care is shifting from achieving weight loss to protecting lean mass, ensuring nutritional adequacy and supporting long-term maintenance. Individualised, culturally appropriate and sustainable dietary change, supported by trained professionals and equitable access to healthy food, should remain central to T2D care.

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