Effectiveness of an educational dietary intervention among patients with type-2 diabetes mellitus in a tertiary hospital, South-West Nigeria: A quasi-experimental study.

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Abstract

Type 2 diabetes mellitus (T2DM) is a leading cause of morbidity and mortality globally, and dietary modification is a major cornerstone in its management. This study aimed to evaluate the effects of an educational dietary intervention in patients with T2DM in a tertiary hospital in Lagos State, Nigeria.

A quasi-experimental study was conducted at the Lagos University Teaching Hospital between November 2023 and February 2024. Patients were split into intervention and control groups. A brochure on healthy dietary habits and a modifiable dietary timetable was developed and deployed to patients in collaboration with a nutritionist. Patients' knowledge of T2DM and dietary behaviors was evaluated using structured pre- and post-questionnaires adapted from a validated questionnaire.

Eighty-four T2DM patients were enrolled, comprising 50 (59.5%) females and 34 (40.5%) males. Most patients were >60 years and had a family history of T2DM (56%). However, these differences were insignificant between the two groups. Responses to study questions were significant in the pre-and post-groups. After intervention, patient's dietary knowledge

significantly increased compared to the control group (8.74±0.49 vs 6.02±1.55, respectively; F=28.92; p<0.001). Using principal component analysis, the primary factors influencing patients' dietary habits were monthly income (0.768), availability (0.649), and taste of food (0.587). Additionally, 83% of patients in the intervention group stated that the dietary timetable was practical, feasible, and worth exploring.

Patient knowledge of dietary modification in T2DM significantly improved after the intervention, and study findings demonstrate the usefulness of educational resources in improving understanding of T2DM management.

Keywords: Dietary intervention; Patient education; Nigeria; Type 2 diabetes mellitus

Introduction

Type 2 diabetes mellitus (T2DM) is a chronic metabolic disease significantly affecting morbidity and mortality globally. According to the World Health Organization (WHO), about 422 million people live with the disease worldwide, with about 1.5 million deaths annually (WHO, 2023). In Nigeria, Uloko et al. suggest a prevalence of 5.77%, indicating that 11.2 million, i.e., 1 out of 17 adults, have T2DM (Uloko *et al.*, 2018). More recently, Olamoyegun et al., 2024 reported a pooled prevalence of 7.0% for T2DM in Nigeria. T2DM arise due to the inability of the body to adequately secrete and/or utilize insulin, leading to insulin resistance. Initial signs and symptoms include polydipsia, polyuria, polyphagia, fatigue, and hyperglycemia. Untreated or inadequately managed long-term T2DM has been associated with several complications, including neuropathy, nephropathy, cardiovascular disease, and retinopathy (Alldredge *et al.*, 2013).

The pathophysiology of T2DM indicates that lifestyle changes, particularly dietary control, can significantly impact disease progression,

making dietary modification a cornerstone of T2DM management. Persistently high glucose levels lead to metabolic syndrome, including obesity (Guo *et al*., 2020). These consistently high glucose levels increase beta-cell function to produce insulin. With hyperinsulinemia to combat high glucose levels, a decline in beta cell function occurs, causing eventual hyperglycemia and subsequent diabetes (Salvia & Quatromoni, 2023). This mechanism suggests that dietary regulation and avoiding hyperglycemic excursions would preserve beta-cell function. Healthy dietary patterns, such as the Dietary Approach to Stop Hypertension (DASH) and Mediterranean diets, have been linked to a significantly reduced risk of developing T2DM, as well as a reduction in T2DM progression and reduced glycated hemoglobin levels (HbA1c) levels among patients with T2DM (Toi *et al.,* 2020; Martin-Pelaez, Fito & Castaner, 2020). A Mediterranean diet comprises primarily whole grains, vegetables, fats, fruits, nuts, and seeds and a reduced intake of processed meats, fried foods, and sweetened products. Most diabetic patients, however, have inadequate knowledge of the right foods to eat, while some are limited by various economic and socio-structural factors.

In Nigeria, with several factors, such as inadequate education and low economic and financial resources, most patients are unaware of and not adherent to the required dietary modification required to manage T2DM (Bolajoko, Olanrewaju & Akingboye, 2018). Patients' knowledge of their disease state, particularly of chronic diseases such as T2DM, is integral for encouraging self-management. A systematic review revealed that methods geared toward improving patient knowledge of specific chronic diseases improved adherence in patients. This, in turn, significantly reduces morbidity, mortality, and overall healthcare costs (Ha Dinh *et al.,* 2016; Mantwill & Schulz, 2015).

As with the management of other conditions, the pharmacist is an important member of the healthcare team, serving as an educator, coach, healthcare manager, and pharmaceutical care provider (Chen *et al.*, 2016). According to the WHO, the community pharmacist is the most accessible health professional to the public (WHO, 2019). This holds significance in managing chronic diseases such as T2DM. As observed by Al Assaf *et al*., interventions led by community pharmacists have contributed to enhanced patient adherence and better patient knowledge and lifestyle modifications, leading to better disease control. Several studies have demonstrated the impact of pharmaceutical care in improving glycemic control in patients with T2DM, indicated by reduced glycated hemoglobin levels (Chen *et al.*, 2016; Borges *et al.*, 2010; Ipingbemi, Erhun & Adisa, 2021). In the latter two studies, medical costs did not differ significantly between the two groups. This indicates that pharmacist-led interventions can significantly improve blood glucose control without significantly increasing costs in patients with T2DM.

While many patients are aware of appropriate foods and 'foods to avoid' in diabetes, many patients are unaware of, or are without requisite knowledge on how to go about dietary revisions for adequate glycemic control. Concerned patients relay such information and frustration to their healthcare practitioner, usually the point-of-care community pharmacist. Providing an educational leaflet detailing the composition of and adequate foods in T2DM is expected to increase patients' knowledge of appropriate dietary patterns and improve adherence. A pharmacist-dietician collaboration was found to reduce HbA1c levels and improve patient satisfaction in a pilot study (Shoji *et al*., 2022).

With dietary modification as a bedrock in T2DM management, increased consumption

of whole grains, fruits, vegetables, and plant-based fats has been associated with improved glycemic control and reduced glycated hemoglobin levels. Adherence to dietary modification in T2DM is low in Nigeria, partly due to inadequate comprehension of dietary requirements provided by healthcare professionals. This study seeks to improve glucose control by providing an intervention leaflet for patients with T2DM. It is expected that this will increase patients' knowledge of appropriate dietary choices for the management of T2DM. This study aimed to evaluate the effects of an educational dietary intervention in patients with T2DM in a tertiary hospital located in Lagos, Nigeria.

Methods

Study Setting

The study was conducted in Lagos State, the commercial nerve center of Nigeria which is located in the South-western part of the country. Study participants were recruited from the Endocrinology clinic of the Lagos University Teaching Hospital (LUTH), which is a tertiary facility that offers care to patients on referrals from other hospitals and is located in the Mushin Local Government area of Lagos State. Lagos University Teaching Hospital's endocrinology clinic attends to diabetic patients every Tuesday, with an average of 60 patients per clinic day.

Study design

A quasi-experimental study was conducted at the Endocrinology clinic of the Lagos University Teaching Hospital (LUTH), Idi-Araba, Lagos, Nigeria.

Study population

The study enrolled patients with T2DM receiving care at the clinic. All patients who met the inclusion criteria and consented to participate in the study were consecutively recruited into the study.

Study Criteria

Inclusion criteria

The inclusion criteria were patients with T2DM who were ≥18 years and who consented to participate in the study, with a dietary intervention program.

Exclusion criteria

The exclusion criteria were patients with gestational diabetes mellitus and patients with co-morbidities such as congestive heart failure, stroke, end-stage renal failure, and eating disorders, which could influence patients' dietary choices.

Sample size determination

Approximately 10−12 new patients visit the endocrinology clinic every week and are available to fill out questionnaires. Information obtained from the hospital's record unit revealed that patients are usually given routine appointments every 3 months in the absence of complications. Thus, to avoid repeating patients, data collection was confined to 3 months, giving an estimated population size of 120 patients.

Using Yamane's formula to find the sample size at a 95% confidence level with a 5% margin of error, a sample size of 92 patients was calculated. Using an attrition rate of 10%, the estimated sample size was 102 patients.

Study tools

Pre-test questionnaire

The pre-test questionnaire used for assessing the dietary choices of the patients was adapted from the validated UK Diabetes and Diet Questionnaire (England *et al.,* 2017). Additional sections were included to assess patient's knowledge of T2DM, as well as factors affecting their food choices. The questionnaire was particularly tailored based on the Nigerian diet. The questionnaire included four sections (A-D): patients' demographics, patients' knowledge of T2DM, patients' typical dietary practices in

the past 1 month, and factors affecting patients' dietary choices, respectively, with approximately 10 questions in each section. Similar pre-test questionnaires were distributed to patients in the intervention and control groups.

Intervention leaflet

The educational intervention was a printed leaflet comprising two major sections – educational information on T2DM, including the foods encouraged and those to be taken in small quantities among patients with T2DM, as well as guidance for managing and monitoring T2DM, per the recommendations of the American Diabetes Association (ADA, 2023). The second section included a proposed weekly plan containing suggested meals and fruits for breakfast, lunch, and dinner, using readily and locally available foods recommended for patients with T2DM, and portion control. It was designed in an easy-to-read manner and was developed with a certified dietitian based on dietary guidelines found in the literature for patients with T2DM. Patients in the intervention group were given this brochure and educated on how to use it. Modifications/substitutions of the dietary timetable, if required by the patient based on availability and preferences, were made during interaction with the patient.

Post-test questionnaire

The post-test questionnaire included two of the four sections in the pre-test questionnaire: patients' demographics (in order to appropriately match the pre-and post-test questionnaires) and patients' knowledge of T2DM (sections A and B, respectively). The post-test questionnaire for the intervention group had two additional questions: 'Would you consider the dietary intervention leaflet feasible and practical for your use?' and 'How effective has the dietary leaflet been in controlling your diet?' Patients were re-evaluated after providing education and the intervention leaflet at their next clinic

appointment. Post-test questionnaires were distributed to patients in both groups.

Study procedure

The enrolled patients were divided into intervention and control groups. To ensure randomization and avoid bias in classifying patients, patients were enrolled into the groups on a weekly basis. Thus, all patients who came to the clinic during a particular week were enrolled in the same group. Since the same average number of patients came to the clinic each week, the number of patients in each group was similar. Pre-test questionnaires were given to patients in both groups to assess their knowledge and self-adherence to dietary guidelines for patients with T2DM. For the intervention group, filling out the pre-questionnaire included asking if the patient was willing to receive an intervention leaflet with a detailed explanation of the contents of the leaflet.

The intervention leaflet was provided to those in the intervention group, along with education on managing diabetes and an explanation of the dietary food table. Patient knowledge was then re-assessed using the post-test questionnaire.

Expected outcome

The primary outcome was the difference in patient knowledge of appropriate dietary choices in T2DM between the groups. The questionnaire responses were used to assess the differences between the intervention and control groups after the intervention leaflet had been provided to the intervention group. The feasibility and ease of use of the intervention guide were also assessed among patients in the intervention group.

Ethical approval

This study was conducted in accordance with ethical conventions, and ethical approval to conduct this study was obtained from the LUTH Ethical Committee, with an assigned number (ADM/DSCST/HREC/APP/6189). Informed consent was obtained from all

patients before their participation in this study.

Data analysis

The manual entries data collected were entered into Microsoft Excel spreadsheets to aid the collation and analysis of the data. The first section, including patient demographic data, such as age, body mass index (BMI), and fasting blood glucose values, are categorical variables and are reported as mean and standard deviations. The student's t-test was used to compare the means across the groups. Fisher's exact test was used to analyze mean differences in pre and post-responses to knowledge assessment in the control and intervention groups. The chi-square (X^2) test was used to analyze categorical variables between the intervention and control groups. Section D, including the factors influencing patient's dietary choices, was analyzed using principal component analysis (PCA). Components with eigenvalues ≥1.0 were considered significant in accordance with Kaiser's rule (Ringner, 2019). Data analysis was carried out using the Statistical Package for the Social Sciences (SPSS) software v.25 (IBM SPSS Statistics Inc, USA). P-values < 0.05 were considered statistically significant.

Results

Demographics of respondents

A total of 85 patients with T2DM participated in this study, giving a response rate of 83.3%. However, one patient was excluded due to pregnancy. A total of 84 patients were analyzed, with 42 patients each in the intervention and control groups. There were 59.5% (50) females and 40.5% (34) males, with most patients in the un-employed category. Most patients were >60 years old in both groups, and 73.8% of all respondents had secondary or tertiary education. There was no significant difference in the demographic characteristics between the intervention and control groups. Table 1

presents the sociodemographic characteristics of participants.

Table 1. Demographic data of participants stratified by treatment group

		TOTAL	Groups		χ^2	*p*
		N (%)	CG	IG		value
Sex	Female	50 (59.5)	28 (66.7)	22 (52.4)	1.779	0.182
	Male	34 (40.5)	14 (33.3)	20 (47.6)		
Age	Mean ± SD	61 ± 9	62 ± 8	60 ± 9		
Age group	21 − 40	2 (2.4)	0 (0.0)	2 (4.8)	2.789	0.248
	41 − 60	35 (41.7)	16 (38.1)	19 (45.2)		
	> 61	47 (56.0)	26 (61.9)	21 (50.0)		
Religion	Christianity	57 (67.9)	29 (69.0)	28 (66.7)	0.055	0.815
	Islam	27 (32.1)	13 (31.0)	14 (33.3)		
Marital Status	Single	5 (6.0)	3 (7.1)	2 (4.8)	2.622	0.454
	Married	72 (85.7)	34 (81.0)	38 (90.5)		
	Divorced	2 (2.4)	2 (4.8)	0 (0.0)		
	Widowed	5 (6.0)	3 (7.1)	2 (4.8)		
Education	Primary	15 (17.9)	5 (11.9)	10 (23.8)	6.929	0.074
	Secondary	33 (39.3)	22 (52.4)	11 (26.2)		

	Tertiary	29 (34.5)	13 (31.0)	16 (38.1)		
	Post-Graduate	7 (8.3)	2 (4.8)	5 (11.9)		
	Trader	8 (9.5)	4 (9.5)	4 (9.5)		
	Civil Servant	7 (8.3)	3 (7.1)	4 (9.5)		
Occupation	Self-Employed	28 (33.3)	11 (26.2)	17 (40.5)	2.624	0.453
	Unemployed	41 (48.8)	24 (57.1)	17 (40.5)		
	0−2 years	9 (10.7)	4 (9.5)	5 (11.9)		
	2−5 years	27 (32.1)	12 (28.6)	15 (35.7)		
Duration of DM					1.672	0.643
	5−10 years	27 (32.1)	13 (31.0)	14 (33.3)		
	> 10 years	21 (25.0)	13 (31.0)	8 (19.0)		
Last Fasting Blood Glucose (mg/dL)	Normal	58 (69.0)	30 (71.4)	28 (66.7)	0.223	0.637
	Elevated	26 (31.0)	12 (28.6)	14 (33.3)		
	Yes	47 (56.0)	24 (57.10)	23 (54.8)		
Family History	No	25 (29.8)	12 (28.6)	13 (31.0)	0.061	0.97
	Not Sure	12 (14.3)	6 (14.3)	6 (14.3)		

CG, control group; IG, intervention group

Comparison of knowledge assessment between the two groups

Responses of the patients to the knowledge assessment are shown in Table 2. Responses to questions on the duration of diabetes, the effect of weight loss, the diabetic plate method, and

knowledge of whole grains were significant. Comparison of the mean difference in pre- and post-test scores between the intervention and control groups revealed a statistically significant difference (8.74±0.49 vs 6.02±1.55, respectively; $p < 0.001$). (Table 3; Figure 1).

Table 2. Responses on knowledge of diabetes mellitus among the treatment groups (Pre and Post-intervention)

	CONTROL (n=42)				INTERVENTION (n = 42)				χ^2	*p*-value
	Pre-Test		Post-Test		Pre-Test		Post-Test			
	Correct n (%)	Incorrect n (%)	Correct n (%)	Incorrect n (%)	Correct n (%)	Incorrect n (%)	Correct n (%)	Incorrect n (%)		
Q1 (Diabetes is a chronic/lifelong disease)	28 (66.7)	14 (33.3)	28 (66.7)	14 (33.3)	28 (66.7)	14 (33.3)	42 (100.0)	0 (0.0)	16.8	<.001*
Q2 (Weight loss can positively affect diabetes**)**	21 (50.0)	21 (50.0)	20 (47.6)	22 (52.4)	28 (66.7)	14 (33.3)	42 (100.0)	0 (0.0)	29.81	<.001*
Q3 (Physical activity is important for controlling type 2 diabetes)	35 (83.3)	7 (16.7)	34 (81.0)	8 (19.0)	34 (81.0)	8 (19.0)	42 (100.0)	0 (0.0)	8.84	0.003
Q4 (Increased consumption of fruits and vegetables plays a role in controlling diabetes)	41 (97.6)	1 (2.4)	41 (97.6)	1 (2.4)	42 (100.0)	0 (0.0)	42 (100.0)	0 (0.0)	1.01	0.314
Q5 (I know the diabetic plate method)	4 (9.5)	38 (90.5)	4 (9.5)	38 (90.5)	5 (11.9)	37 (88.1)	41 (97.6)	1 (2.4)	65.52	<.001*
Q6 (Whole grains like oats, millet, brown rice, and wheat bread are	21 (50.0)	21 (50.0)	22 (52.4)	20 (47.6)	25 (59.5)	17 (40.5)	39 (92.9)	3 (7.1)	17.3	<.001*

better than white rice and white bread)										
Q7 (Fruits are generally not advised in patients with type 2 diabetes)	8 (19.0)	34 (81.0)	33 (78.6)	9 (21.4)	35 (83.3)	7 (16.7)	41 (97.6)	1 (2.4)	7.27	0.007
Q8 (Consuming carbonated drinks, energy drinks, and fruit juices are not advised for people with type 2 diabetes mellitus)	38 (90.5)	4 (9.5)	37 (88.1)	5 (11.9)	39 (92.9)	3 (7.1)	42 (100.0)	0 (0.0)	5.31	0.021
Q9 (Consuming large amounts of carbohydrates (rice, bread, spaghetti, noodles) is considered healthy in type 2 diabetes)	5 (11.9)	37 (88.1)	34 (81.0)	8 (19.0)	34 (81.0)	8 (19.0)	36 (85.7)	6 (14.3)	0.34	0.558

* statistically significant

Table 3. Comparison of mean differences in response to knowledge assessment in the control and intervention groups (Pre-test and Post-test)

	Control Group (n =42)	Intervention Group (n = 42)	Mean Difference	F	*p*-value
Pre-Test	6.17 ±1.56	6.43 ± 1.53	-0.262	0.285	0.595
Post- Test	6.02 ± 1.55	8.74 ± 0.49	-2.714	28.92	<0.001*

* significant difference

F – Fisher's Exact Test

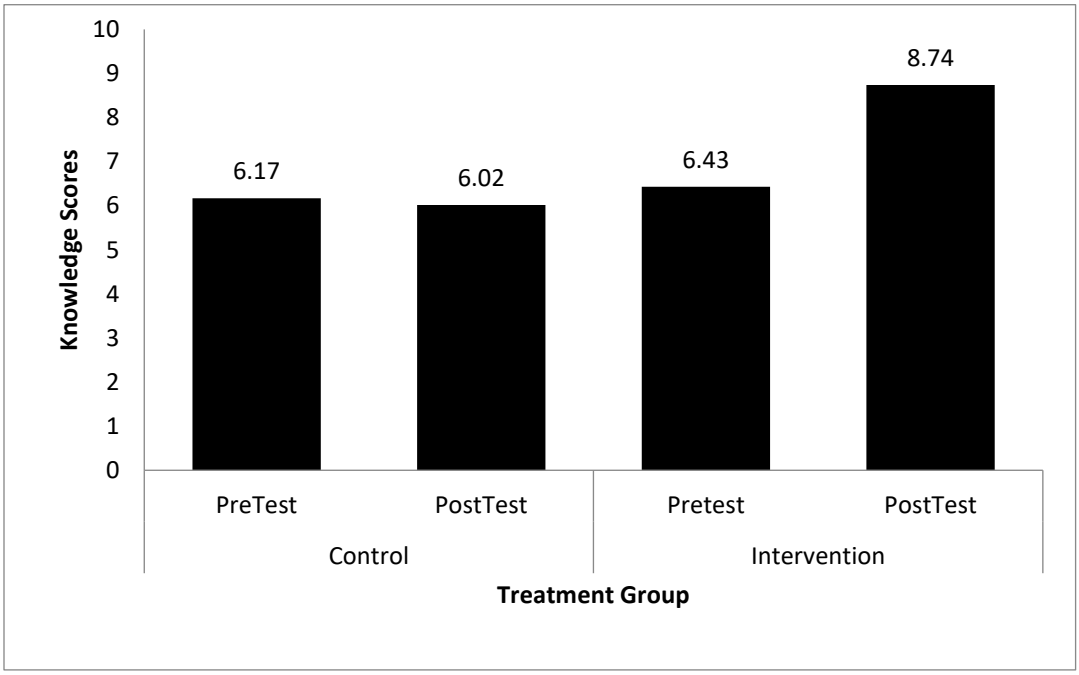

Figure 1. Comparison of mean differences in response between the control and intervention groups

Comparison of levels of knowledge between the groups

After ranking patient scores as 1−4 (poor), 5−7 (moderate), and 8−10 (good) at baseline, most patients were in the moderate category in both the intervention and control groups. However, after the intervention, significantly more patients in the intervention group moved to the 'good' category, indicating improved knowledge of dietary modification required in T2DM ($p< 0.001$) (Table 4).

Assessment of patients' dietary choices

The recent dietary choices of patients with T2DM within the past 1 month were assessed. No statistically significant difference in patients' dietary choices was observed. As shown in Table 5, most patients in both groups consumed vegetables, fruits, beans and legumes, and white rice and bread more than thrice weekly.

Table 4. Comparison of levels of knowledge within the treatment groups

		Treatment Group			
		Control Group N = 42	**Intervention Group** N = 42	**$\chi 2$**	***p* value**
Pre-Test Knowledge	POOR	7 (16.7)	5 (11.9)	0.407	0.816
	MODERATE	26 (61.9)	28 (66.7)		
	GOOD	9 (21.4)	9 (21.4)		
Post-Test Knowledge	POOR	7 (16.7)	0 (0.0)	56.22	<0.001*
	MODERATE	28 (66.7)	1 (2.4)		
	GOOD	7 (16.7)	41 (97.6)		

*significant at $p <0.05$

Table 5. Recent dietary choices made by patients

			Treatment Group		χ^2	*p* value
			Control n (%)	**Intervention** n (%)		
1	How often do you eat a portion of vegetables? This includes cabbage, spinach, *efo*, *ugwu*, saint leaf, Edikaikong, Afang, etc	Never	0 (0.0)	0 (0.0)	1.167	0.761
		Occasionally	4 (9.5)	2 (4.8)		
		Once weekly	3 (7.1)	5 (11.9)		
		> Thrice weekly	18 (42.9)	18 (42.9)		
		Daily	17 (40.5)	17 (40.5)		
2	How often do you eat fruits? This includes all kinds of fruits, excluding fruit juices and smoothies	Never	0 (0.0)	0 (0.0)	2.622	0.425
		Occasionally	9 (21.4)	4 (9.5)		
		Once weekly	5 (11.9)	4 (9.5)		
		> Thrice weekly	17 (40.5)	21 (50.0)		
		Daily	11 (26.2)	13 (31.0)		
3	How often do you eat fried and baked foods like meatpies, fishpies, cakes, etc.?	Never	24 (57.1)	22 (52.4)	2.531	0.470
		Occasionally	16 (38.1)	20 (47.6)		
		Once weekly	1 (2.4)	0 (0.0)		
		> Thrice weekly	1 (2.4)	0 (0.0)		
		Daily	0 (0.0)	0 (0.0)		
4	How often do you take sugary drinks, including carbonated drinks (Coke, Fanta), fruit juices, and energy drinks?	Never	27 (64.3)	27 (64.3)	2.143	0.543
		Occasionally	15 (35.7)	13 (31.0)		
		Once weekly	0 (0.0)	0 (0.0)		
		> Thrice weekly	0 (0.0)	1 (2.4)		
		Daily	0 (0.0)	1 (2.4)		
5	How often do you eat red meat (beef)?	Never	11 (26.2)	12 (28.6)	2.062	0.724
		Occasionally	27 (64.3)	26 (61.9)		
		Once weekly	1 (2.4)	0 (0.0)		
		> Thrice weekly	3 (7.1)	3 (7.1)		
		Daily	0 (0.0)	1 (2.4)		
6	How often do you eat fast food? (foods not prepared at home – including *buka*, restaurants, foods eaten at parties, etc.)	Never	16 (38.1)	18 (42.9)	5.318	0.256
		Occasionally	24 (57.1)	21 (50.0)		
		Once weekly	0 (0.0)	2 (4.8)		
		> Thrice weekly	2 (4.8)	0 (0.0)		
		Daily	0 (-0.0)	1 (2.4)		
7	How often do you drink alcohol?	Never	33 (78.6)	31 (73.8)	1.536	0.464
		Occasionally	8 (19.0)	11 (26.2)		

		Once weekly	0 (0.0)	0 (0.0)		
		> Thrice weekly	1 (2.4)	0 (0.0)		
		Daily	0 (0.0)	0 (0.0)		
		Never	1 (2.4)	0 (0.0)		
8	How often do you eat plant proteins (beans, groundnuts, cashew nuts, chia seeds)?	Occasionally	8 (19.0)	5 (11.9)	2.607	0.626
		Once weekly	3 (7.1)	2 (4.8)		
		> Thrice weekly	15 (35.7)	20 (47.6)		
		Daily	15 (35.7)	15 (35.7)		
		Never	17 (40.5)	16 (38.1)		
		Occasionally	20 (47.6)	21 (50.0)		
9	How often do you use canned foods?	Once weekly	3 (7.1)	4 (9.5)	0.531	0.912
		> Thrice weekly	2 (4.8)	1 (2.4)		
		Daily	0 (0.0)	0 (0.0)		
		Never	1 (2.4)	1 (2.4)		
		Occasionally	6 (14.3)	8 (19.0)		
10	How often do you eat foods like white rice and bread?	Once weekly	6 (14.3)	6 (14.3)	1.429	0.839
		> Thrice weekly	20 (47.6)	15 (35.7)		
		Daily	9 (21.4)	12 (28.6)		

Factors affecting dietary choices of patients with T2DM

The factors affecting patients' dietary choices are shown in Table 6.

Principal component analysis (PCA) was used to extract the most significant factors influencing dietary choices among patients with T2DM. The PCA with the varimax rotation method identified three components with eigenvalue exceeding 1. The eigenvalues for the three components were 2.323, 1.446, and 1.210. Eigenvalues are scalar values obtained during PCA that indicate the principal components of the data. By ranking the factors in order of their eigenvalues (highest to lowest), the principal components can be identified in order of significance. Hence, the items in the first component were the factors with the highest influence on the dietary choices among diabetic patients. These items were "My monthly income affects my dietary choices,"

"I am unable to afford the foods I should be eating," "I regularly eat what is available," and "The taste of the food affects or determines whether I eat it or not" The results of the PCA are shown in Table 7.

Effects of demographic factors on patients' dietary choices

The association between patients' demographic characteristics and their dietary choices was assessed. No statistically significant difference was observed, suggesting that the dietary choices made by patients were independent of their demographic characteristics (Table 8).

Table 6. Responses to diabetic patients' dietary choices (N = 84)

	SA	A	N	DA	SDA	Mean Response
I regularly eat what is available	16 (19.0)	37 (44.0)	8 (9.5)	16 (19.0)	7 (8.3)	2.54
I do not need to change my diet because I have diabetes	11 (13.1)	21 (25.0)	10 (11.9)	34 (40.5)	8 (9.5)	3.08
I know the right things to eat (based on self-education or consultation with a health professional)	16 (19.0)	40 (47.6)	21 (25.0)	6 (7.1)	1 (1.2)	2.24
I am confused about what I should be eating	3 (3.6)	18 (21.4)	19 (22.6)	37 (44.0)	7 (8.3)	3.32
I am unable to make choices about what I eat (for example, my wife prepares what she feels works best for the whole family)	5 (6.0)	11 (13.1)	12 (14.3)	49 (58.3)	7 (9.3)	3.5
I am unable to afford the foods I should be eating	6 (7.1)	23 (27.4)	24 (28.6)	26 (31.0)	5 (6.0)	3.01
The taste of the food affects or determines whether I eat it or not	16 (19.0)	23 (27.4)	2 (2.4)	29 (34.5)	14 (16.7)	3.02
My monthly income affects my dietary choices	19 (22.6)	32 (38.1)	17 (20.2)	10 (11.9)	6 (7.1)	2.43

SA, strongly agree; A, agree; N, neutral; DA, disagree; SDA, strongly disagree. The mean response was obtained as follows:

Each response was assigned 1−5 from SA to SDA. Mean Response = (Likert score x Number of participants per response)/ Total Number of Participants

Table 7. Factors influencing dietary choices among patients with T2DM

Variables /Factors	Component (n = 84) 1	2	3
My monthly income affects my dietary choices	0.768*		
I am unable to afford the foods I should be eating	0.742*		
I regularly eat what is available	0.649*		
The taste of the food affects or determines whether I eat it or not	0.587*		
I am confused about what I should be eating		0.904	
I know the right things to eat (based on self-education or consultation with a health professional)		-0.747	
I am unable to make choices about what I eat (for example, my wife prepares what she feels works best for the whole family)			0.761
I do not need to change my diet because I have diabetes			0.739
Eigen Values (>1.00)	2.323	1.446	1.210

* factors within the principal or first component

Table 8. Relationship between patient demographics (variables) and dietary choices by patients with T2DM

Dietary Choices		GOOD		BAD	
		Odds ratio (95%CI)	p value	Odds ratio (95%CI)	p value
Sex	Male	0.927	1	1.079	1
	Female[R]				
Age Group	20 − 40 years	3.587E+14 (H)	0.998	2.79E-15 (L)	0.998

	41 − 60 years	1.988	1	0.503	1
	> 61 years[R]	.	.	.	.
Religion	Christianity	5.61E-07 (L)	0.999	1781202.912 (H)	0.999
	Islam[R]	.	.	.	.
Education	Primary	5.90E-05 (L)	1	16942.443(H)	1
	Secondary	11.011	1	0.091	1
	Tertiary	1.059	1	0.944	1
	Post-Graduate[R]	.	.	.	.
Occupation	Trader	1.75261E+14 (H)	0.997	5.71E-15 (L)	0.997
	Civil Servant	2.249	1	0.445	1
	Self-Employed	5.7	1	0.175	1
	Unemployed[R]	.	.	.	.
Duration of DM	0−2 years	12302.926 (H)	1	8.13E-05 (L)	1
	2−5 years	0.126	1	7.942	1
	5−10 years	132524.628 (H)	0.999	7.55E-06 (L)	0.999
	> 10 years[R]	.	.	.	.
Marital Status	Single	5.88E-15 (L)	0.997	1.69996E+14 (H)	0.997
	Married	1.407	1	0.711	1
	Divorced	0.627 (0.627 − 0.627)	.	1.595 (1.595 − 1.595)	.
	Widowed[R]	.	.	.	.
Family History	Yes	3.90E-14 (L)	0.992	2.56398E+13 (H)	0.992
	No	5.26E-14 (L)	0.997	1.89959E+13 (H)	0.997
	Not Sure[R]	.	.	.	.

R -reference category

Feasibility of use of the intervention leaflet

After the intervention, patients in the intervention group (n=42) were asked about the suitability and feasibility of the use of the proposed dietary timetable. As shown in Figure 2 below, most patients believed the leaflet was practical, feasible, and worth exploring.

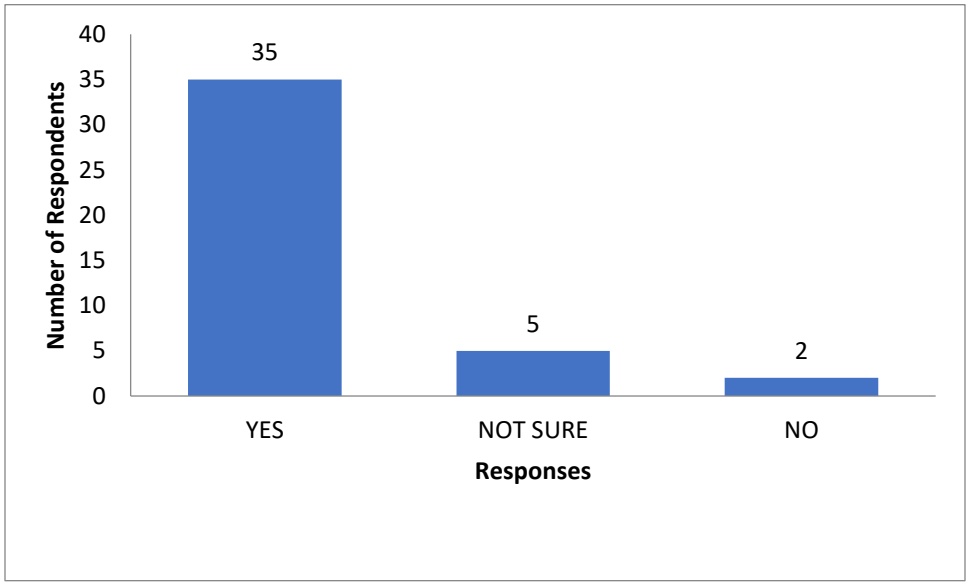

Figure 2. Post-intervention response by participants in the intervention group on the feasibility of use of the educational leaflet (n=42)

Discussion

This study assessed patients' baseline knowledge of healthy eating habits among patients with T2DM. Before the intervention, most participants showed a moderate level of comprehension regarding the dietary adjustments required to manage their illness. The knowledge scores of the intervention group significantly improved after the intervention when compared to the control group ($p<0.001$). This improvement was significant in a number of knowledge categories, including the chronic long-term nature of T2DM, the diabetic plate method,

and the comparable improved benefits of whole grains compared to their more starchy alternatives. These categories emphasize the need for educational initiatives to close currently existing knowledge gaps in patients with T2DM. These findings are consistent with previous research (Ipingbemi, Erhun & Adisa, 2021; Gehlawat, Lakshminarayanan & Kar, 2019; Abiodun, Olaogun & Akinpelu, 2020), showing the beneficial effects of educational interventions on patient knowledge and self-management practices.

Patient knowledge and choices regarding nutrition were compared between the intervention and control groups in order to evaluate the efficacy of the dietary intervention leaflet. The brochure offered easy-to-read information on meal planning, suggested composition, and foods that are readily available in Nigeria. The results of the post-intervention analysis showed that patients' understanding of diet significantly improved in the intervention group, indicating that the leaflet had been successful in educating them. In addition to the significant improvement in patient knowledge, most patients considered the modifiable timetable feasible and practical for use. This result is in line with other studies that show that patients' knowledge and self-management abilities can be greatly improved by providing training materials that are simple to understand and culturally appropriate (Peek *et al.*, 2012).

Several factors were found to impact the dietary preferences of patients with T2DM, with financial restrictions standing out as a key component. Additionally, numerous patients stated that they would eat whatever was available and would let their culinary preferences guide their dietary decisions (Forde & de Graaf, 2023). Furthermore, a significant proportion of the participants conveyed uncertainty about suitable food habits and depended on family members to assist them in making dietary choices. These

findings highlight the difficulties with actual modification of eating habits and imply that information is not enough to manage diets effectively.

Although a large number of patients reported being knowledgeable about what foods to consume based on their research or discussions with medical professionals, this knowledge did not necessarily translate into consistently making good food choices. This disparity highlights the need for behavioral therapies that target the social and psychological elements impacting eating patterns (Timlin *et al.*, 2020).

No statistically significant associations were discovered between dietary choices and demographic variables (such as sex, age, religion, education, occupation, duration of diabetes, marital status, and family history). The sex distribution revealed a higher percentage of females than males, which is consistent with earlier studies from comparable areas that also found that women were more likely than men to have diabetes. Biological causes and variations in health-seeking habits may explain this (Chineye *et al*., 2012; Enikuomehin *et al.*, 2021). The bulk of participants were older adults, as seen by the average age of 61 years. This research emphasizes T2DM as a chronic, progressive illness that typically affects middle-aged and older people. Other studies that similarly found a higher prevalence of T2DM among older adults as a result of increasing insulin resistance also showed similar age distributions (Chentli, Azzoug & Mahgoun, 2015). Participants' religious distribution reflected the demography of the area, with Muslims constituting the minority and Christians the majority. However, religious considerations had no bearing on the study's conclusions because there were no appreciable changes in the distribution of religions between the control and intervention groups. The majority of

individuals were married, which is in line with research showing that marital status affects how well people manage their illnesses and their health. According to de Oliveira et al., married individuals frequently have greater social support networks, which can have a good impact on their adherence to medical advice and health-related behaviors (de Oliveira *et al*., 2020). Participants tended to be highly educated, suggesting that reading comprehension may have an impact on their desire to participate in healthcare interventions. In order to effectively manage chronic illnesses such as T2DM, patients must be better educated in order to improve their comprehension and capacity to apply dietary and lifestyle alterations (ALSharit & Alhalal, 2022).

This study had several limitations. First, this was a single-center quasi-experimental study conducted at a tertiary hospital. The disease stage and duration of diabetes may have affected the baseline knowledge and responses of the participants. Further multicenter randomized controlled trials are required to assess patients' dietary habits as well as evaluate the feasibility and ease of use of the proposed intervention leaflet. Second, due to time and financial constraints, full assessments of clinical parameters, including HbA1c and FBS levels, could not be conducted over time to assess the clinical effectiveness of the dietary leaflet. Finally, the short time between the pre- and post-survey may have affected the post-test scores. Further studies with longer time frames may be required to guarantee patient retention.

Overall, the patient education leaflet was successful in increasing patients' understanding of dietary modifications in T2DM; however, further measures are needed to convert this information into long-term dietary modifications. Improving dietary practices and long-term health outcomes for patients with T2DM requires addressing financial obstacles, such as

through comprehensive insurance packages, as well as providing continuous education as healthcare professionals.

Conclusion

Patient knowledge of dietary modification in T2DM significantly improved after the intervention, and most patients found the modifiable dietary timetable feasible and practical for use. The study findings demonstrate the usefulness of educational resources in improving understanding of T2DM management. In handy, printable formats, modifiable dietary timetables can aid pharmacists in providing holistic care to patients, particularly community pharmacists.

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Conflict of interest

The Authors report no conflict of interest.

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