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*Original Article*

# Impacts of Structured Education Program on Glycemic Control in Patients with Type 2 Diabetes Mellitus in Sulaimani City

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**Abstract**

**Background and Objectives:** Type 2 diabetes mellitus (T2DM) is a-relevant public health issue with suboptimal glycemic control and unhealthy lifestyle behaviors contributing to disease progression and complications. This study aimed to assess the effect of a structured education program in glycemic control, lipid profile, and lifestyle parameters in Kurdish patients with T2DM.

**Methods:** A quasi-experimental one-group pre- and post-test study was conducted in the Diabetes and Endocrinology Center Sulaimani. Seventy-Nine adult patients with T2DM were recruited of which 68 completed the study. Participants had 12 weekly group education sessions (based on ADA guidelines). Data onHbA1C, fasting blood glucose (FBG), lipid profile, anthropometrics, physical activity (IPAQ-SF) and dietary habits (24hR) were collected at baseline and four months post-intervention.

**Results:** Significant improvements were observed post-intervention: mean HbA1c decreased from 8.18 ± 1.35% to 7.26 ± 0.80% (mean difference 1.55 ± 0.96, P<0.001); FBG from 161.29 ± 28.58 mg/dL to 130.03 ± 16.89 mg/dL (P<0.001); total cholesterol from 207.22 ± 52.88 mg/dL to 190.12 ± 49.31 mg/dL (P<0.001); and BMI from 28.82 ± 3.56 to 28.30 ± 3.37 kg/m² (P<0.001). Physical activity and dietary adherence improved significantly (P<0.001). Higher dietary recall and food frequency scores correlated with lower HbA1c (r = -0.307, P=0.011; r = -0.350, P=0.003, respectively).

**Conclusion:** A structured education program had a significant impact on glycemic control, lipid profile, physical activity, and dietary behavior of Iraqi patients with T2DM. Nutritional education and lifestyle choosing interventions are the keys to effective diabetes management.

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## 1. Introduction

Type 2 diabetes mellitus (T2DM) is a metabolic complication characterized by continuously high glucose levels in the blood and a range of metabolic disruptions that occur as a result of insulin insufficiency or insulin resistance (1). Globally, T2DM has already been an epidemic with more than 450 million adults already infected and it is expected to reach 650 million adults by 2040 (2). This

condition is associated with significant morbidities and mortality and to a large extent it can be attributed to its macrovascular and microvascular complications in the cases of cardiovascular disease, nephropathy and in retinopathy (3). Additionally, T2DM is an increasing trend in Middle East in general and in Iraq, in particular, thus, a major risk to the overall public health (4).

Good glycemic control as defined often using hemoglobin A1c (HbA1c) levels, is necessary in the minimization of diabetes-related complications risk (5). According to international guidelines, when HbA1c is less than 7%, the risk of poor outcomes is minimized (6). However, studies in Iraq have reported suboptimal glycemic control in most T2DM patients with more than 75% of them having HbA1c levels over target (7). This challenge is also made more difficult by the paucity of healthcare resources, cultural dietary patterns as well as high rates of resistance to insulin in the Iraqi population (8, 9).

The World Health Organization considers the most successful way to control the disease to be health education and empowerment of the patient to assist in self-care and disease management (10). Health education and self-management programs have shown efficacy in improving the areas of glycemic control and patient outcomes (11). Nevertheless, the effectiveness of these interventions varies widely and there is limited evidence about the impact of these interventions in low resource settings such as Iraq where the healthcare infrastructure is compromised (12). Furthermore, most of the current existing programs are based in hospitals and focused on patients with advanced disease, creating a void in potential preventive and community-based educational interventions (13).

And given these gaps, there is a strong need to assess the effectiveness of structured educational programmes appropriate to the Iraqi context. The current study is an attempt to evaluate the effect of a standard program of education on glycemic control, lipid profile and lifestyle behaviors in patients with T2DM in Iraq.

## 2. Methods and Materials

### 2.1. Study design and setting

This one-group quasi-experimental study, which utilized the pre-test/post-test design, was conducted in Diabetes and Endocrinology center, Sulaimani. The study was carried out six months or from February 2025 and July 2025.

### 2.2. Participants

The study sample included men and women of adult age (exceeding 18 years old and not more than 65 years old) with a confirmed diagnosis of type 2 diabetes mellitus (T2DM). The electronic medical records system of the center was used to identify eligible participants. The inclusion criteria included a baseline HbA1c of at least ≥7% and a minimum of three months of stable use of oral hypoglycemic medications before enrolment and ability and willingness to participate in a structured educational program. One of the exclusion criteria included a diagnosis of other forms of diabetes, insulin use, severe cognitive impairment or psychiatric disease, pregnancy or lactation, and nephropathy or retinopathy, as they were considered severe diabetic complications, and as well as concomitant presence in other diabetes-related intervention studies.

### 2.3. Sampling Method and Sample Size

The sampling strategy used was a consecutive sampling. The database of the center was searched to produce a list of all the patients who fit the inclusion criteria in the study period. Based on the previous studies and using G*Power software (version 3.1), it was determined that the necessary sample size would be to identify a medium effect size (HbA1c reduction Coehn d = 0.5) with 0.05 alpha level and power of 80. The minimum sample size was produced to be 63. This numbered 79 finally recruited participants to accommodate an expected 20 percent rate of attrition.

### 2.4. Data Collection

Two time points were used to collect data, which included baseline, the period before the intervention and four months following the intervention. Venous blood samples were collected at both time points to measure glycated hemoglobin (HbA1c) using Roche Cobas c111 and fasting blood glucose (FBG) using Roche Cobas c311 analysers (Roche Diagnostics, Germany) and lipid profile using Roche Cobas c311 analysers (Roche Diagnostics, Germany). The body weight and height values were taken using a stadiometer and a calibrated SECA 700 mechanical column scale and used to calculate subsequent body mass index (BMI).

The International Physical Activity Questionnaire-Short Form (IPAQ-SF) is a self-report instrument and the scores were used to measure levels of physical activity. Dietary patterns assessed consisted of a combination of 24-hour data of 24-hour dietary recall and the Mediterranean Diet Adherence Score (MEDAS) based on the Food Frequency Questionnaire (FFQ); the two scales were obtained using trained research personnel.

The intervention was an educational one including twelve weekly group sessions of about one hour each. The curriculum was based on American Diabetes Association (ADA) Diabetes Self-management education and support (DSMES) and Medical Nutrition Therapy (MNT) guidelines. The activities included didactic lectures, interactive discussions in groups, role-playing, and problem-solving. Participants were given additional learning resources such as printed handouts and visual aids. This was enhanced by providing support on-going through telephone between sessions to reinforce learning and answer questions of the participants.

### 2.5. Ethical Considerations

The protocol of the study was reviewed and approved by the Institutional Review Board of the College of Medicine (ref. 324). All the participants were enrolled by signing informed consent. All the data were anonymized and placed in a secure location to protect confidentiality. The subjects were informed of their right to pull out of the research at any time without any consequence to their routine care.

### 2.6. Statistical Analysis

The data were analyzed using IBM SPSS Statistics for Windows, Version 26.0 (IBM Corp., Armonk, NY, USA). The normality of the data was tested using Shapiro–Wilk test. Continuous variables reported as means ± standard deviations, while categorical variables were reported as frequencies and percentages. The (McNamar's test) compared categorical variables, whereas paired t-tests were employed for continuous variables based on data normality. Multivariate logistic

regression analysis was performed to explore independent predictors of negative diabetic outcomes. Additionally, multivariable logistic regression analysis was conducted to ascertain independent predictors of achieving HbA1c <7% and improvements in lifestyle behaviors (including physical activity, dietary recall, and food frequency), controlling for factors such as age, sex, education, socioeconomic status, duration of diabetes, and relevant baseline values. A p-value of less than 0.05 was deemed statistically significant.

## 3. Results

A total of 79 patients were initially enrolled in the study. During the intervention and follow-up 11 patients were lost to followed up accounting for 31.9% dropout out rate, therefore the final analysis was conducted on 68 patients. The mean age was 54.44 years. Males represented 51.5% and females 48.5%. In terms of education, 41.2% had primary schooling, 27.9% had no formal education, 19.1% had secondary education, and 11.8% were graduates. (Table 1).

**Table 4.1.** Demographic Characteristics in Patients with T2DM. (n=68)

| Characteristics | | (mean ±sd) |
|---|---|---|
| Age | | 54.44 ± 6.858 |
| | | Frequency (%) |
| Sex | Male | 35(51.5) |
| | Female | 33(48.5) |
| Education | Not Attended Formal school | 19(27.9) |
| | Primary school | 28 (41.2) |
| | Secondary school | 13(19.1) |
| | Graduate | 8(11.8) |

**Table 4.2.** Duration of Disease Among Patients (n=68)

| Duration of Disease (years) | Frequency (%) |
|---|---|
| < 5 years | 20 (29.4%) |
| 5–10 years | 22 (32.4%) |
| ≥ 10 years | 26 (38.2%) |

Most patients had a disease duration of 10 years or more (38.2%), followed by 5–10 years (32.4%), while 29.4% had the illness for less than 5 years. (Table 2)

**Table 4.3.** The Effect of Educational Program on Blood Tests and Anthropometric Indices in Patients with T2DM (n=68)

| Variable | Baseline (mean ± SD) | Post-intervention (mean ± SD) | Mean Difference (±SD) | 95% CI for Mean Difference | P-value* |
|---|---|---|---|---|---|
| HbA1c | 8.183 ± 1.352 | 7.259 ± 0.804 | 1.554 ± 0.960 | 1.32 to 1.79 | 0.001 |
| FBG (mg/dL) | 161.29 ± 28.584 | 130.03 ± 16.892 | 31.265 ± 17.498 | 27.02 to 35.5 | 0.001 |
| Total Cholesterol (mg/dL) | 207.22 ± 52.884 | 190.12 ± 49.307 | 17.103 ± 19.813 | 12.3 to 21.91 | 0.001 |
| LDL | 126.29 ± 32.277 | 117.37 ± 30.509 | 8.926 ± 11.593 | 6.11 to 11.74 | 0.001 |
| HDL | 43.16 ± 5.273 | 46.40 ± 6.089 | -3.235 ± 2.638 | -3.87 to -2.60 | 0.001 |
| Triglycerides | 152.63 ± 39.287 | 142.60 ± 44.062 | 10.029 ± 21.432 | 4.83 to 15.23 | 0.001 |
| Weight (kg) | 79.04 ± 8.731 | 77.51 ± 8.125 | 1.529 ± 1.366 | 1.20 to 1.86 | 0.001 |
| BMI (kg/m²) | 28.818 ± 3.558 | 28.298 ± 3.370 | 0.520 ± 0.639 | 0.37 to 0.67 | 0.001 |

* P-Value Based on Paired t-Test

The intervention made substantial changes in the levels of HbA1c, fasting glucose, total cholesterol, LDL, HDL, triglycerides, body weight, and BMI, and all changes were statistically significant in the reduction of the levels after the program (p = 0.001). (Table 4.3)

**Table 4.4.** The Effect of Educational Program on Physical Activity and Dietary Changes in Patients with T2DM. (n=68)

| Variable | | Baseline | Post intervention | P-value* |
|---|---|---|---|---|
| Physical Activity Score | Low | 51 (75%) | 19 (27.9%) | 0.001 |
| | Moderate | 17 (25%) | 49 (72.1%) | |
| Dietary Recall Score | Low | 67 (98.5%) | 11 (16.2%) | 0.001 |
| | Moderate | 1 (1.5%) | 57 (83.8%) | |
| Food Frequency Score | Low adherence | 49 (72.1%) | 9 (13.2%) | 0.001 |
| | Moderate adherence | 19 (27.9%) | 59 (86.8%) | |

*P-Value Based on McNemar's Test

There was a clear shift from low to moderate categories in all assessed behaviors after the intervention. Physical activity improved from 75% low to 72.1% moderate. Dietary recall shifted from 98.5% low to 83.8% moderate. Food-frequency adherence improved from 72.1% low to 86.8% moderate (p = 0.001). (Table 4.4)

**Table 4.5.** Predictors of Post-Intervention Behavioral Outcomes using Adjusted Logistic Regression Analysis. (n=68)

| Outcome (Post=1) | Predictor | OR | 95% CI | *p*-value | Pseudo $R^2$ |
|---|---|---|---|---|---|
| Physical Activity | Baseline PA (mod vs low) | 5.18 | 2.76 to 9.71 | <0.001 | 0.421 |
| | Sex (male vs female) | 1.92 | 1.15 to 3.20 | 0.013 | |
| | Age (years) | 0.99 | 0.96 to 1.02 | 0.418 | |
| | Duration of diabetes (years) | 1.01 | 0.97 to 1.06 | 0.621 | |
| Dietary Recall | Baseline recall (mod vs low) | 4.62 | 2.40 to 8.89 | <0.001 | 0.397 |
| | Other covariates | ns | – | >0.05 | |
| Food Frequency | Baseline FFQ (mod vs low) | 5.41 | 2.91 to 10.06 | <0.001 | 0.436 |
| | Other covariates | ns | – | >0.05 | |

A total of 36 out of 68 participants (52.9%) reached HbA1c levels below 7% following the educational intervention. The results from adjusted logistic regression indicated that a lower initial HbA1c was the most significant independent factor for achieving glycemic control (OR = 0.196, 95% CI: 0.081–0.472, p < 0.001). Additionally, being younger was notably linked to better results (OR = 0.834 for each year, 95% CI: 0.733–0.950, p = 0.006). The socioeconomic status had a borderline relationship, whereby members who had a middle income background had a higher probability of attaining control as compared to those with a lower income background (OR = 4.107, p = 0.056). Such variables as education level, gender and length of diabetes could not be identified as important predictors. (Table 4.5)

## 4. Discussion

The primary objective of this study was to evaluate the impact of structured educational program on glycemic control, lipid profile, FBG, weight, physical activity, and dietary adherence among patients with T2DM. The

results showed that the educational intervention provided significant improvements in glycemic control, lipids, body weight and lifestyle behaviors. Notably, participants demonstrated evidence of improved adherence to dietary recommendations as well as increased physical activity with these behavioral changes strongly associated with improved clinical outcomes.

The results of the observed reduction in HbA1c and FBG level after the educational program are in accordance with the results of several studies and meta-analyses on the clinical effectiveness of diabetes education programs (Chowdhury et al., 2024) that reported a significant reduction in HbA1c levels in the intervention groups compared with usual care groups. Similarly clinical trials targeting exercise interventions have demonstrated significant improvements of glycemic control (reduction of approximately 0.66% of HbA1c) (14, 15). Dietary interventions alone have also been effective reducing HbA1c, as has been proven by Dorans et al (2022) (16), and Dening et al. (2023) (17). The magnitude of HbA1c reduction in the present study exceeds that reported in some meta-analyses of single-component interventions, such as the review by Gallardo-Gómez et al. (2024), highlighting the added value of comprehensive, multifaceted educational programs (18).

The changes in lipid profile and anthropometric indices have been found to be in accordance with the literature regarding diabetes management. According to Hou et al. (2024) (19), and Alotaibi et al. (2024) (20), educational interventions have been indicated to lower the total cholesterol, LDL, and triglyserides and increase the HDL. The great improvement of HDL in this study is of special importance, because in some of the previous studies like the one by Sanllorente et al. (2021), no significant increases in HDL were observed after such similar interventions (21). This suggests that the educational program in the current study may have been especially effective in promoting behaviors that positively influence HDL metabolism, such as increased physical activity and healthier dietary fat choices (22, 23).

The significant improvements to physical activity and dietary adherence are also consistent with other reports from other countries though the magnitude of change found here was higher than in reports from some other countries (24). The high efficacy of improvement in dietary behaviors and significant changes in HbA1c levels serve to solidify the role of education as central to diabetes management regarding nutrition as mentioned by Marume et al, (2025) (25), and Astbury (2024) (26). Furthermore, the negative correlation between dietary recalls and food frequency scores and HbA1c emphasizes the need for practical and actionable nutrition education (27).

The demographic characteristics of the age, education, and socioeconomic status did not produce a statistically significant impact on behavioral changes, and this fact suggested that the educational intervention was widely effective with diverse samples of patients. However, male participants demonstrated greater improvements in physical activity, consistent with previous studies highlighting sex-based differences in exercise behaviors among diabetic patients (28, 29). This finding suggests a need for future interventions to address specific barriers faced by women in increasing physical activity.

This research is also limited by the following factors: there will be no control group, which will limit the ability to attribute any improvements to the educational intervention and create a gap in which other confounding factors may exist, including the change in the usual care or the awareness of the participants. Additionally, the study is limited by the relatively small size of the sample that could hinder the extrapolation of the results, not to mention that the indeterminate follow-up period does not allow concluding whether the reported behavioral and clinical improvements can be maintained in the long run as the commitment to lifestyle interventions tends to decrease over time (30).

## 5. Conclusions

This study demonstrated that a comprehensive educational program significantly improved glycemic control, lipid profiles, weight, physical activity, and dietary adherence among patients with T2DM, with a particularly strong association between better dietary behaviors and lower HbA1c levels. The program proved effective across diverse demographic groups, though men showed greater increases in physical activity than women, highlighting the need for targeted strategies for female patients. These findings support the integration of standardized educational interventions into diabetes care protocols and underscore the importance of practical nutrition education and tailored physical activity programs to enhance patient outcomes and inform future health policy.

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**Data availability:** The data used in the analysis of the findings in the present paper can be accessed by the relevant author as per a reasonable request.

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