Comprehensive Functional Dietetic Management of an Overweight Adult with Type 2 Diabetes: A 12-Month Case Report.

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Abstract

Background:

Management of overweight adults with type 2 diabetes mellitus poses significant challenges owing to the inability of standard lifestyle changes to produce compliance and metabolic benefit. Information on comprehensive, individualized functional dietetic interventions derived from long-term case studies is not abundant.

Objective:

This case report aimed to study the efficacy of a 12-month comprehensive functional dietetic intervention on anthropometric parameters, glycemic control, metabolic markers, and compliance in an overweight adult with type 2 diabetes mellitus.

Case presentation:

An obese 45-year-old male with poorly controlled Type 2 Diabetes Mellitus sought the services of the Nutrition Clinic of the University of Science and Technology, Aden, Yemen. He participated in a personalized nutritional intervention study for one year from September 2024 to August 2025. The nutritional intervention included a personalized low-glycemic index and high-fiber diet, time-restricted feeding, progressive resistance training, cardio exercises, motivational interviewing, and self-determination-based behavior change strategies with vitamin D, omega-3 fatty acid, and B-complex vitamins supplementation based on laboratory findings

Results:
After a duration of 12 months, the participant experienced a weight reduction of 9 kilograms and a decrease in waist circumference by 6 centimeters. Glycated hemoglobin levels were reduced from 8.2% to 6.5%, and there was notable improvement in fasting blood glucose. Additionally, inflammatory markers showed a decline, the lipid profile exhibited enhancement, vitamin D status was normalized, and the participant reported an increase in quality of life along with greater adherence to healthy lifestyle behaviors.

Conclusion:
This case study demonstrates that the implementation of an integrated and holistic dietetic strategy for patients diagnosed with type 2 diabetes—encompassing personalized nutritional intake, physical activity, behavioral changes, and supplementation tailored to laboratory findings—can facilitate effective management of the condition. However, it is essential to conduct further research with larger sample sizes to validate these findings.

Keywords: Type 2 diabetes mellitus, Overweight, Functional dietetics, Personalized nutrition, Exercise, Behavioral support, Glycemic control, Supplementation

Introduction:

Type 2 diabetes mellitus (T2DM) refers to a metabolic disease marked by the presence of insulin resistance, persistent hyperglycemia, and progressive dysfunction of the pancreatic β cells. This medical condition is linked with obesity, dyslipidemia, hypertension, chronic low-grade inflammation, and cardiovascular risks.[1] The prevalence of type 2 diabetes mellitus is on the increase worldwide, posing a serious public health problem and imposing significant clinical and economic burdens.[2]

Lifestyle modification that includes diet alteration, exercise, and weight reduction is the key to treating T2DM.[2] But even in the light of clinical guidelines, the majority of patients cannot gain glycemic control since the standard approach to the treatment of this disease involves general dietary recommendations and caloric restriction, which do not ensure proper patient compliance.[3]

It has been found that the integration of personalized nutrition through clinical and biochemical assessment with exercise and behavior modification techniques and proper supplementation in functional dietetics could yield better metabolic results than the traditional form of nutrition therapy.[4] Behavior change techniques including Motivational Interviewing (MI) would increase motivation and participation in the patients, while the concept of SDT will encourage sustained behavior change.[5,6]

Even though the above interventions seem to have a lot of potential when used on their own, there is very little scientific literature on how they are used together in an all-inclusive patient-centered functional dietetic program. This would be of great importance if we had longitudinal case reports showing the effects of such a program both clinically, biochemically, anthropometrically, and behaviorally.

Consequently, this case report aimed to document the impact of an integrated functional dietetic approach incorporating personalized nutrition, laboratory-guided supplementation, structured exercise, motivational interviewing, and behavior change strategies in a 45-year-old man with type 2 diabetes mellitus, overweight, and elevated cardiovascular risk. Changes in anthropometric measurements, biochemical markers, dietary behaviors, and quality of life were evaluated to contribute to the growing body of evidence supporting personalized nutrition care for individuals with type 2 diabetes mellitus.

Methodology

Study Design

This study is a prospective single-case study on the application of comprehensive functional dietetic intervention among a patient suffering from T2DM from July 2016 to October 2020. Setting: This intervention took place from September 2024 to August 2025 in the Nutrition Clinic, University of Science and Technology, Aden in Yemen. Follow-up appointments took place once every month in order to follow up on the progress of the patient.

Justification for the Case Selection

A single-case design was selected because the patient presented with multiple metabolic and behavioral challenges, including overweight, poorly controlled T2DM, hypertension, dyslipidemia, unhealthy dietary habits, and a sedentary lifestyle. The availability of complete anthropometric, biochemical, dietary, and behavioral follow-up data over 12 months enabled an in-depth evaluation of an individualized, multidisciplinary nutrition care approach. This design also allowed detailed documentation of the implementation, feasibility, and long-term effects of personalized functional dietetic management in routine clinical practice.

Patient Assessment

The initial assessment done included demographic and medical history; anthropometric measurements (body weight, height, body mass index and waist circumference); dietary assessment which involved dietary history and assessment of eating behaviors; assessment of lifestyle and physical activity behaviors; and biochemical assessment involving measurement of glycated hemoglobin (HbA1c), fasting plasma glucose levels, lipid panel, high-sensitivity C-reactive protein (hs-CRP) and vitamin D status. These assessments were performed at fixed intervals throughout the 12-month intervention period in order to assess clinical progression, adherence, and tailor changes to the nutrition care plan.

Intervention

The patient was provided with an individualized and evidence-based functional dietetic approach with the following four elements:

Nutritional Therapy: An individualized diet with a low glycemic index and high fiber content focusing on whole foods, vegetables, proteins, fats, and time-restricted feeding.

Physical activity: Progressive exercise regimen including walking, strength training, and HIIT (High Intensity Interval Training), with exercise intensity gradually increasing based on the level of tolerance and compliance of the patien**t.**

Behavioral modification: Techniques from motivational interviewing (MI) and Self-Determination Theory (SDT) counseling were used during each follow-up session to increase autonomous motivation, self-monitoring, goal-setting, problem-solving skills, and compliance with lifestyle changes.

Lab-based supplementation: The administration of D3, omega 3, and B-complex vitamins was conducted on the basis of laboratory results alone and was tailored to the results obtained through follow-up biochemical tests.

This was a personalized intervention that changed as per the response of the subject throughout the study period.

Follow-up and Outcome Measures

Monthly follow-up sessions took place during the 12-month intervention period. During these sessions, adherence to diet advice, exercise routine, supplementation, and behavioral modification measures was assessed. Body measurements and fasting blood glucose were measured on a monthly basis, while HbA1c levels and other biochemical variables were rechecked after every clinically reasonable interval, including at 6 and 12 months.

Primary outcome measures included weight, body mass index, waist circumference, HbA1c, and fasting blood glucose levels. Secondary outcomes included alterations in lipid panel, inflammatory status (hs-CRP), vitamin D status, adherence to diet and exercise advice, and quality of life measures.

Data Analysis

Given the exploratory nature of this single-case report, no inferential statistical analyses were conducted. Clinical outcomes were assessed by comparing baseline values with follow-up measurements collected throughout the 12-month intervention. Changes in anthropometric, biochemical, and behavioral parameters were described descriptively and presented in tabular form.

Ethical Considerations

Ethical approval was obtained from the Institutional Review Board of the University of Science and Technology, Aden, Yemen (Approval No.:MEC/AD0174). Written informed consent was obtained from the patient before participation and publication of the case report. All procedures were conducted in accordance with the principles of the Declaration of Helsinki. Patient confidentiality and anonymity were maintained throughout the study by removing all identifying information.

Intervention Timeline

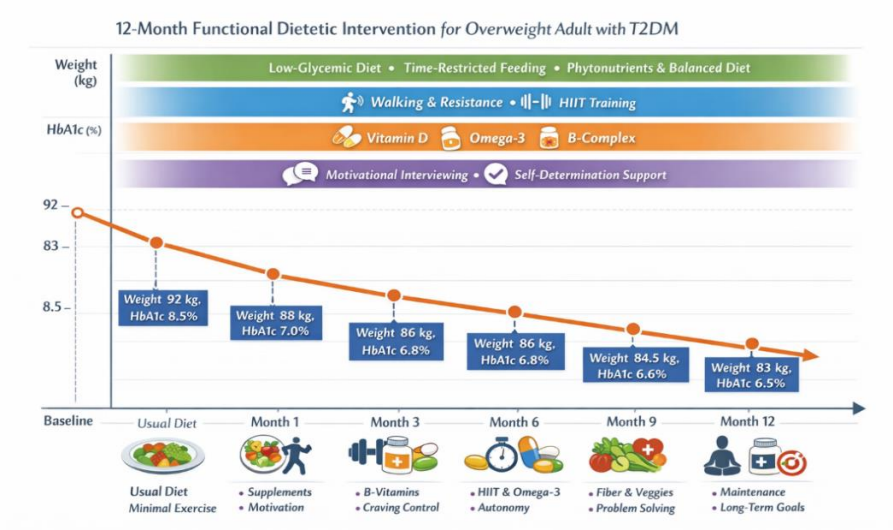
A detailed one-year diet regimen was designed for the patient, including a low glycemic index and a high-fiber elimination diet, where the patient was to eat three meals daily and maintain a ratio of vegetables to fruits of 3:1. The exercise regimen was walking,

weight training, and HIIT, each of which lasted 15 to 30 minutes, three days weekly. Furthermore, the patient was to supplement his diet with vitamin D3 and omega-3 supplements. Motivational interviewing and support, as well as self-determination theory approaches, were used to improve compliance. Weight, waist circumference, fasting blood sugar, and HbA1c measurements were assessed monthly.

Monthly dietetic, exercise, supplementation, behavioral interventions, and outcomes over 12 months (September 2024 – August 2025).

Month	Diet & Nutrition	Exercise	Supplementation	Behavioral Strategies	Outcomes
Baseline	Patient's usual diet	Minimal exercise	None	None	Weight 92 kg; waist circumference 102 cm; HbA1c 8.5%; fasting plasma glucose 137 mg/dL
1	Low-glycemic, high-fiber elimination diet; three meals/day; 3:1 vegetable-to-fruit ratio	Walking 20–30 min, 3×/week	Vitamin D_3 5,000 IU/day; omega-3 fatty acids 1 g/day	Motivational interviewing (MI); self-determination theory (SDT) autonomy support	Weight −1.0 kg; fasting plasma glucose −5 mg/dL
2	Introduced time-restricted feeding (12-hour fasting window)	Walking 30–40 min plus resistance training 2×/week	Continued vitamin D_3 and omega-3	Goal setting and progress review	Weight −1.5 kg; waist circumference −1 cm
3	Included rotation of low-reactive foods	Resistance training 2–3×/week	B-complex vitamins and antioxidants	MI for craving management	Weight −1.5 kg; HbA1c −0.2%
4	Added phytonutrient-rich shakes	High-intensity interval training (HIIT) 15 min plus resistance training	Continued supplementation	SDT to promote autonomous meal choices	Weight −1.0 kg; waist circumference −1 cm
5	Reassess elimination diet, introduce moderate glycemic carbs	HIIT 20 min 3x/week	Omega-3 increased 2 g/day	MI: reinforce adherence	Weight −0.8 kg, HbA1c −0.2%
6	Increased dietary variety while maintaining three meals/day	Resistance training plus HIIT	Continued vitamin D_3 and B-complex	SDT emphasizing satisfaction	Weight −0.7 kg; waist circumference −1 cm

				and self-monitoring	
7	Gradual reintroduction of previously restricted foods	HIIT 25 min, 3×/week	Continued omega-3 (2 g/day)	MI for problem-solving barriers	Weight −0.5 kg; fasting plasma glucose −5 mg/dL
8	Encouraged greater vegetable diversity	HIIT plus resistance training	Continued supplementation	SDT emphasizing autonomy and dietary self-monitoring	Weight −0.7 kg; HbA1c −0.1% (**midpoint milestone**)
9	Emphasized dietary fiber and lean protein	HIIT 30 min	Continued vitamin D_3 and B-complex	MI to reinforce intrinsic motivation	Weight −0.6 kg; waist circumference −0.5 cm
10	Maintained a balanced diet	Resistance training plus HIIT	Continued omega-3 (2 g/day)	SDT reflection on progress	Weight −0.6 kg; HbA1c −0.1%
11	Maintained a flexible 80/20 dietary approach	HIIT plus resistance training	Continued supplementation	MI for relapse prevention	Weight −0.4 kg; waist circumference −0.5 cm
12	**Long-term maintenance plan**	**Moderate exercise, flexibility**	**Continue essential supplements**	**SDT: long-term goal setting**	**Total weight loss −9 kg, waist −6 cm, HbA1c 6.5%((final milestone)**



Laboratory Follow-Up (6 & 12 months)

- **HbA1c:** 8.2% → 7.0% → 6.5%
- **Fasting glucose:** 160 → 135 → 120 mg/dL
- **LDL/HDL:** 155/38 → 140/45 → 130/50 mg/dL
- **Triglycerides:** 180 → 150 → 135 mg/dL
- **hs-CRP:** 6.5 → 4.0 → 2.8 mg/L
- **Vitamin D:** 18 → 32 → 38 ng/mL

Discussion

Obesity and type 2 diabetes mellitus (T2DM) are multifactorial conditions influenced by genetic, metabolic, behavioral, and environmental factors. Management requires a comprehensive approach that addresses both physiological and behavioral components. In this case, a **multi-component functional dietetic program** over 12 months led to improvements in weight, glycemic control, anthropometrics, and metabolic biomarkers.

Physiological Mechanisms

Glycemic Control:

The client followed a high-fiber, low-glycemic diet combined with time-restricted feeding. High-fiber foods slow gastric emptying and glucose absorption, reducing postprandial glucose spikes and improving insulin sensitivity (7). Time-restricted feeding has been shown to enhance metabolic flexibility and improve insulin-mediated glucose uptake, particularly in adults with obesity and T2DM (8). Low-glycemic diets are supported by multiple meta-analyses for reducing HbA1c and improving glycemic control in patients with T2DM (9). Another study showed that both soluble fiber products and fiber from natural foods are effective in improving glycemic control and insulin sensitivity in T2DM patients, the former yielding better effects. (10).

Weight Loss and Body Composition:

Gradual caloric reduction, increased protein and fiber intake, and progressive exercise resulted in significant fat loss, particularly **visceral adiposity**, which is closely linked to insulin resistance and systemic inflammation. Preservation of lean mass through resistance training and HIIT is well-supported in the literature for improving body composition and metabolic health (11). Reduction of visceral fat contributes to decreased inflammatory mediators such as **interleukin-6 (IL-6)** and **tumor necrosis factor-α (TNF-α)**, as shown in studies of obese adults undergoing lifestyle interventions (12). Combining physical activity with caloric restriction appears to be the most efficient method in reducing visceral adipose tissue (VAT) and body weight,

whereas dietary intervention alone is still an achievable option for individuals who cannot engage in physical activity. (13)

Inflammation:

Systemic inflammation was monitored via **CRP**, which declined over the program. Phytonutrient-rich foods, omega-3 supplementation, and weight reduction work synergistically to reduce inflammation. Omega-3 fatty acids have been shown to reduce TNF-α and CRP levels in clinical trials (14). Chronic low-grade inflammation is a key contributor to insulin resistance and cardiovascular disease, supporting the mechanistic rationale for including anti-inflammatory foods and supplements(15).

Lipid Profile and Vitamin D:

The diet emphasized high-quality fats and limited refined carbohydrates, resulting in improved lipid profiles. Vitamin D supplementation addressed deficiency, which is associated with higher BMI and lower insulin sensitivity (16). Cardioprotective dietary patterns, including increased fiber and unsaturated fats, are strongly supported for improving HDL, LDL, and triglyceride levels (17).

Behavioral and Psychological Factors

Motivational Interviewing (MI):

MI techniques encouraged self-reflection and autonomous problem-solving, helping the client identify barriers to adherence and set realistic goals. MI has been shown to improve weight loss outcomes in adults when combined with dietary and exercise interventions (18). A study has shown that Motivational interviewing was demonstrated to be useful in reducing HbA1c levels in diabetes management. 19)

Self-Determination Theory (SDT):

Throughout the intervention, SDT-based strategies emphasizing autonomy, autonomous meal choices, and dietary self-monitoring were incorporated to support sustainable behavior change. The participant demonstrated greater adherence to healthy lifestyle behaviors and reported an improved quality of life following the 12-month intervention. Although these improvements resulted from a comprehensive, multicomponent intervention, they are consistent with previous studies demonstrating that SDT-based interventions improve treatment adherence, diabetes self-management, and quality of life among individuals with diabetes (20.21). These findings suggest that incorporating SDT principles into personalized diabetes management may enhance patient engagement, promote sustained lifestyle modifications, and ultimately improve health outcomes and quality of life.

Exercise Integration

The progressive exercise program—starting with walking, progressing to resistance training, and incorporating **high-intensity interval training (HIIT)**—was critical for metabolic improvements. Exercise improves insulin sensitivity, enhances fat oxidation, preserves lean mass, and supports cardiovascular fitness. HIIT, specifically, provides greater metabolic benefits in shorter durations and improves adherence due to reduced time commitment (22). There is evidence that structured PA interventions involving weight reduction can reduce the incidence of type 2 diabetes by up to 58%. Most effects of PA on the management of diabetes result from acute and chronic improvements in insulin sensitivity achieved through aerobic exercise and strength training. (23).

Supplementation

Laboratory tests determine the individual need for supplementation based on specific deficiencies to maximize their metabolic well-being. Vitamin D3/K2 supplementation may increase insulin sensitivity and reduce inflammation (24), whereas omega-3 fatty acid supplementation has been shown to reduce systemic inflammation and heart disease (25). B-complex vitamins contribute to metabolic energy production and decreased homocysteine (26). These supplements helped achieve the goal of metabolic enhancement

Clinical Implications

This case highlights the **utility of a personalized, multi-component functional dietetic approach** in managing overweight adults with T2DM. Combining dietary modifications, exercise, behavioral support, and supplementation led to meaningful improvements in:

- Glycemic control (HbA1c, fasting glucose, insulin sensitivity)
- Anthropometrics (weight, waist circumference)
- Lipid profile and systemic inflammation

Long-term adherence and success were supported by addressing **physiological, psychological, and behavioral factors simultaneously**, rather than relying solely on calorie restriction or pharmacotherapy.

The case is consistent with evidence showing that **multi-component interventions** are more effective than single-component strategies for improving metabolic outcomes, highlighting the importance of integrating diet, exercise, behavior modification, and supplementation in clinical practice (27).

Patient Perspective

"I have learned to enjoy a balanced diet without feeling deprived. The regular check-ins and guidance from my nutritionist kept me accountable. I now feel more energetic, confident, and in control of my diabetes. Seeing measurable improvements in weight, waist, and lab results motivates me to continue."

Conclusion

This 12-month functional dietetic intervention demonstrated that integrating personalized nutrition, exercise, behavioral support, and lab-guided supplementation can achieve clinically meaningful improvements in weight, glycemic control, lipid profile, and inflammatory markers in a 45-year-old male with type 2 diabetes mellitus (T2DM). Multifaceted, patient-centered approaches may offer superior long-term adherence and outcomes compared to conventional interventions.

Significance and limitations:

This particular case highlights the importance of individual nutrition therapy incorporating personalized dietary, exercise, behavior intervention, and laboratory-directed supplement interventions that can lead to positive metabolic results in a type 2 diabetes patient. Although individualized management is central to nutrition practice, this single-case report cannot be generalized to all patients. Larger studies are needed to confirm these findings.

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