International Journal of Innovative Technologies in Social Science

e-ISSN: 2544-9435

Operating Publisher
SciFormat Publishing Inc.
ISNI: 0000 0005 1449 8214

2734 17 Avenue SW,
Calgary, Alberta, T3E0A7,
Canada
+15878858911
editorial-office@sciformat.ca

ARTICLE TITLE	COMPREHENSIVE TREATMENT OF TYPE 2 DIABETES IN PATIENTS WITH OBESITY: THE ROLE OF PATIENT EDUCATION, WEIGHT REDUCTION, PHARMACOTHERAPY AND LIFESTYLE MODIFICATION - A NARRATIVE REVIEW
DOI	https://doi.org/10.31435/ijitss.2(50).2026.5796
RECEIVED	07 March 2026
ACCEPTED	17 May 2026
PUBLISHED	28 May 2026
LICENSE	The article is licensed under a **Creative Commons Attribution 4.0 International License.**

COMPREHENSIVE TREATMENT OF TYPE 2 DIABETES IN PATIENTS WITH OBESITY: THE ROLE OF PATIENT EDUCATION, WEIGHT REDUCTION, PHARMACOTHERAPY AND LIFESTYLE MODIFICATION - A NARRATIVE REVIEW

Magdalena Fąfara *(Corresponding Author, Email: magdalenaf613@gmail.com)*
Medical College, The Jan Kochanowski University in Kielce, Kielce, Poland
ORCID ID: 0009-0001-8524-9870

Margarita Jeczkało
Medical College, The Jan Kochanowski University in Kielce, Kielce, Poland
ORCID ID: 0009-0003-1103-090X

Monika Kosiorowska
Medical College, The Jan Kochanowski University in Kielce, Kielce, Poland
ORCID ID: 0009-0002-5447-6365

Agata Kowalczyk
Medical College, The Jan Kochanowski University in Kielce, Kielce, Poland
ORCID ID: 0009-0000-9027-7270

Joanna Lasoń
Medical College, The Jan Kochanowski University in Kielce, Kielce, Poland
ORCID ID: 0009-0004-7463-7626

Marcelina Makulska
Medical College, The Jan Kochanowski University in Kielce, Kielce, Poland
ORCID ID: 0009-0008-2075-106X

Weronika Płachta
Medical College, The Jan Kochanowski University in Kielce, Kielce, Poland
ORCID ID: 0009-0003-2460-9435

Wiktoria Sęk
Medical College, The Jan Kochanowski University in Kielce, Kielce, Poland
ORCID ID: 0009-0001-3452-7025

Amelia Sieradzka
Medical College, The Jan Kochanowski University in Kielce, Kielce, Poland
ORCID ID: 0009-0005-9588-3065

Cezary Wegenko
Medical College, The Jan Kochanowski University in Kielce, Kielce, Poland
ORCID ID: 0009-0005-4920-7963

ABSTRACT

Type 2 diabetes and obesity are closely connected chronic conditions that require a comprehensive, patient-centred approach. Traditional management focused primarily on glycaemic control, whereas contemporary care increasingly recognizes weight reduction, cardiovascular-kidney-metabolic risk reduction and digital health tools as integral components of treatment. This narrative review synthesizes current evidence on the complex management of type 2 diabetes in adults with obesity, with emphasis on diabetes self-management education and support, intentional weight loss, lifestyle modification, pharmacotherapy and technology-enabled care. Publications were selected from PubMed-indexed literature, clinical guidelines, systematic reviews, meta-analyses and randomized controlled trials relevant to the intersection of diabetes, obesity, education, lifestyle and innovative health technologies. Education can improve glycaemic control and adherence. Structured weight-management interventions can support clinically meaningful weight loss and, in selected patients, remission of type 2 diabetes. Nutrition therapy and physical activity remain foundational, but their implementation requires individualized counselling, behavioural strategies and attention to social determinants of health. Pharmacotherapies such as metformin, sodium-glucose cotransporter 2 inhibitors (SGLT2 inhibitors), glucagon-like peptide-1 receptor agonists (GLP-1 receptor agonists) and dual glucose-dependent insulinotropic polypeptide/glucagon-like peptide-1 receptor agonists (dual GIP/GLP-1 receptor agonists) have shifted treatment from a purely glucose-centred model toward weight-centred. Digital health applications, wearable devices and continuous glucose monitoring may strengthen education and self-management, although equity and long-term engagement remain. Integrated care models combining education, weight management, pharmacotherapy and digital follow-up are likely to produce the greatest clinical and public health benefit.

KEYWORDS

Type 2 Diabetes, Obesity, Patient Education, Weight Reduction, Pharmacotherapy, Lifestyle Modification

CITATION

Magdalena Fąfara, Margarita Jeczkało, Monika Kosiorowska, Agata Kowalczyk, Joanna Lasoń, Marcelina Makulska, Weronika Płachta, Wiktoria Sęk, Amelia Sieradzka, Cezary Wegenko. (2026) Comprehensive Treatment of Type 2 Diabetes in Patients with Obesity: The Role of Patient Education, Weight Reduction, Pharmacotherapy and Lifestyle Modification - A Narrative Review. *International Journal of Innovative Technologies in Social Science*. 2(50). doi: 10.31435/ijitss.2(50).2026.5796

1. Introduction

Type 2 diabetes mellitus (T2D) and obesity are two interrelated chronic conditions that represent a major challenge for health systems, patients, families and societies. Their coexistence is common, clinically important and difficult to manage because excess adiposity contributes to insulin resistance, chronic low-grade inflammation, ectopic fat deposition, beta-cell stress and multiple cardiometabolic complications (Chobot et al., 2018; Gadde et al., 2018; Lu et al., 2024; Taylor, 2025). In adults with obesity and T2D, treatment is rarely limited to the normalization of blood glucose (Davies et al., 2022; American Diabetes Association Professional Practice Committee for Diabetes, 2026a; Kalyani et al., 2025). Effective care must also address body weight, blood pressure, lipid profile, cardiovascular and kidney risk, health-related quality of life, social determinants of health and the patient's ability to understand and sustain long-term self-management behaviours (Davies et al., 2022; American Diabetes Association Professional Practice Committee for Diabetes, 2026a; Hill-Briggs et al., 2021).

For many years, the treatment of T2D was commonly described in a glucose-centred way: treatment was intensified when glycated haemoglobin (HbA1c) remained above target, and success was often measured mainly by glycaemic outcomes. This approach remains important because glycaemic control reduces the risk of microvascular complications and improves symptoms of hyperglycaemia. However, contemporary evidence and clinical guidance increasingly support a broader model. The 2022 consensus report of the American Diabetes Association and the European Association for the Study of Diabetes emphasized person-centred care, shared decision-making, weight management, cardiorenal risk reduction, social determinants of health and diabetes self-management education and support. Similarly, recent standards of care and clinical reviews position obesity management and pharmacotherapy selection as central to the treatment plan for many patients

with T2D and obesity (Davies et al., 2022; American Diabetes Association Professional Practice Committee for Diabetes, 2026a, 2026b; Kalyani et al., 2025).

The shift from a glucose-centred to an integrated model is particularly relevant in the context of innovative technologies and social science (Davies et al., 2022; Hill-Briggs et al., 2021; Bretschneider et al., 2025). Patients do not experience T2D as a set of isolated laboratory values. They experience the daily work of monitoring food choices, physical activity, medications, appointments, costs, stigma, stress and digital tools (Hill-Briggs et al., 2021; Gonzalez-Zacarias et al., 2016). In this sense, diabetes care is not only a biomedical issue but also an educational, behavioural and social challenge (Davies et al., 2022; Chrvala et al., 2016; Hill-Briggs et al., 2021).

The coexistence of T2D and obesity also creates a substantial treatment workload for patients. In routine life, the patient is expected to combine dietary decisions, physical activity, medication adherence, symptom interpretation, weight monitoring and follow-up visits while also managing family, work and financial responsibilities. This workload is not evenly distributed across society. Patients with lower socioeconomic status, limited health literacy or restricted access to specialist care may experience greater difficulty in translating clinical recommendations into sustainable action (Davies et al., 2022; Gonzalez-Zacarias et al., 2016; Hill-Briggs et al., 2021; Barrios Quinta et al., 2022).

The aim of this narrative review is to synthesize current evidence on the comprehensive treatment of T2D in patients with obesity, focusing on four interdependent pillars: patient education, weight reduction, pharmacotherapy and lifestyle modification. A secondary aim is to discuss how digital technologies and social determinants of health can support or limit implementation of these interventions in routine care.

2. Methodology

This article is a narrative review. The literature base was based from PubMed-indexed publications and peer-reviewed full-text articles relevant to T2D, obesity, patient education, weight management, pharmacotherapy, lifestyle interventions and digital health. The review prioritized clinical practice guidelines, consensus reports, systematic reviews, meta-analyses, randomized controlled trials and high-quality narrative reviews published mainly between 2015 and 2026. Older articles were included when they provided foundational evidence or conceptual background, such as the mechanisms of metformin or the clinical role of exercise in T2D.

Search concepts were organized into thematic blocks: type 2 diabetes and obesity; diabetes self-management education and support, health literacy, adherence; weight loss, weight management and diabetes remission; nutrition therapy, physical activity and lifestyle intervention; glucose-lowering and weight-lowering pharmacotherapy, including metformin, sodium-glucose cotransporter 2 inhibitors (SGLT2i), glucagon-like peptide-1 receptor agonists (GLP-1 RA), dual glucose-dependent insulinotropic polypeptide/glucagon-like peptide-1 receptor agonists (GIP/GLP-1 RA) and insulin therapy; digital health, mobile applications, telemedicine, wearable devices and continuous glucose monitoring and social determinants of health, health inequalities, stigma and barriers to adherence. Typical search terms included “type 2 diabetes”, “obesity”, “patient education”, “diabetes self-management education”, “DSMES”, “weight loss”, “lifestyle modification”, “exercise”, “diet therapy”, “GLP-1 receptor agonist”, “SGLT2 inhibitor”, “tirzepatide”, “semaglutide”, “mHealth”, “telemedicine”, “continuous glucose monitoring” and “social determinants of health”.

Studies were included if they addressed adults with T2D, obesity or overweight. Studies focused exclusively on type 1 diabetes, gestational diabetes, paediatric populations, molecular mechanisms without clinical implications or animal models were not central to the synthesis. Because this is a narrative review rather than a systematic review, no formal meta-analysis, risk-of-bias scoring or PRISMA flow diagram was prepared. Evidence was synthesized thematically, with attention to clinical implications and relevance for education, technology and public health.

During synthesis, the included publications were grouped according to their main contribution to the integrated care model. Particular attention was paid to whether studies described clinically relevant outcomes such as HbA1c, body weight, waist circumference, cardiovascular and kidney risk, medication adherence, quality of life, self-management behaviours and access to care. Evidence from pharmacological trials was interpreted together with educational and behavioural evidence because, in practice, medication effectiveness depends on correct use, tolerability, affordability and follow-up.

3. Results

3.1. Obesity as a driver and treatment target in type 2 diabetes

Obesity contributes to the development and progression of T2D through several overlapping mechanisms (Gadde et al., 2018; Lu et al., 2024; Kong et al., 2025). Increased visceral adiposity is associated with insulin resistance, higher free fatty acid flux, inflammatory cytokine production, hepatic steatosis and pancreatic beta-cell stress. The relationship is not merely correlational: excess ectopic fat in the liver and pancreas has been proposed as a central mechanism in the development and potential reversibility of T2D in susceptible individuals (Taylor, 2025). Obesity also increases the risk of hypertension, dyslipidaemia, sleep apnoea, osteoarthritis, cardiovascular disease and reduced quality of life. These conditions can interfere with diabetes self-management by limiting exercise tolerance (Chobot et al., 2018; Gadde et al., 2018; Kong et al., 2025).

Weight reduction is therefore a therapeutic target, not only a cosmetic or lifestyle goal (American Diabetes Association Professional Practice Committee for Diabetes, 2026a; Davies et al., 2022). Even moderate weight loss can improve insulin sensitivity, glycaemic control and cardiometabolic risk factors, while larger weight reductions may produce more substantial benefits and, in selected patients with shorter disease duration, remission of T2D (Ryan & Yockey, 2017; Taylor, 2025). This principle is reflected in contemporary guidelines that increasingly recommend weight management as part of the core treatment of T2D, especially in patients with obesity (American Diabetes Association Professional Practice Committee for Diabetes, 2026a; Davies et al., 2022).

Clinicians and health educators should avoid treating glycaemia and body weight as separate problems. A patient with T2D and obesity should be offered a plan that explains how nutrition, physical activity, sleep, stress, medications and self-monitoring fit together. The plan should be realistic and individualized (Davies et al., 2022; American Diabetes Association Professional Practice Committee for Diabetes, 2026a; Kalyani et al., 2025).

The goal is to recognize excess adiposity as a modifiable driver of cardiometabolic risk while avoiding moral judgements about the patient. Many adults with obesity have experienced repeated unsuccessful weight-loss attempts and inconsistent medical advice. These experiences may reduce willingness to attend appointments or begin physical activity. A comprehensive model should therefore explain the biological and environmental determinants of obesity, and present treatment options as forms of support (Davies et al., 2022; Rubino et al., 2020; Schabert et al., 2013).

Examples of comprehensive diabetes management are presented in Table 1.

Table 1. Comprehensive treatment of type 2 diabetes in patients with obesity

Treatment domain	Expected benefit	Main evidence base
Patient education and DSMES	Improved HbA1c, self-management, adherence and confidence	Systematic reviews, meta-analyses and education trials (Chrvala et al., 2016; Chowdhury et al., 2024; Roshan-Nejad et al., 2024).
Weight reduction	Improved insulin sensitivity, lower HbA1c, improved cardiometabolic risk and possible remission in selected patients	Weight-management trials, dietary trials and pharmacotherapy studies (Maula et al., 2020; Mueller et al., 2025; Ryan & Yockey, 2017; Umphonsathien et al., 2022).
Lifestyle modification	Weight loss, improved body composition, better fitness and quality of life	Nutrition, physical activity and behavioural intervention studies (Forouhi, 2023; Petroni et al., 2021; Kirwan et al., 2017; Li et al., 2024).
Pharmacotherapy	Glycaemic control, weight reduction, cardiorenal protection and reduced treatment burden in selected patients	Guidelines, RCTs and meta-analyses of metformin, SGLT2i, GLP-1 RA and GIP/GLP-1 RA (American Diabetes Association Professional Practice Committee for Diabetes, 2026b; Davies et al., 2022; Hu et al., 2024; Karagiannis et al., 2022).
Digital health and telemedicine	More frequent feedback, education reinforcement and easier monitoring	mHealth, app, telemedicine, wearable and CGM studies (Bentley et al., 2016; Enricho Nkhoma et al., 2021; Bretschneider et al., 2025; Yin et al., 2022).

3.2. Patient education, self-management and health literacy

Patient education is a core treatment component because T2D requires daily decisions outside the clinic. Patients must understand medication timing, nutrition, physical activity, self-monitoring, hypoglycaemia risk, weight-management strategies, follow-up appointments and warning symptoms. Diabetes self-management education and support (DSMES) aims to develop knowledge, skills and problem-solving capacity. It should be understood as an ongoing process rather than a one-time recommendation at diagnosis (Chrvala et al., 2016; Chowdhury et al., 2024; Davies et al., 2022).

Systematic reviews show that diabetes self-management education is associated with improved glycaemic outcomes in adults with T2D (Chrvala et al., 2016). More recent evidence from low- and middle-income countries also shows the effect of DSME on HbA1c and cardiometabolic outcomes, although intervention intensity and follow-up vary substantially between studies (Chowdhury et al., 2024). Educational weight-loss interventions in adults with T2D and obesity have also shown potential benefit, particularly when education is paired with structured behavioural support and practical weight-management tools (Maula et al., 2020).

Health literacy is especially important in patients with obesity and T2D because treatment plans are becoming more complex. Modern therapy may include several medication classes, injectable therapy, dietary targets, physical activity prescriptions, home monitoring and digital applications. A patient who does not understand why a medication is prescribed, how to titrate it, how to manage gastrointestinal adverse effects or how to interpret glucose readings is less likely to adhere to treatment. Teach-back training and literacy-sensitive education can improve treatment adherence and aspects of quality of life (Roshan-Nejad et al., 2024; Davies et al., 2022; Bretschneider et al., 2025).

Education should be individualized. A person newly diagnosed with T2D and obesity may need basic explanation of insulin resistance, nutrition, medication options and the meaning of HbA1c (Chrvala et al., 2016; Davies et al., 2022). A person with long-standing T2D on insulin therapy may need support in preventing hypoglycaemia during weight loss, adjusting diet and exercise, and understanding newer pharmacotherapies (Davies et al., 2022; Kalyani et al., 2025; American Diabetes Association Professional Practice Committee for Diabetes, 2026b). Education also needs to address beliefs, weight stigma, previous unsuccessful diet attempts and financial barriers (Rubino et al., 2020; Hill-Briggs et al., 2021). Motivational interviewing and shared decision-making can improve engagement by respecting autonomy (Chrvala et al., 2016; Roshan-Nejad et al., 2024; Davies et al., 2022).

A practical educational programme for patients with T2D and obesity should be organized around treatment transitions. At diagnosis, education should focus on understanding the disease, reducing fear and explaining why weight reduction can improve metabolic health (Chrvala et al., 2016; Davies et al., 2022). When pharmacotherapy is initiated or intensified, education should cover expected benefits, adverse effects, titration, missed doses and warning symptoms. When insulin is introduced, the patient needs support in hypoglycaemia prevention, injection technique, carbohydrate awareness and weight-gain prevention (American Diabetes Association Professional Practice Committee for Diabetes, 2026b; Davies et al., 2022). When digital tools are used, patients need instruction on how to interpret data (Bretschneider et al., 2025; Nishikage et al., 2025). In this way, education becomes a continuous clinical process rather than a single informational session (Chrvala et al., 2016; Davies et al., 2022).

The content of education is just as important as the amount of information delivered. Highly technical advice may be scientifically correct but ineffective if the patient cannot translate it into daily decisions (Chrvala et al., 2016; Gonzalez-Zacarias et al., 2016; Roshan-Nejad et al., 2024). Teach-back methods, visual materials, nutrition examples and written action plans can help patients. Education should also include realistic problem-solving: how to choose meals, how to restart activity after a setback and how to manage gastrointestinal symptoms after incretin therapy (Roshan-Nejad et al., 2024; Gonzalez-Zacarias et al., 2016; Yılmaz & Bastemir, 2025).

3.3. Weight reduction and remission-oriented care

Intentional weight loss can improve glycaemic control and reduce treatment burden in patients with T2D and obesity. The degree of benefit depends on baseline body weight, duration of diabetes, beta-cell reserve, intensity of intervention and maintenance of weight loss. Moderate weight loss can improve insulin sensitivity and blood pressure, while larger weight reductions may allow medication de-escalation or remission in selected patients (Maula et al., 2020; Ryan & Yockey, 2017; Taylor, 2025; Liu et al., 2025). For this reason, current obesity and diabetes guidelines increasingly encourage clinicians to define weight-loss goals as part of diabetes

treatment rather than treating weight as a secondary issue (American Diabetes Association Professional Practice Committee for Diabetes, 2026a; Kalyani et al., 2025).

Weight-management interventions may include structured education, commercial behavioural programmes, very-low-calorie diets, pharmacotherapy and metabolic-bariatric surgery (Maula et al., 2020; Kheniser et al., 2021; Umphonsathien et al., 2022; American Diabetes Association Professional Practice Committee for Diabetes, 2026a). The GLoW randomized trial evaluated a remotely delivered tailored diabetes education and behavioural weight-management programme in adults with a recent diagnosis of T2D and overweight or obesity. This type of intervention is important because it combines diabetes education with practical behavioural weight management (Mueller et al., 2025). Trials of intermittent very-low-calorie diets and energy-restricted regimens have also shown improvements in glycaemic control and cardiometabolic risk, but these approaches require medical supervision (Li et al., 2024; Umphonsathien et al., 2022).

The concept of remission has attracted increasing attention in weight-centred T2D care. Remission should not be presented as guaranteed or permanent, but it can be a motivating and clinically meaningful target for some individuals, particularly those with shorter diabetes duration and substantial weight loss. A multicentre trial of dapagliflozin plus calorie restriction reported higher remission rates than calorie restriction alone in selected adults with T2D, suggesting that pharmacological and lifestyle approaches may work synergistically in appropriate patients. However, remission-oriented care must be communicated carefully. Many patients will still benefit from weight loss and improved fitness even when HbA1c targets require continued medication (Liu et al., 2025; Mueller et al., 2025; Taylor, 2025; Ryan & Yockey, 2017).

Long-term weight maintenance is one of the main challenges in obesity care. Biological adaptation, increased appetite, cost, stress and reduced adherence can contribute to weight regain. Therefore, weight management should be designed as chronic care rather than a short-term diet. Follow-up, relapse-prevention strategies and medication review are necessary. Programmes that only deliver information without behavioural support may have limited effects; programmes that combine education, self-monitoring and social support are more likely to be effective (Kheniser et al., 2021; Ryan & Yockey, 2017; Maula et al., 2020).

Clinicians should explain obesity as a chronic, biologically influenced condition and present weight management as part of diabetes treatment rather than as a moral obligation. A useful discussion may focus on the expected health benefits of 5%, 10% or greater weight loss, but also acknowledge that improvements in fitness, waist circumference, blood pressure, glycaemic variability and medication burden can matter even when weight loss is slower than expected. Such communication supports adherence and reduces the risk of disengagement (Rubino et al., 2020; Davies et al., 2022; Ryan & Yockey, 2017).

Preservation of lean mass is another important issue in weight-centred diabetes care. Rapid or substantial weight loss, especially during energy restriction or highly effective incretin-based pharmacotherapy, may be accompanied by loss of muscle mass. For patients with T2D and obesity, this is clinically relevant because skeletal muscle is a major site of glucose disposal and an important determinant of functional independence. Nutritional counselling should therefore consider adequate protein intake where appropriate, and physical activity plans should include progressive resistance training when feasible. This reinforces the need to integrate weight reduction with lifestyle education rather than presenting pharmacotherapy as a stand-alone solution (Anyiam et al., 2025; Kirwan et al., 2017; Sandsdal et al., 2023; Davies et al., 2022).

3.4. Lifestyle modification: nutrition, physical activity and behavioural change

Lifestyle modification remains the foundation of treatment, even in the era of highly effective pharmacotherapy. Nutrition therapy can reduce energy intake, improve glycaemic variability, lower blood pressure and support weight loss. However, the evidence does not support a single universal diet for all patients with T2D and obesity. Mediterranean-style diets, reduced-energy diets, low-carbohydrate approaches, high-protein diets and meal-timing strategies may all be useful for selected patients, depending on clinical status and preferences (Davies et al., 2022; Forouhi, 2023; Petroni et al., 2021).

Low-carbohydrate and ketogenic diets may improve glycaemic control and weight in some patients, but they require attention to nutritional adequacy, lipid changes, kidney function, medication adjustment and patient preference. A randomized trial comparing moderate-carbohydrate and very-low-carbohydrate diets in adults with T2D or prediabetes found clinically relevant metabolic changes, while a systematic review of ketogenic diets reported reductions in HbA1c and fasting glucose (Saslow et al., 2017; Yuan et al., 2020). These findings support individualized dietary counselling rather than rigid dietary prescriptions (Forouhi, 2023; Petroni et al., 2021).

Physical activity improves insulin sensitivity, cardiorespiratory fitness and muscle function. Both aerobic and resistance training are important. Resistance training is particularly relevant during weight loss and incretin-based pharmacotherapy because preservation of lean mass may influence long-term metabolic health, physical function and weight maintenance. Exercise also provides benefits that cannot be fully replaced by medication, including improved mobility, reduced frailty risk and better sleep (Anyiam et al., 2025; Esteves-Stanford & Stanford, 2024; Kirwan et al., 2017).

The challenge is adherence. Patients with obesity and T2D may face fatigue, fear of hypoglycaemia, low fitness or previous negative experiences with exercise (Gonzalez-Zacarias et al., 2016; Barrios Quinta et al., 2022). Effective counselling should therefore move from generic advice such as 'exercise more' to concrete, achievable plans: walking after meals, progressive resistance exercises, step goals or digital voice assistant interventions for older adults (Dickinson et al., 2019; Glavas et al., 2024). Physical activity should be framed as a tool for metabolic health and function rather than only as a method for burning calories (Kirwan et al., 2017; Esteves-Stanford & Stanford, 2024).

Lifestyle interventions also include sleep, stress management and reduction of sedentary time. Stress and poor sleep may worsen appetite regulation, glycaemic control and adherence. In this context, lifestyle medicine is not simply the instruction to eat less and move more; it is a structured behavioural intervention that should be supported by education, follow-up and pharmacotherapy (Forouhi, 2023; Gonzalez-Zacarias et al., 2016; Esteves-Stanford & Stanford, 2024).

Nutrition counselling should be translated into concrete and socially realistic choices. Patients may benefit from guidance on portion size, meal regularity, fibre intake, protein distribution, sugary drinks and ultra-processed foods. A Mediterranean-style eating pattern or a lower-carbohydrate plan may be effective for some patients, but neither will be sustainable if it conflicts completely with the patient's budget or preferences. The educational task is therefore to adapt evidence-based principles to real-life constraints (Forouhi, 2023; Petroni et al., 2021; Hill-Briggs et al., 2021).

Physical activity should also be prescribed with attention to feasibility and safety (Kirwan et al., 2017; Esteves-Stanford & Stanford, 2024). For some patients, the first step may be reducing sedentary time or walking for 10 minutes after meals rather than joining a gym (Kirwan et al., 2017). For others, supervised exercise, resistance training or aquatic exercise may be appropriate (Kirwan et al., 2017; Esteves-Stanford & Stanford, 2024). The goal is to create a progression that the patient can sustain (Kirwan et al., 2017). Combining aerobic activity with resistance exercise is particularly useful because it supports glycaemic control, cardiovascular fitness, muscle preservation and long-term weight maintenance (Kirwan et al., 2017; Esteves-Stanford & Stanford, 2024; Li et al., 2024). Digital step counters or wearable devices may support this process, but only when goals are realistic and feedback is interpreted constructively (Li et al., 2024; Glavas et al., 2024).

3.5. Pharmacotherapy within a weight-centred and organ-protective model

Pharmacotherapy is central to the treatment of T2D, but medication choice should be integrated with weight goals, cardiovascular and kidney risk, cost, tolerability and patient preferences (Davies et al., 2022; Kalyani et al., 2025). Metformin remains widely used, has a long safety record and acts through complex mechanisms including effects on glucose production and cellular energy metabolism (Rena et al., 2017; Yao et al., 2024). Nevertheless, contemporary treatment no longer assumes that metformin alone is sufficient for all patients, especially when obesity, cardiovascular disease, heart failure or chronic kidney disease are present (Davies et al., 2022; Kalyani et al., 2025).

SGLT2 inhibitors reduce glucose through urinary glucose excretion and have important cardiovascular and kidney benefits in selected populations. Their weight effect is usually modest compared with incretin-based agents, but they may contribute to weight reduction and improve cardiorenal outcomes. They require patient education about volume depletion and the rare risk of ketoacidosis. In patients with obesity and T2D, SGLT2 inhibitors can be considered part of broader metabolic rather than only glucose-lowering treatment (Pereira & Eriksson, 2019; Sargeant et al., 2022; American Diabetes Association Professional Practice Committee for Diabetes, 2026b; Davies et al., 2022).

GLP-1 receptor agonists have transformed the management of T2D and obesity. Their effects include glucose-dependent insulin secretion, reduced glucagon secretion during hyperglycaemia, delayed gastric emptying, appetite suppression and weight loss (Müller et al., 2019; Hu et al., 2024). Semaglutide and liraglutide have been studied for obesity treatment and for patients with T2D, showing clinically meaningful weight reduction and glycaemic improvement in appropriate populations (Bergmann et al., 2023; Garvey et al., 2022; Hu et al., 2024; Garvey et al., 2020). Liraglutide 3.0 mg in patients with overweight or obesity and

insulin-treated T2D produced greater weight loss than placebo when combined with intensive behavioural therapy, illustrating the importance of combining medication with behavioural support (Garvey et al., 2020).

Dual GIP/GLP-1 receptor agonists, especially tirzepatide, have extended the weight-centred treatment paradigm (Karagiannis et al., 2022; Nauck & D'Alessio, 2022; Sinha et al., 2023). Systematic reviews and clinical trial programmes suggest substantial reductions in HbA1c and body weight in adults with T2D and obesity (Karagiannis et al., 2022; Nauck & D'Alessio, 2022; Sinha et al., 2023). The SURMOUNT-3 trial showed that tirzepatide after intensive lifestyle intervention produced additional weight loss in adults with overweight or obesity, reinforcing the concept that pharmacotherapy and lifestyle modification may be complementary (Wadden et al., 2023).

Pharmacotherapy also has limitations (Davies et al., 2022; Kalyani et al., 2025). Gastrointestinal adverse effects are common with GLP-1 RA and dual GIP/GLP-1 RA therapy and may reduce adherence if patients are not prepared for gradual titration, meal-size changes and symptom management (Yılmaz & Bastemir, 2025). Weight loss may include loss of lean mass, making protein intake and resistance training clinically important (Anyiam et al., 2025). Cost, availability, insurance coverage and health-system capacity are major barriers (Aroda et al., 2025). Pharmacotherapy must be accompanied by education, follow-up and shared decision-making (Davies et al., 2022).

Insulin therapy remains necessary for some patients, especially those with marked hyperglycaemia, catabolic symptoms, long-standing disease or insufficient beta-cell function. However, insulin can promote weight gain and may increase fear of hypoglycaemia. For patients with obesity, clinicians should periodically reassess whether insulin dose can be simplified or reduced after weight loss, GLP-1 RA, SGLT2i or improved lifestyle adherence. The goal is not to avoid insulin when needed but to use it in a way that minimizes burden and supports the broader metabolic treatment plan (Davies et al., 2022; Kalyani et al., 2025; American Diabetes Association Professional Practice Committee for Diabetes, 2026b).

Medication selection should be accompanied by structured counselling (American Diabetes Association Professional Practice Committee for Diabetes, 2026b; Davies et al., 2022). Patients starting GLP-1 RA or dual GIP/GLP-1 RA treatment need to understand that smaller meals, slower eating and avoidance of very fatty meals may reduce gastrointestinal symptoms (Yılmaz & Bastemir, 2025; Davies et al., 2022). They should also know when nausea is expected and when medical advice is needed (Yılmaz & Bastemir, 2025). Patients prescribed SGLT2 inhibitors need clear instructions on hydration and temporary discontinuation during acute illness (American Diabetes Association Professional Practice Committee for Diabetes, 2026b; Davies et al., 2022). Patients taking insulin or sulfonylureas require education about hypoglycaemia risk when diet and physical activity change (American Diabetes Association Professional Practice Committee for Diabetes, 2026b; Davies et al., 2022). These examples show that pharmacotherapy is inseparable from education and self-management (American Diabetes Association Professional Practice Committee for Diabetes, 2026b; Davies et al., 2022; Yılmaz & Bastemir, 2025).

Equity is also relevant to pharmacotherapy (Hill-Briggs et al., 2021; Davies et al., 2022). Newer agents may be clinically attractive but inaccessible because of price or reimbursement rules (Aroda et al., 2025; Hill-Briggs et al., 2021). If a patient cannot obtain or continue treatment, the treatment plan should not collapse (Hill-Briggs et al., 2021). Clinicians should provide alternative pathways, including nutrition support, physical activity planning, metformin or other appropriate glucose-lowering agents, and referral to obesity or diabetes education services where available (Davies et al., 2022; Kalyani et al., 2025; Hill-Briggs et al., 2021). In this sense, shared decision-making should include not only medical preference but also affordability, treatment burden and continuity of care (Davies et al., 2022; Kalyani et al., 2025; Hill-Briggs et al., 2021).

The practical elements of an integrated patient-centered treatment plan are presented in Table 2.

Table 2. Practical components of a patient-centred integrated treatment plan

Step	Clinical action	Educational content	Technology or social support option
Initial assessment	Evaluate HbA1c, BMI, waist circumference, comorbidities, medications, diet, activity, sleep and psychosocial barriers (Davies et al., 2022; Kalyani et al., 2025; Hill-Briggs et al., 2021).	Explain the link between obesity, insulin resistance, HbA1c and complications	Digital questionnaire, teleconsultation, shared decision aid
Goal setting	Set individualized glycaemic, weight, activity and quality-of-life goals (American Diabetes Association Professional Practice Committee for Diabetes, 2026a; Ryan & Yockey, 2017).	Discuss realistic weight-loss targets and avoid blame-based language	App-based goal tracking or wearable activity monitor
Lifestyle plan	Nutrition therapy, progressive physical activity and behavioural strategies (Forouhi, 2023; Petroni et al., 2021; Kirwan et al., 2017; Li et al., 2024).	Teach meal planning, self-monitoring, hypoglycaemia prevention and relapse management	Calorie-counting app, digital coaching, remote dietitian support
Medication plan	Choose pharmacotherapy according to HbA1c, weight goals, cardiorenal risk, cost and tolerability (American Diabetes Association Professional Practice Committee for Diabetes, 2026b; Davies et al., 2022; Kalyani et al., 2025).	Explain mechanism, benefits, adverse effects, titration and sick-day rules	Medication reminders, remote follow-up, e-prescriptions
Monitoring and follow-up	Review HbA1c, weight, waist, blood pressure, symptoms, adherence and treatment burden (Chrvala et al., 2016; Konnyu et al., 2023; Bretschneider et al., 2025; Nishikage et al., 2025).	Reinforce education, problem-solving and self-efficacy	Telemedicine, CGM, app feedback, peer support

3.6. Digital health, telemedicine and innovative technologies

Mobile health applications, telemedicine, wearable devices, continuous glucose monitoring and digital coaching enable personalised diabetes care beyond the clinic (Enricho Nkhoma et al., 2021; Bretschneider et al., 2025; Yin et al., 2022; Nishikage et al., 2025). They may provide reminders, feedback, educational modules, step counts, nutrition tracking and glucose trends (Bentley et al., 2016; Enricho Nkhoma et al., 2021; Bretschneider et al., 2025).

A feasibility study of portable technology for weight loss and HbA1c control in T2D demonstrated the practical potential of wearable or mobile feedback systems, although small sample size and feasibility design limited conclusions (Bentley et al., 2016). A systematic review and meta-analysis of DSMES app interventions suggested that mobile applications may support medication adherence (Enricho Nkhoma et al., 2021). More recent randomized trials of digital diabetes applications, such as the Vitadio app, reflect increasing interest in structured digital support for glycaemic control, weight, waist circumference, diabetes distress and self-management (Bretschneider et al., 2025).

Telemedicine may be useful for patients with obesity and T2D because it reduces travel burden, supports frequent follow-up and can reinforce education. During the COVID-19 pandemic, telemedicine management was studied in overweight and obese young and middle-aged adults with T2D, illustrating how remote care

can maintain contact when in-person visits are limited (Yin et al., 2022; Hill-Briggs et al., 2021). Digital voice assistants have also been tested for home-based exercise delivery in older adults with obesity and T2D, suggesting that technology can support physical activity when traditional exercise programmes are difficult to access (Glavas et al., 2024).

Continuous glucose monitoring and intermittently scanned systems may provide immediate feedback on the relationship between meals, activity, medications and glucose patterns. This can strengthen education because patients observe how behaviour affects glucose in real time. For some patients with T2D, CGM may improve engagement and reduce glycaemic variability, while for others it may increase anxiety. A pilot randomized controlled trial of intermittently scanned CGM in individuals with overweight and impaired glucose tolerance or mild diabetes illustrates the potential role of glucose-feedback technologies in weight management (Nishikage et al., 2025; Davies et al., 2022).

Despite promise, digital health can widen inequalities if design and implementation are not inclusive. Patients with low digital literacy, older age, limited internet access, low income or disabilities may not benefit equally. Therefore, digital health interventions should be evaluated not only for HbA1c and weight effects but also for usability, engagement, accessibility, equity and integration with routine care (Enricho Nkhoma et al., 2021; Bretschneider et al., 2025; Hill-Briggs et al., 2021).

A mobile application that records glucose, diet and activity may be useful only if the patient receives feedback and if clinicians can interpret the data efficiently. Similarly, CGM data may support education when glucose patterns are reviewed in relation to meals, movement, medication timing and sleep. Without guided interpretation, however, the same data can create confusion or anxiety. Implementation should therefore include training, data governance, clear responsibilities and criteria for when digital alerts require clinical action (Bretschneider et al., 2025; Enricho Nkhoma et al., 2021; Nishikage et al., 2025).

Digital interventions also offer an opportunity to personalize education at scale. Automated reminders, short educational modules, interactive goal setting, teleconsultations and remote monitoring can help maintain contact between clinic visits. Nevertheless, technology should not be assumed to be neutral. Design, language, accessibility for people with disabilities, internet access, data costs and trust in data privacy all influence whether patients benefit. Future digital tools for T2D and obesity should therefore be assessed not only as technical products but also as social interventions embedded in specific communities and health systems (Enricho Nkhoma et al., 2021; Bretschneider et al., 2025; Hill-Briggs et al., 2021; Yin et al., 2022).

3.7. Social determinants, adherence and equity

Comprehensive treatment cannot ignore the social context of disease. Food insecurity, housing conditions, education, medication costs, cultural food practices and mental health all affect the ability to follow treatment recommendations. A person may understand the importance of a healthy diet but lack access to affordable food; another may be willing to exercise but experience joint pain; another may want GLP-1 RA therapy but be unable to afford it. Social determinants are therefore not external to treatment; they are part of treatment implementation (Gonzalez-Zacarias et al., 2016; Barrios Quinta et al., 2022; Hill-Briggs et al., 2021).

Reviews of demographic, socioeconomic and psychological factors show that glycaemic self-management is influenced by more than medical advice (Gonzalez-Zacarias et al., 2016). Health inequalities among disadvantaged patients with T2D may reduce access to structured education, preventive care and effective follow-up (Barrios Quinta et al., 2022). Stigma related to obesity or diabetes can further reduce engagement (Rubino et al., 2020; Schabert et al., 2013). A comprehensive care model should screen for barriers, use education and design goals that are compatible with the patient's life (Gonzalez-Zacarias et al., 2016; Barrios Quinta et al., 2022; Hill-Briggs et al., 2021).

Adherence should be discussed as a shared outcome of patient, clinician, treatment design and health system (Davies et al., 2022; Gonzalez-Zacarias et al., 2016). Complex regimens, poor tolerability, lack of explanation, high cost, low trust, depression and limited follow-up all reduce adherence (Gonzalez-Zacarias et al., 2016; Hill-Briggs et al., 2021). Quality improvement strategies can improve diabetes care when they address system-level processes rather than relying only on individual motivation (Konnyu et al., 2023). Similarly, self-management support interventions in primary care can help translate education into routine practice (Dickinson et al., 2019).

The most innovative diabetes treatment may not be a single drug or app but the integration of biomedical, educational, behavioural and social components. The success of an intervention depends on how it fits into the patient's daily environment and health system (Davies et al., 2022; Konnyu et al., 2023; Dickinson et al., 2019; Hill-Briggs et al., 2021).

Stigma deserves special attention because it can undermine every component of treatment. Weight-related stigma may occur in healthcare encounters, workplaces, families and digital spaces. It can lead to avoidance of care, reduced physical activity in public settings and lower trust in clinicians. Diabetes stigma can similarly affect medication use, glucose monitoring and disclosure of the condition (Rubino et al., 2020; Schabert et al., 2013).

4. Discussion

The evidence reviewed supports a comprehensive model of treatment for adults with T2D and obesity (Davies et al., 2022; American Diabetes Association Professional Practice Committee for Diabetes, 2026a; Kalyani et al., 2025). The four central pillars - patient education, weight reduction, pharmacotherapy and lifestyle modification - are mutually reinforcing (Davies et al., 2022; Chrvala et al., 2016; Maula et al., 2020). Education improves understanding and self-efficacy, which supports lifestyle adherence and medication use (Chrvala et al., 2016; Roshan-Nejad et al., 2024). Weight reduction improves glycaemic and cardiometabolic outcomes, which may reduce treatment burden (Maula et al., 2020; Ryan & Yockey, 2017). Pharmacotherapy can support weight loss and cardiorenal protection, but it requires education and follow-up to maximize benefit and minimize adverse effects (Davies et al., 2022; Karagiannis et al., 2022; Yılmaz & Bastemir, 2025). Lifestyle modification remains foundational, but it is more effective when supported by behavioural strategies and digital feedback (Forouhi, 2023; Chrvala et al., 2016; Bretschneider et al., 2025).

The most important conceptual shift is the move from 'treating HbA1c' to treating the person with T2D and obesity. HbA1c remains important, but it should be interpreted alongside weight, waist circumference, blood pressure, lipids, cardiorenal status, medications, hypoglycaemia risk, quality of life and the patient's goals. This shift is consistent with recent consensus documents and standards of care emphasizing person-centred, weight-aware and organ-protective treatment (American Diabetes Association Professional Practice Committee for Diabetes, 2026a, 2026b; Davies et al., 2022).

Another key implication is that modern pharmacotherapy should not reduce attention to lifestyle and education (Davies et al., 2022). GLP-1 RA and GIP/GLP-1 RA therapies can produce substantial weight loss and glycaemic improvement, but long-term outcomes depend on tolerability, affordability, adherence, preservation of lean mass and maintenance of health behaviours (Bergmann et al., 2023; Karagiannis et al., 2022; Anyiam et al., 2025). Patients need education about realistic expectations, gastrointestinal symptoms, dose titration, food intake, protein consumption, resistance exercise and what to do if therapy is interrupted (Yılmaz & Bastemir, 2025; Anyiam et al., 2025; Davies et al., 2022). Similarly, SGLT2 inhibitors require education about hydration and sick-day management (Pereira & Eriksson, 2019; American Diabetes Association Professional Practice Committee for Diabetes, 2026b; Davies et al., 2022).

Digital health tools are promising but should be evaluated critically. The best digital interventions are likely those that provide actionable feedback. Apps and wearables may help patients monitor food intake, activity, body weight or glucose patterns; telemedicine may reduce barriers to follow-up; CGM may make invisible glucose responses visible. However, digital solutions may also create new burdens or inequity. Future studies should report not only clinical outcomes but also engagement, usability, digital literacy requirements and integration with existing healthcare workflows (Bentley et al., 2016; Yin et al., 2022 Enricho Nkhoma et al., 2021; Bretschneider et al., 2025; Nishikage et al., 2025; Hill-Briggs et al., 2021).

The role of social determinants of health is particularly important. Lifestyle advice that ignores food insecurity, occupational constraints or stigma may be ineffective and ethically limited (Hill-Briggs et al., 2021; Barrios Quinta et al., 2022; Rubino et al., 2020). Health systems should support referral pathways to dietitians, diabetes educators, psychologists, physiotherapists, community programmes and financial assistance where possible. Public health strategies should also address environments that promote unhealthy food consumption and physical inactivity. In this way, comprehensive treatment of T2D and obesity becomes a bridge between clinical medicine, social policy and technological innovation (Hill-Briggs et al., 2021; Forouhi, 2023; Davies et al., 2022; Bretschneider et al., 2025).

The integrated model proposed in this review also changes how outcomes should be evaluated. A narrow assessment based only on HbA1c may miss important benefits and harms. More appropriate evaluation should include waist circumference, medication burden, hypoglycaemia, blood pressure, lipid profile, cardiorenal outcomes, physical function, patient knowledge, self-efficacy, treatment satisfaction, digital engagement and equity of access (Davies et al., 2022; Konnyu et al., 2023; Bretschneider et al., 2025; Hill-Briggs et al., 2021).

4.1. Practical implications

Patients with T2D and obesity should receive structured education at diagnosis and at major treatment transitions, including medication initiation, insulin intensification, weight-management planning and use of digital tools. Education should include plain-language explanation of insulin resistance, HbA1c, weight-loss targets, medication mechanisms, adverse effects, hypoglycaemia, nutrition and physical activity (Chrvala et al., 2016; Chowdhury et al., 2024; Davies et al., 2022).

Weight management should be explicitly integrated into the diabetes care plan. Clinicians should discuss realistic weight-loss goals, available interventions and the difference between short-term weight loss and long-term maintenance. Patients should be offered options rather than a single rigid pathway (American Diabetes Association Professional Practice Committee for Diabetes, 2026a; Maula et al., 2020; Ryan & Yockey, 2017; Davies et al., 2022).

Pharmacotherapy should be individualized. GLP-1 RA, GIP/GLP-1 RA and SGLT2 inhibitors should be considered according to glycaemic needs, weight goals, cardiovascular and kidney status, cost, contraindications and patient preferences. Insulin should be used when clinically necessary, with attention to weight gain and hypoglycaemia risk (American Diabetes Association Professional Practice Committee for Diabetes, 2026b; Davies et al., 2022; Kalyani et al., 2025).

Lifestyle modification should be operationalized into achievable behaviours. Instead of abstract advice, patients need specific meal strategies, activity plans, self-monitoring tools and follow-up (Forouhi, 2023; Petroni et al., 2021; Kirwan et al., 2017). Resistance training should be encouraged when feasible to preserve muscle during weight loss (Kirwan et al., 2017; Anyiam et al., 2025).

Digital tools should be selected according to patient needs and capacity. Mobile applications, CGM and telemedicine should be integrated with clinician feedback and education rather than used as stand-alone solutions (Bretschneider et al., 2025; Enricho Nkhoma et al., 2021; Nishikage et al., 2025). Equity should be assessed before and during implementation (Hill-Briggs et al., 2021).

Healthcare teams should actively screen for social barriers before assuming non-adherence. Questions about food insecurity, medication affordability, family support and digital access can reveal why a plan is difficult to follow. Addressing these barriers may require referral to community resources, simplification of treatment, remote follow-up or culturally adapted education (Barrios Quinta et al., 2022; Hill-Briggs et al., 2021; Gonzalez-Zacarias et al., 2016; Davies et al., 2022).

Evaluation of integrated diabetes and obesity care should include patient-reported and implementation outcomes. Clinicians and researchers should assess not only whether an intervention lowers HbA1c or body weight but also whether it is acceptable, understandable, affordable and sustainable (Konnyu et al., 2023; Dickinson et al., 2019).

4.2. Limitations

This review has limitations. The selected studies vary in population, intervention intensity, follow-up duration, baseline HbA1c, diabetes duration, obesity severity and healthcare context. Some evidence comes from obesity trials without diabetes, which may not fully generalize to adults with T2D (Davies et al., 2022; Kalyani et al., 2025). Digital health evidence is still heterogeneous, and many studies have short follow-up, small samples or limited reporting of equity and long-term engagement (Bretschneider et al., 2025; Enricho Nkhoma et al., 2021; Hill-Briggs et al., 2021).

Another limitation is that evidence from clinical trials may not fully represent patients encountered in routine care. Trial participants often receive intensive follow-up, structured support and free medication or technology, whereas real-world patients may face cost, comorbidity, limited time or low digital literacy. Therefore, the clinical efficacy described in trials should be interpreted together with implementation evidence and social context. This limitation also highlights the value of interdisciplinary research that combines clinical outcomes with health education, behavioural science and technology assessment (Konnyu et al., 2023; Dickinson et al., 2019; Hill-Briggs et al., 2021).

5. Conclusions

The treatment of T2D in patients with obesity has moved beyond a narrow focus on glycaemic control. Comprehensive care should integrate patient education, intentional weight reduction, lifestyle modification, individualized pharmacotherapy, digital tools and attention to social determinants of health. Patient education and health literacy are essential because they translate complex therapeutic options into daily self-management. Weight reduction can improve glycaemic control, cardiometabolic risk and, in selected patients, remission. Lifestyle modification remains foundational, but it must be realistic, supported and individualized. Modern pharmacotherapies, especially GLP-1 RA, dual GIP/GLP-1 RA and SGLT2 inhibitors, can support weight-centred and organ-protective treatment but require careful education and follow-up. Digital health and telemedicine may strengthen engagement, yet they must be implemented with attention to equity, usability and privacy. The most effective model is therefore not a single intervention but an integrated, patient-centred and socially responsive system of care.

Funding: No external funding was received for the preparation of this manuscript.
Conflicts of Interest: No conflicts of interest to declare.

REFERENCES

1. American Diabetes Association Professional Practice Committee for Diabetes. (2026a). Obesity and weight management for the prevention and treatment of diabetes: Standards of Care in Diabetes—2026. *Diabetes Care, 49*(Suppl. 1). https://doi.org/10.2337/dc26-S008
2. American Diabetes Association Professional Practice Committee for Diabetes. (2026b). Pharmacologic approaches to glycemic treatment: Standards of Care in Diabetes—2026. *Diabetes Care, 49*(Suppl. 1). https://doi.org/10.2337/dc26-S009
3. Anyiam, O., Ardavani, A., Abdul Rashid, R. S., Panesar, A., & Idris, I. (2025). How do glucagon-like peptide-1 receptor agonists affect measures of muscle mass in individuals with, and without, type 2 diabetes: A systematic review and meta-analysis. *Obesity Reviews, 26*, e13916. https://doi.org/10.1111/obr.13916
4. Aroda, V. R., Jørgensen, N. B., Kumar, B., Lingvay, I., Laulund, A. S., & Buse, J. B. (2025). High-dose semaglutide (up to 16 mg) in people with type 2 diabetes and overweight or obesity: A randomized, placebo-controlled, phase 2 trial. *Diabetes Care, 48*(6), 905–913. https://doi.org/10.2337/dc24-2425
5. Barrios Quinta, C. J., et al. (2022). Reducing health inequalities among most disadvantaged type 2 diabetes patients: A cross-sectional exploratory pilot study. *Journal of Nursing Scholarship*. https://doi.org/10.1111/jnu.12781
6. Bentley, C. L., Otesile, O., Bacigalupo, R., Elliott, J., Noble, H., Hawley, M. S., Williams, E. A., & Cudd, P. (2016). Feasibility study of portable technology for weight loss and HbA1c control in type 2 diabetes. *BMC Medical Informatics and Decision Making, 16*, 92. https://doi.org/10.1186/s12911-016-0331-2
7. Bergmann, N. C., Davies, M. J., Lingvay, I., & Knop, F. K. (2023). Semaglutide for the treatment of overweight and obesity: A review. *Diabetes, Obesity and Metabolism, 25*(1), 18–35. https://doi.org/10.1111/dom.14863
8. Bretschneider, M. P., Kolasińska, A. B., Šomvárska, L., Klásek, J., Mareš, J., & Schwarz, P. E. H. (2025). Evaluation of the impact of mobile health app Vitadio in patients with type 2 diabetes: Randomized controlled trial. *Journal of Medical Internet Research, 27*, e68648. https://doi.org/10.2196/68648
9. Chobot, A., Górowska-Kowolik, K., Sokołowska, M., & Jarosz-Chobot, P. (2018). Obesity and diabetes: Not only a simple link between two epidemics. *Diabetes/Metabolism Research and Reviews, 34*, e3042. https://doi.org/10.1002/dmrr.3042
10. Chowdhury, H. A., Harrison, C. L., Siddiquea, B. N., et al. (2024). The effectiveness of diabetes self-management education intervention on glycaemic control and cardiometabolic risk in adults with type 2 diabetes in low- and middle-income countries: A systematic review and meta-analysis. *PLOS ONE, 19*, e0297328. https://doi.org/10.1371/journal.pone.0297328
11. Chrvala, C. A., Sherr, D., & Lipman, R. D. (2016). Diabetes self-management education for adults with type 2 diabetes mellitus: A systematic review of the effect on glycemic control. *Patient Education and Counseling, 99*(6), 926–943. https://doi.org/10.1016/j.pec.2015.11.003
12. Davies, M. J., Aroda, V. R., Collins, B. S., Gabbay, R. A., Green, J., Maruthur, N. M., Rosas, S. E., Del Prato, S., Mathieu, C., Mingrone, G., Rossing, P., Tankova, T., Tsapas, A., & Buse, J. B. (2022). Management of hyperglycemia in type 2 diabetes, 2022: A consensus report by the American Diabetes Association and the European Association for the Study of Diabetes. *Diabetes Care, 45*(11), 2753–2786. https://doi.org/10.2337/dci22-0034
13. Dickinson, W. P., Dickinson, L. M., Jortberg, B. T., Hessler, D. M., Fernald, D. H., Cuffney, M., & Fisher, L. (2019). A cluster randomized trial comparing strategies for translating self-management support into primary care practices. *Journal of the American Board of Family Medicine, 32*(3), 341–352. https://doi.org/10.3122/jabfm.2019.03.180254

14. Enricho Nkhoma, D., Jenya Soko, C., Joseph Banda, K., Greenfield, D., Li, Y. C., & Iqbal, U. (2021). Impact of DSMES app interventions on medication adherence in type 2 diabetes mellitus: Systematic review and meta-analysis. *BMJ Health & Care Informatics, 28*, e100291. https://doi.org/10.1136/bmjhci-2020-100291
15. Esteves-Stanford, A., & Stanford, K. I. (2024). Exercise as a tool to mitigate metabolic disease. *American Journal of Physiology-Cell Physiology*. https://doi.org/10.1152/ajpcell.00144.2024
16. Forouhi, N. G. (2023). Embracing complexity: Making sense of diet, nutrition, obesity and type 2 diabetes. *Diabetologia*. https://doi.org/10.1007/s00125-023-05873-z
17. Gadde, K. M., Martin, C. K., Berthoud, H. R., & Heymsfield, S. B. (2018). Obesity: Pathophysiology and management. *Journal of the American College of Cardiology, 71*(1), 69–84. https://doi.org/10.1016/j.jacc.2017.11.011
18. Garvey, W. T., Batterham, R. L., Bhatta, M., Buscemi, S., Christensen, L. N., Frias, J. P., Jódar, E., Kandler, K., Rigas, G., Wadden, T. A., Wharton, S., & the STEP 5 Study Group. (2022). Two-year effects of semaglutide in adults with overweight or obesity: The STEP 5 trial. *Nature Medicine, 28*, 2083–2091. https://doi.org/10.1038/s41591-022-02026-4
19. Garvey, W. T., Birkenfeld, A. L., Dicker, D., Mingrone, G., Pedersen, S. D., Satylganova, A., Skovgaard, D., Sugimoto, D., Jensen, C., & Mosenzon, O. (2020). Efficacy and safety of liraglutide 3.0 mg in individuals with overweight or obesity and type 2 diabetes treated with basal insulin: The SCALE Insulin randomized controlled trial. *Diabetes Care, 43*(5), 1085–1093. https://doi.org/10.2337/dc19-1745
20. Glavas, C., Scott, D., Sood, S., George, E. S., Daly, R. M., Gvozdenko, E., de Courten, B., & Jansons, P. (2024). Exploring the feasibility of digital voice assistants for delivery of a home-based exercise intervention in older adults with obesity and type 2 diabetes mellitus: Randomized controlled trial. *JMIR Aging, 7*, e53064. https://doi.org/10.2196/53064
21. Gonzalez-Zacarias, A. A., Mavarez-Martinez, A., Arias-Morales, C. E., Stoicea, N., & Rogers, B. (2016). Impact of demographic, socioeconomic, and psychological factors on glycemic self-management in adults with type 2 diabetes mellitus. *Frontiers in Public Health, 4*, 195. https://doi.org/10.3389/fpubh.2016.00195
22. Hill-Briggs, F., Adler, N. E., Berkowitz, S. A., Chin, M. H., Gary-Webb, T. L., Navas-Acien, A., Thornton, P. L., & Haire-Joshu, D. (2021). Social determinants of health and diabetes: A scientific review. *Diabetes Care, 44*(1), 258–279. https://doi.org/10.2337/dci20-0053
23. Hu, E. H., Tsai, M. L., Lin, Y., Chou, T. S., & Chen, T. H. (2024). A review and meta-analysis of the safety and efficacy of using glucagon-like peptide-1 receptor agonists. *Medicina, 60*, 357. https://doi.org/10.3390/medicina60030357
24. Islam, M. M., Poly, T. N., Walther, B. A., & Li, Y. C. (2020). Use of mobile phone app interventions to promote weight loss: Meta-analysis. *JMIR mHealth and uHealth, 8*, e17039. https://doi.org/10.2196/17039
25. Karagiannis, T., Avgerinos, I., Liakos, A., Del Prato, S., Matthews, D. R., & Tsapas, A. (2022). Management of type 2 diabetes with the dual GIP/GLP-1 receptor agonist tirzepatide: A systematic review and meta-analysis. *Diabetologia, 65*, 1251–1261. https://doi.org/10.1007/s00125-022-05715-4
26. Kalyani, R. R., Neumiller, J. J., Maruthur, N. M., et al. (2025). Diagnosis and treatment of type 2 diabetes in adults. *JAMA*. https://doi.org/10.1001/jama.2025.5956
27. Kheniser, K., Saxon, D. R., & Kashyap, S. R. (2021). Long-term weight loss strategies for obesity. *The Journal of Clinical Endocrinology & Metabolism, 106*(7), 1854–1866. https://doi.org/10.1210/clinem/dgab091
28. Kirwan, J. P., Sacks, J., & Nieuwoudt, S. (2017). The essential role of exercise in the management of type 2 diabetes. *Cleveland Clinic Journal of Medicine, 84*(7 Suppl. 1), S15–S21. https://doi.org/10.3949/ccjm.84.s1.03
29. Kong, S., et al. (2025). Obesity: Pathophysiology and therapeutic interventions. *Molecular Biomedicine, 6*, 25. https://doi.org/10.1186/s43556-025-00264-9
30. Konnyu, K. J., Yogasingam, S., Lépine, J., Sullivan, K., Alabousi, M., Edwards, A., et al. (2023). Quality improvement strategies for diabetes care: Effects on outcomes for adults living with diabetes. *Cochrane Database of Systematic Reviews, 5*, CD014513. https://doi.org/10.1002/14651858.CD014513.pub2
31. Li, M., Li, J., Xu, Y., Gao, J., Cao, Q., Ding, Y., et al. (2024). Effect of 5:2 regimens: Energy-restricted diet or low-volume high-intensity interval training combined with resistance exercise on glycemic control and cardiometabolic health in adults with overweight/obesity and type 2 diabetes: A three-arm randomized controlled trial. *Diabetes Care, 47*(6), 1074–1083. https://doi.org/10.2337/dc24-0241
32. Liu, Q. K. (2024). Mechanisms of action and therapeutic applications of GLP-1 and dual GIP/GLP-1 receptor agonists. *Frontiers in Endocrinology, 15*, 1431292. https://doi.org/10.3389/fendo.2024.1431292
33. Liu, Y., Chen, Y., Ma, J., Lin, J., Liu, C., Li, X., et al. (2025). Dapagliflozin plus calorie restriction for remission of type 2 diabetes: Multicentre, double blind, randomised, placebo controlled trial. *BMJ, 388*, e081820. https://doi.org/10.1136/bmj-2024-081820
34. Lu, X., Xie, Q., Pan, X., Zhang, R., Zhang, X., Peng, G., et al. (2024). Type 2 diabetes mellitus in adults: Pathogenesis, prevention and therapy. *Signal Transduction and Targeted Therapy, 9*. https://doi.org/10.1038/s41392-024-01951-9

35. Maula, A., Kai, J., Woolley, A. K., Weng, S., Dhalwani, N., Griffiths, F. E., Khunti, K., & Kendrick, D. (2020). Educational weight loss interventions in obese and overweight adults with type 2 diabetes: A systematic review and meta-analysis of randomized controlled trials. *Diabetic Medicine, 37*(4), 623–635. https://doi.org/10.1111/dme.14193
36. Mueller, J., Breeze, P., Fusco, F., Sharp, S. J., Pidd, K., Brennan, A., et al. (2025). Glucose Lowering through Weight management (GLoW): A randomised controlled trial of the clinical and cost effectiveness of a diabetes education and behavioural weight management programme versus a diabetes education programme in adults with a recent diagnosis of type 2 diabetes. *Diabetologia, 68*, 969–980. https://doi.org/10.1007/s00125-024-06355-6
37. Müller, T. D., Finan, B., Bloom, S. R., D'Alessio, D., Drucker, D. J., Flatt, P. R., et al. (2019). Glucagon-like peptide 1 (GLP-1). *Molecular Metabolism, 30*, 72–130. https://doi.org/10.1016/j.molmet.2019.09.010
38. Nauck, M. A., & D'Alessio, D. A. (2022). Tirzepatide, a dual GIP/GLP-1 receptor co-agonist for the treatment of type 2 diabetes with unmatched effectiveness regarding glycaemic control and body weight reduction. *Cardiovascular Diabetology, 21*, 169. https://doi.org/10.1186/s12933-022-01604-7
39. Nishikage, S., Nakagawa, Y., Hirota, Y., Yoshimura, K., Ueda, M., Yamamoto, A., et al. (2025). Effects of intermittently scanned continuous glucose monitoring on body weight and glycemic variability in individuals with overweight and impaired glucose tolerance or mild diabetes: A pilot randomized controlled trial. *Obesity Research & Clinical Practice*. https://doi.org/10.1016/j.orcp.2025.01.008
40. O'Neil, P. M., Miller-Kovach, K., Tuerk, P. W., Becker, L. E., Wadden, T. A., Fujioka, K., et al. (2016). Randomized controlled trial of a nationally available weight control program tailored for adults with type 2 diabetes. *Obesity, 24*, 2269–2277. https://doi.org/10.1002/oby.21616
41. Pereira, M. J., & Eriksson, J. W. (2019). Emerging role of SGLT-2 inhibitors for the treatment of obesity. *Drugs, 79*, 219–230. https://doi.org/10.1007/s40265-019-1057-0
42. Petroni, M. L., Brodosi, L., Marchignoli, F., Sasdelli, A. S., Caraceni, P., Marchesini, G., & Ravaioli, F. (2021). Nutrition in patients with type 2 diabetes: Present knowledge and remaining challenges. *Nutrients, 13*, 2748. https://doi.org/10.3390/nu13082748
43. Rena, G., Hardie, D. G., & Pearson, E. R. (2017). The mechanisms of action of metformin. *Diabetologia, 60*, 1577–1585. https://doi.org/10.1007/s00125-017-4342-z
44. Roshan-Nejad, M., Hosseini, M., Vasli, P., Nasiri, M., & Hejazi, S. (2024). Effect of health literacy-based teach-back training on quality of life and treatment adherence in type 2 diabetes: An experimental study. *Scientific Reports, 14*. https://doi.org/10.1038/s41598-024-84399-9
45. Rubino, F., Puhl, R. M., Cummings, D. E., Eckel, R. H., Ryan, D. H., Mechanick, J. I., Nadglowski, J., Ramos Salas, X., Schauer, P. R., Twenefour, D., Apovian, C. M., Aronne, L. J., Batterham, R. L., Berthoud, H. R., Boza, C., Busetto, L., Dicker, D., De Groot, M., Eisenberg, D., Flint, S. W., et al. (2020). Joint international consensus statement for ending stigma of obesity. *Nature Medicine, 26*(4), 485–497. https://doi.org/10.1038/s41591-020-0803-x
46. Ryan, D. H., & Yockey, S. R. (2017). Weight loss and improvement in comorbidity: Differences at 5%, 10%, 15%, and over. *Current Obesity Reports, 6*, 187–194. https://doi.org/10.1007/s13679-017-0262-y
47. Sargeant, J. A., King, J. A., Yates, T., Redman, E. L., Bodicoat, D. H., et al. (2022). The effects of empagliflozin, dietary energy restriction, or both on appetite-regulatory gut peptides in individuals with type 2 diabetes and overweight or obesity: The SEESAW randomized, double-blind, placebo-controlled trial. *Diabetes, Obesity and Metabolism, 24*, 1509–1521. https://doi.org/10.1111/dom.14721
48. Sandsdal, R. M., et al. (2023). Combination of exercise and GLP-1 receptor agonist treatment reduces severity of metabolic syndrome, abdominal obesity, and inflammation: A randomized controlled trial. *Cardiovascular Diabetology, 22*, 41. https://doi.org/10.1186/s12933-023-01765-z
49. Saslow, L. R., Daubenmier, J. J., Moskowitz, J. T., Kim, S., Murphy, E. J., Phinney, S. D., et al. (2017). Twelve-month outcomes of a randomized trial of a moderate-carbohydrate versus very low-carbohydrate diet in overweight adults with type 2 diabetes mellitus or prediabetes. *Nutrition & Diabetes, 7*, 304. https://doi.org/10.1038/s41387-017-0006-9
50. Schabert, J., Browne, J. L., Mosely, K., & Speight, J. (2013). Social stigma in diabetes: A framework to understand a growing problem for an increasing epidemic. *The Patient: Patient-Centered Outcomes Research, 6*(1), 1–10. https://doi.org/10.1007/s40271-012-0001-0
51. Sinha, R., Papamargaritis, D., Sargeant, J. A., & Davies, M. J. (2023). Efficacy and safety of tirzepatide in type 2 diabetes and obesity management. *Journal of Obesity & Metabolic Syndrome, 32*(1), 25–45. https://doi.org/10.7570/jomes22067
52. Taylor, R. (2025). Aetiology of type 2 diabetes: An experimental medicine odyssey. *Diabetologia, 68*, 1375–1389. https://doi.org/10.1007/s00125-025-06428-0
53. Umphonsathien, M., Rattanasian, P., Lokattachariya, S., Suansawang, W., Boonyasuppayakorn, K., & Khovidhunkit, W. (2022). Effects of intermittent very-low calorie diet on glycemic control and cardiovascular risk factors in obese patients with type 2 diabetes mellitus: A randomized controlled trial. *Journal of Diabetes Investigation, 13*(1), 156–166. https://doi.org/10.1111/jdi.13619

54. Wadden, T. A., Chao, A. M., Machineni, S., Kushner, R., Ard, J., Srivastava, G., et al. (2023). Tirzepatide after intensive lifestyle intervention in adults with overweight or obesity: The SURMOUNT-3 phase 3 trial. *Nature Medicine, 29*, 2909–2918. https://doi.org/10.1038/s41591-023-02597-w
55. Yao, L., Wang, L., Zhang, R., Soukas, A. A., & Wu, L. (2024). The direct targets of metformin in diabetes and beyond. *Trends in Endocrinology & Metabolism*. https://doi.org/10.1016/j.tem.2024.07.017
56. Yılmaz, N., & Bastemir, M. (2025). Gastrointestinal adverse effects of GLP-1 and dual GLP-1/GIP receptor agonists: A comprehensive update in diabetic and obese populations. *Diabetes, Metabolic Syndrome and Obesity, 19*, 584175. https://doi.org/10.2147/DMSO.S584175
57. Yin, W., Liu, Y., Hu, H., Sun, J., Liu, Y., & Wang, Z. (2022). Telemedicine management of type 2 diabetes mellitus in obese and overweight young and middle-aged patients during COVID-19 outbreak: A single-center, prospective, randomized control study. *PLOS ONE, 17*, e0275251. https://doi.org/10.1371/journal.pone.0275251
58. Yuan, X., Wang, J., Yang, S., Gao, M., Cao, L., Li, X., Hong, D., Tian, S., & Sun, C. (2020). Effect of the ketogenic diet on glycemic control, insulin resistance, and lipid metabolism in patients with T2DM: A systematic review and meta-analysis. *Nutrition & Diabetes, 10*, 38. https://doi.org/10.1038/s41387-020-00142-z