# Non-Pharmacological Approach to Uncontrolled Type 2 Diabetes: A Case Report

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## ABSTRACT

Type 2 diabetes is a highly prevalent metabolic condition with significant long-term health risks. First-line therapy for managing diabetes includes pharmaceuticals alongside nutritional, physical activity, and weight management interventions. However, some patients do not adhere to these recommendations or decline them altogether. This case report aims to document a case in which non-pharmacological treatment had a beneficial impact on severe uncontrolled type 2 diabetes. The subject is an unmedicated 59-year-old male patient with a reported 15-year history of uncontrolled type 2 diabetes. He presented with physical symptoms (fatigue, cravings, polyuria), signs of end-organ damage (neuropathy, retinopathy), and baseline labs indicative of severe glycemic dysregulation including an elevated fasting glucose and an elevated HbA1c. Despite the practitioner recommending pharmaceuticals as per clinical practice guidelines, the patient opted for non-pharmacological naturopathic interventions. Individualized nutritional modifications, increased physical activity, and two herbal-nutrient supplements were recommended. Over 4 months, the patient's diabetic symptoms improved alongside a corresponding significant improvement in lab markers (2.0% reduction in HbA1c from 10.1% to 8.1%; 5.7 mmol/L reduction in fasting glucose from 15.9 mmol/L to 10.2 mmol/L). This case demonstrates a significant improvement in symptoms and laboratory markers of glycemic regulation following 4 months of a multimodal, non-pharmacological treatment approach for a patient with uncontrolled diabetes who declined pharmacotherapy. This case adds to a body of literature suggesting that further research investigating non-pharmacological treatment options for managing diabetes is warranted.

**Key Words** Diabetes, metabolic, berberine, chromium, gymnema, diet, nutrition, physical activity, naturopathic

## INTRODUCTION

Type 2 diabetes mellitus (T2DM) is a highly prevalent metabolic disease involving hyperglycemia, impacting an estimated 29% of Canadians.[1] This condition features a combination of insulin resistance in select tissues and defective insulin secretion by pancreatic beta cells.[2] The prevalence of T2DM has increased in parallel to the prevalence of obesity, which is largely attributed to a sedentary lifestyle as well as increased access to and consumption of obesogenic foods.[3] Uncontrolled T2DM has significant long-term health risks that place individuals at risk of premature death. Well-established complications associated with unmanaged T2DM include retinopathy, peripheral neuropathy, kidney disease, stroke, coronary heart disease, and peripheral vascular disease.[4] Beyond these, emerging complications include affective disorders, functional disability, cognitive impairment, and cancer.[4]

T2DM is typically managed with a combination of behavioural interventions, such as nutritional therapy, weight management, and physical activity, alongside the primary focus of pharmacotherapy.[5] According to Diabetes Canada Clinical Practice Guidelines, glycemic targets should be individualized based on a patient's functional dependence, life expectancy, personal medical conditions, and other risk factors.[5] That said, the HbA1c target for most individuals with T2DM is less than or equal to 7%.[5] For individuals whose glycated hemoglobin (HbA1c) is greater than or equal to 1.5% above their individualized target, therapeutic guidelines recommend that pharmaceutical agents be initiated concomitantly with behavioural interventions and that consideration be given to initiating two pharmaceutical agents together.[5] Decisions about which pharmaceutical is best depend on several factors. However, first-line medications include metformin, while second-line medications include DPP-4 inhibitors, GLP-1 agonists,

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**To cite:** Alexander B, Hall JA, Aucoin M. Non-pharmacological approach to uncontrolled type 2 diabetes: a case report. *CAND Journal.* 2024;31(2):10–17. https://doi.org/10.54434/candj.172

**Received:** 8 March 2024; **Accepted:** 21 May 2024; **Published:** 27 June 2024

SGLT2 inhibitors, insulin secretagogues, thiazolidinediones, and insulin therapy.[5] Despite the available treatments, T2DM is responsible for enormous mortality and morbidity. There is therefore a need to explore additional options for management.

Despite the current recommended standard of care to deliver nutritional, weight management, and physical activity therapeutics as part of multifaceted management for all patients with T2DM, one study found that more than 75% of physicians felt inadequately trained to make dietary and physical activity recommendations to their patients.[6] In fact, only one-third of all primary care office visits involve nutritional and physical activity counselling discussions.[7] This is an area where naturopathic doctors have a high level of training.[8] Longer patient visits permit more time for behavioural counselling and it has been documented that these interventions are used consistently in the delivery of naturopathic care.[8,9] In a retrospective chart audit of naturopathic care for T2DM, 100% of patients received dietary counselling.[10]

There is evidence to support many nutritional approaches to T2DM management, and the recommendation should be individualized to ensure good adherence.[5] It is understood that the dominant driver of improvements in glycemic control is sustained weight loss, which is why numerous dietary patterns can work, and no universal diet is considered to be optimal for T2DM management.[11] Low carbohydrate diets (< 130 g/day) and very low carbohydrate diets (< 50 g/day) are safe and effective in managing weight and lowering HbA1c in people with T2DM, compared with moderate carbohydrate consumption (120–225 g/day).[12-14] A meta-analysis found that a low-carbohydrate diet resulted in a 0.62% reduction over 24 months.[15] Systematic reviews and meta-analyses have also shown that replacing high glycemic index foods with low glycemic index foods improves glycemic control and cholesterol in individuals with T2DM.[16-20] Similarly, following a high-fibre diet can improve HbA1c, fasting blood glucose, and blood lipids.[21] The Mediterranean diet has been shown to improve glycemic control, blood pressure, and blood lipids in individuals with T2DM.[21-23] Similarly, plant-based dietary patterns have been shown to improve glycemic control, cholesterol, and body composition in individuals with T2DM.[24]

Physical activity is another important component of T2DM management, as it helps to improve cardiorespiratory parameters, lipid profile, glycemic control, and decrease insulin resistance.[25] Exercise increases insulin sensitivity, leading to more efficient uptake and utilization of glucose from the bloodstream.[26] Aerobic exercise has been shown to reduce HbA1c and slow the development of T2DM complications such as peripheral neuropathy.[27,28] Resistance training has been shown to improve glycemic control, as well as increase muscle strength, muscle mass, and bone mineral density, thereby improving functional status.[29] However, an optimal resistance training program has not yet been established for the management of T2DM.[29] That said, both aerobic and resistance exercise are beneficial, and Diabetes Canada Clinical Practice Guidelines recommend at least 150 minutes of aerobic activity each week in addition to two resistance training sessions.[5] A meta-analysis found that exercise durations of more than 150 minutes per week can result in HbA1c reductions of 0.89%, while exercise durations of less than 150 minutes per week result in reductions of 0.36%.[30]

Despite the numerous health complications that can occur with unmanaged T2DM, poor adherence to dietary, exercise, and medication recommendations is very common. In one study, only 15.7% of participants were found to have good adherence to their recommended dietary plan.[31] Additionally, rates of non-adherence to exercise recommendations are as high as 64.3%.[32] Poor medication adherence is also very common, ranging from 38% to 93%.[33-35] As such, it is important to understand other therapeutic options that may be suitable and efficacious for individuals with T2DM.

The effects of several herbal and nutraceutical supplements on T2DM have been studied. *Berberis vulgaris*, otherwise known as barberry, contains an extract berberine that can lower blood glucose levels, increase insulin secretion, and improve fat metabolism.[36,37] It is proposed that it stimulates pancreatic G protein-coupled receptor 40, inhibits alpha-glucosidase activity, thereby decreasing intestinal glucose absorption, upregulates the expression of glucose transporter-4, and upregulates glucagon-like-peptide-1 genes, all of which contribute to glycemic control.[38] A systematic review and meta-analysis found that, compared with lifestyle modification alone, a co-intervention with berberine resulted in significantly improved glycemic and lipid control.[36] Compared with pharmacological agents for T2DM, berberine has shown no significant differences in glucose-lowering ability but demonstrated an additional lipid-lowering benefit, and an ability to significantly reduce fasting blood glucose and HbA1c.[36,39] In one study investigating the impact of berberine supplementation, it was found that berberine alone produced a 0.38% reduction in HbA1c over 3 months, with stronger effects (0.91% reduction in HbA1c) found when used in combination with pharmacological agents.[40] Interestingly, berberine alone, or in combination with pharmacological agents for T2DM, did not significantly increase the risk of adverse effects, including hypoglycemia.[39]

Other herbs and nutrients have also been studied in the management of T2DM. *Gymnema sylvestre*, otherwise known as gymnema, contains bioactive compounds that have a similar atomic arrangement to glucose and are therefore proposed to block the receptor site for sugar in the intestines, delaying the absorption of glucose into the blood.[41] Supplementation of gymnema has been shown to significantly reduce fasting blood glucose, postprandial blood glucose, HbA1c, as well as triglycerides and total cholesterol.[42] One small study found that 3 months of gymnema supplementation resulted in a 0.4% reduction in HbA1c.[43] Chromium, an essential mineral for carbohydrate and lipid metabolism, has also shown favourable effects on glycemic control in individuals with T2DM.[44] A systematic review and meta-analysis found that chromium supplementation resulted in a 0.71% reduction in HbA1c.[45] Other studies have investigated alpha-lipoic acid in individuals with T2DM, and, while some studies show that supplementation may mildly improve glycemic control and symptoms of peripheral neuropathy, other studies suggest little or no effect on glycemic control or neuropathy symptoms.[46,47] *Silybum marianum*, also known as milk thistle, has also been shown to improve glycemic control when used in combination with other herbs in patients with T2DM.[48] It is important to note

that the available evidence on herbal and nutraceuticals for T2DM is far more limited than the available evidence on pharmaceuticals.

Despite the evidence demonstrating the benefits of non-pharmacological interventions in the management of T2DM, there have been very few reports of the impact of using an entirely non-pharmacological approach. Given that current guidelines recommend the implementation of pharmacological agents immediately with high levels of glycemic dysregulation, there is limited opportunity to effectively investigate the potency of non-pharmacological antihyperglycemic tools in managing a case of uncontrolled T2DM without concurrent pharmacotherapy. As such, this case report details the clinical impact of a multimodal, entirely non-pharmacological approach in a patient with severe uncontrolled T2DM.

## CASE PRESENTATION

### Presenting Concern

A 59-year-old man presented to the clinic with a chief concern of T2DM. Fifteen years prior, a general practitioner had informed him that, according to bloodwork, he had T2DM. At this time, the general practitioner recommended the patient take metformin for blood sugar management. However, he declined pharmacologic therapy and did not pursue any other treatment for his hyperglycemia. He did not have any prior lab assessments and did not have a family doctor. Written informed consent was obtained from the patient for publication of his details.

At the time of presentation, he was not taking any pharmaceuticals; natural health products included 4,400 IU of vitamin D3, 1330 mg of eicosapentaenoic acid (EPA, an omega-3 fatty acid supplement), and 266 mg of docosahexaenoic acid (DHA), taken daily. He was seeking guidance in assessing the severity of his diabetes and was interested in non-pharmacological therapeutics for managing it.

He reported symptoms of fatigue and low energy, with frequent napping, brain fog, irritability, cravings, frequent urination, and increased thirst. In addition, when screening for end-organ damage due to T2DM, the patient reported a tingling and burning sensation in his feet suggestive of peripheral neuropathy, double vision, and blurred vision. He had also been told by an optometrist just a few weeks prior that he had diabetic retinopathy.

### Clinical Findings

A diet history was obtained through a 24-hour diet recall.[49] Although the 24-hour diet recall has some limitations, it is a frequently used and accepted tool for efficiently collecting dietary information in a clinical setting.[50,51] This revealed the following food intake and exercise regimen at the initial appointment:

Breakfast: Oatmeal with homemade applesauce, protein powder, nuts, ½ banana
Lunch: Grilled chicken, sweet potatoes, roasted vegetables
Dinner: Pasta or rice with vegetables or homemade soup with noodles and bread
After-dinner snack: Protein bar or donuts or nuts or ½ bag chips dipped in olive oil
Beverages: 1 L water/day, 6 cups of black coffee/day
Additional notes: The patient also reported that he felt as though he was eating too much, eating too late, and eating the wrong foods. He also reported that his frequent cravings were often for salty foods, sugary foods, or pasta.
Physical activity: Outdoor walking (1–2 km), once per week

### Relevant Medical History

In addition to T2DM, the patient reported suffering from a depressed mood for many years. He reported feelings of lethargy, anger, and sulking, although had no thoughts of harm towards himself or to others. The patient expressed that he might seek support for mood in the future but was primarily interested in T2DM support from us at this time. The patient also shared that he had never smoked, had never consumed alcohol, and had never used recreational drugs.

### Diagnostic Factors and Assessment

The patient presented with a height of 5'10" (178 cm) and a weight of 175 lbs (79 kg), which corresponds to a body mass index (BMI) of 25.1. Before beginning any interventions, the patient was sent a lab requisition to obtain baseline objective values for his T2DM and further metabolic risk assessment to help guide treatment. Baseline measurements revealed HbA1c of 10.1% and fasting glucose of 15.9 mmol/L. Additional physical exams were not possible as this patient accessed services using telemedicine.

### Therapeutic Recommendations

After reviewing the baseline lab results, a first follow-up visit occurred 3 weeks after the initial visit to develop a treatment plan (Figure 1). Based on the available evidence, the patient was counselled that at this severity of lab markers and with clinical evidence of end-organ damage, pharmaceuticals are recommended according to Diabetes Canada Clinical Practice Guidelines.[5] He reported that he would decline pharmaceuticals and wanted to try non-pharmacological approaches first. After fully informing the patient of the risks and benefits, we agreed with the patient to do a 4-month trial of consistent dietary, lifestyle, and supplemental interventions before re-assessing blood markers and re-evaluating the option of pharmacologic therapy. The treatment plan that was recommended for the patient is presented in Table 1.

## RESULTS

At the second follow-up visit, 9 weeks after the initial visit, the patient reported some symptomatic improvements, including a reduction in brain fog, fatigue, and moodiness, fewer cravings, and that his urine was clearer in color and less sweet-smelling than before. He also reported good adherence to the dietary modifications, although reported that bread remained the source of most of his carbohydrate intake. He reported that he had begun walking a minimum of 10 minutes regularly after each meal to achieve his 30 minutes per day of physical activity. Finally, he reported good adherence to the supplementation with no adverse effects.

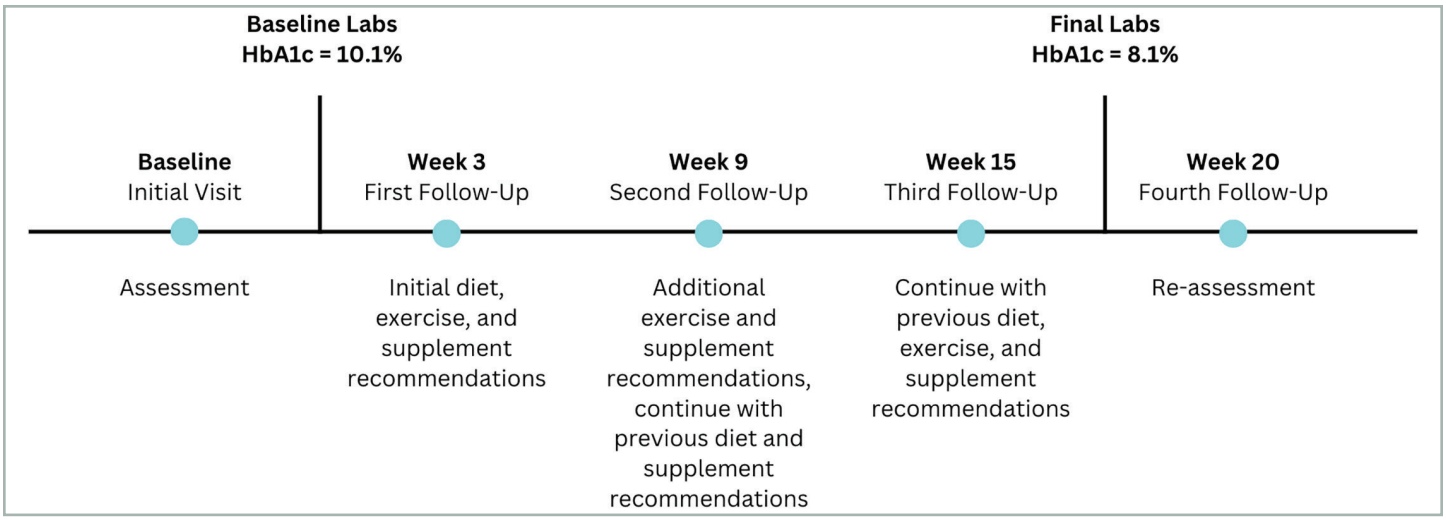


**FIGURE 1** Timeline of Appointments and Recommendations

**TABLE 1** Summary of Interventions

| | Dietary Recommendations | Lifestyle Recommendations | Natural Health Product Recommendations |
|---|---|---|---|
| **Initial Visit** | No recommendations provided | No recommendations provided | No recommendations provided |
| **First Follow-Up (3 Weeks After Initial Visit)** | Patient was provided with handouts and extensive discussions about the following dietary modifications:<br>- Mediterranean-style diet<br>- Low carbohydrate diet with an example 5-day low carbohydrate dietary plan<br>- Incorporating low glycemic index foods and avoiding high glycemic index foods<br>- Incorporating savory breakfast (e.g., eggs and vegetables) instead of a daily sweet breakfast (oatmeal)<br>- Using a vegetable starter (eating vegetables before other foods) at the beginning of all meals to reduce blood sugar spikes<br>- Ideas for after dinner snack substitutions including vegetables and hummus or Greek yogurt and berries | Patient was recommended to increase exercise frequency from his pre-existing once per week walk to the following intervention:<br>Type: Walking<br>Duration: 30 minutes (in minimum 10-minute bouts)<br>Frequency: 5 days per week<br>Goal: Aim for 150 minutes of aerobic exercise per week | Capsule contents: 500 mg berberine (*Berberis vulgaris*)<br>Dosing instructions: Take 1 capsule, three times per day, 30 minutes before meals |
| **Second Follow-Up (9 Weeks After Initial Visit)** | Continue with previous recommendations | Additional recommendations after successful completion of the previous recommendation:<br>Type: Walking<br>Duration: 1 hour (in minimum 10-minute bouts)<br>Frequency: 7 days per week<br><br>Type: Strengthening exercise<br>Incorporate some body weight strengthening exercises (planks, wall sits, body weight squats) and resistance band exercises into the weekly activity routine. | Additional recommendation alongside good adherence to the previous recommendation:<br>Capsule contents (per 3 capsules): 900 mcg chromium (from chromium polynicotinate), 2,700 mcg vanadium (from BGOV), 1200 mg *Gymnema sylvestre* extract, 315 mg wildcraft nopal cactus leaf (*Opuntia streptacantha*), 300 mg alpha lipoic acid (thiotic acid), 225 mg organic milk thistle seed (*Silybum marianum*), 75 mg milk thistle seed extract (*Silybum marianum*)<br>Dosing instructions: Take 2 capsules, twice daily with food |
| **Third Follow-Up (15 Weeks After Initial Visit)** | Continue with previous recommendations | Continue with previous recommendations | Continue with previous recommendations |
| **Fourth Follow-Up (20 Weeks After Initial Visit)** | Continue with previous recommendations | Continue with previous recommendations | Continue with previous recommendations |

During this visit, the patient reported the following 24-hour diet recall:

Breakfast: Plain yogurt with fruit (blueberries, raspberries) and ¼ cup walnuts or eggs with bacon and sourdough toast
Snack: Homemade applesauce with 2 tbsp psyllium and ground flax
Lunch: Grilled chicken or turkey with butternut squash noodles
Dinner: Chicken souvlaki on pita with tomatoes and salad or red lentil pasta

After-dinner snack: Nuts
Additional information: The patient also reported that he had successfully removed chips, soda, and donuts as after-dinner snacks and had been measuring out his food to improve portion sizes.

At the third follow-up visit, 15 weeks after the initial visit, the patient reported good adherence to the dietary, exercise (cardiorespiratory and strength training), and supplemental recommendations with no reported adverse effects. He reported increased mental sharpness, napping less throughout the day, improved energy, further improvements in urine colour and odor, fewer cravings, no double vision, mild improvements in neuropathy, and a more focused mood. He was provided with a lab requisition to be performed in the week leading up to his next follow-up appointment. Table 2 shows lab results obtained 4 months following initiating interventions.

In the fourth follow-up appointment, 20 weeks after the initial visit, the updated lab results were reviewed with the patient. He reported continued symptomatic improvements and reported his clothing was fitting better. In addition, he reported a significant improvement in bowel movement regularity. Based on the marked improvement in glycemic control compared with baseline measurement (2.0% reduction in HbA1c from 10.1% to 8.1%), as well as the improvement in lipid markers, it was mutually decided to continue with the current supplemental, nutritional, and physical activity recommendations and reassess after performing another lab assessment. The patient has reported good adherence to the dietary, lifestyle, and supplemental interventions and continues to schedule regular follow-up appointments for treatment guidance.

## DISCUSSION

This case report details the management of a 59-year-old man with severe, uncontrolled T2DM who experienced a significant improvement in symptoms over 4 months while using a non-pharmacological treatment approach. Objective lab markers collected at baseline and follow-up were consistent with this symptomatic improvement and demonstrated glycemic control results beyond what was anticipated over just a 4-month period. Among the treatments recommended, the HbA1c reductions reported in the literature range from 0.38% to 0.89%. However, it is worth noting that these occur over time periods as long as 24 months.[15,30,40] A key feature of naturopathic medicine is its use of multimodal, individualized treatment approaches.[52] While early observational research has documented the impact of whole practice naturopathic medicine on T2DM, the mechanism by which multiple modalities contribute to outcomes, individually or through synergistic or additive effects, is not currently known.[10,53]

The most noteworthy improvements which resulted for this patient were reductions in HbA1c (2.0% reduction from 10.1% to 8.1%), fasting glucose (5.7 mmol/L reduction from 15.9 mmol/L to 10.2 mmol/L), and non-HDL cholesterol (1.01 mmol/L reduction from 4.58 mmol/L to 3.57 mmol/L). These improvements have important clinical benefits, particularly with respect to cardiovascular risk. Reducing HbA1c by just 0.2% can lower cardiovascular and ischemic heart disease mortality by 10%.[54] Improving glycemic control attenuates the progression of coronary artery calcification, thereby helping to reduce the incidence of cardiovascular diseases as well as vascular complications, including neuropathy, retinopathy, and nephropathy.[55] Lowering HbA1c in individuals with T2DM decreases the absolute risk of developing coronary heart disease by 5–17%, as well as the risk of overall mortality by 6–15%.[56] Beyond this clinical importance, there is also an economic benefit associated with reducing HbA1c, as a 1% reduction in HbA1c is associated with a 1.7% reduction in all-cause total healthcare costs and a 6.9% reduction in diabetes-related healthcare costs.[57] As with HbA1c, improvements in non-HDL cholesterol are associated with reduced risk of a cardiovascular disease event by the age of 75 by means of mitigating atherosclerotic progression.[58] Specifically, for each 1 mmol/L reduction in LDL

**TABLE 2** Lab Assessments at Baseline (Pre-Interventions) and after 4 Months of Interventions

| Lab Marker | Reference Range | Baseline | Fourth Follow-Up (20 Weeks After Initial Visit) |
|---|---|---|---|
| **Glucose—Fasting** | 3.6–6.0 mmol/L | 15.9 mmol/L | 10.2 mmol/L |
| **Glycated Hemoglobin (HbA1c)** | < 6.0% | 10.1% | 8.1% |
| **Creatinine** | 67–117 umol/L | 58 umol/L | 63 umol/L |
| **Estimated Glomerular Filtration Rate (eGFR)** | ≥ 90 mL/min/1.73m$^2$ | 107 mL/min/1.73m$^2$ | 103 mL/min/1.73m$^2$ |
| **Alanine Transaminase (ALT)** | < 50 U/L | 18 U/L | 20 U/L |
| **Alkaline Phosphatase (ALP)** | 40–129 U/L | 90 U/L | 96 U/L |
| **Hours Fasting** | | 12 hours | 12 hours |
| **Triglycerides** | | 1.67 mmol/L | 0.74 mmol/L |
| **Cholesterol** | | 5.45 mmol/L | 4.74 mmol/L |
| **High-Density Lipoprotein (HDL) Cholesterol** | | 0.87 mmol/L | 1.17 mmol/L |
| **Cholesterol/HDL Ratio** | < 6 | 6.3 | 4.1 |
| **Low-Density Lipoprotein (LDL) Cholesterol (Calculated)** | | 3.82 mmol/L | 3.25 mmol/L |
| **Non-HDL Cholesterol** | | 4.58 mmol/L | 3.57 mmol/L |

cholesterol, there is an associated relative risk reduction in major vascular events of 12%.[59]

Adjunctive naturopathic care in patients with uncontrolled T2DM has revealed significant improvements in glucose measurements, diet, mood, and motivation to change lifestyle.[53] Specifically, nutritional care delivered by naturopathic doctors results in meaningful improvements in eating behaviours, physical activity, self-management, and blood sugar, improving HbA1c by an average of 0.5%.[60] It is worth noting that these investigations have focused on adjunctive care, and therefore, little is known about the impact of naturopathic care in isolation. The present case report is novel, as it demonstrates the role of non-pharmacological naturopathic care alone in the management of uncontrolled T2DM. One recent case report detailed a similar patient case of a 45-year-old man with unmedicated T2DM who pursued an entirely non-pharmacological treatment approach.[61] He chose to work with a practitioner who prescribed very strict behavioural interventions, consisting of only two meals daily with highly specific instructions on what to eat, as well as walking a minimum of 4.5 km within 45 minutes daily.[61] The results from this case report were significant, resulting in a 9.8% reduction in the patient's HbA1c over 3 months (from 14.9% to 5.1%) without the use of any pharmacological agents.[61] It is worth noting that the "Dixit diet" and exercise parameters prescribed are incredibly strict and may not serve as a sustainable option for many patients trying to manage T2DM.

One strength of the current case report is that important lab parameters were assessed at baseline and after treatment to objectively document change. Additionally, while it would be unethical to assign an individual with severe, uncontrolled T2DM to an intervention study that involved withholding the guideline-recommended pharmacotherapies, this case allowed for observation of the effects of a combination non-pharmacological intervention in isolation, due to the patient's declining of pharmaceutical management. One limitation of this case is that it retrospectively documents the course of care of a single patient, and thus, in the absence of a comparison or ability to account for confounding factors, a cause-and-effect relationship cannot be established. Additionally, multiple therapeutic tools, including diet, physical activity, and supplementals, were prescribed for management, and thus the individual impact of each treatment on the parameter improvements cannot be established. However, this case report documents the impact of a multimodal intervention, as opposed to individual agents in isolation, which is representative of real-world naturopathic practice.

## CONCLUSION

This case demonstrates a significant improvement in symptoms and laboratory markers of glycemic regulation following 4 months of a multimodal, non-pharmacological treatment approach for a patient with uncontrolled T2DM who was unwilling to initiate pharmacotherapy. This case adds to a body of literature suggesting that further research investigating non-pharmacological treatment options for managing T2DM is warranted.

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### ACKNOWLEDGEMENTS

Dr. John Alexander Hall, ND, oversaw and approved of all treatment recommendations for this patient.

### CONFLICTS OF INTEREST DISCLOSURE

We have read and understood the *CAND Journal*'s policy on conflicts of interest and declare that we have none.

### FUNDING

This research did not receive any funding.

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