

REMISSION OF TYPE 2 DIABETES MELLITUS WITH LIFESTYLE MEDICINE: A
SCOPING REVIEW OF CURRENT CLINICAL EVIDENCE AND REAL-WORLD
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Article Received: 20 Sept. 2025

Article Revised: 10 Oct. 2025

Article Published: 01 Nov. 2025

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DOI: <https://doi.org/10.5281/zenodo.17490065>**How to cite this Article:** Harsahaj Singh Wilkhoo*, Afra Wasama Islam, Yash Sailesh Kumar, Alexis Tressa Babu, Swapnil Ahuja, Mohammad Azim, Harkirat Singh Wilkhoo. (2025). Remission of Type 2 Diabetes Mellitus with Lifestyle Medicine: A Scoping Review of Current Clinical Evidence and Real-World Applications. World Journal of Advance Healthcare Research, 9(11), 88–98.

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ABSTRACT

Introduction: Type 2 diabetes mellitus (T2DM) is a multifactorial chronic disease characterized by insulin resistance, β -cell dysfunction, and systemic metabolic dysregulation. With rising global prevalence, understanding effective management strategies and potential for remission is critical. Evidence suggests lifestyle modifications, pharmacotherapy, and surgical interventions can significantly alter disease trajectory. **Methods:** A scoping review was conducted following PRISMA-ScR guidelines. Comprehensive searches were performed in PubMed, Scopus, Cochrane Library, Google Scholar, and Embase to identify studies addressing T2DM pathophysiology, management strategies, and remission outcomes. After removing 8 duplicates, 74 records were screened, 6 were excluded, and 68 full-text reports were assessed for eligibility. Two studies were excluded based on pre-defined criteria, yielding 66 included studies. Data extraction was independently performed by two reviewers, focusing on study characteristics, interventions, outcomes, and mechanistic insights. **Discussion:** Evidence indicates that structured lifestyle interventions, pharmacologic therapies, and bariatric procedures contribute to T2DM remission in select populations. Mechanistic pathways involving metabolic regulation, inflammation, and gut microbiota are central to disease progression and therapeutic response. However, heterogeneity in study designs and populations limits generalizability. The review highlights the importance of individualized treatment strategies and identifies gaps in long-term outcome data. **Conclusion:** This scoping review is among the most updated and first of its kind to integrate T2DM mechanisms, management strategies, and remission outcomes. It uniquely highlights the interplay of metabolic regulation, inflammation, and gut microbiota in disease progression and therapeutic response. Findings reinforce evidence-based lifestyle and clinical interventions while identifying critical research gaps. By synthesizing mechanistic and clinical insights, this review provides a foundation for optimizing individualized, patient-centered care and guiding future studies in T2DM management and remission.

KEYWORDS: Endocrinology, Lifestyle Medicine, Remission, Type 2 Diabetes Mellitus.**INTRODUCTION**

Diabetes mellitus is a chronic metabolic disorder characterized by persistent hyperglycemia. Among its types, Type 2 diabetes mellitus (T2DM) is the most prevalent, primarily caused by systemic metabolic impairments leading to insulin resistance. It typically

develops after the age of 40–50 years and is strongly associated with genetic predisposition, obesity, and sedentary lifestyles. Peripheral insulin resistance affects key organs such as the liver, skeletal muscle, and adipose tissue, disrupting glucose metabolism. In addition to genetic and metabolic factors certain drugs, including

glucocorticoids, statins, thiazide diuretics, and atypical antipsychotics, can contribute to the development of T2DM.^[1,2] Patients frequently report polyuria, polydipsia, polyphagia, and unexplained weight loss, but many are asymptomatic in the early stages. T2DM is a significant public health concern, with the International Diabetes Federation estimating approximately 530 million cases worldwide, with the figure expected to reach 780 million by 2045.^[3] T2DM is on the rise in younger populations, with the prevalence of the disease increasing in recent decades among children aged 10 to 19.^[4] Ethnic differences also exist, with South Asians, Afro-Caribbeans, and Latin Americans having a higher risk than white Europeans, regardless of fat or insulin production. Despite its chronic nature, T2DM can be avoided or treated with lifestyle changes including keeping a healthy BMI, engaging in regular physical activity, and eating a well-balanced diet. Early interventions are critical for reducing complications and improving patient outcomes.^[5,6]

Given the growing volume of research and the variety of interventions under the banner of lifestyle medicine, a scoping review was chosen the most appropriate method for completely mapping existing data. This method enables a greater range of study types (e.g., randomized trials, meta-analyses, observational studies, and expert guidelines) to capture the multifaceted impact of lifestyle-based treatments on T2DM prevention, remission, and maintenance. This review adheres to the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews) criteria provided by Tricco et al. (2018) to ensure methodological transparency and rigor in study selection, synthesis, and reporting.

This scoping review intends to give a complete, updated overview of current research and clinical applications of lifestyle medicine in the remission and management of Type 2 Diabetes Mellitus, highlighting major interventions, outcomes, and implementation gaps.

Methods

This scoping review was conducted in accordance with the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews) guidelines to ensure methodological rigor and transparency (Figure 1). A systematic search was performed across five electronic databases—PubMed, Scopus, Cochrane Library, Google Scholar, and Embase—to identify studies relevant to type 2 diabetes mellitus (T2DM), including mechanistic insights, lifestyle interventions, pharmacological therapies, and remission strategies. No records were identified from study registers.

Following deduplication ($n = 8$), 74 records were screened for eligibility based on titles and abstracts, leading to the exclusion of 6 studies that did not meet the inclusion criteria. Full texts of 68 reports were retrieved

and assessed for eligibility, with two studies excluded due to insufficient relevance or incomplete data. Ultimately, 66 studies were included in the review.

Eligibility criteria comprised peer-reviewed original research, systematic reviews, meta-analyses, and expert consensus statements published in English, focusing on adult populations with T2DM. Studies were excluded if they lacked direct relevance to the pathophysiology, clinical management, or lifestyle-based interventions for T2DM.

Data extraction was independently performed by two reviewers using a structured template to collect information on study design, population characteristics, interventions, outcomes, and principal findings. Discrepancies were resolved through consensus discussions.

This approach enabled a comprehensive mapping of the current literature, identification of knowledge gaps, and synthesis of evidence to inform future research directions and clinical practice. The study selection process, including identification, screening, eligibility, and inclusion of studies, is presented in Figure 1 as a PRISMA flow diagram.

RESULTS AND DISCUSSION

Understanding Type 2 Diabetes Mellitus: Pathophysiology, risk factors associated to the disease progression and complication

Insulin sensitivity refers to cells' ability to respond efficiently to insulin, boosting glucose absorption and maintaining normal blood glucose. Insulin resistance is a biological reaction that reduces glucose absorption and causes hyperglycemia. Initially, the pancreas adjusts by secreting more insulin, but long-term resistance leads to persistent hyperglycemia and hyperinsulinemia, which are hallmarks of type 2 diabetes mellitus (T2DM).^[6,7]

Insulin resistance is highly associated with metabolic syndrome, which comprises abdominal obesity, hypertension, high triglycerides, poor HDL cholesterol, and high fasting glucose. Genetic susceptibility, obesity, inactivity, and chronic inflammation are all possible causes. Dysfunctional adipose tissue produces free fatty acids and proinflammatory cytokines (IL-6, TNF- α), which disrupt insulin signaling. The buildup of lipids in the liver and muscles inhibits glucose absorption. Initially, hyperinsulinemia compensates, but continuous strain causes β -cell failure.^[8-11]

Obesity, particularly central obesity, is a significant factor. Adipose tissue acts as an endocrine organ, releasing adipokines that negatively impact β -cell activity and hyperglycemia. Diets heavy in processed meats, smoking, and sedentary lifestyles all contribute to obesity and inflammation. Cytokines (IL-1 β , TNF- α , IL-6), adipose hypoxia, and macrophage infiltration contribute to resistance. Elevated free fatty acids cause

endoplasmic reticulum stress and oxidative damage, leading to β -cell death.^[12–14] Latest evidence suggests that β -cells can dedifferentiate or transdifferentiate, leading to decreased insulin production. Mitochondrial failure reduces ATP generation, raises ROS levels, and affects insulin pathways.^[15–18]

The gut microbiota can effect T2DM through dysbiosis, lipopolysaccharide release, and systemic inflammation, affecting glucose metabolism and β -cell activity. Poor nutrition and inactivity raise triglyceride-rich lipoproteins (VLDL, chylomicrons), which produce ROS, whereas physical activity boosts insulin sensitivity by reducing inflammation and increasing antioxidants.^[19–21]

T2DM is caused by both non-modifiable risk factors (family history, age >45 years, high-risk ethnicities (African American, Hispanic/Latin American, Native American, Asian, Pacific Islander) and modifiable risk factors such as abdominal obesity, physical inactivity, high refined carbohydrate/saturated fat intake, and comorbidities (gestational diabetes, PCOS, hypertension, dyslipidemia, sleep disorders).^[19,22,23]

T2DM prevalence was 7.5% globally in 2019, with a projected 8.6% by 2045 (IDF). The American Diabetes Association defines prediabetes as fasting glucose 5.6–6.9 mmol/L, OGTT glucose 7.8–11.0 mmol/L, or HbA1c 5.7–6.4%. Prediabetes hastens T2DM onset, especially in younger people. Lifestyle changes continue to be the most effective prevention, cutting risk by 27–58%; metformin may benefit high-risk persons, but no FDA-approved medicine exists for prevention.^[24–37]

Risk assessment is essential for prevention and early detection. The ADA Risk Test and Finnish Diabetes Risk Score (FINDRISC) assess age, family history, activity, and weight. Diagnostic tests such as fasting blood glucose (FBG), oral glucose tolerance test (OGTT), and HbA1c evaluate both short- and long-term glycemic management. BMI and waist circumference reveal obesity and visceral fat, which are key contributors to resistance. Blood pressure monitoring can detect hypertension, which is both a risk factor and a consequence. Lipid profile testing can detect dyslipidemia and cardiovascular risk. Targeted therapies are made possible by doing a comprehensive clinical assessment that includes lifestyle and family history. Regular follow-up with at-risk persons provides early detection, appropriate management modifications, and tailored prevention initiatives. In terms of management plans or prevention of T2DM, assessment of risk plays a very crucial role.^[34,36,38,39] There are many methods to assess a person's risk for T2DM. However, the most accurate and important ones are listed as follows and illustrated in Figure 2.

Overview of Current Management Regime for Type 2 Diabetes Mellitus

The present treatment landscape for T2DM includes a multifaceted approach adopted to tackle this complex condition. In terms of medications, the initial cornerstone of treatment includes metformin, which exerts its effects by reducing hepatic glycogenolysis, peripheral insulin resistance, and delaying digestion, alongside increasing postprandial GLP-1 secretion. When metformin monotherapy fails to achieve adequate glycemic control, sulfonylureas and meglitinides, which act as insulin secretagogues, are often used as next-line treatments. However, these medications may induce weight gain, and hypoglycemia, and exhibit limited long-term efficacy. As the illness worsens, many T2DM patients require insulin therapy, which is commonly delivered via numerous daily subcutaneous injections. Within a decade of T2DM diagnosis, nearly half of patients may require insulin therapy. However, this treatment has several downsides. It can cause weight gain, and hypoglycemia, and might raise the risk of colorectal cancer.^[38,39]

The regulation of GLP-1 receptor (GLP-1R) activity has been discovered as a possible therapeutic strategy. DPP-IV inhibitors slow the degradation of GLP-1, boosting GLP-1 levels and improving glycemic control. However, these inhibitors could have long-term negative consequences. GLP-1 analogs, such as exenatide, liraglutide, lixisenatide, albiglutide, dulaglutide, semaglutide, and tirzepatide, directly increase GLP-1 activity. They improve insulin secretion, inhibit glucagon secretion, prolong stomach emptying, and promote weight loss. These analogs have shown efficacy comparable to second-line treatments in improving glycemic control. They may even increase adiponectin secretion, which improves insulin sensitivity and weight loss.^[39,40]

Bariatric surgery has emerged as a compelling strategy due to its ability to produce long-term weight loss, improve glycemic control, and lower obesity-related morbidity and death. Despite its efficacy, bariatric surgery has significant economic costs and a range of post-operative complications which include nutritional deficiencies and gastrointestinal disturbances. Recent research shows that persistent deficits in insulin secretion can lead to failures in post-surgical remission of T2DM, prompting continued investigations to optimize outcomes.^[41]

Management Approach Based on Principles of Lifestyle Medicine

Lifestyle medicine is an emerging medical specialty that utilizes therapeutic lifestyle interventions to manage chronic conditions such as cardiovascular diseases and type 2 diabetes mellitus (T2DM). This approach has gained popularity among both patients and healthcare providers as an effective strategy for treating diseases like T2DM. The uniqueness of lifestyle medicine lies in its ability to not only treat the disease but also improve

the patient's overall quality of life. By implementing the core principles of lifestyle medicine, a personalized management plan for T2DM can be developed, as outlined in Table 1.^[41]

The International Diabetes Federation (IDF) estimates that roughly 540 million individuals worldwide have diabetes, with many uninformed of their disease. According to projections, one in every eight people will get diabetes by 2045, with type 2 diabetes accounting for more than 90% of cases. T2DM-related mortality has increased in recent decades, owing mostly to cardiovascular consequences, emphasizing the need for more effective treatment options and comorbidity management.^[42,43]

Current T2DM treatments focus on decreasing blood glucose levels rather than addressing the underlying cause. Antihyperglycemic medicines are the primary treatment, with insulin therapy reserved for severe insulin resistance. While helpful, these approaches frequently result in medication reliance and potential negative effects. In extreme situations, bariatric surgery is an option that has shown short-term success in glucose reduction and diabetes remission. However, long-term remission is unknown, and surgical risks persist even with minimally invasive procedures. The excessive cost further restricts access, especially for insured patients. While pharmaceutical and surgical therapies have advantages, their invasive nature and accompanying risks may fail to improve, or perhaps deteriorate, the patient's overall quality of life.^[44-48]

Lifestyle medicine, on the other hand, provides a viable alternative by targeting the underlying causes of T2DM with fewer consequences, higher cost-effectiveness, and a considerable increase in patients' quality of life. This methodology focuses on illness remission rather than just glucose control. Although "remission" and "reversal" are frequently used interchangeably, new research suggests distinguishing between acute reversal, real remission, and complete remission. Several studies have found that combining dietary changes with structured physical activity can result in diabetic remission. Earlier studies concentrated on glycemic control using low-calorie diets, but more recent trials, including the Look AHEAD project, have demonstrated that stringent lifestyle interventions result in higher remission rates than traditional treatments.^[49-51]

Dietary Interventions in Lifestyle Medicine

A sustained and well-balanced diet is crucial for achieving remission. There are many different dietary regimens, but whole-food, plant-based diets (WFPB) have become popular and beneficial. Some studies suggest that weight loss can correct T2DM by restoring pancreatic beta cells' ability to generate insulin. This finding lends credence to the possible relevance of Very Low Energy Diets (VLEDs) in diabetes management. However, VLEDs provide a risk of vitamin shortages,

demanding careful supplementation. Given the difficulties of adhering to any single dietary pattern over time, a mix of WFPB diets and regulated carbohydrate intake appears to be the most beneficial technique. The American Diabetes Association (ADA) highlights the need to create personalized meal plans based on individual needs. Table 2 outlines key dietary aspects such as quantity control, carbohydrate management, and meal scheduling. Nutritional recommendations are classified according to their function and safety.^[41,43,44,50,51]

Carbohydrate intake is categorized into four levels: extremely low (20-50 g/day), low (<130 g/day), moderate (130-225 g/day), and high carbohydrate diets. Low-carbohydrate diets (LCDs) vary in definition, but they typically involve limiting daily carbohydrate intake to 20g-130g. According to the Scottish Intercollegiate Guidelines Network (SIGN), eating at least 50g of carbs per day is safe for up to six months. LCDs are gaining popularity for their potential in T2DM management. An ideal diet should emphasize complete foods, plant-based options, moderate carbohydrate intake, and foods with a low glycemic index. Furthermore, nutritional deficits should be evaluated and addressed as necessary. Meal time is also important, with smaller, more frequent meals recommended to maintain glucose and insulin levels.^[5,51,52]

Physical Activity and Behavioral Therapy

Physical exercise, a crucial part of lifestyle medicine, is critical in T2DM remission. Regular exercise improves metabolic health by increasing insulin sensitivity, lowering glycogen levels, and promoting beta-cell activity. Insulin resistance, a major component of T2DM, is greatly reduced by enhanced mitochondrial activity and GLUT4 protein expression in skeletal muscles. These changes reduce HbA1c levels and enhance glucose regulation. Physical activity reduces visceral fat buildup, a major risk factor for type 2 diabetes, notably in the liver and pancreas, improving insulin sensitivity. Exercise also improves cardiovascular health and helps manage hyperlipidemia, which reduces diabetes complications.^[41,43,53,54]

Behavioral counseling is essential for maintaining lifestyle modifications. The American Heart Association (AHA) supports behavioral therapies such as cognitive-behavioral therapy (CBT), which helps people stick to diet and activity plans. Digital tools, like the Changing Health PWeR study, improve long-term diabetes management. Mindfulness and meditation can help you reduce stress and change your behavior.^[41,44]

Lifestyle medicine is a sustained, cost-effective therapy for T2DM remission that focuses on long-term health rather than symptom treatment. Weight regain is difficult, but it can be managed with counseling and behavioral therapy. This holistic approach enhances

general well-being and produces better long-term results than traditional treatments.

Managing Comorbidities and Complications of Type 2 Diabetes Through Lifestyle Medicine

T2DM is associated with numerous comorbidities and consequences, necessitating a multifaceted strategy of care that includes lifestyle changes, therapeutic medicines, and regular monitoring. T2DM is commonly associated with dyslipidemia, which includes high triglycerides (TGLs >150-200 mg/dL), low HDL cholesterol (<40 mg/dL in men and <50 mg/dL in women), and increased LDL cholesterol. These disorders heighten cardiovascular risk and metabolic instability. Cardiovascular diseases (CVDs) are the leading cause of morbidity and mortality in type 2 diabetes. A poor diet, physical inactivity, and hyperglycemia all contribute to atherosclerosis by altering endothelial function and producing advanced glycation end products (AGEs), which cause plaque development. Cystic fibrosis-related diabetes (CFRD) affects 15-20% of adolescents and 40-50% of cystic fibrosis patients. Insulin shortage is the principal cause, and OGTT is the standard diagnostic procedure, supported by A1C testing for early detection. Depression and anxiety are common mental health issues linked to type 2 diabetes. Adolescents with diabetes are 20%-30% more likely to attempt suicide than their non-diabetic counterparts, highlighting the importance of psychological assistance.^[3,6,41]

Lifestyle changes such as weight control and BMI <25 kg/m², frequent physical activity (at least >60 minutes, 5 days per week), and fiber and unsaturated fat diets are crucial. Pharmacological therapies such as metformin, sulfonylureas, and fibrates help to regulate glucose and cholesterol levels. Diabetic retinopathy affects 40%-50% of diabetes patients as a result of hyperglycemia-induced pericyte apoptosis and blood-retina barrier disruption. It is identified by fundus photography, and the prognosis is dependent on timely lifestyle and medicinal care. Diabetic Nephropathy affects 30-40% of diabetes patients, producing podocyte dysfunction and glomerular basement membrane thickening. It is the major cause of death, demanding early management. Non-alcoholic steatohepatitis (NASH), which is connected to hyperglycemia and insulin resistance, causes liver fibrosis. Imaging and blood testing for ALT and triglycerides are used to diagnose the condition, and lifestyle modification is critical. Diabetic neuropathy, which affects 30% to 35% of diabetics, produces discomfort, numbness, and motor impairment, particularly in the lower limbs. Neurologic examinations that test muscular strength and reflexes are critical to early detection. Addressing these comorbidities and consequences with customized care and preventive actions is crucial for improving T2DM patient outcomes.^[17,40,42,55]

A summary of all the trials and studies conducted between 2015-2025, relevant to this review is tabulated in Table 3.

Clinical Outcome and Success Rate in Remission

The majority of people with type 2 diabetes work to reduce their risk of macrovascular and microvascular problems, which are mostly caused by poor metabolic and glycemic management. This frequently demands intense pharmaceutical control, ultimately leading to exogenous insulin therapy (IT). However, research into Lifestyle Intervention (LSI) is emerging as a successful technique for delaying or preventing T2DM onset through food and exercise.^[59]

Calorie restriction by portion control, reduced energy density, and the use of liquid meal replacements are all successful methods for weight loss and improved prognosis. A diet consisting of whole, plant-based foods (vegetables, legumes, fruits, nuts, and seeds) while limiting or eliminating meat, refined meals, ultra-processed items, and added fats is extremely helpful. The plant-based, whole-food, DASH, and Mediterranean diets are thought to be the most beneficial for obtaining long-term T2DM remission.^[56-58]

In addition to dietary adjustments, physical activity is essential for enhancing remission results. Exercising after meals helps to reduce hyperglycemia while taking movement breaks and doing aerobic and resistance training weekly improves glucose metabolism. Exercise lowers blood pressure, cholesterol, and body fat, which improves overall metabolic health.

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The medication-free LSI technique has both immediate and long-term benefits. Short-term benefits include decreased blood pressure, increased fitness, and a higher quality of life. If sustained, LSM-based remission has the potential to reduce or eliminate the requirement for medication while also reducing diabetes problems in the long run, making it a promising T2DM management option.^[59-62]

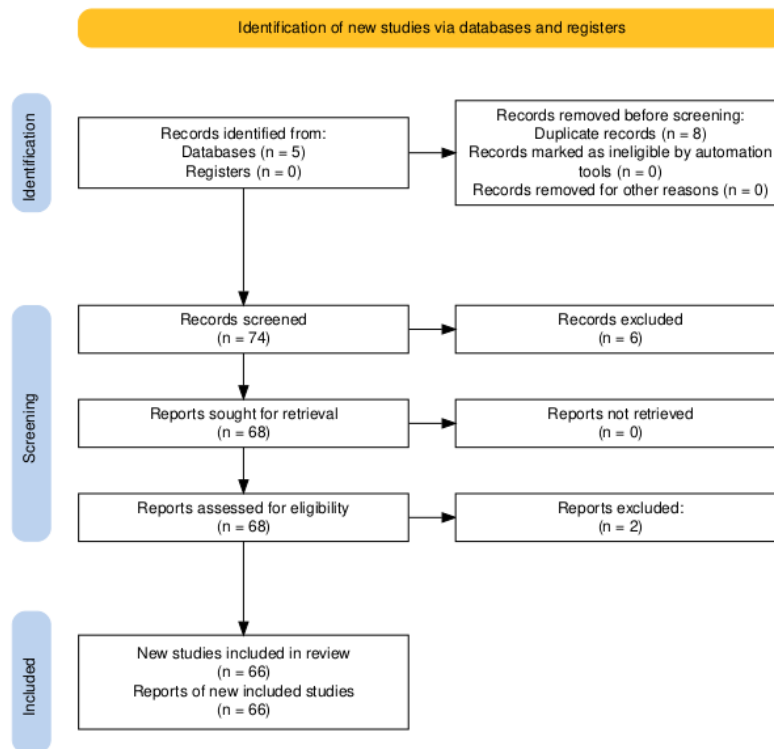


Figure 1: PRISMA flowchart.

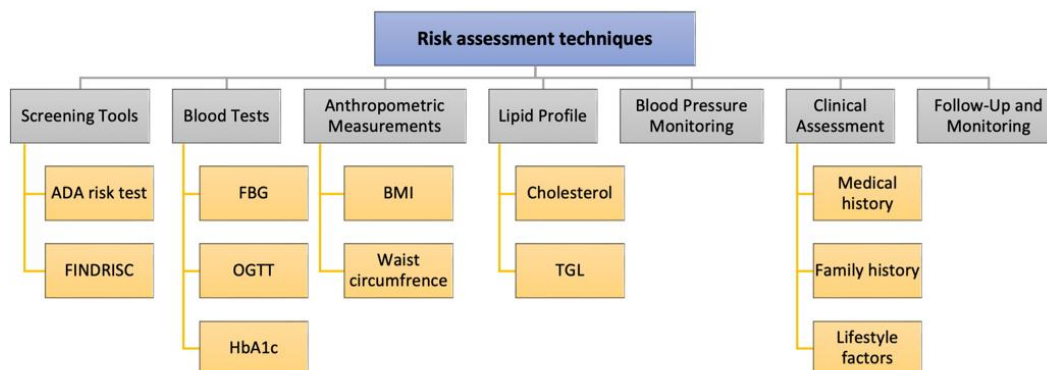


Figure 2: T2DM Risk assessment techniques.

(ADA= American Diabetes Association, FINDRISC = Finnish Diabetes Risk Score, FBG= Fasting Blood Glucose, OGTT = oral glucose tolerance tests, TGL= Triglycerides.)

Table 1: Pillars of lifestyle medicine.

Pillar	Detail
Nutrition	Dietary modifications aimed to prevent and manage chronic conditions and also reversing such illness. A whole food, plant based diet that is rich in fibers, whole grains, antioxidants, vitamins and minerals is recommended in a nutrition regime. There should be inclusion of minimally processed food, vegetables, fruits, legumes, nuts and seeds.
Physical activity	Regular and consistent physical activity helps in reversing such conditions. The exercise regime should aim in building overall health that includes physical, mental and emotional health. A regular physical exercise of about 150 minutes/ week of moderate intensity is mostly recommended when prescribing a personalized plan.
Stress management	Excessive stress and related conditions can cause anxiety, depression and is a major contributing factor in obesity and patients with T2DM. Reduction in stress ensures prevention from its negative factors and also helps in adherence.

	to the reversal journey
Avoidance of substance	Tobacco and alcohol consumption increases the risk of many fatal diseases. In order to prevent and also manage the chronic disease, it is very important for the patient to abstain from these substances.
Restorative Sleep	Inadequate and irregular sleeping pattern is seen as a link to many risk factors associated to chronic ailments as well as it negatively affects the quality of life of the patient by bringing negative changes to the mood, diminishing attention span, etc.
Social connection	It is important to have a positive social relationship and a positive circle. This helps in building overall health. It acts as a powerful motivating factor as well.
<i>Derived from American College of Lifestyle Medicine^[59]</i>	

Table 2: Nutrition recommendation for reversal of T2DM.

Diet type	Information
Mediterranean diet	Emphasizes on fruits, vegetables, whole grains, legume, nuts, seeds, olive oil and moderate consumption of fish, poultry and red wine. This type of diet is rich in fibre, antioxidants, healthy fats and is seen too have an improvement in cardiovascular health and T2DM management.
DASH diet (Dietary approach to stop hypertension)	It was originally designed to lower blood pressure and to control hypertension and even prevent it. This type of diet encourages consumption of fruits, vegetables, whole grain, lean protein and low fat dairy products limiting sodium intake, saturated fats and processed foods. Due to this, DASH diet is rich in fibers, potassium, calcium, magnesium. It has seen to benefit people with T2DM and also other cardiovascular diseases.
Plant based diet	One of the most popular dietary approach in lifestyle medicine. Emphasizing on usage of food derived from plants like fruits, vegetables, whole grains, seeds, nuts and legumes. These diets are rich in antioxidants, vitamins and minerals which help in improving insulin sensitivity and reducing cholesterol.
Low carbohydrate diet (LCD)	This type of diet restricts the amount of carbohydrate to reduce blood sugar spikes, improve insulin sensitivity and emphasizing on usage of low glycemic index food. This type of diet can help in weightloss, blood glucose control, reduced dependence of prescribed drugs.
Very low calorie diet (VLCD)	Involves drastically reducing the calories to a very low level. Typically at a level of 800-1000 calories per day or lower. This can induce rapid weight loss and very beneficial in giving a kick start to the weight loss journey in severe insulin resistance and severe obesity
Low fat and high protein diets	Involves in consuming diet lower in fats especially saturated and trans fat and supports heart health. Avoidance of deep-fried food and processed snacks are some of the key features of this diet. On the other hand, high protein diets are important in preserving muscle mass and even gaining muscle as a whole. This diet includes lean meats, poultry, fishes, eggs, tofu, dairy products, etc.

Table 3: Summary of studies supporting effectiveness of lifestyle medicine for remission of T2DM accounting last 10 years of data.

Year	Author(s)	Trial / Study Name	Key Findings
2024	American Diabetes Association	ADA Standards of Care 2024	Recommends intentional weight loss of $\geq 10\%$ through intensive lifestyle intervention as a viable method to achieve remission of T2DM in selected individuals. Emphasizes plant-based diets, physical activity, and behavioral support. ^[63]
2023	Yang J et al.	Meta-analysis of 17 RCTs	Showed a mean reduction of HbA1c by 0.36%, improved triglycerides, HDL levels, and body weight across various ethnicities. Supported the effectiveness of structured lifestyle interventions in overweight/obese adults with T2DM. ^[7]
2023	Hocking SL et al.	DiRECT-Aus	Australian adaptation of DiRECT trial showed significant remission rates in early T2DM patients using intensive primary care-based low-calorie diet (LCD), physical activity, and clinician support. ^[61]
2020	Hallberg SJ et al.	Virta Health	Continuous remote care using ketogenic diet and coaching

		Trial	showed sustained T2DM remission (20% at 2 years), substantial HbA1c and weight reduction, and reduced insulin use. ^[64]
2018	Lean MEJ et al.	DiRECT Trial	Landmark UK study: 46% remission at 1 year and 36% at 2 years with primary care-led VLCD, supported by withdrawal of diabetes medications and follow-up. ^[65]
2016	Look AHEAD Research Group	Look AHEAD RCT	Largest lifestyle intervention trial in T2DM; 8.6% remission at 1 year using intensive lifestyle (diet + 175 min/week physical activity) in overweight/obese patients. ^[66]
2016	Dutton GR et al.	Look AHEAD Extension	Even after trial conclusion, long-term data showed maintained remission and improved cardiovascular health in a subset of patients who sustained weight loss and lifestyle changes. ^[49]

CONCLUSION

Type 2 Diabetes Mellitus is an increasing worldwide health burden with a complicated etiology and complex pathophysiology that includes genetic, behavioral, and environmental factors. Lifestyle medicine is a promising non-pharmacological method for addressing the underlying metabolic abnormalities through long-term behavioral changes. Evidence suggests that plant-based diets, physical activity, and stress reduction can improve glycemic control, reduce weight, and even achieve remission. However, real-world deployment necessitates overcoming obstacles such as patient compliance, socioeconomic differences, and cultural adaption. Future research must focus on longitudinal studies to validate long-term effects, and healthcare systems should incorporate lifestyle medicine into standard diabetic management. Adopting this paradigm shift is not only cost-effective, but also consistent with individualized, preventive treatment, providing hope for increased remission rates and a higher quality of life for millions.

Abbreviations

- ABG – Arterial Blood Gas
- ADA – American Diabetes Association
- BMI – Body Mass Index
- BP – Blood Pressure
- CDC – Centers for Disease Control and Prevention
- CKD – Chronic Kidney Disease
- CV – Cardiovascular
- CVD – Cardiovascular Disease
- DPP-4 – Dipeptidyl Peptidase-4
- DSMES – Diabetes Self-Management Education and Support
- ECG – Electrocardiogram
- ECHO – Echocardiogram
- FPG – Fasting Plasma Glucose
- GLP-1 – Glucagon-Like Peptide-1
- HbA1c – Glycated Hemoglobin
- HDL – High-Density Lipoprotein
- HHS – Hyperosmolar Hyperglycemic State
- IDF – International Diabetes Federation
- IFG – Impaired Fasting Glucose
- IGT – Impaired Glucose Tolerance
- IR – Insulin Resistance
- LDL – Low-Density Lipoprotein
- MetS – Metabolic Syndrome
- OGTT – Oral Glucose Tolerance Test
- PCOS – Polycystic Ovary Syndrome

- PRISMA – Preferred Reporting Items for Systematic Reviews and Meta-Analyses
- RAAS – Renin-Angiotensin-Aldosterone System
- RCTs – Randomized Controlled Trials
- SGLT2 – Sodium-Glucose Cotransporter-2
- SMBG – Self-Monitoring of Blood Glucose
- T2DM – Type 2 Diabetes Mellitus
- WHO – World Health Organization

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Conflicts of interest

Author(s) declare no Conflicts of Interest.

Ethical approval

Not applicable.

Consent to participate

Not applicable.

Consent to publication

Not applicable.

Availability of data and materials

Not applicable.

Funding

Not applicable.

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