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Original Article

Effectiveness of Nutritional Education Interventions on Glycemic Outcomes Among Low-Income Patients With Type 2 Diabetes in Lodhran

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ABSTRACT

Background: Type 2 diabetes mellitus is a major public health concern in low-resource settings, where limited dietary awareness, low health literacy, and restricted access to structured nutrition counseling contribute to poor glycemic control. Structured nutrition education may provide a feasible strategy for improving diabetes self-management among low-income patients. Objective: To evaluate the effect of a structured nutrition education intervention on HbA1c levels among low-income adults with type 2 diabetes mellitus in Lodhran, Pakistan. Methods: A single-group quasi-experimental pre-test/post-test study was conducted at Shahida Islam Teaching Hospital, Lodhran. Twenty-nine adult patients with type 2 diabetes mellitus were selected through convenience sampling. Baseline demographic characteristics and pre-intervention HbA1c were recorded, followed by a structured nutrition education intervention. Post-intervention HbA1c was measured and compared with baseline values. Data were analyzed using SPSS version 27. Descriptive statistics and paired-sample t-test were applied, with $p < 0.05$ considered statistically significant. Results: Most participants were aged 46–55 years, 55.2% were female, 51.7% had no formal education, and all had no previous nutrition counseling. Mean HbA1c decreased from 8.15 ± 1.41% before the intervention to 6.80 ± 1.10% after the intervention, with a mean reduction of 1.36 percentage points, 95% CI 1.03–1.69, $t(28) = 8.497$, and $p < 0.001$. Conclusion: Structured nutrition education was associated with a significant within-participant reduction in HbA1c among low-income adults with type 2 diabetes mellitus. Larger controlled studies with longer follow-up are recommended to confirm effectiveness and sustainability. Keywords: Type 2 diabetes mellitus; HbA1c; nutrition education; glycemic control; low-income population; quasi-experimental study; Pakistan.

INTRODUCTION

Type 2 diabetes mellitus is a major and growing public health concern worldwide, with increasing prevalence in low- and middle-income countries where rapid urbanization, sedentary lifestyles, unhealthy dietary practices, and limited access to structured diabetes care contribute to poor glycemic control (1). Effective management of type 2 diabetes requires sustained lifestyle modification alongside pharmacological treatment, and dietary behavior remains one of the most important modifiable determinants of long-term glycemic status. Glycated hemoglobin is widely used as a clinical indicator of average blood glucose control over the preceding months, and persistently elevated HbA1c is associated with increased risk of microvascular and macrovascular complications.

In Pakistan, diabetes management is complicated by low health literacy, financial constraints, cultural food practices, limited access to dietetic services, and inconsistent follow-up care. These barriers are

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particularly important among low-income patients, who may have difficulty adopting standard dietary recommendations because many plans are not adapted to their educational level, food availability, affordability, or household eating patterns (2,3). In such settings, generalized advice alone may be insufficient, while structured nutrition education delivered in simple, culturally appropriate, and practical terms may improve understanding, dietary adherence, and self-management behaviors.

Previous evidence supports the role of nutrition education in improving diabetes-related outcomes. Patient-centered nutrition education has been associated with improved eating behavior and better glycemic control among individuals with uncontrolled type 2 diabetes (1). Similarly, structured health education interventions have been reported to improve diabetes knowledge, treatment adherence, and self-care practices in different clinical and community settings (4,5). However, much of the existing evidence has been generated in settings with greater healthcare access or has focused on broad diabetes education rather than nutrition-focused intervention among low-income populations. Evidence from Pakistan remains limited, especially regarding structured nutrition education among patients who have not previously received formal nutrition counseling.

Low-income populations in South Punjab face additional challenges because dietary decisions are shaped not only by knowledge but also by affordability, food availability, family practices, and cultural acceptability. Studies from Pakistan have identified dietary adherence barriers among patients with type 2 diabetes, including economic limitations, low awareness, and difficulty modifying traditional carbohydrate-rich diets (2,3). These factors indicate the need for locally relevant, feasible, and low-cost educational strategies that can be integrated into routine outpatient diabetes care. Generating local evidence from Lodhran is therefore important for understanding whether structured nutrition education can improve glycemic outcomes in a population with limited previous exposure to nutrition counseling.

The present study was conducted to evaluate the effect of a structured nutrition education intervention on HbA1c levels among low-income adult patients with type 2 diabetes mellitus attending Shahida Islam Teaching Hospital, Lodhran, Pakistan. The study specifically aimed to compare pre-intervention and post-intervention HbA1c values to determine whether structured nutrition education was associated with improvement in glycemic control in this low-resource clinical setting.

MATERIALS AND METHODS

This single-group quasi-experimental pre-test/post-test study was conducted at Shahida Islam Teaching Hospital, Lodhran, Punjab, Pakistan, to assess changes in HbA1c levels following a structured nutrition education intervention among adult patients with type 2 diabetes mellitus. The design was selected to compare glycemic status before and after the educational intervention within the same participants, allowing each participant to serve as his or her own baseline comparator.

The study population consisted of adult patients diagnosed with type 2 diabetes mellitus who were attending Shahida Islam Teaching Hospital. Participants aged 18 years or above with a diagnosis of type 2 diabetes mellitus for at least six months were eligible for inclusion. Pregnant and lactating women and patients already enrolled in another nutrition program were excluded. A total of 29 participants were selected through convenience sampling after assessment of eligibility. Participation was voluntary, and informed consent was obtained before data collection.

Data were collected in two phases. In the pre-test phase, baseline demographic and clinical information was obtained, including age group, gender, educational level, duration of diabetes, marital status, occupation, and history of previous nutrition counseling. Baseline HbA1c was measured before the intervention to determine pre-intervention glycemic control. After baseline assessment, participants received a structured nutrition education intervention focused on diabetes-related dietary awareness and practical nutrition guidance suitable for a low-resource setting. Post-intervention HbA1c was then measured and compared with the baseline value to assess change in glycemic control.

The primary outcome variable was HbA1c level, measured before and after the structured nutrition education intervention. Demographic variables included age, gender, educational level, duration of diabetes, marital status, occupation, and previous nutrition counseling status. The main analysis compared within-participant change in HbA1c from pre-intervention to post-intervention assessment. Because the study used a single-group pre-test/post-test design, interpretation of improvement was limited to within-group change over time rather than comparison with an untreated control group.

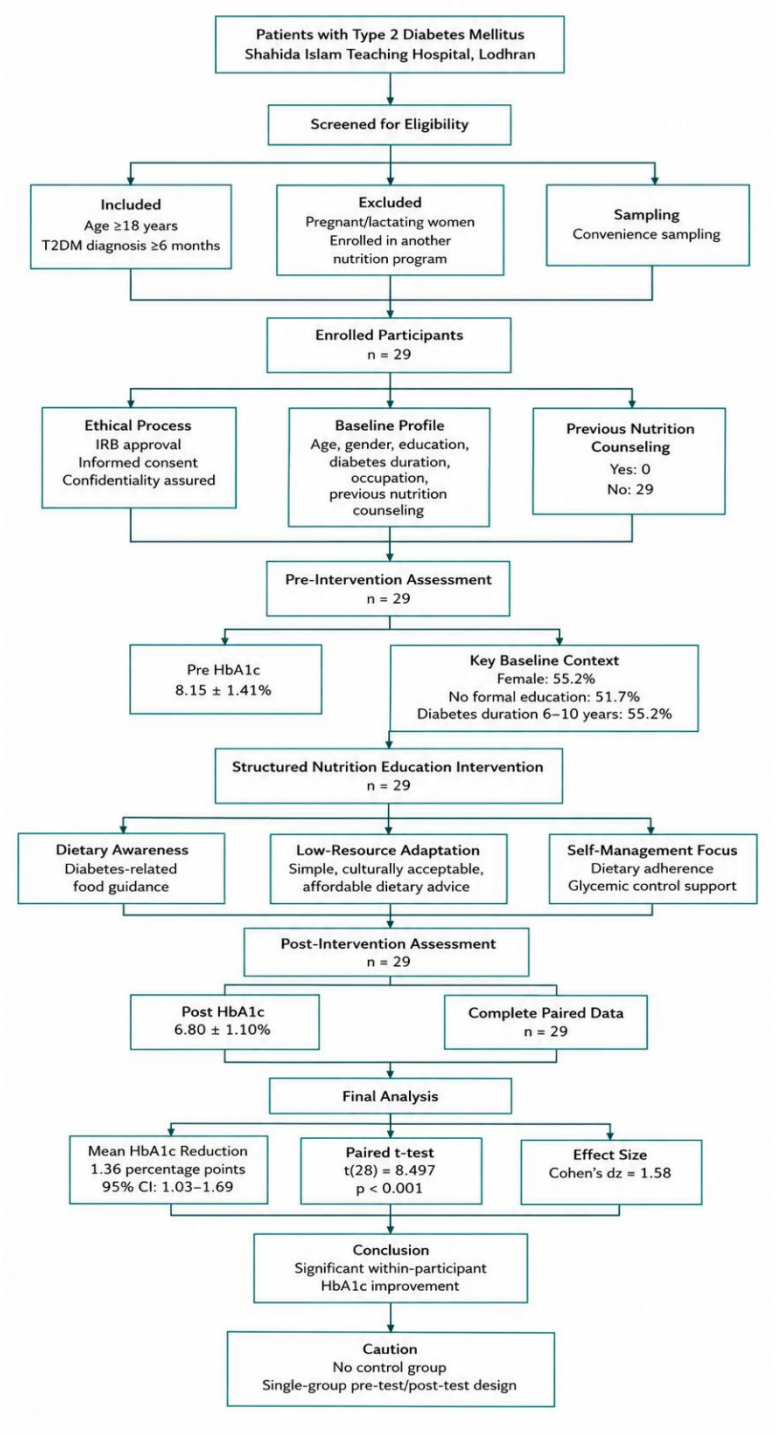


Figure 1 CONSORT Flowchart

Data were analyzed using SPSS version 27. Descriptive statistics were used to summarize participant characteristics. Categorical variables were reported as frequencies and percentages, while HbA1c values were summarized as mean and standard deviation. A paired-sample t-test was applied to compare mean pre-intervention and post-intervention HbA1c values among the same participants. Statistical

significance was set at $p < 0.05$. The analysis was conducted using complete paired HbA1c observations for the included participants.

Ethical approval was obtained from the relevant Institutional Review Board before commencement of the study. All participants were informed about the purpose of the study, voluntary participation, confidentiality of their information, and their right to withdraw from participation. Informed consent was obtained from all participants before enrollment, and data were handled confidentially for research purposes only.

RESULTS

A total of 29 patients with type 2 diabetes mellitus were included in the study. The demographic profile of participants is presented in Table 1.

Table 1. Demographic Characteristics of Participants With Type 2 Diabetes Mellitus (n = 29)

Variable	Category	n	%
Age, years	18–25	2	6.9
	26–35	2	6.9
	36–45	9	31.0
	46–55	12	41.4
	≥56	4	13.8
Gender	Male	13	44.8
	Female	16	55.2
Educational level	No formal education	15	51.7
	Primary	7	24.1
	Secondary	1	3.4
	Higher	3	10.3
	Graduation or above	3	10.3
Duration of diabetes	<1 year	1	3.4
	1–5 years	10	34.5
	6–10 years	16	55.2
	>10 years	2	6.9
Marital status	Single	3	10.3
	Married	25	86.2
	Other	1	3.4
Occupation	Unemployed	16	55.2
	Employed	4	13.8
	Self-employed	9	31.0
Previous nutrition counseling	Yes	0	0.0
	No	29	100.0

The largest proportion of participants was aged 46–55 years, followed by those aged 36–45 years. Females represented 55.2% of the sample, and more than half of the participants had no formal education. Most participants had been diagnosed with diabetes for 6–10 years, and none had previously received nutrition counseling, indicating limited prior exposure to formal dietary guidance before the intervention.

Table 2. Pre-Intervention and Post-Intervention HbA1c Levels Among Participants (n = 29)

Outcome	Assessment	n	Mean ± SD
HbA1c, %	Pre-intervention	29	8.15 ± 1.41
HbA1c, %	Post-intervention	29	6.80 ± 1.10

Mean HbA1c decreased from 8.15 ± 1.41% before the structured nutrition education intervention to 6.80 ± 1.10% after the intervention. This reduction indicates improvement in glycemic control following the intervention period, although interpretation should remain within the limitations of a single-group pre-test/post-test design.

Table 3. Paired-Sample Comparison of HbA1c Before and After the Intervention (n = 29)

Outcome	Mean Difference	95% CI	t	df	p-value	Cohen's dz
HbA1c, %	1.36	1.03 to 1.69	8.497	28	<0.001	1.58

Mean difference was calculated as pre-intervention HbA1c minus post-intervention HbA1c. CI, confidence interval; df, degrees of freedom.

The paired-sample analysis showed a statistically significant reduction in HbA1c after the structured nutrition education intervention. The mean reduction was 1.36 percentage points, with a 95% confidence interval from 1.03 to 1.69 percentage points. The effect size was large based on Cohen's dz = 1.58, supporting a substantial within-participant reduction in HbA1c after the intervention. Because the study did not include a control group, the result should be interpreted as a significant within-group improvement rather than definitive evidence of superiority over usual care.

Reviewer-style note: The available aggregate data allowed calculation of mean difference, 95% confidence interval, degrees of freedom, and paired-effect size from the reported sample size, means, and t-value. However, participant-level data were not available; therefore, subgroup analyses by age, gender, education, diabetes duration, or occupation could not be validly performed. The Results section would be strengthened further by reporting the timing of post-intervention HbA1c measurement, intervention adherence, missing data status, and whether diabetes medication changes occurred during the study period.

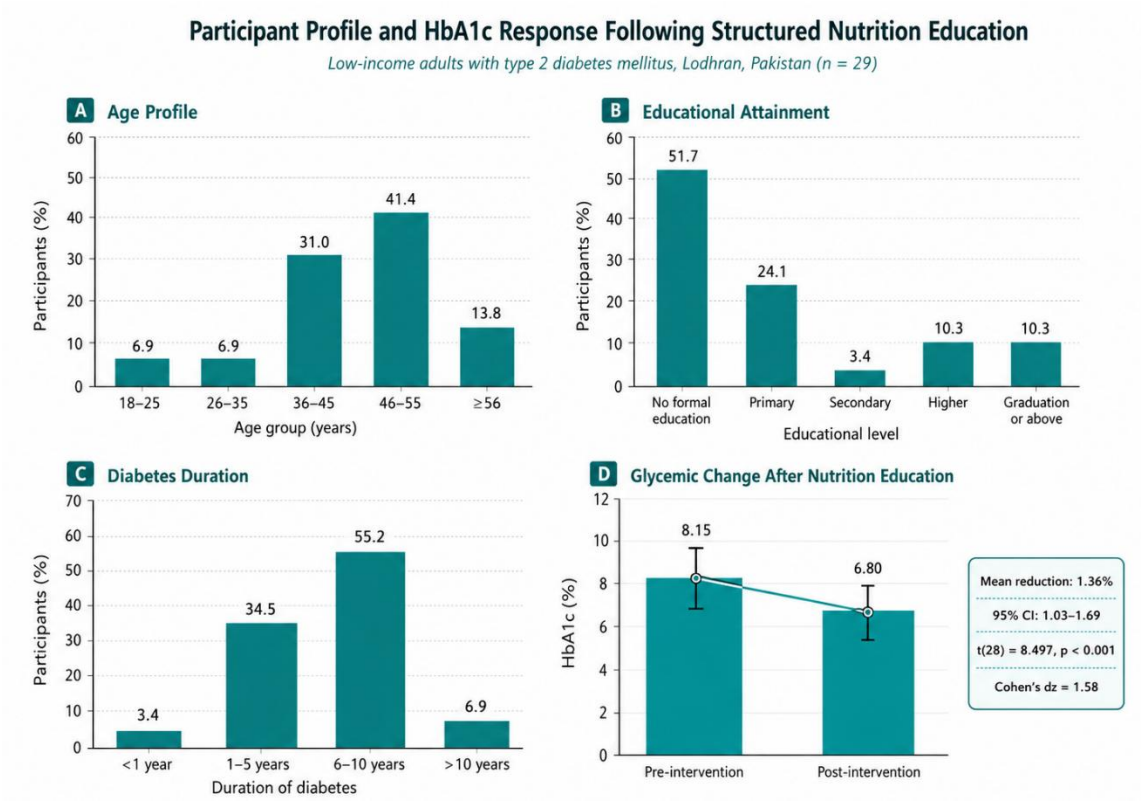


Figure 2 Participant Profile and HbA1c Response Following Structured Nutrition Education Among Low-Income Adults With Type 2 Diabetes Mellitus. The figure summarizes the age profile, educational attainment, diabetes duration, and pre–post HbA1c response among 29 participants. The largest participant group was aged 46–55 years, 51.7% had no formal education, and 55.2% had diabetes for 6–10 years. Mean HbA1c decreased from 8.15 ± 1.41% before the intervention to 6.80 ± 1.10% after the intervention, with a mean reduction of 1.36 percentage points, 95% CI 1.03–1.69, t(28) = 8.497, p < 0.001, and Cohen's dz = 1.58. Because the study used a single-group pre-test/post-test design, the figure supports a substantial within-participant improvement in glycemic control following structured nutrition education, while causal interpretation should remain cautious.

DISCUSSION

This single-group quasi-experimental study evaluated changes in HbA1c following a structured nutrition education intervention among low-income adults with type 2 diabetes mellitus attending Shahida Islam Teaching Hospital, Lodhran. The participants represented a clinically important population because most were middle-aged, more than half had no formal education, the majority had

lived with diabetes for several years, and none had previously received formal nutrition counseling. These characteristics highlight a major gap in diabetes education access in this low-resource setting and support the relevance of structured, practical, and culturally appropriate nutrition education for patients with limited prior exposure to dietary counseling.

The main finding was a statistically significant reduction in HbA1c after the intervention, with mean HbA1c decreasing from 8.15 ± 1.41% before the intervention to 6.80 ± 1.10% after the intervention. The mean reduction was 1.36 percentage points, with a 95% confidence interval of 1.03 to 1.69, indicating a substantial within-participant improvement in glycemic control. The large paired effect size further suggests that the observed reduction was not only statistically significant but also clinically relevant. However, because the study did not include a control group, the findings should be interpreted as an improvement associated with the intervention rather than definitive proof of an independent intervention effect.

The observed improvement is consistent with previous evidence showing that structured and patient-centered nutrition education can improve dietary behavior and glycemic outcomes among individuals with uncontrolled type 2 diabetes (1). The findings also align with evidence from diabetes education programs indicating that improved knowledge, self-care behavior, and adherence can contribute to better diabetes management in clinical and community populations (4,5). In the present study, the absence of previous nutrition counseling among all participants may have increased the potential responsiveness to structured dietary education, as even basic counseling may produce meaningful behavioral changes when baseline awareness is low.

The reduction in HbA1c is also supported by studies reporting benefits of customized or individualized dietary guidance among patients with type 2 diabetes. Alrige et al. reported that customized nutrient-profiling approaches were associated with improved glycated hemoglobin levels, suggesting that dietary interventions can influence metabolic control when they are structured and patient-oriented (6). Similarly, Rahman et al. reported an association between dietary habits and glycemic control among patients with type 2 diabetes, supporting the central role of diet-related behavior in diabetes management (7). Chen and Chen also emphasized that nutrition strategies adapted to individual needs and diabetes risk profiles may improve long-term metabolic outcomes (8). Although the present intervention was described as structured nutrition education rather than a fully personalized nutrition model, the findings support the practical value of organized dietary counseling in low-resource settings.

The demographic profile of the participants provides important context for interpretation. More than half of the participants had no formal education, and most had diabetes for 6–10 years, indicating that poor glycemic control may have persisted despite long disease duration. Low educational attainment can reduce understanding of diet plans, food labels, portion control, and long-term diabetes risks. Financial constraints and traditional dietary patterns may further limit adherence to recommended dietary changes among Pakistani patients with type 2 diabetes (2,3). Therefore, nutrition education in such populations should be simple, culturally acceptable, affordable, and focused on practical meal choices rather than idealized dietary plans that are difficult to sustain.

The findings should also be interpreted in relation to broader barriers to diabetes control in Pakistan. Taimur et al. highlighted persistent challenges in glycemic control, awareness, adherence, complications, and treatment costs among patients with type 2 diabetes in Pakistan (9). These barriers may limit the long-term sustainability of short-term improvements unless education is reinforced through follow-up visits, family involvement, and integration into routine outpatient services. Egede et al. further emphasized that social and economic interventions may be relevant in diabetes care, suggesting that education alone may be insufficient when financial insecurity limits patients' ability to implement dietary advice (10). For low-income populations, nutrition education should therefore be linked with cost-conscious dietary planning and ongoing support.

Despite the promising HbA1c reduction, several limitations should be acknowledged. The study used a single-group pre-test/post-test design without a control group, which limits causal inference. Changes in HbA1c may have been influenced by factors other than the intervention, including medication adjustment, changes in physical activity, clinical attention, regression to the mean, or improved adherence to existing treatment. The sample size was small, and participants were selected through convenience sampling from a single hospital, limiting generalizability to other populations and healthcare settings. The manuscript did not report intervention duration, session frequency, educator qualification, intervention adherence, timing of post-intervention HbA1c measurement, or whether medication changes were monitored during the study period. These omissions reduce reproducibility and make it difficult to determine which components of the intervention contributed most to the observed improvement.

Future studies should use larger multicenter designs with control or comparison groups, longer follow-up, and more detailed reporting of the nutrition education protocol. Participant-level data should be used to examine whether response differs by age, gender, education, diabetes duration, baseline HbA1c, medication use, or socioeconomic status. Future interventions should also measure dietary adherence, physical activity, medication changes, and patient knowledge to better explain the mechanism of HbA1c improvement. Regular reinforcement sessions and integration of diabetes education into routine primary care may improve sustainability of glycemic benefits in low-resource communities.

CONCLUSION

This study found that a structured nutrition education intervention was associated with a significant reduction in HbA1c among low-income adults with type 2 diabetes mellitus attending Shahida Islam Teaching Hospital, Lodhran. Mean HbA1c decreased from 8.15 ± 1.41% before the intervention to 6.80 ± 1.10% after the intervention, with a mean reduction of 1.36 percentage points. The findings suggest that structured, practical, and culturally appropriate nutrition education may support improved glycemic control among patients with limited previous exposure to formal dietary counseling. However, because the study used a single-group pre-test/post-test design without a control group, the results should be interpreted as a significant within-participant improvement rather than definitive evidence of causality. Larger controlled studies with longer follow-up and detailed intervention reporting are recommended to confirm effectiveness and sustainability in low-resource diabetes care settings.

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