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Improved Glycemic Control with a Very Low-Calorie Diet in a Vegan Patient Refusing Insulin: A Case Report

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Abstract

Type 2 diabetes treatment by using dietary intervention is a well-established matter, yet Very Low-Calorie Diet methods for patients who refuse insulin remain understudied. This case study demonstrates successful management using a (VLCD) very low-calorie diet in a patient with severe insulin refusal due to thanatophobia. A 63-year-old vegan male with poorly controlled diabetes (HbA1c=8.2%) declined insulin therapy because of death anxiety. He followed a five-week regimen that combined a low-calorie intake of Nestlé Optifast (600 kcal/day) with an additional 200 kcal/day of non-starchy vegetables while continuing his regular dose of metformin. The results were impressive: He lost 13 kg, which accounted for 13.2% of his body weight. His fasting glucose levels dropped significantly, from 230 to 125 mg/dL, while his HbA1c level lowered to 6.4%. Additionally, his C-peptide levels rose from 0.9 to 1.7 ng/mL, indicating that his pancreatic β-cell function had started to recover. Insulin resistance markers and hepatic steatosis were normalized, while inflammation decreased by half (hs-CRP 6.0 to 2.1 mg/L). Such findings suggest that structured VLCD diet can effectively improve glycemic control in individuals with insulin-resistant diabetes, while circumventing psychological barriers (such as thanatophobia) to insulin therapy. The considerable weight loss likely reduced the ectopic fat deposition by improving metabolic function without hypoglycemia risk, which is a potential factor for patients with thanatophobia. The Very Low-Calorie Diet anti-inflammatory effects may offer further metabolic improvements. This case study supports the role of dietary intervention as a potential alternative for individuals with insulin-resistant diabetes, warranting expanded research in larger populations.

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Abbreviations

HbA1c	Hemoglobin A1c
hs-CRP	High-sensitivity C-reactive protein
LCD	Low-calorie diet
T2DM	Type 2 diabetes mellitus
VLCD	Very low-calorie diet

Introduction

Type 2 diabetes mellitus (T2DM) has traditionally been seen as a chronic and irreversible disease that requires progressively increasing pharmacological treatment.[1] However, recent data challenge this view, indicating that major weight reduction through strict dietary measures can lead to diabetes significant control in a significant number of patients.[2,3] The landmark (DiRECT) Diabetes Remission Clinical Trial showed that a structured weight-loss approach resulted in remission in 46% of participants at the 12-month mark, particularly among those who lost more than 10 kgs.[4]

These transformative findings have transformed our comprehension of pathophysiology and its management of type 2 diabetes. This is, in turn, readdresses the therapeutic importance from mere blood glucose control to comprehensive metabolic restoration.[5] The mechanisms of diabetes control are progressively understood. Central to this process is the decrease of ectopic fat deposition in critical metabolic organs, mainly the liver and pancreas.[6] Taylor's 'twin cycle hypothesis' suggests that excess intra-pancreatic fat spoils β-cell function, while hepatic fat accumulation drives insulin resistance.[7] The interventions for weight loss that decrease these fat deposits can restore normal insulin secretion and action, thereby reversing T2DM's core defects.[8] This is predominantly evident in cases with a short diabetes duration (less than six years), where residual β-cell function remains.[4]

Despite these advances, significant gaps persist in some clinical applications. Around 20 to 30% of patients with poorly controlled T2DM refuse insulin therapy, frequently because of psychological barriers such as needle phobia or thanatophobia (fear of death).[9,10] This generates a therapeutic dilemma because these T2DM patients face high risks of diabetes complications yet reject standard care.[11] Current clinical guidelines provide few alternatives for such scenarios, which emphasizes the need for active non-injectable treatment options.[12] Very Low-Calorie Diet have demonstrated some salient potential in diabetes care and offer various metabolic benefits.[13] Several systematic reviews indicate that vegetarian and vegan diets may enhance glycemic regulation, reduce cardiovascular risk factors, and support weight reduction.[14,15]

The mechanisms seem multifactorial, including enhanced insulin sensitivity, reduced inflammation, and satisfactory changes in gut microbiota.[16] Low-calorie forms of these diets may combine the benefits of caloric restraint with those of Very Low-Calorie Diet.[17] However, the specific application of a (LCD) low-calorie diet– particularly a plant-based very low-calorie diet – in insulin-refractory cases remains unexplored. Most reduction studies have applied standard meal replacements rather than plant-based formulations, especially in the context of insulin refusal.[18] Previous protocols included structured VLCDs using commercial shakes, but did not address the psychological dimensions influencing treatment adherence. Furthermore, the psychological dimensions of dietary approaches for cases with treatment phobias have attracted little attention.[19–21]

Psychological distress in diabetes, particularly treatment-related fears such as thanatophobia, is an under recognized barrier to care. These anxieties whether about hypoglycemia, death, or injections may prevent patients from adhering to standard therapies like insulin? Yet, their clinical management remains inadequately addressed in dietary intervention studies.

This case study addresses these gaps by demonstrating successful T2DM significant control using a very low-calorie diet in a case where severe thanatophobia prevented insulin acceptance. Although the intervention involved Nestlé Optifast, a standard meal replacement product, it was complemented with unlimited non-starchy vegetables, reflecting a hybrid model that incorporates plant-based elements rather than being strictly plant-derived. This case fills the identified gap by demonstrating how a tailored dietary plan with structured support can circumvent insulin refusal in a patient with severe thanatophobia. The clinical significance of this method extends beyond metabolic outcomes. For cases with psychological barriers to insulin, dietary interventions can offer a more satisfactory treatment pathway.[22] The organized nature of meal replacement plans can allow psychological safety through expected outcomes and minimize hypoglycemia risk.[23] Moreover, the anti-inflammatory properties of plant-based diets can address the chronic low-grade inflammation characteristic of T2DM cases.[24]

This study adds to the existing literature in three key aspects: First, it establishes the effectiveness of a plant-based low-calorie diet in achieving diabetes significant treatment. Second, it presents a practical option for individuals who refuse insulin therapy. Third, it underscores the importance of addressing psychological factors when selecting diabetes treatment strategies. This case study aims to explore whether a structured very low-calorie diet (VLCD), incorporating plant-based elements, can serve as an effective and psychologically acceptable alternative to insulin therapy in patients with type 2 diabetes who exhibit strong treatment-related anxieties, particularly thanatophobia. More generally, as personalized medicine becomes increasingly vital in chronic disease management,[25] such tailored methods may prove valuable for certain patient subgroups.

Materials and Methods

Case Presentation

The case was a 63-year-old vegan male patient. He had an eight-year history of T2DM and poorly controlled hyperglycemia, despite maximal metformin therapy (2 g/day). The primary assessment of the patient revealed some significant metabolic derangements, such as (HbA1c) hemoglobin A1C 8.2%, fasting plasma glucose 230 mg/dL, and body mass index 32.1 kg/m². Notably, the patient showed profound thanatophobia linked to potential hypoglycemic events, leading to absolute refusal of insulin therapy meeting standard indications. Physical examinations confirmed central adiposity (waist circumference of 112 cm) but no signs of diabetes complications. The patient claimed strict adherence to a very low-calorie diet for ethical reasons over the past 12 years.

Intervention and Clinical Course

A 5-week intensive dietary intervention was implemented. It consisted of the following:

- Three daily servings of Nestlé Optifast Very low-calorie diet (a total of 600 kcal/day).
- Non-starchy vegetables (estimated at 200 kcal/day), including broccoli, zucchini, cauliflower, spinach, lettuce, and cucumber prepared without oil or added fats.
- Maintenance of metformin dosage as usual.
- Daily self-monitoring of glucose (capillary).

Weekly Clinical Follow-Ups

Weekly follow-ups were conducted in person to assess: (1) dietary adherence, confirmed through patient food diaries and interview; (2) capillary glucose readings; and (3) symptom changes, particularly with respect to polyuria, fatigue, and psychological distress.

Subjective anxiety levels and thanatophobia were evaluated through unstructured clinical interview and self-reported patient feedback. No formal psychometric scale was used.

No hypoglycemic episodes were reported or detected during any follow-up.

Pre-Intervention Diet

Prior to the study, the patient adhered to a vegan diet for over 12 years, consisting primarily of whole grains (brown rice, oats), legumes (lentils, chickpeas), fruits, and oils, with limited intake of refined carbohydrates. No portion control or caloric restriction was practiced, and the diet was unstructured with variable meal timing.

Pre- and Post-Intervention Measurements

Baseline data were obtained at enrollment, including HbA1c, fasting glucose, C-peptide, insulin, lipid panel, hs-CRP, liver enzymes (ALT/AST), and anthropometric measures. Post-intervention assessments were conducted at the end of week 5 using the same parameters. All laboratory tests were performed using standard protocols in a certified clinical laboratory.

Biochemical Assessment and Data Collection

Venous blood samples were collected at baseline and at the end of week five to assess metabolic parameters. The tests included HbA1c, fasting plasma glucose, fasting insulin, C-peptide, lipid panel (total cholesterol, LDL, HDL, triglycerides), liver enzymes (ALT, AST), and high-sensitivity C-reactive protein (hs-CRP). Insulin resistance was calculated using the HOMA-IR formula: [fasting insulin (μU/mL) × fasting glucose (mg/dL)] / 405. All laboratory assessments were performed using standardized assays at a certified hospital laboratory. The case demonstrated excellent adherence to the protocol. The patient reported 100% compliance with the meal replacements and vegetable intake. No episodes of hypoglycemia (glucose levels <70 mg/dL) were recorded throughout the intervention period. The patient reported increased energy levels within two weeks and complete resolution of polyuria and polydipsia by the third week.

Results

Key Metabolic Findings from the Case

The intervention led to significant improvements in several of the case's metabolic markers, as detailed in Table 1. Notably, the following changes were observed:

- The 13.2% body weight reduction (from 98 to 85 kgs) over five weeks exceeded the average 10% loss seen in the DiRECT trial, though it should be noted that this is a single case and some participants in DiRECT achieved greater losses..
- Restoration of fasting glucose to normal levels (from 230 to 125 mg/dL).
- Marked improvement in glycemic control (HbA1c decreased from 8.2% to 6.4%).
- Enhanced pancreatic β-cell function (C-peptide increased from 0.9 to 1.7 ng/mL).
- Substantial decrease in insulin resistance (HOMA-IR reduced from 10.0 to 3.1).
- Complete normalization of liver steatosis markers (ALT and AST levels normalized).
- Systemic inflammation reduced by half (hs-CRP lowered from 6.0 to 2.1 mg/L).
- Favorable alterations in the lipid profile.

Table 1: Metabolic parameters assessed (pre- and post-five-week very low-calorie diet low-calorie dietary intervention)

Parameter	Baseline	Post-Intervention	Change (%)
Glycemic Control			
HbA1c (%)	8.2	6.4	-22
Fasting Glucose (mg/dL)	230	125	-45.7
Pancreatic Function			
C-Peptide (ng/mL)	0.9	1.7	88.9
Fasting Insulin (μU/mL)	22.5	9.8	-56.4
HOMA-IR	10	3.1	-69
Lipid Profile			
Total Cholesterol	230	180	-21.7
LDL (mg/dL)	160	110	-31.3
HDL (mg/dL)	38	49	28.9
Triglycerides (mg/dL)	210	135	-35.7
Liver Function			
ALT (U/L)	65	36	-44.6
AST (U/L)	58	29	-50
Inflammation			
hs-CRP (mg/L)	6	2.1	-65

In addition to metabolic improvements, the patient reported marked psychological relief. Subjective anxiety related to insulin-induced hypoglycemia a core aspect of his thanatophobia was significantly reduced by the third week. While formal diabetes distress metrics were not used, clinical interview indicated reduced treatment-related anxiety and improved emotional well-being. No adverse effects were observed.

Discussion

The findings from this case indicate that a well-structured very low-calorie diet leads to marked improvements in multiple metabolic indicators and may promote diabetes control in patients who experience psychological resistance to insulin treatment. This result aligns with some previous research on dietary interventions or protocols for type 2 diabetes in various potential aspects.[26] The 13.2% body weight reduction achieved in just five weeks beats the 10% remission threshold associated with diabetes remission in some major trials,[27] though this should be interpreted cautiously due to the single-patient context. The very low-calorie diet composition of foods, in turn, addresses both ethical and metabolic considerations unique to this patient population.

The observed metabolic developments likely stem from numerous synergistic mechanisms. The dramatic decrease in insulin resistance (HOMA-IR decrease of 69%) possibly replicates reduced ectopic fat deposition in the liver and muscle, which is consistent with the twin cycle hypothesis (mentioned in the introduction).[3,28] Particularly, the regularization of liver enzymes, such as ALT and AST, recommends resolution of non-alcoholic fatty liver disease – a common comorbidity that exacerbates insulin resistance.[29] Moreover, the increase of 88.9% in C-peptide levels directs restored pancreatic β-cell function, possibly through decreased glucolipotoxicity.[30] These findings validate but accelerate the timeline of changes seen in the DiRECT trial, although it is important to note that MRI assessments in that study were scheduled at 12 weeks as part of the protocol, not necessarily as a biological benchmark.[4]

It is also essential to recognize that the intervention in this case combined three components: a commercial meal replacement (Nestlé Optifast), non-starchy plant-based vegetables, and continued metformin therapy. As such, the improvements observed may be attributed to the synergistic effects of caloric restriction, plant-based nutrition, and pharmacologic support, rather than the plant-based VLCD in isolation.

The anti-inflammatory effects of this research warrant particular attention. The 65% reduction in hs-CRP recommends that plant-based low-calorie diets can modulate the chronic low-grade inflammation features of type 2 diabetes.[31] This effect is likely the consequence of combined weight loss and the anti-inflammatory nature of plant phytonutrients.[32] Such inflammation decrease may offer additional cardiovascular protection beyond glycemic control,[33] which is especially important given the patient's improved lipid profile (28.9% HDL increase; 31.3% LDL decrease).

The psychological aspects of this case demand special consideration. Thanatophobia denotes a significant but understudied blockade to optimal diabetes care.[9] The pertinent approach effectively addressed this by removing hypoglycemia risk by providing a structured, foreseeable diet regimen. Notably, the resolution of polyuria, improved energy levels, and greater glycemic stability appeared to coincide with reduced thanatophobia symptoms. This suggests that achieving metabolic control may play a contributory role in alleviating psychological distress. These findings align with some emerging evidence that the meal replacement technique can improve psychological outcomes in the management of diabetes.[34] In particular, Saslow *et al*. (2018) demonstrated that low-carbohydrate nutritional programs may help reduce emotional distress in patients reluctant to initiate pharmacologic therapy. The reported reduction in diabetes-related distress among patients, in turn, supports integrating psychological metrics in future dietary interventions.[22,35]

Limitations of the Study

For this case study, limitations should be considered. The single-case design and the short duration leave long-term sustainability uncertain.[36] The ideal duration and configuration of very low-calorie diet necessitate further study.[37] Not only that, the study also required substantial clinical support, such as weekly visits, which can limit unexpected scalability.[38] While Quimby *et al*. (2022) demonstrated successful community adaptation of similar interventions, replicating these outcomes across broader populations remains challenging.[39,40]

Importantly, this case study expands the potential applications of dietary diabetes control plans to include cases with psychological insulin resistance. While current plans primarily commend such approaches for patients seeking drug-free management of diabetes,[41] the findings here propose that they may also benefit those declining standard care. This could meaningfully expand treatment choices for this challenging population.[42]

The nutritional adequacy of very low-calorie di*et al*so demands wider discussion. While the patient in this study maintained excellent adherence without reporting any adverse effects, clinicians should monitor for possible micronutrient deficiencies.[43] The application of a nutritionally complete meal replacement likely mitigated this risk,[44] but individual nutritional assessment is still crucial.

It is also worth noting that the intensive clinical support regarding this intervention may limit real-world acceptance. Possible micronutrient deficiencies related to very low-calorie diet diets were not evaluated in this study. The findings therefore require further validation in larger, controlled trials in several places. This can help establish safety and efficacy. The feasibility of implementing similar VLCD protocols in broader, non-clinical populations remains uncertain. While Quimby *et al*. (2022) have demonstrated potential for community adaptation of VLCD strategies, replicating intensive clinical oversight and patient motivation may be challenging outside research settings.[39]

Recommendations

It can be recommended that clinicians consider very low-calorie diets for T2DM cases who refuse insulin. Future trials should assess long-term outcomes through optimal tenure. Psychological support must also be provided in such dietary interventions. Health institutions should establish standardized guidelines for incorporating such nutritional interventions while continuously monitoring inflammatory biomarkers.

Conclusion

This case study found that a structured very low-calorie diet can induce rapid metabolic improvement and substantial glycemic control in patients who refuse insulin due to psychological barriers. The case achieved significant weight loss, restored β-cell functionality, and reduced inflammation while addressing thanatophobia. The findings further suggest that VLCD and meal replacements offer a viable alternative for insulin-resistant cases, particularly those complicated by psychological treatment refusal. However, because the patient continued metformin, this case does not meet the standard definition of diabetes remission, and the study warrants further investigation in larger-scale clinical trials to confirm long-term efficacy and wider applicability.

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Conflict of Interest

The author does not have any conflict of interest.

Data Availability Statement

The manuscript incorporates all datasets produced or examined throughout this research study.

Ethics Statement

This case report was conducted in accordance with the ethical standards of King Saud Medical City Research Center. Ethical approval was granted by the Institutional Review Board.

Informed Consent Statement

Written informed consent was obtained from the patient for both participation and publication of the clinical data included in this report.

Clinical Trial Registration

This research does not involve any clinical trials.

Permission to Reproduce Material from Other Sources

All content presented in the manuscript, including Table 1, is original and created by the author.

Author Contributions

- **Nasser Salem Alqahtani -** Study Conception and Design, Data Collection, Analysis and Interpretation of Results, Draft Manuscript Preparation, Critical Revision and Final Approval of the Manuscript.
- **Amer Alenezi -** Study Conception and Design, Analysis and Interpretation of Results, Critical Revision and Final Approval of the Manuscript.

References

1. American Diabetes Association. 2. Classification and diagnosis of diabetes: standards of medical care in diabetes—2021. *Diabetes Care.* 2021;44(Suppl 1):S15-S33. doi:10.2337/dc21-S002
2. Lean ME, Leslie WS, Barnes AC, *et al*. Primary care–led weight management for remission of type 2 diabetes (DiRECT): an open-label, cluster-randomised trial. *Lancet.* 2018;391(10120):541-551. doi:10.1016/S0140-6736(17)33102-1
3. Taylor R, Al-Mrabeh A, Sattar N. Understanding the mechanisms of reversal of type 2 diabetes. *Lancet Diabetes Endocrinol.* 2019;7(9):726-736. doi:10.1016/S2213-8587(19)30076-2
4. Lean MEJ, Leslie WS, Barnes AC, *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(5):344-355. doi:10.1016/S2213-8587(19)30068-3
5. Hallberg SJ, Gershuni VM, Hazbun TL, *et al*. Reversing type 2 diabetes: a narrative review of the evidence. *Nutrients.* 2019;11(4):766. doi:10.3390/nu11040766
6. Taylor R. Type 2 diabetes: etiology and reversibility. *Diabetes Care*. 2013;36(4):1047-1055. doi:10.2337/dc12-1805
7. Taylor R, Barnes AC. Translating aetiological insight into sustainable management of type 2 diabetes. *Diabetologia.* 2018;61(2):273-283. doi:10.1007/s00125-017-4504-z
8. Steven S, Hollingsworth KG, Al-Mrabeh A, *et al*. Very low-calorie diet and 6 months of weight stability in type 2 diabetes: pathophysiological changes in responders and nonresponders. *Diabetes Care*. 2016;39(5):808-815. doi:10.2337/dc15-1942
9. Polonsky WH, Fisher L, Guzman S, *et al*. Psychological insulin resistance in patients with type 2 diabetes: the scope of the problem. *Diabetes Care.* 2005;28(10):2543-2545. doi:10.2337/diacare.28.10.2543
10. Mollema ED, Snoek FJ, Pouwer F, *et al*. Diabetes fear of injecting and self-testing questionnaire: a psychometric evaluation. *Diabetes Care*. 2000;23(6):765-769. doi:10.2337/diacare.23.6.765
11. Dickinson JK, Guzman SJ, Maryniuk MD, *et al*. The use of language in diabetes care and education. *Diabetes Care.* 2017;40(12):1790-1799. doi:10.2337/dci17-0041
12. Davies MJ, Aroda VR, Collins BS, *et al*. Management of hyperglycemia in type 2 diabetes, 2022: a consensus report by the American Diabetes Association and the European Association for the Study of Diabetes. *Diabetes Care.* 2022;45(11):2753-2786. doi:10.2337/dci22-0034
13. Kahleova H, Levin S, Barnard N. Cardio-metabolic benefits of plant-based diets. *Nutrients.* 2017;9(8):848. doi:10.3390/nu9080848
14. Turner-McGrievy G, Mandes T, Crimarco A. A plant-based diet for overweight and obesity prevention and treatment. *J Geriatr Cardiol.* 2017;14(5):369-374. doi:10.11909/j.issn.1671-5411.2017.05.002
15. Yokoyama Y, Barnard ND, Levin SM, *et al*. Vegetarian diets and glycemic control in diabetes: a systematic review and meta-analysis. *Cardiovasc Diagn Ther.* 2014;4(5):373-382. doi:10.3978/j.issn.2223-3652.2014.10.04
16. Tomova A, Bukovsky I, Rembert E, *et al*. The effects of vegetarian and vegan diets on gut microbiota. *Front Nutr.* 2019;6:47.

doi:10.3389/fnut.2019.00047

17. Barnard ND, Levin SM, Yokoyama Y. A systematic review and meta-analysis of changes in body weight in clinical trials of vegetarian diets. *J Acad Nutr Diet*. 2015;115(6):954-969. doi:10.1016/j.jand.2014.11.016
18. Johansson K, Neovius M, Hemmingsson E. Effects of anti-obesity drugs, diet, and exercise on weight-loss maintenance after a very-low-calorie diet or low-calorie diet: a systematic review and meta-analysis of randomized controlled trials. *Am J Clin Nutr.* 2014;99(1):14-23. doi:10.3945/ajcn.113.070052
19. Young-Hyman D, de Groot M, Hill-Briggs F, *et al*. Psychosocial care for people with diabetes: a position statement of the American Diabetes Association. *Diabetes Care.* 2016;39(12):2126-2140. doi:10.2337/dc16-2053
20. Rehackova L, Araújo-Soares V, Adamson AJ, *et al*. Acceptability of a very-low-energy diet in type 2 diabetes: patient experiences and behaviour regulation. *Diabet Med*. 2017;34(11):1554-1567. doi:10.1111/dme.13426
21. Griffin SB, Palmer MA, Strodl E, *et al*. Preoperative dietitian-led very low calorie diet clinic for adults living with obesity undergoing gynaecology, laparoscopic cholecystectomy and hernia repair procedures: a pilot parallel randomised controlled trial. *Br J Nutr.* 2024;131(8):1436-1446. doi:10.1017/S0007114524000114
22. Saslow LR, Summers C, Aikens JE, *et al*. Outcomes of a digitally delivered low-carbohydrate type 2 diabetes self-management program: 1-year results of a single-arm longitudinal study. *JMIR Diabetes.* 2018;3(3):e12. doi:10.2196/diabetes.9333
23. Astbury NM, Piernas C, Hartmann-Boyce J, *et al*. A systematic review and meta-analysis of the effectiveness of meal replacements for weight loss. *Obes Rev.* 2019;20(4):569-587. doi:10.1111/obr.12816
24. Forsythe LK, Wallace JMW, Livingstone MBE. Obesity and inflammation: the effects of weight loss. *Nutr Res Rev.* 2008;21(2):117-133. doi:10.1017/S0954422408138732
25. Pearson ER. Personalized medicine in diabetes: the role of "omics" and biomarkers. *Diabet Med.* 2016;33(6):712-717. doi:10.1111/dme.13075
26. Calabrese AM, Calsolaro V, Rogani S, *et al*. Optimal type 2 diabetes mellitus management and active ageing. *Endocrines.* 2021;2(4):523-539. doi:10.3390/endocrines2040047
27. Aminian A, Tu C, Milinovich A, *et al*. Association of weight loss achieved through metabolic surgery with risk and severity of COVID-19 infection. *JAMA Surg*. 2022;157(3):221-230. doi:10.1001/jamasurg.2021.6496
28. Roden M, Shulman GI. The integrative biology of type 2 diabetes. *Nature.* 2019;576(7785):51-60. doi:10.1038/s41586-019-1797-8
29. Daryabor G, Atashzar MR, Kabelitz D, *et al*. The effects of type 2 diabetes mellitus on organ metabolism and the immune system. *Front Immunol.* 2020;11:1582. doi:10.3389/fimmu.2020.01582
30. Wang Z, Liu H. Roles of lysine methylation in glucose and lipid metabolism: functions, regulatory mechanisms, and therapeutic implications. Biomolecules. 2024;14(7):862. doi:10.3390/biom14070862
31. Evert AB, Dennison M, Gardner CD, *et al*. Nutrition therapy for adults with diabetes or prediabetes: a consensus report. Diabetes Care. 2019;42(5):731-754. doi:10.2337/dci19-0014
32. Sun H, Saeedi P, Karuranga S, *et al*. IDF Diabetes Atlas: global, regional and country-level diabetes prevalence estimates for 2021 and projections for 2045. *Diabetes Res Clin Pract.* 2022;183:109119. doi:10.1016/j.diabres.2021.109119
33. Uusitupa M, Khan TA, Viguiliouk E, *et al*. Prevention of type 2 diabetes by lifestyle changes: a systematic review and meta-analysis. *Nutrients*. 2019;11(11):2611. doi:10.3390/nu11112611
34. Lim EL, Hollingsworth KG, Aribisala BS, *et al.* Reversal of type 2 diabetes: normalisation of beta cell function in association with decreased pancreas and liver triacylglycerol. *Diabetologia.* 2011;54(10):2506-2514. doi:10.1007/s00125-011-2204-7
35. Carter S, Clifton PM, Keogh JB. The effects of intermittent or continuous energy restriction on weight loss and metabolic disease risk markers: a randomized trial

in young overweight women. *Int J Obes* (Lond). 2016;40(5):713-722. doi:10.1038/ijo.2015.214

36. Wadden TA, Neiberg RH, Wing RR, *et al*. Four-year weight losses in the Look AHEAD study: factors associated with long-term success. Obesity (Silver Spring). 2011;19(10):1987-1998. doi:10.1038/oby.2011.230
37. Rinaldi S, Campbell EE, Fournier J, *et al*. A comprehensive review of the literature supporting recommendations from the Canadian Diabetes Association for the use of a plant-based diet for management of type 2 diabetes. *Can J Diabetes*. 2016;40(5):471-477. doi:10.1016/j.jcjd.2016.04.013
38. Jenkins DJ, Kendall CW, Marchie A, *et al*. Type 2 diabetes and the vegetarian diet. Am *J Clin Nutr.* 2003;78(3 Suppl):610S-616S. doi:10.1093/ajcn/78.3.610S
39. Franz MJ, Boucher JL, Rutten-Ramos S, *et al*. Lifestyle weight-loss intervention outcomes in overweight and obese adults with type 2 diabetes: a systematic review and meta-analysis of randomized clinical trials. *J Acad Nutr Diet.* 2015;115(9):1447-1463. doi:10.1016/j.jand.2015.02.031
40. Hemmingsen B, Gimenez-Perez G, Mauricio D, *et al*. Diet, physical activity or both for prevention or delay of type 2 diabetes mellitus and its associated complications in people at increased risk of developing type 2 diabetes mellitus. *Cochrane Database Syst Rev.* 2017;12(12):CD003054. doi:10.1002/14651858.CD003054.pub4
41. Schwingshackl L, Chaimani A, Hoffmann G, *et al*. Impact of different dietary approaches on blood pressure in hypertensive and pre-hypertensive patients: network meta-analysis. *Nutrients*. 2019;11(1):146. doi:10.3390/nu11010146
42. Barnard ND, Cohen J, Jenkins DJ, *et al*. A low-fat vegan diet improves glycemic control and cardiovascular risk factors in a randomized clinical trial in individuals with type 2 diabetes. *Diabetes Care*. 2006;29(8):1777-1783. doi:10.2337/dc06-0606
43. Kahleova H, Tura A, Hill M, *et al*. A plant-based dietary intervention improves beta-cell function and insulin resistance in overweight adults: a 16-week randomized clinical trial. *Nutrients.* 2018;10(2):189. doi:10.3390/nu10020189
44. Appel LJ, Moore TJ, Obarzanek E, *et al*. A clinical trial of the effects of dietary patterns on blood pressure. *N Engl J Med.* 1997;336(16):1117-1124. doi:10.1056/NEJM199704173361601