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A case series of CBT-inspired behavioral and medical interventions for uncontrolled type 2 diabetes

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Abstract

Type 2 diabetes mellitus (T2DM) is a global health challenge often complicated by poor treatment adherence, suboptimal lifestyle habits, and progressive metabolic deterioration. Cognitive behavioral therapy (CBT) has been shown to improve adherence and psychological outcomes, yet its integration with structured lifestyle modification and pharmacotherapy in routine clinical care remains underexplored. A descriptive case series of five patients with uncontrolled T2DM (baseline HbA1c 11–14.5%) was conducted in a primary care setting in Palestine. The intervention combined CBT-inspired behavioral counseling (goal setting, problem-solving, cognitive restructuring) with a structured two-meal low-carbohydrate diet, exercise and sleep hygiene guidance, and pharmacotherapy optimization (withdrawal of insulin/sulfonylureas, initiation of metformin, DPP-4 inhibitors, and SGLT2 inhibitors as appropriate). Patients were followed for 3–6 months. All five patients achieved clinically meaningful improvements. Mean HbA1c decreased from 12.6% at baseline to 7.4% at follow-up. Weight loss ranged from 5–17 kg (mean ~10 kg). Additional benefits included reductions in blood pressure, improvements in renal function and lipid profiles, and resolution of quality-of-life issues such as fatigue and erectile dysfunction. Several patients discontinued insulin or sulfonylurea therapy while maintaining improved glycemic control. The integration of CBT-inspired counseling with structured lifestyle intervention and pharmacotherapy adjustments was associated with short-term improvements in uncontrolled T2DM, including outcomes approaching remission. Although the small sample size and uncontrolled design limit causal interpretation, the program is being done in a low-income, limited-resources area like Palestine. Patients do not have the privilege to attend and receive care from several healthcare professionals. Hence, conducting such practice in a primary care clinic and yielding such results and improvement in diabetes status is promising and provides hope to the patients with low income.

Keywords

cognitive behavioral therapy (CBT), lifestyle intervention, diabetes remission, pharmacotherapy optimization, behavioral counseling

Introduction

Type 2 diabetes mellitus (T2DM) is a metabolic disorder characterized by chronic hyperglycemia due to defects in insulin secretion and/or action [1]. The prevalence of diabetes has reached alarming levels worldwide. In 2014, the World Health Organization (WHO) reported that 422 million people were living with diabetes, with 3.7 million annual deaths attributable to diabetes and its complications [2].

A major challenge in diabetes management is ensuring patient adherence to treatment and lifestyle recommendations [3]. Patient non-compliance with medications is widespread and is linked to poor glycemic control, higher hospitalization rates, and increased mortality [4]. Psychosocial factors, including depression, diabetes-related distress, and health beliefs, often contribute to suboptimal self-care in diabetes [5]. Therefore, interventions targeting behavior change and psychological support have gained attention as complements to standard medical therapy.

Cognitive behavioral therapy (CBT) has been explored as a strategy to improve diabetes outcomes [6, 7]. CBT is a form of psychotherapy that helps individuals modify dysfunctional thoughts and behaviors, which in the context of diabetes can translate to better medication adherence, dietary habits, and coping strategies.

We identified and analyzed a series of five cases from a primary care clinic in which a CBT-inspired behavioral-metabolic approach was being applied in routine care. The behavioral component was not a formal, manualized CBT protocol. All counseling was delivered by the treating physician, who applied selected CBT principles, including cognitive reframing, problem-solving training, and structured goal setting, to support adherence to diet, medication, and lifestyle. The same core behavioral framework was applied to all patients, but session content was individualized based on each patient's difficulties. Because no standardized CBT manual was followed, we describe the intervention as CBT-inspired rather than formal CBT. The CBT-inspired protocol was delivered by the treating physician as part of routine care at a primary care clinic. The physician is a family physician with a public health specialty and extensive experience in diabetes care and patient-education programs.

The basic principles of the CBT-inspired program in addressing T2DM adopted by Dr. BAM:

1. Cognitive behavioral training program:
    a. Sessions of explaining the diabetes, current disease status, treatment goals, medications being given, and involving the patient totally, and explaining all aspects of illness.
    b. Provide an open channel for patients' support, questions, and concerns (e.g., Facebook®, WhatsApp®, phone calls).
    c. Regular follow-up for adherence check, reinforcement, reassurance, and encouragement.
2. Medication optimization:
    a. Stop using any drug acting mainly on the pancreas.
    b. Withdrawal of any type of insulin gradually.
    c. Using alternative drugs acting on the liver, intestinal tracts, and kidneys.
    d. Vitamin B12 will be supplied because of possible deficiencies after medications.
3. A structured low-carbohydrate diet:
    a. Patients were educated to avoid simple sugars and refined carbohydrates, focusing instead on vegetables and lean protein.
    b. They were advised to limit fruit intake (due to high fructose content) and eliminate sugar-sweetened beverages and trans fats (hydrogenated oils) from their diet.
    c. The eating pattern was modified to only two meals per day (a late morning meal around 11 AM and an early evening meal around 6–7 PM) with no snacks in between.

d. If hunger arose between meals, patients could have water, unsweetened tea (green or black), or a simple salad as alternatives.

4. Lifestyle modification:
   a. It is recommended to practice an evening walk for at least 20 minutes.
   b. It is recommended to sleep at least 7 hours/day.
5. Preliminary consent of the service user in using the program and to fully cooperate with the training physician.
6. The service user is aware of his illness, and he must participate actively in decision-making and self-management.
7. Looking for social support services for patients incapable of buying medications.

The rationale for combining behavioral counseling, aggressive dietary restructuring, and medication optimization was to simultaneously address three contributors to uncontrolled diabetes: behavioral barriers, excessive carbohydrate intake, and pharmacologic overstimulation of insulin secretion. This integrated strategy is consistent with recent American Diabetes Association (ADA) recommendations favoring weight glycemic control and use of agents with cardiovascular and renal benefit [8, 9]. Hence, the present report was motivated by the observation that this real-world clinical practice was producing outcomes that appeared disproportionate to the available resources and warranted formal scientific description and contextualization within the existing literature.

Timeline

The key clinical characteristics, intervention components, and outcomes for all five cases are summarized in Table 1.

Table 1. Summary of the five cases.

Case/Period	Key problems at entry	Interventions	Overall outcomes
Case 1 (F, 78 y) Jan–May 2021	Longstanding uncontrolled diabetes; lifestyle inconsistency	CBT-inspired counseling; structured two-meal diet; medication optimization	Marked glycemic improvement; weight reduction; improved daily functioning
Case 2 (M, 55 y) Jan–May 2021	Uncontrolled diabetes; obesity; erectile dysfunction	CBT-inspired lifestyle change; optimized oral therapy; increased activity	Improved glycemic control; weight loss; improved sexual function
Case 3 (M, 45 y) Jan–Jun 2021	Severe uncontrolled diabetes; obesity; insulin dependence; surgery deferred	Stopped insulin/sulfonylurea; CBT-inspired diet plan; oral therapy; gradual exercise	Major improvement; significant weight loss; cleared for surgery; better quality of life
Case 4 (F, 50 y) Jan–Mar 2021	Uncontrolled diabetes; obesity; hypertension; dyslipidemia	CBT-inspired nutritional intervention; medication adjustments	Improved glycemic control; weight reduction; better BP and lipid profile
Case 5 (M, 58 y) Jan–Apr 2021	Uncontrolled diabetes; nephropathy; obesity; hypertension; dyslipidemia	Insulin withdrawal; structured diet; optimized oral therapy; lifestyle modification	Significant metabolic improvement; improved renal function; reduced edema; weight loss

CBT: cognitive behavioral therapy; BP: blood pressure.

Narrative

Case 1

A 78-year-old female with a 20-year history of T2DM and hypertension was referred for uncontrolled diabetes management. At baseline, she was obese (weight 97 kg) and on a regimen of metformin 850 mg three times daily, glimepiride 2 mg once daily, and enalapril 5 mg for blood pressure (BP). Her recent

laboratory results showed an HbA1c of 11.7% (January 2021) and a serum creatinine of 1.4 mg/dL (estimated creatinine clearance ~55 mL/min), indicating moderate renal impairment.

Intervention: CBT-inspired initiated with emphasis on nutritional therapy and medication adjustments. The patient and her family received counseling to substantially reduce intake of simple carbohydrates and to follow the two-meal-a-day (at 11 am and 6–7 pm), relying on the complex carbs in veggies, protein intake, and reduction of fruits. Stop all types of hydrogenated oils, and reduce as much as possible of carbonated drinks. Glimepiride was discontinued to avoid further pancreatic stress, and her treatment was switched to metformin plus sitagliptin (Januet® sitagliptin/metformin 50/1,000 mg) and dapagliflozin 10 mg daily, given her adequate renal function. She was instructed to eliminate sugary snacks and drinks entirely; only water, green tea, or salads were allowed between the two main meals. Light daily exercise and proper sleep hygiene were also reinforced as part of her CBT regimen. The patient came every 4–6 weeks for follow-up, reinforcement, counseling, and to check adherence.

Outcomes: After roughly three months in the program, the patient returned with clinically significant improvements. Her family reported that she was highly adherent to the diet and lifestyle recommendations. Her HbA1c had dropped to 6.1%, indicating near normalization from the previously uncontrolled level. She had lost 7 kg (now 90 kg), and her serum creatinine improved to 1.1 mg/dL. With this progress, dapagliflozin was discontinued, and the sitagliptin-metformin combination was reduced to once daily, since her blood sugars were now well controlled with the low-carb diet. The care plan projected that if she maintained this progress, she would be able to step down from the intensive CBT-inspired program by September 2021. This case illustrates that significant glycemic remission can be achieved in an older patient through strict behavioral modification combined with appropriate pharmacotherapy.

Case 2

A 55-year-old male with T2DM (baseline HbA1c 11%) and a history of obesity presented with complaints of erectile dysfunction and chronically elevated blood sugars. He had evidence of insulin resistance and had been experiencing difficulty improving his glycemic control under standard care. His vital signs were within normal limits, and he did not have major diabetes complications yet, aside from the sexual dysfunction symptoms.

Intervention: The patient's medication regimen was optimized by using metformin and sitagliptin (Januet® sitagliptin/metformin 50/1,000 mg) twice daily as the core therapy, while insulin secretagogues were avoided. Intensive counseling was given to incorporate regular physical activity, as he was capable of exercise, and to adhere strictly to the prescribed diet (two balanced meals per day, no snacks, no sugary beverages). The CBT-inspired sessions addressed his motivation and any emotional factors that might interfere with self-care, and also educated him on the possible link between poor diabetes control and erectile dysfunction, aiming to increase his engagement in diabetes management.

Outcomes: Over approximately 3–4 months, the patient demonstrated clinically significant improvement. By May 2021, he had lost 5 kg through improved diet and exercise. He reported an improvement in erectile function, which coincided with better glycemic control. His HbA1c fell to 6.7%, a considerable reduction from baseline, reflecting improved insulin sensitivity and adherence. BP and other vitals remained stable in the normal range. The patient was optimistic and planned to continue the lifestyle changes, but he stepped out of the program after more than 3 months.

Case 3

A 45-year-old male with obesity (115 kg) and long-standing uncontrolled T2DM (baseline HbA1c 14.5%) was considered for bariatric surgery, but his hyperglycemia had previously made surgery too high-risk. He had been on insulin therapy (long-acting insulin) alongside glimepiride 4 mg daily and metformin 850 mg twice daily, yet his glycemic control remained very poor (HbA1c consistently above 13%). He had no acute diabetes complications at presentation, but the extremely high glucose levels put him at risk for future complications.

Intervention: The patient started the CBT-based program with a comprehensive overhaul of his treatment. Insulin and glimepiride were tapered and eventually stopped, given his lack of response and the aim to reduce weight gain and hypoglycemia risk. He was transitioned to (Januet® sitagliptin/metformin 50/850 mg) twice daily and dapagliflozin 10 mg once daily, along with vitamin B12 supplementation. Rigorous dietary modification was implemented per the CBT guidelines (strict low-carbohydrate intake, two meals daily schedule). The patient was also encouraged to increase physical activity gradually, as his weight and conditioning limited immediate vigorous exercise. CBT sessions with him focused on building confidence that he could improve his health and reinforcing each small achievement (e.g., every few kilograms of weight lost or slight drop in glucometer readings) as positive feedback.

Outcomes: By his follow-up in late June 2021, after roughly six months in the program, the patient had achieved significant improvements. His weight decreased to 98 kg (a loss of 17 kg). His HbA1c had improved to 8.1%, down from 14.5%, representing a good reduction, although not yet reached the target range. Importantly, this glycemic improvement allowed him to be cleared for the elective surgery he needed (which had been previously postponed due to hyperglycemia). He also reported feeling more energetic and having a much-improved quality of life; for instance, he noted being able to be more physically active and engaged in daily activities than before. This demonstrated the potential for a CBT-inspired approach to enable weight loss and glycemic improvement in a patient with severe insulin resistance, possibly averting the need for lifelong insulin therapy.

Case 4

A 50-year-old female with T2DM presented with comorbid hypertension, dyslipidemia, and class III obesity (118 kg). Her diabetes was poorly controlled (HbA1c 14.5%), and she reported difficulty losing weight. Despite being on multiple medications, including metformin and insulin, her blood sugars remained elevated, and her cholesterol was high [low-density lipoprotein (LDL) cholesterol 285 mg/dL]. She sought help primarily for better diabetes control and weight management.

Intervention: The patient was initiated on the CBT-inspired program alongside adjustments to her medication. Her treatment was centered on metformin with sitagliptin (Januet® 50/850 mg twice daily). She was also maintained on her antihypertensive regimen (Exforge® amlodipine/valsartan 80/5 mg) adjusted for BP control. Intensive diet counseling was provided, emphasizing the elimination of high-carb foods and strict caloric intake control through only two meals per day. Because of her obesity, the importance of portion control and gradual exercise (like short walks, building up over time) was stressed. CBT sessions helped her identify emotional triggers for overeating and develop coping strategies such as mindful eating techniques.

Outcomes: Within months of starting the program, the patient exhibited a modest response. Her HbA1c decreased to 9.0%, which, although still above goal, represented a significant improvement from the baseline 14.5%. She lost 8 kg, bringing her weight down to about 110 kg, and reported better-fitting clothes and increased physical comfort. Her BP also improved, stabilizing with the existing medication dose. Notably, her total cholesterol dropped from 285 to 196 mg/dL, despite not being on any cholesterol-specific medication during that period. This improvement in her lipid profile was likely a consequence of her improved diet and weight loss. This case underlines how significant metabolic improvements, including on cholesterol levels, can occur with intensive lifestyle-focused therapy, even before introducing or without requiring high-dose statin therapy, though long-term management of dyslipidemia would still need to be addressed.

Case 5

A 58-year-old male with longstanding T2DM complicated by obesity (122 kg), hypertension, and dyslipidemia came to the clinic for a second opinion. He had an HbA1c of 11.4% and evidence of diabetic nephropathy (serum creatinine 1.7 mg/dL). His current medications included glimepiride 4 mg twice daily, high-dose rosuvastatin 20 mg for cholesterol, a combination antihypertensive (amlodipine/valsartan 160/10 mg, Exforge®), furosemide for edema, and insulin glargine (Lantus®) 20 IU nightly (with

instructions from a previous provider to up-titrate the insulin by 2 units daily until glucose control improved). Despite this intensive regimen, his diabetes remained uncontrolled.

Intervention: After discussion, the patient agreed to undertake the CBT-based program with close supervision. The insulin dose was gradually reduced by 4 IU every few days and eventually stopped, as his diet became stricter and oral agents were optimized. He was transitioned to (Januet® sitagliptin/metformin 50/850 mg twice daily) and dapagliflozin 10 mg once daily. Aspirin and vitamin B12 were added to his regimen (aspirin for cardiovascular prevention, given his risk profile, and B12 due to metformin use). The patient received extensive education on the two-meal diet plan and the importance of avoiding snacking, especially given his insulin resistance. He was advised to walk for at least 30 minutes each day (breaking it into shorter walks if needed due to his weight), and to adhere to a low salt diet alongside the low carb diet to help his BP and fluid retention. Behavioral counseling focused on helping him adjust to life without relying on insulin injections, addressing any anxiety about initially higher sugars during insulin taper, and reinforcing his successes (like weight loss milestones).

Outcomes: The patient showed clinically relevant health improvements. His HbA1c dropped to 7.1%, a notable improvement from 11.4%. His weight was reduced to 108 kg (a loss of 14 kg). Correspondingly, his renal function improved (serum creatinine down to 1.1 mg/dL), suggesting better kidney perfusion or less diabetic nephropathy progression. His BP responded well: the dose of Exforge® amlodipine/valsartan was halved to 80/5 mg daily, and the frequency of furosemide was reduced (from daily to every other day) as his edema diminished. He reported a marked improvement in his quality of life; he felt more energetic and was able to walk longer distances without exhaustion. The patient was advised to continue the CBT-inspired program for another six months for consolidation.

Diagnostics

A full clinical assessment was performed for all patients at baseline and follow-up, including laboratory evaluation (HbA1c, renal function, lipid profile when available), anthropometric measures, and BP monitoring. Laboratory tests were performed in accredited local laboratories following standard reference ranges.

Case 1 (F, 78 y)

- Baseline: HbA1c 11.7%; weight 97 kg; serum creatinine 1.4 mg/dL; long-standing T2DM.
- Follow-up: HbA1c 6.1%; weight 90 kg; creatinine 1.1 mg/dL.

Case 2 (M, 55 y)

- Baseline: HbA1c 11%; obesity; erectile dysfunction; normal vital signs.
- Follow-up: HbA1c 6.7%; weight −5 kg; symptomatic improvement.

Case 3 (M, 45 y)

- Baseline: HbA1c 14.5%; weight 115 kg; long-standing insulin dependence; surgery deferred due to hyperglycemia.
- Follow-up: HbA1c 8.1%; weight 98 kg; cleared for surgery; improved functional status.

Case 4 (F, 50 y)

- Baseline: HbA1c 14.5%; weight 118 kg; hypertension; LDL 285 mg/dL.
- Follow-up: HbA1c 9.0%; weight 110 kg; LDL 196 mg/dL; improved BP control.

Case 5 (M, 58 y)

- Baseline: HbA1c 11.4%; weight 122 kg; serum creatinine 1.7 mg/dL; hypertension; dyslipidemia; edema.
- Follow-up: HbA1c 7.1%; weight 108 kg; creatinine 1.1 mg/dL; improved BP and reduced edema.

All laboratory measurements were performed at accredited local laboratories.

Patient perspective

Patient perspectives were obtained through open-ended questions during routine follow-up visits and documented in the clinical notes. No validated questionnaire was used, and responses were summarized qualitatively. Themes were summarized descriptively from clinical notes; no formal coding was done. All participants reported a sense of empowerment from understanding the behavioral logic behind glucose fluctuations. Several described improved family relationships and self-esteem. They felt they were controlling their disease themselves, not the disease controlling them. One of the patients reported, "I feel like I have no diabetes anymore". Most patients reported the same themes.

Discussion

This case series represents an analytical examination of a real-world behavioral-metabolic practice observed in a routine primary care setting in a low-resource environment. Although the uncontrolled design limits causal inference, several consistent patterns across the five cases help illuminate how structured behavioral support, carbohydrate reduction, and rational medication adjustment may work together to improve glycemic control.

This case series illustrates that marked short-term metabolic improvement is achievable in severely uncontrolled T2DM within routine primary care when three levers are pulled together: (1) a clear behavioral structure that builds adherence and self-efficacy, (2) a significant reduction in dietary glycemic load with simplified meal timing, and (3) pharmacotherapy aligned with insulin-sparing, cardio-renal-protective principles. Across five patients with very high baseline HbA1c, the magnitude and consistency of HbA1c reduction, weight loss, and improvement in symptoms and cardio-metabolic markers suggest a synergistic effect that exceeds what would be expected from any single component delivered in isolation.

A central interpretation is that the "CBT-inspired" element functioned less as psychotherapy and more as an adherence and problem-solving framework embedded into medical care. In uncontrolled diabetes, the barrier is often not knowledge of "what to do" but the repeated failure to translate intentions into daily decisions under stress, social pressure, habitual eating, and low perceived control. The counseling approach in these cases explicitly targeted those barriers: patients were guided to reinterpret glucose readings as feedback rather than failure, to identify triggers for nonadherence, to create practical coping plans, and to set observable short-term goals. This aligns with evidence that CBT-based interventions improve diabetes distress, depressive symptoms, treatment adherence, and quality of life in adults with T2DM, with modest improvements in HbA1c when CBT is delivered as a stand-alone intervention [6]. In the present series, the behavioral component likely amplified the impact of dietary and medication changes by reducing "behavioral dropout", strengthening self-monitoring, and sustaining consistency long enough for metabolic improvements to emerge [10, 11].

Medication adjustments aligned with contemporary American Diabetes Association Standards of Care, which emphasize person-centered selection of glucose-lowering agents with proven cardiovascular and renal benefit and recommend minimizing use of agents associated with hypoglycemia and weight gain, such as sulfonylureas, when effective alternatives are available [12, 13]. The medication rationalization strategy, particularly favoring reduced reliance on insulin secretagogues, may have complemented the metabolic effects of dietary change [14, 15]. As the current series is not about judging guidelines or testing specific therapies, the aim was to use an insulin-sparing approach [16].

Dietary restructuring and meal timing were likely major drivers of rapid glycemic change [17]. A strict reduction in refined carbohydrates coupled with a defined two-meal pattern may reduce post-prandial glucose changes, simplify decision-making, and extend fasting intervals that can improve insulin sensitivity in some individuals. Unlike complex diet prescriptions that require extensive counting or frequent meal planning, the two-meal structure is cognitively simple: fewer eating episodes, fewer opportunities for glycemic spikes, and fewer moments requiring willpower. Studies in T2DM have shown that reduced meal frequency and time-restricted eating can improve weight and glycemic control [18, 19], and systematic reviews support the potential of low-carbohydrate strategies for diabetes improvement and, in some cases,

remission [20, 21]. Resembling the intermittent fasting techniques, which have been proven for their efficiency in controlling weight and improving blood sugar [22–25]. This approach aimed to reduce continuous glycemic spikes and possibly improve insulin sensitivity by extending the fasting interval between meals [17, 26, 27].

Each patient underwent individualized educational sessions to understand the nature of T2DM, the impact of diet and exercise, and the rationale behind their medication changes. Misconceptions and beliefs (for example, passive attitudes about diabetes or doubts about their ability to influence their health) were addressed through cognitive techniques. Patients were guided to set realistic goals and to self-monitor their blood glucose and adherence. The primary care physician regularly engaged patients in problem-solving discussions to overcome barriers, thus applying CBT principles to enhance self-efficacy and motivation.

The program emphasized the patient's active role and required a preliminary commitment from the patient (and family, when applicable) to adhere to the plan. Follow-up visits were scheduled approximately every 4–6 weeks to monitor progress, reinforce behavioral changes, and adjust the plan as needed. Social support was encouraged; family members were involved in diet planning and reminded to provide encouragement rather than tempting the patient with non-compliant foods. No formal control group was used, but each patient served as their own control by comparing baseline and follow-up outcomes. Patients were able to contact the physician for questions and concerns, in addition to receiving support whenever they needed, which helped in reinforcing the behavioral changes and counseling.

Medication optimization may have complemented these behavioral and nutritional changes by removing therapies that can conflict with weight loss efforts and by prioritizing agents that support cardio-renal outcomes [28]. Insulin and sulfonylureas can cause low blood sugar and weight gain. When patients experience hypoglycemia, they often become afraid of it happening again. This fear can lead them to eat more carbohydrates "just in case," even when they are not hungry. By reducing these medications in appropriate patients, this fear may decrease, making it easier for patients to follow dietary recommendations [18, 29]. Meanwhile, continued use of metformin and selective addition of dipeptidyl peptidase-4 (DPP-4) inhibitors and sodium-glucose cotransporter-2 (SGLT2) inhibitors provided glucose-lowering support with a lower hypoglycemia burden and potential renal and cardiovascular benefits, broadly consistent with contemporary guideline directions [30, 31]. Importantly, the approach in this series suggests a practical clinical sequencing: medication de-intensification (especially insulin tapering) becomes more plausible when dietary glycemic load is first reduced, and follow-up is sufficiently close to respond to early instability.

Quality-of-life changes reported by patients, improved energy, reduced fatigue, improved erectile function, and a subjective sense of "control", matter clinically because they likely act as reinforcement loops that sustain behavior change. For many patients, early symptomatic improvement is more persuasive than abstract risk reduction. Weight loss and improved glycemia are both associated with better sexual function and general well-being in T2DM, and the present narratives suggest that symptom relief may have strengthened motivation, creating a self-reinforcing cycle: adherence, improved readings/symptoms, higher self-efficacy, continued adherence [32, 33].

"Remission" of diabetes is discussed in the medical literature [34–36]. Some patients in this series approached remission criteria; longer-term follow-up is needed before such a conclusion can be drawn. Even if patients can discontinue diabetes medications, they remain at risk for hyperglycemia if healthy behaviors are not maintained. The outcomes of this series are consistent with the findings of large lifestyle-focused trials such as the DiRECT study, where intensive diet-induced weight loss led to diabetes remission in a significant proportion of patients [37, 38]. However, our approach differed by explicitly incorporating CBT-inspired techniques to reinforce adherence. Unlike classical CBT protocols targeting comorbid depression, our program applied behavioral principles to diabetes self-management more broadly. This aligns with a growing body of evidence that psychosocial interventions can support diabetes remission when combined with metabolic strategies [39, 40].

A notable aspect of this case series is the setting: a primary care clinic in a low-resource region such as Palestine, where access to multidisciplinary diabetes services, dietitians, psychologists, and diabetes educators is limited [41, 42]. Prior observational work in similar contexts shows that simplified, physician-delivered behavioral and nutritional programs can achieve meaningful improvements when more intensive services are unavailable [43, 44]. The consistency of the present outcomes with the literature suggests that structured counseling delivered by an experienced primary care physician may be a pragmatic, scalable strategy for systems that lack specialist infrastructure. This aligns with global recommendations emphasizing behavioral counseling and carbohydrate reduction as first-line interventions that can be delivered in primary care [45].

The magnitude of HbA1c reduction observed in this series (ranging from 38 to 48%) is substantially greater than the 1.0–1.5% mean reductions typically reported in pharmacological trials. This finding should be interpreted in the context of extremely high baseline HbA1c values and the concurrent implementation of multiple interventions, including intensive carbohydrate restriction and the use of insulin-sparing therapies such as metformin and SGLT2 inhibitors, in patients with marked insulin resistance or failing prior regimens.

Although rapid glycemic improvement has historically raised concerns regarding early worsening of diabetic retinopathy, particularly when achieved through insulin intensification, emerging evidence suggests that in patients with very poor baseline glycemic control, early normalization may reflect reversal of glucotoxicity rather than pathological overcorrection. Importantly, the present case series does not permit conclusions regarding long-term microvascular or mortality outcomes, and sustained benefits require confirmation through longer follow-up and controlled study designs [46].

As with all case series, the findings must be interpreted cautiously. The small sample size (five patients from a single clinic) limits generalizability, and the absence of a control group limits conclusions about causality [47]. The patients included may represent self-selection, as motivated patients might be more willing to participate in the program. The magnitude of glycemic improvements likely reflects the synergy of multiple interventions rather than CBT alone. The short follow-up period prevents assessment of long-term sustainability or relapses. Moreover, psychological outcomes were not assessed using validated tools, and follow-up durations varied between cases (3–6 months, although follow-up visits were scheduled every 4–6 weeks; real-world variability occurred based on patient availability and clinical need), limiting conclusions about the specific mental health benefits of CBT. In addition, safety monitoring should have been more intensified, as combining strict carbohydrate restriction with SGLT2 inhibitors may increase the risk of euglycemic diabetic ketoacidosis in certain contexts, which did not occur in the current series. As multiple components were delivered simultaneously, this case series cannot determine the independent effect of CBT-inspired counseling. The behavioral component likely functioned as an adherence-support mechanism for diet and pharmacotherapy, consistent with literature showing that psychosocial engagement enhances diabetes self-management. The heterogeneity of patients in this series, including differences in age, disease duration, comorbidities, baseline treatments, and social circumstances, limits generalizability. Outcomes may reflect a combination of high patient motivation, close follow-up, and context-specific factors that may not be reproducible in broader populations. As a descriptive case series, the findings should be viewed as hypothesis-generating rather than confirmatory.

Future research should test this integrated model in a prospective design with standardized behavioral content, predefined safety monitoring, and longer follow-up. Practical next steps include: (1) a pilot pragmatic trial in primary care comparing this structured behavioral-metabolic package to usual care, (2) measurement of adherence, diabetes distress, and self-efficacy using validated scales, and (3) evaluation of durability at 12–24 months with standardized remission criteria. If efficacy and safety are confirmed, such an approach could offer a realistic pathway to large glycemic improvements and potential de-intensification of therapy in settings where patients have limited access to multidisciplinary resources.

The approach used here (brief structured behavioral counseling, defined meal timing, carbohydrate reduction, and medication rationalization) may offer a feasible model for integration into routine practice,

especially in low-resource settings. Potential barriers include limited consultation time and variability in patient engagement. Future work should evaluate whether similar metabolic improvements can be sustained long term and whether outcomes can be replicated in broader populations.

Conclusions

This case series provides real-world evidence that intensive behavioral and medical interventions can lead to improvements in uncontrolled T2DM. Although causality cannot be established, the cases highlight both the potential for diabetes remission in routine practice and the importance of incorporating behavioral principles into standard care. Future controlled studies are needed to disentangle the relative contribution of CBT components, validate long-term sustainability, and determine how such programs can be systematically integrated into health systems.

Abbreviations

BP: blood pressure

CBT: cognitive behavioral therapy

LDL: low-density lipoprotein

SGLT2: sodium-glucose cotransporter-2

T2DM: type 2 diabetes mellitus

Declarations

Author contributions

AN: Conceptualization, Methodology, Data curation, Formal analysis, Investigation, Visualization, Writing—original draft, Writing—review & editing, Project administration. BAM: Investigation, Resources, Validation, Supervision, Writing—review & editing. Both authors read and approved the final manuscript.

Conflicts of interest

The authors declare that they have no conflicts of interest.

Ethical approval

The intervention described in this report was delivered as part of routine clinical care rather than a predefined research program. All behavioral counseling and medication adjustments were components of standard management for uncontrolled diabetes in this primary care setting. The institutional framework determined that the case series met criteria for exemption from formal ethical review because the analysis was retrospective, all data were de-identified, and no procedures exceeded routine practice. No experimental treatments, investigational agents, or non-standard behavioral protocols were administered. The article complies with the Declaration of Helsinki (2013 version).

Consent to participate

Informed consent to participate in the study was obtained from all participants.

Consent to publication

Not applicable.

Availability of data and materials

De-identified data underlying this case series are available from the corresponding author upon reasonable request.

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References

1. Magliano DJ, Boyko EJ; IDF Diabetes Atlas 10th edition scientific committee. IDF DIABETES ATLAS [Internet]. In: Chapter 1 What is diabetes? 10th ed. Brussels: International Diabetes Federation; 2021.
2. Global report on diabetes [Internet]. World Health Organization; c2026 [cited 2025 Aug 4]. Available from: https://www.who.int/publications/i/item/9789241565257
3. Świątoniowska-Lonc N, Tański W, Polański J, Jankowska-Polańska B, Mazur G. Psychosocial Determinants of Treatment Adherence in Patients with Type 2 Diabetes - A Review. Diabetes Metab Syndr Obes. 2021;14:2701–15. [DOI] [PubMed] [PMC]
4. Donnan PT, MacDonald TM, Morris AD. Adherence to prescribed oral hypoglycaemic medication in a population of patients with Type 2 diabetes: a retrospective cohort study. Diabet Med. 2002;19: 279–84. [DOI] [PubMed]
5. Piragine E, Petri D, Martelli A, Calderone V, Lucenteforte E. Adherence to Oral Antidiabetic Drugs in Patients with Type 2 Diabetes: Systematic Review and Meta-Analysis. J Clin Med. 2023;12:1981. [DOI] [PubMed] [PMC]
6. Abbas Q, Latif S, Habib HA, Shahzad S, Sarwar U, Shahzadi M, et al. Cognitive behavior therapy for diabetes distress, depression, health anxiety, quality of life and treatment adherence among patients with type-II diabetes mellitus: a randomized control trial. BMC Psychiatry. 2023;23:86. [DOI] [PubMed] [PMC]
7. Vlachou E, Ntikoudi A, Owens DA, Nikolakopoulou M, Chalimourdas T, Cauli O. Effectiveness of cognitive behavioral therapy-based interventions on psychological symptoms in adults with type 2 diabetes mellitus: An update review of randomized controlled trials. J Diabetes Complications. 2022; 36:108185. [DOI] [PubMed]
8. Das AK, Saboo B, Unnikrishnan AG. Current Practices and Gaps in Management of Dyslipidemia in Type 2 Diabetes Mellitus (T2DM) in Accordance with American Diabetes Association (ADA) Guidelines: A Subset Analysis from a Real-World, Cross-Sectional Observational Study (LEADD Study). Diabetes Metab Syndr Obes. 2021;14:2693–700. [DOI] [PubMed] [PMC]
9. Colling C, Atlas SJ, Wexler DJ. Application of 2021 American Diabetes Association Glycemic Treatment Clinical Practice Recommendations in Primary Care. Diabetes Care. 2021;44:1443–6. [DOI] [PubMed] [PMC]
10. Uchendu C, Blake H. Effectiveness of cognitive-behavioural therapy on glycaemic control and psychological outcomes in adults with diabetes mellitus: a systematic review and meta-analysis of randomized controlled trials. Diabet Med. 2017;34:328–39. [DOI] [PubMed]
11. Li C, Xu D, Hu M, Tan Y, Zhang P, Li G, et al. A systematic review and meta-analysis of randomized controlled trials of cognitive behavior therapy for patients with diabetes and depression. J Psychosom Res. 2017;95:44–54. [DOI] [PubMed]

12. American Diabetes Association Professional Practice Committee. 9. Pharmacologic Approaches to Glycemic Treatment: Standards of Care in Diabetes-2025. Diabetes Care. 2025;48:S181–206. [DOI] [PubMed] [PMC]
13. Heerspink HJL, Stefánsson BV, Correa-Rotter R, Chertow GM, Greene T, Hou F, et al.; DAPA-CKD Trial Committees and Investigators. Dapagliflozin in Patients with Chronic Kidney Disease. N Engl J Med. 2020;383:1436–46. [DOI] [PubMed]
14. Aroda VR, Edelstein SL, Goldberg RB, Knowler WC, Marcovina SM, Orchard TJ, et al.; Diabetes Prevention Program Research Group. Long-term Metformin Use and Vitamin B12 Deficiency in the Diabetes Prevention Program Outcomes Study. J Clin Endocrinol Metab. 2016;101:1754–61. [DOI] [PubMed] [PMC]
15. American Diabetes Association Professional Practice Committee. Summary of revisions: Standards of Care in Diabetes-2025. Diabetes Care. 2025;48:S6–13. [DOI] [PubMed] [PMC]
16. Gerstein HC, Yale J, Harris SB, Issa M, Stewart JA, Dempsey E. A randomized trial of adding insulin glargine vs. avoidance of insulin in people with Type 2 diabetes on either no oral glucose-lowering agents or submaximal doses of metformin and/or sulphonylureas. The Canadian INSIGHT (Implementing New Strategies with Insulin Glargine for Hyperglycaemia Treatment) Study. Diabet Med. 2006;23:736–42. [DOI] [PubMed]
17. Pavlou V, Cienfuegos S, Lin S, Ezpeleta M, Ready K, Corapi S, et al. Effect of Time-Restricted Eating on Weight Loss in Adults With Type 2 Diabetes: A Randomized Clinical Trial. JAMA Netw Open. 2023;6: e2339337. [DOI] [PubMed] [PMC]
18. Sarmento RA, Antonio JP, de Miranda IL, Nicoletto BB, de Almeida JC. Eating Patterns and Health Outcomes in Patients With Type 2 Diabetes. J Endocr Soc. 2017;2:42–52. [DOI] [PubMed] [PMC]
19. Campbell AP. DASH Eating Plan: An Eating Pattern for Diabetes Management. Diabetes Spectr. 2017; 30:76–81. [DOI] [PubMed] [PMC]
20. Wheeler ML, Dunbar SA, Jaacks LM, Karmally W, Mayer-Davis EJ, Wylie-Rosett J, et al. Macronutrients, food groups, and eating patterns in the management of diabetes: a systematic review of the literature, 2010. Diabetes Care. 2012;35:434–45. [DOI] [PubMed] [PMC]
21. Papamichou D, Panagiotakos DB, Itsiopoulos C. Dietary patterns and management of type 2 diabetes: A systematic review of randomised clinical trials. Nutr Metab Cardiovasc Dis. 2019;29:531–43. [DOI] [PubMed]
22. Morales-Suarez-Varela M, Sánchez EC, Peraita-Costa I, Llopis-Morales A, Soriano JM. Intermittent Fasting and the Possible Benefits in Obesity, Diabetes, and Multiple Sclerosis: A Systematic Review of Randomized Clinical Trials. Nutrients. 2021;13:3179. [DOI] [PubMed] [PMC]
23. Albosta M, Bakke J. Intermittent fasting: is there a role in the treatment of diabetes? A review of the literature and guide for primary care physicians. Clin Diabetes Endocrinol. 2021;7:3. [DOI] [PubMed] [PMC]
24. Santos HO. Intermittent fasting in the management of diabetes: a review of glycemic control and safety. Nutr Rev. 2024;82:1437–43. [DOI] [PubMed]
25. Dyńka D, Rodzeń Ł, Rodzeń M, Łojko D, Deptuła A, Grzywacz Ż, et al. Intermittent fasting in the treatment of type 2 diabetes. Front Nutr. 2025;12:1629154. [DOI] [PubMed] [PMC]
26. Kahleova H, Belinova L, Malinska H, Oliyarnyk O, Trnovska J, Skop V, et al. Eating two larger meals a day (breakfast and lunch) is more effective than six smaller meals in a reduced-energy regimen for patients with type 2 diabetes: a randomised crossover study. Diabetologia. 2014;57:1552–60. [DOI] [PubMed] [PMC]
27. Goldenberg JZ, Day A, Brinkworth GD, Sato J, Yamada S, Jönsson T, et al. Efficacy and safety of low and very low carbohydrate diets for type 2 diabetes remission: systematic review and meta-analysis of published and unpublished randomized trial data. BMJ. 2021;372:m4743. [DOI] [PubMed] [PMC]

28. Rangaswami J, Bhalla V, de Boer IH, Staruschenko A, Sharp JA, Singh RR, et al.; American Heart Association Council on the Kidney in Cardiovascular Disease; Council on Arteriosclerosis, Thrombosis and Vascular Biology, Council on Cardiovascular and Stroke Nursing, Council on Clinical Cardiology, and Council on Lifestyle and Cardiometabolic Health. Cardiorenal Protection With the Newer Antidiabetic Agents in Patients With Diabetes and Chronic Kidney Disease: A Scientific Statement From the American Heart Association. Circulation. 2020;142:e265–86. [DOI] [PubMed]
29. Wang Y, Zeng Z, Ding J, Yuan R, Wang R, Zhang Y, et al. Fear of hypoglycaemia among patients with type 2 diabetes mellitus: a cross-sectional study. Sci Rep. 2021;11:7971. [DOI] [PubMed] [PMC]
30. Tomovic K, Lazarevic J, Kocic G, Deljanin-Ilic M, Anderluh M, Smelcerovic A. Mechanisms and pathways of anti-inflammatory activity of DPP-4 inhibitors in cardiovascular and renal protection. Med Res Rev. 2019;39:404–22. [DOI] [PubMed]
31. Wang H, Lin S, Hung S, Chiou Y, Hsu W, Chang C, et al. Renal Protective Effect of Metformin in Type 2 Diabetes Patients. J Clin Endocrinol Metab. 2025;110:1224–34. [DOI] [PubMed]
32. Esposito K, Giugliano F, Palo CD, Giugliano G, Marfella R, D'Andrea F, et al. Effect of lifestyle changes on erectile dysfunction in obese men: a randomized controlled trial. JAMA. 2004;291:2978–84. [DOI] [PubMed]
33. Wing RR, Rosen RC, Fava JL, Bahnson J, Brancati F, Gendrano INC, et al. Effects of weight loss intervention on erectile function in older men with type 2 diabetes in the Look AHEAD trial. J Sex Med. 2010;7:156–65. [DOI] [PubMed] [PMC]
34. Riddle MC, Cefalu WT, Evans PH, Gerstein HC, Nauck MA, Oh WK, et al. Consensus Report: Definition and Interpretation of Remission in Type 2 Diabetes. J Clin Endocrinol Metab. 2022;107:1–9. [DOI] [PubMed] [PMC]
35. Sherifali DT, Racey ME, Greenway MK, Alliston PE, Ali MU, Gerstein HC, et al. Type 2 Diabetes Remission: A Systematic Review and Meta-analysis of Nonsurgical Randomized Controlled Trials. Diabetes Care. 2025;48:2181–91. [DOI] [PubMed] [PMC]
36. Velayutham K, Panneerselvam G, Ramanathan B. Understanding Diabetes Remission. Apollo Medicine. 2025;22:184–91. [DOI]
37. Lean ME, Leslie WS, Barnes AC, Brosnahan N, Thom G, McCombie L, et al. Primary care-led weight management for remission of type 2 diabetes (DiRECT): an open-label, cluster-randomised trial. Lancet. 2018;391:541–51. [DOI] [PubMed]
38. Lean MEJ, Leslie WS, Barnes AC, Brosnahan N, Thom G, McCombie L, et al. Durability of a primary care-led weight-management intervention for remission of type 2 diabetes: 2-year results of the DiRECT open-label, cluster-randomised trial. Lancet Diabetes Endocrinol. 2019;7:344–55. [DOI] [PubMed]
39. Yang X, Li Z, Sun J. Effects of Cognitive Behavioral Therapy-Based Intervention on Improving Glycaemic, Psychological, and Physiological Outcomes in Adult Patients With Diabetes Mellitus: A Meta-Analysis of Randomized Controlled Trials. Front Psychiatry. 2020;11:711. [DOI] [PubMed] [PMC]
40. Dong N, Wang X, Yang L. The short- and long-term effects of cognitive behavioral therapy on the glycemic control of diabetic patients: a systematic review and meta-analysis. Biopsychosoc Med. 2023;17:18. [DOI] [PubMed] [PMC]
41. Marie M, Battat M. Access Limitation to Health Services in Palestine and its Consequences on Palestinian Mental Health and Wellbeing: Literature Review. Research Square rs.3.rs-167116 [Preprint]. 2021 [cited 2025 Aug 4]. Available from: https://www.researchsquare.com/article/rs-167116/v2
42. Radwan M, Akbari Sari A, Rashidian A, Takian A, Elsous A, Abou-Dagga S. Factors hindering the adherence to clinical practice guideline for diabetes mellitus in the Palestinian primary healthcare clinics: a qualitative study. BMJ Open. 2018;8:e021195. [DOI] [PubMed] [PMC]

43. Mikhael EM, Hassali MA, Hussain SA, Nouri AI, Shawky N. Pharmacist-led interventional programs for diabetic patients in Arab countries: A systematic review study. Int J Diabetes Dev Ctries. 2019;39: 600–10. [DOI]
44. Islam MA, El-Dahiyat F, Nouri A, Alefan Q, Naqvi AA. Validation of the Arabic version of the general medication adherence scale in patients with type 2 diabetes mellitus in Jordan. Front Pharmacol. 2023;14:1194672. [DOI] [PubMed] [PMC]
45. American Diabetes Association. *Standards of Care in Diabetes-2023* Abridged for Primary Care Providers. Clin Diabetes. 2022;41:4–31. [DOI] [PubMed] [PMC]
46. Simó R, Franch-Nadal J, Vlacho B, Real J, Amado E, Flores J, et al. Rapid Reduction of HbA_{1c} and Early Worsening of Diabetic Retinopathy: A Real-world Population-Based Study in Subjects With Type 2 Diabetes. Diabetes Care. 2023;46:1633–9. [DOI] [PubMed]
47. Nouri AI, Abdi AM, Hassali MA. Synopsis of Research Methodologies: A Brief Guide for Pharmacists. JPRI. 2018;24:1–16. [DOI]