

Effectiveness of a Nutrition Promotion Intervention on Glycaemic Control among Patients with Type 2 Diabetes Mellitus: A Quasi-experimental Study

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ABSTRACT

Introduction: Type 2 Diabetes Mellitus (T2DM) is one of the global health concerns that needs effective management of blood glucose levels to avoid the complications. Nutritional interventions for the control of diabetes mellitus have been promising, yet studies assessing their effectiveness are few.

Aim: To assess the effectiveness of nutrition promotion intervention in controlling blood glucose levels in T2DM patients

Materials and Methods: The present quasi-experimental study was conducted from November 2025 to April 2026 among patients with T2DM enrolled from the Non-communicable Disease (NCD) clinic of an Urban Health Centre. A total of 104 T2DM patients were enrolled on the quasi-experimental study. A semi-structured questionnaire was used to collect the baseline data. Sociodemographic information, such as age, gender, and socioeconomic status, was comprehensively gathered. Nutritional health education and a novel nutrition promotion intervention were given to the patients and followed up for 24

weeks. The blood glucose levels and Glycated Haemoglobin (HbA1c) were evaluated at baseline and after the intervention period of 24 weeks. Data analysis was performed on Statistical Package for the Social Sciences (SPSS) software version 25. Significance test for the difference between the pre- and post-intervention values was conducted using a paired t-test.

Results: According to the study, males accounted for 80.77% of the study population, with most of them being employed. The intervention was associated with significant reductions in Fasting Blood Glucose (FBS) ($p=0.001$), Postprandial Blood Glucose (PPBS) ($p=0.001$) and Glycated Haemoglobin (HbA1c) ($p=0.001$) of the participants significantly improved following the nutritional intervention.

Conclusion: The study observed reductions in glycaemic parameters after a nutrition promotion intervention in regulating the blood glucose levels among T2DM patients. The study also supported the importance and effect of customised nutrition counselling and health education in diabetes management to improve glycaemic control.

Keywords: Diet therapy, Health education, Health promotion, Self-care, Treatment adherence and compliance

INTRODUCTION

The T2DM is a chronic metabolic disease that results from elevated blood sugar levels due to a combination of insulin resistance and insulin insufficiency [1]. This occurs gradually over the years as a result of several factors such as genetics, obesity, sedentary lifestyle, and old age. T2DM poses a major threat because of its complications, such as Cardiovascular Disease (CVDs), chronic kidney disease, which significantly affect life expectancy and quality of life. Preventing these complications through the early detection and management of high blood sugar, hypertension, and abnormal lipid levels is crucial in reducing diabetes-related morbidity and mortality [2].

The prevalence of Diabetes according to the International Diabetes Federation (IDF) Diabetes Atlas (2021), is 10.5% (536 million people) among the 20-79 years age group. IDF estimated that 783 million adults will have diabetes by 2045, which is a 46% rise [3]. The incidence of diabetes has increased in South Asian countries for the past 20 years [4]. It is predicted that India would have 101 million individuals with diabetes by 2030 [5]. The Diabetes incidence in India is expected to increase to 10.9% by 2045 [4]. T2DM patients suffer both psychologically and physically affecting their Quality of Life (QoL) [6]. A survey conducted on 4600 newly diagnosed T2DM patients in India revealed 35% were in 31-40 years age group and 40% of the population were in 41-50 years age group; majority of patients with diabetes are in the range of 45-64 years in India [7]. Hence, it is important to concentrate on the age group above

40 years as they are prone to develop complications especially in developing countries like India.

A nutrition promotion intervention is a strategic approach aimed at educating and empowering individuals to adopt healthier dietary habits for improved health outcomes. Lifestyle modifications are very significant in managing the condition it poses the equal importance as that of medical treatment [8]. This lifestyle change typically entails identifying all dietary intakes, setting up a tailored meal plan, providing diabetes education, and offering ongoing support through follow-up consultations and resources. The patient may overemphasise the use of medication and neglect to understand the benefits of a balanced diet for better insulin sensitivity and optimising glycaemic control in the absence of appropriate nutrition counselling. This may result in the development of poor or unhealthy practices, such as poor nutrition practices, which may lead to hyperglycaemia and a higher risk of complications, such as nephropathy, neuropathy and CVD. The interventions should be culturally relevant and acceptable to the person(s) in the target group, and enable them to gain a better understanding and manage their condition by making informed dietary and lifestyle decisions. These programs have been found to improve self-care and health outcomes of people with diabetes in the communities through the specific barriers addressed and culturally appropriate methods employed [9].

Several studies have demonstrated that tailored diabetes education interventions can be more effective than medical therapy alone in improving diabetes knowledge and promoting healthier lifestyles

[9-12]. According to a study by Eknithiset R et al., the use of a pictorial diary handbook significantly improved knowledge and practice scores while reducing HbA1c levels among older adults with T2DM [9]. Despite the documented benefits of diabetes education and dietary interventions, evidence regarding culturally tailored nutrition promotion interventions among South Asian populations with T2DM remains limited [13]. Furthermore, studies evaluating structured nutrition promotion packages that combine individualised dietary counselling, educational materials, and regular follow-up within routine primary care settings in India are scarce. The novelty of the present study lies in evaluating a culturally tailored nutrition promotion intervention integrating personalised dietary counselling, a study-specific nutrition education booklet, and periodic follow-up among T2DM patients attending an Urban Health Centre. Therefore, the present study was undertaken to assess the effectiveness of this intervention in controlling blood glucose levels among individuals with T2DM.

MATERIALS AND METHODS

The present quasi-experimental study was conducted from November 2025 to April 2026 among patients with T2DM attending the Non-Communicable Disease (NCD) Outpatient Department (OPD) of an Urban Health Centre affiliated with a tertiary care hospital in Tiruvallur district, Tamil Nadu, India. Institutional Ethics Committee approval was obtained prior to the commencement of the study (IEC Approval Reference No: 023/11/2025/IEC/SMCH).

Inclusion and Exclusion criteria: Patients diagnosed with T2DM who understood the regional Tamil language and provided written informed consent were included in the study. Patients with T2DM who had developed microvascular or macrovascular complications and those who were unable to understand the regional language were excluded from the study.

Sample size estimation: The sample size was calculated based on the mean and standard deviation of FBS values before intervention (199.2 ± 76.57 mg/dL) and after six months of intervention (172.13 ± 54.82 mg/dL) reported by Eshete A et al., [14]. Assuming 80% power, 95% confidence level, and 10% non-response rate, the minimum required sample size was estimated to be 104 participants using OpenEpi version 3.01.

Study Procedure

Participants were selected using a simple random sampling technique. After obtaining written informed consent, baseline sociodemographic and clinical information was collected using a semi-structured questionnaire.

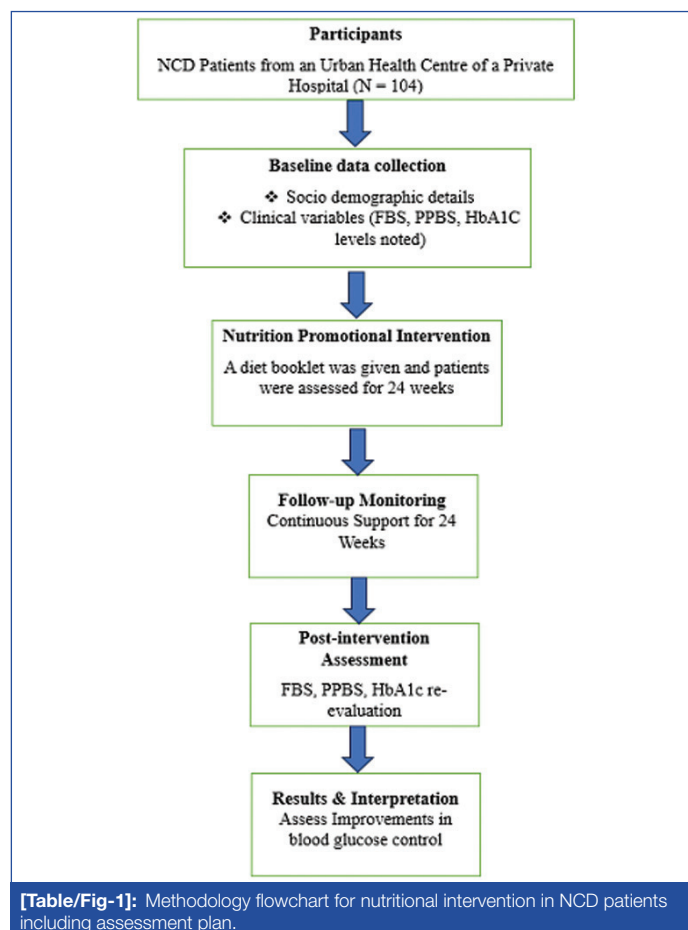
A nutrition promotion intervention package consisting of a study-specific diabetic diet booklet and individualised dietary counselling was administered to all participants. The booklet was developed by the investigators based on the recommendations of the Indian Council of Medical Research-National Institute of Nutrition (ICMR-NIN) dietary guidelines, standard diabetes management guidelines [15,16]. The content was reviewed by subject experts from the Department of Community Medicine for clarity, relevance, and cultural appropriateness before implementation.

The booklet was prepared in Tamil and included information on diabetes mellitus, principles of a balanced diabetic diet, meal planning, portion control, meal timing, foods to be preferred and avoided, healthy cooking practices, the importance of physical activity, and locally available nutritious foods known to aid glycaemic control. Individualised dietary counselling was provided twice monthly for 5.5 months to reinforce dietary recommendations and promote adherence to healthy eating practices.

Baseline and post-intervention assessments of FBS, PPBS, and HbA1c were performed using standard laboratory procedures.

These parameters were measured before the intervention and at the end of the six-month follow-up period.

Data collection involved obtaining sociodemographic and clinical information from the study participants along with objective measurements of blood glucose levels. In the present study, age, gender, educational status, employment status, socioeconomic status, type of diet, physical activity, Body Mass Index (BMI), and duration of T2DM were considered independent variables. The outcome variables, namely FBS, PPBS, and HbA1c levels, were measured using standard laboratory procedures at the health centre before the intervention and at the end of the six-month follow-up period [Table/Fig-1].



Physical activity assessment: The International Physical Activity Questionnaire (IPAQ) assessed the participants' physical activity. Participants were classified as having a moderate level of physical activity if they met the IPAQ criteria, including participation in vigorous-intensity activity on ≥ 3 days for at least 30 minutes per day, moderate-intensity activity and/or walking on ≥ 5 days for at least 30 minutes per day, or any combination of activities achieving ≥ 600 Metabolic Equivalent of Task (MET)-minutes per week. Participants who did not meet these criteria were classified as having inadequate/low physical activity [17].

STATISTICAL ANALYSIS

The data were analysed using SPSS Statistics. The continuous variables such as FBS, PPBS, and HbA1c levels, were presented as Mean $\pm$ Standard Deviation (SD). Categorical variables were presented as percentages. The comparison of pre and post-intervention values of FBS, PPBS, and HbA1c was done by using a paired t-test. A p-value of < 0.05 was considered statistically significant. Before the trial started, approval from the Institutional Ethics Committee was obtained. Written informed consent was obtained from participants, ensuring their voluntary involvement in the study and their right to withdraw at any time without affecting their routine medical care.

RESULTS

The sociodemographic and clinical profiles of the study participants (N=104) are presented in [Table/Fig-2]. More than half of them were male (80.77%) aged above 40 years, females constituted 20 (19.23%) of the study participants 38 (36.54%) of them had attained primary education, 34 (32.70%) studied secondary education, 26 (25%) were graduates and 6 (5.76%) of them were illiterate. According to the Modified B.G. Prasad scale 2023, the majority of them were employed (87, 83.65%) and belonged to Socioeconomic status Class 1 (78, 75%) [18]. Around 16.35% of them were unemployed. The majority of them had a non-vegetarian diet 76 (73.08%) and 28 (26.92%) were vegetarians. More than half of them 65 (62.5%) had adequate physical activity.

S. No	Sociodemographic factors	n (%)
1	Age	
	Age ≤40	29 (27.88%)
	Age >40	75 (72.12%)
2	Gender	
	Female	20 (19.23%)
	Male	84 (80.77%)
3	Educational status of the respondent	
	Illiterate	6 (5.76%)
	Primary	38 (36.54%)
	Secondary	34 (32.70%)
	Graduate	26 (25%)
4	Employment status of the respondent	
	Employed	87 (83.65%)
	Unemployed	17 (16.35%)
5	Socioeconomic status (Modified B.G. Prasad 2023)	
	Class I	78 (75%)
	Class II	24 (23.08%)
	Class III	2 (1.92%)
6	Type of diet	
	Vegetarian	28 (26.92%)
	Non vegetarian	76 (73.08%)
7	Physical activity *	
	Adequate	65 (62.5%)
	Inadequate	39 (37.5%)

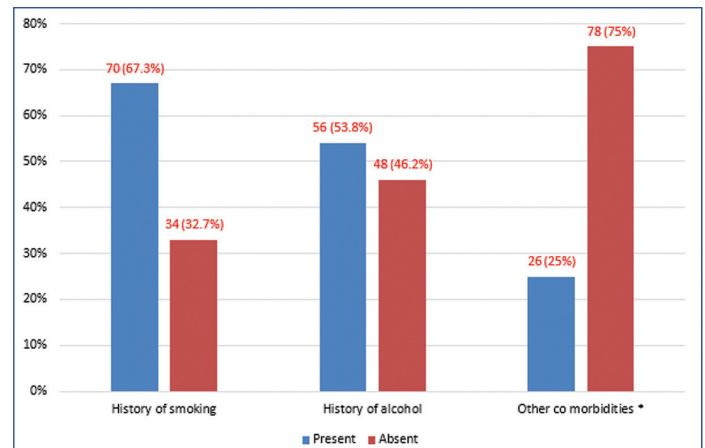
[Table/Fig-2]: Baseline sociodemographic and clinical profiles of study participants (N=104).
Physical activity: Adequate when they scored Moderate level on the International Physical activity questionnaire

As shown in [Table/Fig-3] the Body Mass Index (BMI) distribution and length of time with T2DM among the study participants. 3.85% of study participants were underweight, 25.96% were normal, 38.46% were overweight and 31.73% were obese. The majority of them (75%) had T2DM for more than or equal to five years and 25% had DM for less than five years.

As shown in [Table/Fig-4] the percentage of risk factors related to T2DM in the study participants. More than half of them had

Variables	Category	Frequency (%)
BMI	Underweight	4 (3.85%)
	Normal	27 (25.96%)
	Overweight	40 (38.46%)
	Obese	33 (31.73%)
Length of time with Type 2 DM	<5 years	26 (25%)
	≥5 years	78 (75%)

[Table/Fig-3]: BMI distribution and length of time with type 2 DM among the participants (N=104).



[Table/Fig-4]: Risk factors related to T2DM in the study participants (N =104).
Other co-morbidities: Hypertension, Bronchial asthma, Dyslipidaemia, COPD

a history of smoking 70 (67.3%) and the remaining 34 (32.7%) were non smokers. About 56 (53.8%) of the respondents were alcoholics and 48(46.2%) were non alcoholics. The other co-morbidities included in the present study were hypertension, bronchial asthma, dyslipidaemia, and Chronic Obstructive Pulmonary Disease (COPD) as they were the most predominant in our NCD clinics and the majority (75%) had them. The other co-morbidities were absent in 25% of the present study participants.

In the current study, the mean FBS value post-intervention was 153.250±18.49 mg/dL with p=0.001; the PPBS value post-intervention was 231.885±41.28 mg/dL with a p=0.001; the HbA1c value post-intervention was 6.915±0.38% with p=0.001. Hence, the mean blood glucose levels were all reduced after the nutrition promotion intervention [Table/Fig-5].

Blood glucose parameters	Intervention	Mean±SD	Mean difference (95% CI)	t-value	p-value
FBS (mg/dL)	Pre-intervention	174.692±24.00	21.44 (16.8-26.07)	9.2	0.001*
	Post-intervention	153.250±18.49			
PPBS (mg/dL)	Pre-intervention	260.827±43.81	29 (24.20-33.6)	12.2	0.001*
	Post-intervention	231.885±41.28			
HbA1c (%)	Pre-intervention	7.362±0.50	0.45 (0.35-0.56)	10.31	0.001*
	Post-intervention	6.915±0.38			

[Table/Fig-5]: Comparison of glycaemic parameters among patients with T2DM before and after intervention N=104.
Paired t-test was used for p-value calculation

DISCUSSION

The present study observed that the majority of participants with T2DM were males aged above 40 years. Similar demographic patterns were reported by Devi VB et al., who found a higher prevalence of diabetes mellitus among male individuals and in the age group of 41-60 years. The results suggest that the disease burden is increasing among middle-aged adults and thus stress the need for early lifestyle interventions and nutritional interventions [19].

The present quasi-experimental study shows the effect of a structured nutrition promotion intervention on glycaemic control among T2DM patients. The results of the current study state a significant reduction in FBS (mean 21.44 mg/dL), PPBS (mean 29 mg/dL) and HbA1c (mean 0.45%) following the six-month intervention. The results obtained by the researcher in the current study are consistent with the results obtained by Eshete A et

al., where the researcher found that after providing nutritional intervention to the patients, there was a significant improvement in dietary adherence and glycaemic outcomes [14]. Personalised and culturally sensitive dietary education is an important factor in managing glycaemic index, which also corresponds with the results of another study done by Guo Y et al., [10]. Another study conducted by Anil D et al., (2023) at Mysuru, India demonstrated that a structured health education intervention can significantly reduce the Fasting Blood Sugar (FBS) levels (from 164.79±47.59 mg/dL to 141.92±25.63 mg/dL) and improve BMI in patients with T2DM over six months, which is similar to the current study findings [20].

The results from the present study are similar to the results from Martos-Cabrera MB et al., (2021) study, which cited the positive effects of intensive health education for the T2DM patients [11]. The results showed that the intervention group had a significant decrease in HbA1c (8.97 to 8.06) while the control group had a slight decrease (6.97 to 6.75) [11]. Likewise, improvements in glycaemic parameters were achieved with the intervention group in the current study, demonstrating the effectiveness of a well-structured and patient-focused educational approach. Unlike the research by Abraham AM et al., which only utilised a brief self-management intervention over three months and observed significant HbA1c reductions, the current study was for six-month duration provided extended follow-up and continuous support. This extended period allowed for better sustainable lifestyle changes [12].

In the present study, nutrition promotion intervention showed a significant change in glycaemic parameters in patients with T2DM. Gokul D et al., reported that diabetic patients who underwent comprehensive diabetic care services like diet counseling, physical exercise and lifestyle modification services had better outcomes in terms of quality of life [21]. The integration of nutrition education in diabetes care at the individual patient level is not the only public health impact. Culturally relevant nutrition education programs can improve community-based health programs and patient self-management. Farhat G et al., emphasised the need for culturally tailored dietary interventions among South Asian populations, highlighting their potential to improve glycaemic control and long-term disease management [13]. This empowerment through education can help to increase adherence to the treatment plan and help with long-term glycaemic control.

The results of this study support the need for incorporating nutrition promotion interventions into the standard care for diabetes. Community-based nutrition education programs tailored to the cultural background of patients may improve self-management practices and long-term glycaemic control. Recommendations for a diabetic diet should be incorporated into community-based health care and the need to consider the patient's cultural background to support patient self-management practices. To strengthen self-management habits, it is essential to implement timely and comprehensive patient-centered interventions that promote self-care behaviors in both households and the community. One way to put this into practice is by incorporating diabetes control nutrition strategies into community health programs.

The major strength of the study was the adoption of culturally tailored and accepted nutritional intervention, repeated follow-up counselling, and objective biochemical assessment of glycaemic parameters.

Limitation(s)

The study has a few drawbacks; one of the limitations is poor generalisability, since the study was conducted in a single centre. The absence of a control group limits the ability to attribute the observed improvements solely to the intervention. The lack of control over medication can be a confounding factor that complicates

the isolation of the intervention's true impact. The possibility of behavioural change due to the continuous monitoring can be another limitation, say the Hawthorne effect. The sustainability towards following the healthy interventions cannot be guaranteed in the case of no follow-ups.

CONCLUSION(S)

The present study demonstrated that a culturally tailored nutrition promotion intervention significantly improved glycaemic control among patients with T2DM, as evidenced by reductions in FBS, PPBS, and HbA1c levels. The findings highlight the effectiveness of integrating individualised dietary counselling, nutrition education, and regular follow-up into routine diabetes care. Such interventions can enhance patients' understanding of healthy dietary practices and support sustained lifestyle modifications. Incorporating culturally appropriate nutrition promotion strategies into non-communicable disease clinics and primary healthcare settings may strengthen diabetes self-management and improve long-term health outcomes. Wider implementation of similar interventions at the community level could contribute to better glycaemic control and reduce the burden of diabetes-related complications.

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