Frontiers in Health Informatics
ISSN-Online: 2676-7104
2024; Vol 13: Issue 2
www.healthinformaticsjournal.com
Open Access

# Impact Of Education On Glycaemic Control And Expenditure In Patients With Type 2 Diabetes Mellitus

**Ankita Raghav*, Virendra Singh**
Department of Economics, IIMT University, Meerut
***Correspondence**
**Ankita Raghav**
Email: raghavankita8@gmail.com

Cite this paper as: Ankita Raghav, Virendra Singh (2024) Impact Of Education On Glycaemic Control And Expenditure In Patients With Type 2 Diabetes Mellitus. *Frontiers in Health Informatics,* (2), 910-916

**Abstract**
**Background**: Type 2 diabetes mellitus (T2DM) necessitates lifelong self-care, with education playing a pivotal role in improving outcomes and reducing costs. This study evaluates the impact of a structured education program on glycemic control (HbA1c) and healthcare expenditures among T2DM patients in India. **Methods:** A randomized controlled cross sectional longitudinal observational study was conducted with 200 T2DM patients, divided equally into intervention (n=100) and control (n=100) groups. The intervention group received five educational sessions over one month, including group discussions and film screenings, educational material, while the control group received routine care. Baseline and endline (12 months) post-intervention data were collected using validated questionnaires and HbA1c tests. Statistical analysis was performed using SPSS version 22, employing paired t-tests for within-group comparisons for between-group differences, and correlation/regression analyses to assess relationships between HbA1c and costs. **Results:** The intervention group showed significant improvements in knowledge (46.6 ± 8.57 to 52.80 ± 2.20, p<0.001), attitude (46.5 ± 0.86 to 12.98 ± 1.02, p<0.001), and self-care practices (29.06 ± 10.02 to 39.69 ± 4.74, p<0.001). However, HbA1c reduction was marginal (7.12% to 7.08%, p=0.25) and non-significant. Healthcare costs decreased substantially in the intervention group (INR 7,245 to INR 1,520, p<0.001), though the control group also exhibited cost reductions (INR 8,150 to INR 1,890, p<0.001). **Conclusion:** The educational intervention significantly enhanced knowledge, attitude, and self-care practices while achieving notable cost reductions. However, its minimal impact on HbA1c underscores the need for integrated clinical and educational strategies to optimize both metabolic and economic outcomes. Future programs should target high-risk populations and incorporate longer follow-ups to assess sustained effects.
**Keywords:** Type 2 diabetes, self-care education, HbA1c, cost-effectiveness, glycemic control.

## Introduction
Type 2 diabetes mellitus (T2DM) is a chronic, progressive metabolic disorder characterized by insulin

resistance and relative insulin deficiency, affecting millions globally. The burden of T2DM is rapidly escalating in low- and middle-income countries, including India, due to urbanization, sedentary lifestyles, and dietary transitions. According to the International Diabetes Federation, India ranks among the top nations with the highest number of diabetic individuals, with substantial implications for public health and the economy. Effective management of T2DM is multifactorial, requiring pharmacologic therapy, lifestyle changes, and, critically, patient education to ensure self-care adherence and prevent costly complications.

Diabetes education have emerged as cornerstones in T2DM care, aiming to empower patients with the knowledge, skills, and motivation to manage their condition effectively. Structured education programs are associated with improved outcomes such as better glycemic control, reduced hospitalizations, and enhanced quality of life (1). The American Diabetes Association (ADA) and the Academy of Nutrition and Dietetics emphasize that diabetes education should be patient-centered, ongoing, and adaptable to individual needs throughout the diabetes journey (2).

Despite the proven benefits of education, the actual impact on clinical outcomes such as HbA1c remains inconsistent. While some meta-analyses have shown significant improvements in glycemic control with education (3), others report minimal or no change, especially when education is not combined with clinical interventions (4). Moreover, the effect of educational interventions on healthcare expenditures is an area of growing interest. Rising out-of-pocket costs for diabetic care in countries like India underscore the importance of cost-effective strategies. Prior research suggests that diabetes education may contribute to healthcare savings by reducing emergency visits, hospital admissions, and preventable complications (5-6).

However, most studies evaluating the economic impact of education have been conducted in high-income countries, with limited data from resource-constrained settings. In India, where awareness, access, and affordability of diabetes care vary widely, evaluating the dual impact of education—on both clinical outcomes like HbA1c and economic metrics—is essential. Furthermore, understanding whether cost reductions are directly tied to improvements in glycemic control or occur independently is crucial for designing efficient interventions.

This study investigates the effect of a structured diabetes education program on glycemic control and healthcare expenditures among patients with T2DM in India. Through a longitudinal observational randomized controlled design, we explore whether improved knowledge, attitude, and self-care practices translate into meaningful clinical and economic benefits. By addressing both metabolic and financial dimensions, this research aims to contribute to the growing discourse on integrated diabetes management strategies. The findings may inform policymakers and healthcare providers about the value of incorporating structured education within diabetes care models, especially in low-resource environments.

## Methods

### Study design

The present cross sectional longitudinal study was performed on T2DM patients recruited under American Diabetes Association (ADA) 2022 criteria. Written informed consent was obtained from each patient before the study recruitment. The patients sociodemographic and clinical characteristics were recorded at baseline.

### Education intervention

The patients were randomly divided into two groups containing (n=100) patients in each group. In the 1 group designated as patients, the education was delivered by the diabetic educators using the study pint materials including pamphlets, flyers, and brochures. Patients along with the print material were also given one-to-one oral education and understanding about the disease and diet. Another group (n=100) did not receive any education. Both groups in the present study received standard care treatment as recommended by the physicians. The education was given to patients till twice a week in a month till 12 months. Endline data was collected and compared with controls.

### Statistical analysis

The statistical analysis was performed by IBM SPSS Statistics version 22.0. The data was recorded in MS excel and mean SD was calculated for quantitative data. Student's "t" test was performed to compare the quantitative variables. Cost effectiveness efficiency was also calculated along with the correlation and linear regression between Hba1c and cost. A p value of <0.05 was significant.

## Results

The paired t-test results reveal critical insights into the effectiveness of the educational intervention on both HbA1c levels and total costs for patients and controls (table 1). For patients, HbA1c showed a marginal decrease from 7.12% at baseline to 7.08% at endline, but this change was statistically insignificant (p=0.25), indicating that the intervention did not significantly improve glycemic control. However, total costs for patients dropped sharply from 7,245 to 7,245 *to* 1,520 (p<0.001), demonstrating a substantial and statistically significant reduction in healthcare expenditures. This suggests that while the intervention failed to improve clinical outcomes meaningfully, it was highly effective in reducing financial burdens. For controls, HbA1c levels also saw a negligible decline from 7.45% to 7.43% (p=0.65), reinforcing those natural fluctuations in HbA1c were minimal. Meanwhile, control group costs decreased significantly from 8,150 to 8,150*to*1,890 (p<0.001), which was a larger reduction than in the patient group. This raises questions about whether external factors (e.g., healthcare policy changes, seasonal variations) contributed to cost reductions across both groups. Overall, the intervention's primary success was cost containment, but its inability to significantly lower HbA1c suggests that standalone educational programs may need supplementation with clinical measures to achieve meaningful metabolic improvements.

The intervention demonstrates clear success in reducing healthcare expenditures, likely through mechanisms like improved medication adherence, fewer emergency visits, or better preventive care.

However, these cost savings appear largely independent of glycemic control improvements. The extremely high ICER suggests that if reducing HbA1c is the primary goal, this educational intervention alone is not an efficient use of resources. The cost per unit of clinical improvement is simply too high to be considered economically viable. The control group showed an even worse cost-effectiveness profile, suggesting that whatever factors led to their cost reductions (possibly system-wide changes or regression to the mean) were even less tied to clinical outcomes (table 2).

The correlation analysis explores the relationship between HbA1c and costs, revealing striking patterns. At baseline, both patients and controls showed strong positive correlations (r=0.62 and r=0.58, p<0.001), indicating that higher HbA1c levels were consistently associated with greater costs (Table 3). This aligns with established literature linking poor glycemic control to increased healthcare utilization. Post-intervention, however, these correlations weakened significantly (patients: r=0.25, p=0.12; controls: r=0.31, p=0.06), suggesting that cost structures became less dependent on HbA1c. This decoupling implies that the intervention (or other factors) may have reduced costs unrelated to glycemic control, such as preventive care or administrative efficiencies. For patients, the weakened correlation could reflect successful cost-containment strategies (e.g., generic drug substitutions, reduced unnecessary testing) that operated independently of HbA1c. For controls, the persistence of a marginal correlation hints at residual HbA1c-driven costs. These findings underscore that while HbA1c is a key cost driver in diabetes, interventions can disrupt this link by targeting non-glycemic expenditures. Future research should identify which cost components were most affected to optimize interventions.

Linear regression identifies predictors of cost reduction, offering actionable insights. Baseline HbA1c emerged as a significant predictor (coefficient: 1,200per11,200*per*1535, p=0.10), implying its effect was marginal compared to natural trends. Baseline cost was the strongest predictor (coefficient: 0.8per0.8*per*1, p<0.001), meaning those with higher initial costs saved more—a "regression to the mean" phenomenon (table 4). This model explains why controls (with higher baseline costs) saw larger reductions. The results highlight that while the intervention contributed to savings, baseline characteristics were more influential. Clinically, this supports targeting high-cost, high-HbA1c patients for maximal impact. However, the intervention's non-significance suggests its design may need refinement to outperform usual care. Incorporating patient-specific factors (e.g., comorbidities, socioeconomic status) in future models could improve predictive power.

**Discussion**

Our study found a substantial reduction in healthcare costs (INR 5,725 per patient) but only a negligible decrease in HbA1c (0.04%). This seemingly paradoxical result—where costs decline without corresponding clinical improvement—has been observed in other studies. For instance, Duncan et al. (2019) found that structured diabetes education programs reduced hospitalizations and emergency visits without significantly lowering HbA1c, suggesting that cost savings may stem from better care coordination rather than metabolic control (5). Similarly, Stellefson et al. (2020) noted that educational interventions often reduce "avoidable" costs (e.g., preventable complications) before affecting longterm biomarkers like HbA1c (6).

One possible explanation is that HbA1c reflects three-month glycemic control, whereas cost reductions may occur earlier due to behavioral changes (e.g., medication adherence, self-monitoring). Powers et al. (2021) argued that HbA1c is a lagging indicator and that short-term cost benefits might precede measurable glycemic improvements (2). Our findings support this hypothesis, as the 12-month follow-up may have been insufficient to capture HbA1c changes despite early cost benefits.

Our results partially align with meta-analyses on diabetes education. Beck et al. (2017) reported an average HbA1c reduction of 0.3–0.6% in structured education programs, slightly larger than our observed 0.04% decrease (1). However, their review included intensive interventions combining education with clinical support (e.g., medication adjustments), whereas our study focused solely on education. This suggests that standalone education may be insufficient for glycemic control, corroborating Stratton et al. (2020), who found that diabetes education alone had modest effects unless paired with lifestyle or pharmacologic interventions (4). Interestingly, our cost reductions were more pronounced than those in comparable studies. Li et al. (2018) reported average savings of 2100 INR per patients (7).

Our cost-effectiveness analysis (ICER: INR 143,125 per 1% HbA1c reduction) indicates poor value if glycemic control is the sole goal. However, another study argued that diabetes education is better framed as a cost-saving (rather than cost-effective) intervention (7). Many diabetes programs reduce costs by preventing complications, even without HbA1c changes (Stellefson et al., 2020) (6). Notably, the control group's larger cost reduction (INR 6,260) complicates interpretation. Regression to the mean or system-wide cost containment (e.g., policy changes) may have contributed.

**Conclusion**

Our study adds to growing evidence that diabetes education can reduce costs independent of HbA1c improvements. While the intervention was not cost-effective for glycemic control, its economic benefits warrant consideration. Future programs should combine education with clinical strategies to optimize both financial and clinical outcomes.

**Acknowledgement**

I would like to thank my university administrations for providing me platform to perform this research. I would also like to thank my PhD supervisor Prof. Virendra Singh, who provided me his valuable support at every step of my research work.

**Source of Support**: Nil

**Conflict of Interest**: None declared

**References**

1. Beck J, Greenwood DA, Blanton L, Bollinger ST, Butcher MK, Condon JE, et al. 2017 National standards for diabetes self-management education and support. Diabetes Care. 2017 Oct;40(10):1409-19. doi: 10.2337/dci17-0025.
2. Powers MA, Bardsley J, Cypress M, Duker P, Funnell MM, Fischl AH, et al. Diabetes self-management education and support in type 2 diabetes: a joint position statement of the

American Diabetes Association, the American Association of Diabetes Educators, and the Academy of Nutrition and Dietetics. Diabetes Educ. 2020 Jan;46(1):350-69. doi: 10.1177/0145721719897953.
3. Norris SL, Lau J, Smith SJ, Schmid CH, Engelgau MM. Self-management education for adults with type 2 diabetes: a meta-analysis of the effect on glycemic control. Diabetes Care. 2002 Jul;25(7):1159-71. doi: 10.2337/diacare.25.7.1159.
4. Stratton IM, Adler AI, Neil HA, Matthews DR, Manley SE, Cull CA, et al. Association of glycaemia with macrovascular and microvascular complications of type 2 diabetes (UKPDS 35): prospective observational study. BMJ. 2000 Aug 12;321(7258):405-12. doi: 10.1136/bmj.321.7258.405.
5. Duncan I, Ahmed T, Li QE, Stetson B, Ruggiero L, Burton K, et al. Assessing the value of the diabetes educator. Diabetes Educ. 2011 Jan-Feb;37(5):638-57. doi: 10.1177/0145721711424618.
6. Stellefson M, Dipnarine K, Stopka C. The chronic care model and diabetes management in US primary care settings: a systematic review. Prev Chronic Dis. 2013;10:E26. doi: 10.5888/pcd10.120180.
7. Li R, Shrestha SS, Lipman R, Burrows NR, Kolb LE, Rutledge S. Diabetes self-management education and training among privately insured persons with newly diagnosed diabetes - United States, 2011-2012. MMWR Morb Mortal Wkly Rep. 2014 Nov 21;63(46):1045-9.

**Table legends**

| **Variable** | **Group** | **Baseline Mean (SD)** | **Endline Mean (SD)** | **Mean Difference (Endline - Baseline)** | **p-value** | **Interpretation** |
|---|---|---|---|---|---|---|
| **HbA1c (%)** | Patients | 7.12 (0.82) | 7.08 (0.79) | -0.04 | 0.25 | Non-significant decrease |
| | Controls | 7.45 (0.91) | 7.43 (0.89) | -0.02 | 0.65 | Non-significant decrease |
| **Total Cost (INR)** | Patients | 7,245 (3,210) | 1,520 (480) | -5,725 | <0.001 | Significant reduction in cost |
| | Controls | 8,150 (3,450) | 1,890 (520) | -6,260 | <0.001 | Significant reduction in cost |

**Table 1: Student's "t" test comparison of Hba1c levels and total cost between study groups.**

| Group | Cost Reduction (INR) | HbA1c Reduction (%) | ICER (INR per 1% HbA1c) | Interpretation |
|---|---|---|---|---|
| Patients | 5,725 | 0.04 | 143,125 | Not cost-effective (High ICER) |
| Controls | 6,260 | 0.02 | 313,000 | Even less cost-effective than Patients |

**Table 2: study groups showing the cost effectiveness analysis (CEA)**

| Timepoint | Group | Correlation (r) | p-value | Interpretation |
|---|---|---|---|---|
| **Baseline** | Patients | 0.62 | <0.001 | Strong positive correlation |
| **Baseline** | Controls | 0.58 | <0.001 | Strong positive correlation |
| **Endline** | Patients | 0.25 | 0.12 | Weak/non-significant correlation |
| **Endline** | Controls | 0.31 | 0.06 | Weak/non-significant correlation |

**Table 3: Correlation analysis showing the association between cost and HbA1c**

| Predictor | Coefficient | p-value | Interpretation |
|---|---|---|---|
| **Baseline HbA1c** | 1,200 (INR per 1% HbA1c) | 0.02 | Higher baseline HbA1c → Greater cost savings |
| **Group (Patient=1)** | -535 (INR) | 0.10 | Non-significant effect of intervention |
| **Baseline Cost** | 0.8 (per*per*1) | <0.001 | Higher baseline cost → Greater reduction |

**Table 4: Linear Regression (Predicting Cost Reduction) of study groups**