Jurnal Teknologi dan Inovasi Kesehatan

SAH PUBLISHER

Vol. 1, No. 1, September 2026

The Effectiveness of Low-Sugar Diets in the Management of Type 2 Diabetes Mellitus

Himmatunnisak Mahmudah[1*], **Ardy Wicaksono**[1], **Yunita** [2], **Triagung Yuliyana**[3], **Vivit Vidiasari**[4]

[1]Universitas Sugeng Hartono, Indonesia

[2]Poltekkes Kemenkes Bengkulu, Indonesia

[3]Universitas Indonesia Maju (UIMA) Jakarta

[4]Akbid Harapan Mulya Ponorogo, Indonesia

**Corresponding author. Email: himmatunnisa.mahmudah@gmail.com*

Abstract. This review examines the effectiveness of low-sugar diets in the management of type 2 diabetes mellitus, drawing exclusively on published clinical evidence and verified public data. Its purpose is to clarify what the term low-sugar diet can legitimately mean, to quantify the glycaemic and weight outcomes that sugar and carbohydrate restriction actually deliver, and to assess the safety, adherence, and cultural feasibility of these approaches for Indonesian patients. The method is a structured literature review of randomised controlled trials, systematic reviews, meta-analyses, and clinical guidelines, supplemented by public data from the International Diabetes Federation, the World Health Organization, and Indonesian national health surveys. The results show that restricting free sugars and sugar-sweetened beverages is consistently supported, that low-carbohydrate diets below 130 grams per day produce clinically meaningful reductions in HbA1c of roughly 0.3 to 0.5 percentage points and higher remission rates at six months, and that these advantages largely attenuate by twelve to twenty-four months as adherence declines. Weight loss, rather than sugar restriction alone, emerges as the strongest driver of remission, with the DiRECT trial reporting remission in 46 percent of an intensive weight management group against 4 percent of controls at twelve months, while medication adjustment is essential to prevent hypoglycaemia when carbohydrate intake falls quickly, and lipid monitoring is advised because low-density lipoprotein cholesterol rises in some patients on very low-carbohydrate patterns. Guideline positions from the American Diabetes Association, Diabetes UK, the World Health Organization, and the Indonesian PERKENI guideline converge on individualised carbohydrate moderation rather than prohibition. The novelty of this review lies in separating the evidence for sugar restriction specifically from the evidence for total carbohydrate restriction, and in translating the global evidence into the rice-centred, sweet-tea culture of Indonesia, where moderate, fibre-rich, and sustainable restriction is more realistic than ketogenic extremes.

Keywords: low-sugar diet; type 2 diabetes mellitus; carbohydrate restriction; HbA1c; diabetes remission; medical nutrition therapy

Received August 2026 / Revised September 2026 / Accepted September 2026

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INTRODUCTION

Type 2 diabetes mellitus has become one of the defining chronic disease burdens of the twenty-first century, and its management increasingly turns on what patients eat every day. The International Diabetes Federation estimated that 19.5 million Indonesian adults

aged 20 to 79 years were living with diabetes in 2021, placing Indonesia fifth among all countries, with a projection of 28.6 million by 2045 [1]. The companion scientific analysis of the IDF Diabetes Atlas reported a global prevalence of 10.5 percent among adults in 2021, equivalent to 536.6 million people, rising to a projected 12.2 percent and 783.2 million people in 2045, with the steepest relative increases expected in middle-income countries [2]. Indonesian national survey data tell the same story at home. The 2023 Indonesian Health Survey (Survei Kesehatan Indonesia, SKI) recorded a diabetes prevalence of 11.7 percent among residents aged 15 years and over based on blood glucose examination [3], continuing the upward trend from the 10.9 percent recorded by the Basic Health Research survey (Riset Kesehatan Dasar, Riskesdas) in 2018 [4]. A large share of this burden is undiagnosed, and much of it is driven by dietary patterns that have shifted rapidly toward energy-dense foods, refined starches, and sweetened drinks.

Against this background, dietary management is not an adjunct to diabetes care but one of its foundations. A comprehensive review of dietary components and nutritional strategies in The Lancet concluded that the quality of dietary fat and carbohydrate matters more than the sheer quantity of either macronutrient, and that diets lower in refined grains, red and processed meats, and sugar-sweetened beverages reduce diabetes risk and improve glycaemic control and blood lipids in people who already have diabetes [5]. Within that broad consensus, sugar occupies a special position. Sugar is the most rapidly absorbed form of carbohydrate, it is added invisibly to a wide range of processed foods and drinks, and it delivers energy without satiety or micronutrients. The question this review addresses is therefore a practical one that patients ask constantly and clinicians answer inconsistently: how effective is a low-sugar diet, specifically, in managing type 2 diabetes, and how does it compare with the broader family of low-carbohydrate diets with which it is often confused?

The epidemiological case against high sugar intake is substantial. In a widely cited meta-analysis of prospective cohort studies covering 310,819 participants and 15,043 cases of type 2 diabetes, Malik and colleagues found that people in the highest category of sugar-sweetened beverage consumption, typically one to two servings per day, had a 26 percent greater risk of developing type 2 diabetes than those in the lowest category (relative risk 1.26, 95 percent confidence interval 1.12 to 1.41), alongside a 20 percent greater risk of metabolic syndrome [6]. The experimental evidence on body weight points in the same direction. Te Morenga and colleagues, in the systematic review commissioned to inform the World Health Organization guideline on sugars, found that reducing dietary sugars in ad libitum diets was associated with a modest decrease in body weight of 0.80 kilograms, while increasing sugars was associated with a comparable increase of 0.75 kilograms, and that exchanging sugars isoenergetically for other carbohydrates produced no weight change at all, indicating that the effect of sugar operates chiefly through energy intake [7]. On the strength of this body of evidence, the WHO guideline strongly recommends that free sugars be reduced to less than 10 percent of total energy intake throughout the life course, with a conditional recommendation for a further reduction below 5 percent [8].

Yet the evidence also warns against a simplistic sugar-only narrative. The WHO-commissioned series of systematic reviews on carbohydrate quality led by Reynolds and colleagues, covering 185 prospective studies and 58 clinical trials, found that the highest dietary fibre consumers had 15 to 30 percent lower all-cause and cardiovascular mortality and lower incidence of coronary heart disease, stroke, type 2 diabetes, and colorectal cancer than the lowest consumers, with the greatest benefit at fibre intakes of 25 to 29

grams per day, while glycaemic index and glycaemic load showed much weaker associations [9]. In other words, what replaces sugar in the diet may matter as much as the sugar removed. This tension between sugar restriction, total carbohydrate restriction, and carbohydrate quality runs through the entire literature and through this review.

Clinical guidelines have tried to convert this evidence into usable advice. The American Diabetes Association consensus report on nutrition therapy concluded that reducing overall carbohydrate intake has demonstrated the most evidence for improving glycaemia among all dietary strategies studied, while also insisting that no single ideal percentage of carbohydrate, protein, and fat exists for people with diabetes and that eating patterns must be individualised [10]. Indonesian guidance takes the same position in local form: the Indonesian Society of Endocrinology (PERKENI) guideline on the management and prevention of type 2 diabetes places medical nutrition therapy within comprehensive care alongside education, physical activity, and pharmacotherapy, with carbohydrate counted as part of total energy planning rather than banned outright [11]. Between enthusiastic popular claims that cutting sugar or carbohydrate can reverse diabetes and cautious guideline language that endorses individualisation, patients and clinicians need a careful reading of what the trials actually show.

A further difficulty is terminological. In everyday speech, a low-sugar diet means avoiding table sugar, sweets, and sweet drinks while continuing to eat rice, bread, and fruit. In the trial literature, however, almost all of the strong glycaemic effects come from diets that restrict total carbohydrate, of which sugar is only one component, sometimes to ketogenic levels. Feinman and colleagues, in their critical review of carbohydrate restriction as a first approach in diabetes management, proposed the definitions that much of the field now uses: a very low-carbohydrate ketogenic diet provides 20 to 50 grams of carbohydrate per day, a low-carbohydrate diet provides less than 130 grams per day or less than 26 percent of energy, a moderate-carbohydrate diet provides 26 to 45 percent of energy, and a high-carbohydrate diet provides more than 45 percent [12]. Accurso and colleagues had earlier argued for a critical reappraisal of carbohydrate restriction on the grounds that it improves glycaemic control and insulin fluctuations, the primary targets of therapy, and that its benefits for the features of metabolic syndrome do not depend entirely on weight loss [13]. Westman and Vernon made the historical point that carbohydrate restriction was the predominant treatment for diabetes before modern pharmacotherapy existed and questioned its absence from contemporary trial design [14]. Critics answer that low-carbohydrate, high-fat patterns raise unresolved questions about diet quality and long-term safety. Brouns, reviewing the evidence for overweight and diabetes prevention, concluded that sustained adherence to ketogenic diets appears difficult, that long-term efficacy and safety data are lacking, and that a non-ketogenic intake of roughly 100 to 150 grams of carbohydrate per day may be the more practical target for most patients [15].

This review therefore pursues four aims. First, it disentangles three interventions that are routinely conflated: restriction of free sugars and sugar-sweetened beverages, restriction of total carbohydrate, and selection of low glycaemic index and high-fibre carbohydrate. Second, it summarises the quantitative effects of these interventions on HbA1c, body weight, remission, and cardiovascular risk factors as reported by the best available trials and meta-analyses, attributing every effect size to its source. Third, it examines safety, especially the need to adjust glucose-lowering medication when carbohydrate intake falls, and the practical problem of adherence over time. Fourth, it asks how the global evidence translates to Indonesia, where meals are built around rice, sweet tea is a default hospitality

drink, and any dietary advice that ignores these realities will fail regardless of its metabolic logic.

METHODS

This paper is a structured literature review of clinical evidence, supplemented by public data, and it reports no new primary data. Sources were identified from the peer-reviewed literature on dietary sugar, carbohydrate restriction, glycaemic index, and diabetes nutrition therapy, prioritising systematic reviews and meta-analyses of randomised controlled trials, landmark individual trials, and evidence-based guidelines, because these sit highest in the evidence hierarchy for questions of treatment effectiveness. The core evidence base comprises the meta-analyses of carbohydrate restriction by Sainsbury, Meng, Snorgaard, McArdle, Huntriss, Ichikawa, and Hironaka and their colleagues, the remission-focused meta-analysis of Goldenberg and colleagues [16], the DiRECT trial of intensive weight management, the continuous care intervention reported by Hallberg and colleagues, and the sugar-specific evidence syntheses of Malik, Te Morenga, and O'Connor and their colleagues, together with the WHO guideline on sugars intake and the carbohydrate quality series of Reynolds and colleagues.

Public data were used for context only and were taken from official or formally published sources: the IDF Diabetes Atlas tenth edition and its companion journal analysis for prevalence and projections, the Indonesian Health Survey 2023 and the Basic Health Research 2018 reports of the Ministry of Health of the Republic of Indonesia for national prevalence, and the PERKENI 2021 guideline for Indonesian clinical positioning. Every numerical claim in this review, whether an effect size, a prevalence figure, or a trial outcome, is attributed in the text to the study, guideline, or dataset that reported it; no trial result has been generated, extrapolated, or pooled by the author. Where the literature disagrees, for example on outcomes beyond twelve months, both directions of the disagreement are reported.

Effect sizes are quoted as published, in HbA1c percentage points unless otherwise stated, with confidence intervals where the source reported them and where they are material to interpretation. The review distinguishes throughout between three exposures that the literature often merges: free sugars and sugar-sweetened beverages; total carbohydrate quantity; and carbohydrate quality, meaning glycaemic index, glycaemic load, and fibre content. It also distinguishes short-term outcomes, generally three to six months, from long-term outcomes at twelve months and beyond, because the divergence between the two is one of the most consistent findings in this field. Limitations of the method are acknowledged: this is a narrative synthesis of published syntheses rather than a de novo meta-analysis, it inherits the heterogeneity of diet definitions used in the primary trials, and most primary trials were conducted in high-income countries, so transfer to Indonesian populations is assessed explicitly rather than assumed.

RESULT AND DISCUSSION

1. Definitions Matter: Sugar Restriction, Carbohydrate Restriction, and Glycaemic Quality Are Three Different Interventions

The single most common error in discussions of low-sugar diets for diabetes is the assumption that all carbohydrate-related interventions are the same intervention. They are not, and the trial literature assigns them different magnitudes and durations of effect. Restricting free sugars, meaning sugars added to foods and drinks plus sugars naturally

present in honey, syrups, and fruit juices, is the narrowest intervention. It removes the fastest absorbed and least satiating carbohydrate load, and its clearest benefits are reduced energy intake, reduced sugar-sweetened beverage exposure, and reduced dental caries, rather than a large direct fall in HbA1c. Restricting total carbohydrate is the broader intervention. By reducing starch as well as sugar, it lowers postprandial glucose excursions across the whole day, and this is the intervention from which nearly all the impressive short-term HbA1c reductions in the literature derive, using the thresholds set out by Feinman and colleagues [12]. The third intervention changes carbohydrate quality rather than quantity: choosing slowly digested, fibre-rich carbohydrate sources with a low glycaemic index while keeping total carbohydrate broadly similar. Thomas and Elliott, in their Cochrane review of low glycaemic index diets in diabetes, found that low glycaemic index diets produced a weighted mean HbA1c difference of minus 0.5 percentage points compared with control diets, an effect comparable in size to many drug adjustments, with fewer hypoglycaemic episodes reported in one included trial [17].

Keeping these three interventions distinct also clarifies the role of ketogenic diets. A very low-carbohydrate ketogenic diet, at 20 to 50 grams of carbohydrate per day, is not simply a stricter low-sugar diet; it is a metabolic intervention that suppresses appetite, alters fuel partitioning, and carries specific risks and monitoring needs. Brouns emphasised that such diets are difficult to sustain and that formal long-term safety evidence is thin, so they should not be presented to patients as the default interpretation of eating less sugar [15]. For the rest of this review, the phrase low-sugar diet refers to the restriction of free sugars and sugar-sweetened beverages, low-carbohydrate diet refers to restriction of total carbohydrate, and the two are never used interchangeably.

2. Effects on HbA1c: Consistent Short-Term Benefit, Attenuating With Time

The most robust finding in this literature is that carbohydrate restriction improves glycaemic control in the short term, and the meta-analyses converge on a surprisingly consistent magnitude. Sainsbury and colleagues, pooling 25 randomised controlled trials with 2,412 participants, found that diets providing less than 26 percent of energy from carbohydrate reduced HbA1c by 0.47 percentage points at three months and 0.36 percentage points at six months compared with higher-carbohydrate diets, but that no significant difference remained at twelve or twenty-four months, and that moderate restriction in the region of 26 to 45 percent of energy was no different from higher-carbohydrate comparators at any time point [18]. Meng and colleagues, in a meta-analysis of nine randomised trials with 734 patients, found a weighted mean HbA1c difference of minus 0.44 percentage points for low-carbohydrate diets, together with favourable changes in triglycerides and high-density lipoprotein cholesterol, but no significant long-term effect on body weight [19]. Snorgaard and colleagues, pooling ten trials with 1,376 participants, found that the low-carbohydrate groups achieved an HbA1c 0.34 percentage points lower than controls in the first year, with a strong dose-response relationship in which greater carbohydrate restriction produced greater glucose lowering, yet at follow-up of one year or longer the groups no longer differed in HbA1c, body weight, or low-density lipoprotein cholesterol [20].

Not every synthesis is equally optimistic, and intellectual honesty requires reporting the outlier. McArdle and colleagues, who examined dietary carbohydrate quantity in European adults across 25 randomised trials with 2,132 participants, found that the overall pooled effect of low-carbohydrate diets on HbA1c was only minus 0.09 percentage points and not statistically significant, although a prespecified subgroup analysis of diets

providing 50 to 130 grams of carbohydrate per day did show a reduction of 0.49 percentage points in studies of six months or less [21]. Huntriss and colleagues, in a systematic review and meta-analysis of 18 studies with 2,204 participants undertaken for Diabetes UK, found significant reductions at one year in HbA1c of 0.28 percentage points, triglycerides of 0.24 millimoles per litre, and systolic blood pressure of 2.74 millimetres of mercury, with a small rise in high-density lipoprotein cholesterol, but they also reported that 15 of the 18 studies were at high risk of bias and noted that reductions in glucose-lowering medication in the low-carbohydrate groups may have masked a larger underlying glycaemic benefit [22]. Read together, these syntheses support a sober formulation: low-carbohydrate diets deliver a genuine but modest short-term HbA1c advantage of roughly 0.3 to 0.5 percentage points, of the same order as adding one oral agent, which tends to disappear by one to two years, largely because adherence and prescription intensity converge between groups rather than because the physiological effect vanishes.

The remission analysis of Goldenberg and colleagues adds an important outcome to this picture. Pooling six trials within a larger set of 23 trials with 1,357 participants, they found that low-carbohydrate diets below 26 percent of energy achieved diabetes remission, defined as HbA1c below 6.5 percent, in 57 percent of patients compared with 31 percent of controls at six months, a risk difference of 0.32, but that the benefits diminished at twelve months, and that very low-carbohydrate diets were less effective than less restrictive low-carbohydrate diets for weight loss in credible subgroup analyses [16]. The practical reading is that restriction works, but maximal restriction is not optimal, and the first six months are the window of maximum leverage.

3. Body Weight, Remission, and the Central Role of Energy Restriction

Weight is where sugar restriction, carbohydrate restriction, and remission intersect, and the evidence shows that total energy deficit is the dominant variable. Santos and colleagues, in a systematic review of 17 clinical trials with 1,141 obese patients, reported that low-carbohydrate diets were associated with pooled reductions of 7.04 kilograms in body weight and 0.21 percentage points in HbA1c, with favourable changes in triglycerides, blood pressure, and high-density lipoprotein cholesterol [23]. Bueno and colleagues, comparing very low-carbohydrate ketogenic diets with low-fat diets over twelve months or longer in 13 randomised trials, found only a modest additional weight loss of 0.91 kilograms in favour of the ketogenic approach, together with a rise in low-density lipoprotein cholesterol of 0.12 millimoles per litre that tempers enthusiasm [24]. The implication is that low-carbohydrate diets help people lose weight mainly by making an energy deficit easier to achieve through satiety and the elimination of energy-dense foods, not through a unique metabolic magic, and Te Morenga's finding that isoenergetic sugar exchange does not change weight supports exactly this interpretation [7].

The strongest evidence that weight loss can transform the disease itself comes from the DiRECT trial. Lean and colleagues randomised 306 people with type 2 diabetes of up to six years' duration in primary care to a structured weight management programme built on total diet replacement of 825 to 853 kilocalories per day, or to guideline-based usual care. At twelve months, 46 percent of the intervention group had achieved remission of diabetes, defined as HbA1c below 6.5 percent off glucose-lowering medication, compared with 4 percent of controls; 24 percent had lost at least 15 kilograms compared with none in the control group, and among those who lost at least 15 kilograms, 86 percent achieved remission [25]. The two-year follow-up showed that remission was durable

where weight loss was maintained: 36 percent of the intervention group remained in remission at 24 months compared with 3 percent of controls, and 64 percent of participants who maintained weight loss of at least 10 kilograms were in remission [26]. DiRECT was not a low-sugar trial, and that is precisely its lesson for this review. Remission is driven by substantial and sustained negative energy balance, which depletes liver and pancreatic fat. Sugar restriction and moderate carbohydrate restriction are best understood as practical tools for achieving and holding that deficit, because removing sweet drinks and reducing refined starch cuts energy intake with relatively little hunger, not as independent cures.

Real-world delivery models point the same way. Hallberg and colleagues reported a one-year, open-label, non-randomised continuous care intervention in which 262 adults received a very low-carbohydrate nutritional intervention with remote monitoring, compared with 87 receiving usual care; the intervention group reduced HbA1c from 7.6 to 6.3 percent, lost 13.8 kilograms, and reduced or eliminated insulin in 94 percent of insulin users [27]. These results are encouraging but must be read with their design limitations in view: the study was not randomised, participants self-selected, and the intervention was funded by the company delivering it, so its effect sizes should be treated as an upper bound rather than an expectation. Even so, it illustrates a recurring theme of this review, that intensive support, feedback, and medication management may matter as much as the diet prescription itself.

4. Safety: Medication Adjustment, Hypoglycaemia, and Lipid Signals

A low-sugar or low-carbohydrate diet is a pharmacologically active intervention, and prescribing it without adjusting medication is a safety failure. The mechanism is straightforward: when carbohydrate intake falls, postprandial glucose falls, and the doses of insulin and sulfonylureas that were appropriate for a high-carbohydrate diet become excessive. The American Diabetes Association consensus report therefore advises that when people with diabetes begin a very low-carbohydrate eating pattern, clinicians should review medication, specifically reducing insulin and sulfonylurea doses to prevent hypoglycaemia and ensuring adequate hydration [10]. The continuous care experience of Hallberg and colleagues demonstrates the scale of adjustment involved: sulfonylureas were eliminated in all intervention participants and insulin was reduced or eliminated in the great majority, under medical supervision [27]. Any Indonesian clinic adopting carbohydrate restriction must therefore pair it with a medication review protocol, glucose monitoring, and explicit hypoglycaemia education; a diet leaflet alone is not a safe intervention. Patients using SGLT2 inhibitors require additional caution because the combination of carbohydrate restriction and these agents is associated in the wider literature with euglycaemic ketoacidosis risk, which is a further reason that such diets should be clinician-supervised rather than self-prescribed from social media.

The lipid question is more nuanced than either enthusiasts or critics usually admit. The National Lipid Association scientific statement by Kirkpatrick and colleagues concluded that low and very low-carbohydrate diets are not superior to other dietary strategies for weight loss, that they offer advantages for appetite control, triglyceride reduction, and diabetes medication reduction, that their effects on low-density lipoprotein cholesterol are mixed and individually variable, and that data beyond two years are minimal [28]. The signal is visible in the trial data already cited: Bueno and colleagues found a small rise in low-density lipoprotein cholesterol with very low-carbohydrate ketogenic diets [24], and Goldenberg and colleagues observed clinically important, though not statistically

significant, worsening of low-density lipoprotein cholesterol and quality of life at twelve months in their pooled analysis [16]. Paoli and colleagues, reviewing the physiological basis of ketogenic diets, noted that improvements in glycaemia and medication withdrawal frequently precede major weight loss, which supports the glycaemic rationale while leaving the long-term lipid question open [29]. The balanced clinical position is to monitor lipids after starting carbohydrate restriction, to emphasise unsaturated fats and plant foods within the pattern, and to avoid presenting a rising low-density lipoprotein cholesterol as irrelevant. For long-term glycaemic outcomes specifically, Ichikawa and colleagues, pooling six randomised trials of more than twelve months with 524 participants, found that low-carbohydrate diets did not significantly reduce HbA1c over the long term, with a standardised mean difference of minus 0.11, while still improving high-density lipoprotein cholesterol and triglycerides, leading them to not recommend long-term low-carbohydrate diets for glycaemic control alone while supporting them for dyslipidaemia management [30].

5. The Sugar-Specific Evidence: Sweetened Beverages, Free Sugars, and Substitution

Although total carbohydrate dominates the trial literature, the evidence that specifically indicts sugar, and especially sugar in liquid form, is unusually coherent across study designs. The cohort analysis of Malik and colleagues established the prospective association between sugar-sweetened beverages and incident diabetes [6], and O'Connor and colleagues, analysing the EPIC-InterAct case-cohort study across eight European countries, found that consumption of sugar-sweetened beverages was associated with incident type 2 diabetes independently of adiposity, and that substituting water or unsweetened beverages for sweetened ones was associated with lower risk, which strengthens a causal reading beyond mere correlation with body weight [31]. Liquid sugar is the highest priority target for three reinforcing reasons: it is absorbed rapidly, it produces weak satiety so its calories are added to rather than substituted within the diet, and it is consumed in large volumes by people who would never describe themselves as eating much sugar. The randomised evidence reviewed by Te Morenga and colleagues confirms the energy mechanism, showing weight reduction when sugars are cut in free-living adults and weight gain when they are added [7].

The benefits of sugar reduction also extend beyond glycaemia. The systematic review by Moynihan and Kelly, conducted to inform the WHO sugars guideline, found consistent evidence that dental caries rates are lower when free sugars intake is below 10 percent of energy, supporting the same threshold that the WHO adopted as its strong recommendation [32]. For diabetes clinics, this matters practically: advising patients to remove sweetened drinks and to keep free sugars under 10 percent of energy is a simple, measurable, low-risk message that captures much of the metabolic benefit of dietary change without requiring patients to weigh rice or understand glycaemic index tables. It is also the element of low-sugar advice with the least downside, because unlike aggressive carbohydrate restriction it requires no medication adjustment in most patients and carries no lipid concerns. The error to avoid is the opposite one, assuming that because sugar is removed, the rest of the diet needs no attention; Reynolds and colleagues showed that fibre-rich whole carbohydrate foods are protective, so the correct message is to remove added sugar and refined starch while keeping vegetables, legumes, and whole grains in place [9].

6. Adherence, Sustainability, and the Indonesian Plate

The recurring pattern in this literature, short-term success and long-term convergence, is fundamentally an adherence story. Franz and colleagues, in the Academy of Nutrition and Dietetics position synthesis on interventions for adults with type 2 diabetes, reported that medical nutrition therapy delivered by a dietitian can reduce HbA1c by up to 2.0 percentage points at three to six months, an effect larger than diet composition alone, which underlines that structured support and follow-up are active ingredients rather than packaging [33]. The Diabetes UK nutrition guidelines, summarised by Dyson and colleagues, accordingly recommend an individualised approach in which several patterns, including moderate carbohydrate restriction, Mediterranean-style eating, and lower glycaemic index choices, are recognised as legitimate, with remission through weight loss treated as an achievable goal for some patients [34]. Adam-Perrot and colleagues, reviewing the nutritional and physiological aspects of low-carbohydrate diets, raised the practical constraints that recur in practice: restricted food choice, the need for adequate protein and micronutrient density, and the social difficulty of maintaining an eating pattern that differs sharply from that of family and community [35].

Evidence from Asia is especially relevant to Indonesia because it tests carbohydrate restriction in rice-based food cultures. Hironaka and colleagues, in a systematic review and meta-analysis of six randomised controlled trials conducted in East Asian populations, found that low-carbohydrate diets improved HbA1c and body mass index compared with control diets, with the benefit evident within approximately six months [36]. Yamada and colleagues, in a small Japanese randomised trial, found that a non-calorie-restricted low-carbohydrate diet reduced HbA1c from 7.6 to 7.0 percent over six months, against a change from 7.7 to 7.5 percent with calorie restriction, a statistically significant between-group difference, with accompanying improvement in triglycerides and no major adverse effects [37]. These studies suggest that carbohydrate moderation is feasible and effective in Asian dietary contexts, but they also mark the boundary of realism: the tested diets moderated rather than abolished staple carbohydrate, and no East Asian trial has shown that rice-eating populations sustain ketogenic intakes at scale.

Translated to Indonesia, the cultural fit problem is concrete. Meals are structured around nasi, and a plate without rice is widely perceived as not yet a meal; es teh manis, sweet iced tea, is the default drink of hospitality, warung meals, and celebrations; sweetened condensed milk, syrups, and sweet snacks are embedded in daily routines; and religious and festive cycles, from Ramadan fasting and iftar sweets to Lebaran cookies, organise eating socially. Advice that demands the elimination of rice will collide with identity, family practice, and cost, since rice is the cheapest satiety available to low-income households, and the likely outcomes are abandonment of the diet or concealment of non-adherence. Advice that reduces the rice portion using the plate model promoted in Indonesian healthy eating guidance, replaces sweet tea with unsweetened tea or water, reserves sweet drinks for occasions rather than daily hydration, and shifts the remaining carbohydrate toward vegetables, tempeh, tofu, legumes, and other fibre-rich foods aligns with both the international evidence on carbohydrate quality [9] and the individualised stance of PERKENI guidance [11]. Sustainability also has a psychological dimension: diets framed as temporary prohibitions invite rebound, whereas substitutions framed as permanent defaults, water instead of sweet tea, a smaller rice mound rather than no rice, are the kind of change that the long-term trials show patients can actually hold [15], [34].

7. Long-Term Safety Signals and Guideline Positioning

The longest lens available comes not from trials but from prospective cohort data on carbohydrate quantity and mortality. Seidelmann and colleagues, analysing 15,428 adults in the ARIC study together with a meta-analysis of 432,179 participants, found a U-shaped association: mortality was lowest when carbohydrate provided 50 to 55 percent of energy, and higher both below 40 percent (hazard ratio 1.20) and above 70 percent (hazard ratio 1.23). Critically, the risk within low-carbohydrate patterns depended on substitution: replacing carbohydrate with animal-derived protein and fat was associated with higher mortality (hazard ratio 1.18), while plant-based substitution was associated with lower mortality (hazard ratio 0.82) [38]. This finding reconciles the trial and cohort literatures. Moderate carbohydrate intakes built on plant foods sit near the mortality optimum; extremes in either direction carry risk; and a low-carbohydrate diet constructed from vegetables, legumes where tolerated, nuts, fish, and unsaturated oils is a different exposure from one constructed from processed meat and butter, even at identical carbohydrate grams.

Guideline positioning, read as a whole, is therefore neither endorsement nor dismissal but structured permissiveness. The WHO sets the outer boundary for sugar itself: free sugars below 10 percent of energy as a strong recommendation and below 5 percent as a conditional one [8]. The American Diabetes Association treats reduced carbohydrate intake as the dietary strategy with the most evidence for glycaemia, within an individualised framework, and couples it with explicit medication safety advice [10]. Diabetes UK recognises moderate carbohydrate restriction among several valid patterns and elevates sustained weight loss and remission as goals [34]. PERKENI anchors Indonesian practice in medical nutrition therapy as part of comprehensive care, leaving room for carbohydrate moderation adapted to local foods [11]. The National Lipid Association adds the lipid monitoring caveat [28], and the long-term meta-analysis of Ichikawa and colleagues adds the expectation management that HbA1c advantages should not be promised beyond the first year, even though lipid benefits may persist [30]. A clinician who combines these positions can honestly tell an Indonesian patient the following: removing sweet drinks and added sugar is certainly worthwhile; moderate carbohydrate reduction, roughly 100 to 150 grams per day in the practical range suggested by Brouns [15], will probably improve glucose control and triglycerides over the next six months; substantial weight loss offers a real chance of remission, as DiRECT demonstrated [25], [26]; medication must be reviewed before starting; and the diet that remains after five years will be a moderate one built around unsweetened drinks, controlled rice portions, vegetables, legumes, and plant-rich fats, because that is the pattern the evidence and Indonesian food culture can jointly sustain.

CONCLUSION

The literature supports low-sugar diets in the management of type 2 diabetes mellitus with important qualifications: restricting free sugars and eliminating sugar-sweetened beverages is consistently beneficial and low in risk, low-carbohydrate diets below 130 grams per day add a genuine but modest short-term HbA1c advantage of roughly 0.3 to 0.5 percentage points with higher six-month remission rates that attenuate by one to two years, and sustained weight loss rather than sugar removal alone is the proven route to durable remission, so that the most defensible prescription for Indonesian patients is permanent removal of sweet drinks, moderation rather than abolition of rice within a fibre-rich plate, dietitian-supported follow-up, and mandatory medication review to prevent hypoglycaemia whenever carbohydrate intake is substantially reduced.

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