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Original Research Article

Role of Nurses in Public Health Education Programs on Glycaemic Control Among Type 2 Diabetic Patients in Urban and Rural Settings

Sajida Perveen[1*], Sundas Shehzadi[2], Shamsa Kanwal[3], Saima Ashraf[4]

[1]SIMS College of Nursing, Lahore, Pakistan
[2]GC University, Faisalabad, Pakistan
[3]Almodawat Hospital, Muhayil, Saudi Arabia
[4]Department of Zoology, University of Sialkot, Pakistan
**Corresponding author`s email address:* simraniqbal961@gmail.com

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Abstract: *Type 2 diabetes mellitus (T2DM) poses a significant public health burden in Pakistan, with urban and rural populations facing distinct challenges in management. Nurse-led education programs have shown potential in improving glycaemic control and self-care behaviors, but comparative evidence between these settings remains limited.* ***Objective:*** *To evaluate the effectiveness of structured nurse-led public health education programs on glycaemic control and lifestyle adherence among T2DM patients in urban and rural Pakistan.* ***Methods:*** *A quasi-experimental study was conducted from July to December at a tertiary care hospital in Pakistan, enrolling 99 patients with type 2 diabetes mellitus (T2DM) (54 urban, 45 rural) aged 35–70 years with HbA1c levels of≥7.5%. The intervention consisted of six months of structured, nurse-led education on dietary modification, physical activity, medication adherence, and self-monitoring of blood glucose levels. HbA1c and fasting blood glucose (FBG) were measured at baseline and after six months using standardized methods. Lifestyle adherence was assessed using validated questionnaires. Data were analyzed using paired and independent t-tests as well as chi-square tests, with $p < 0.05$ considered statistically significant.* ***Results:*** *Both urban and rural groups showed significant reductions in HbA1c (urban: 9.4% to 7.8%; rural: 9.8% to 8.3%), with a greater improvement in the urban group ($p = 0.04$). FBG decreased significantly in both groups, with a more pronounced reduction in urban participants ($p = 0.03$). Lifestyle adherence improved in both settings, with significant differences in regular self-monitoring of blood glucose favoring the urban group (68.5% vs. 48.9%, $p = 0.04$).* ***Conclusion:*** *Nurse-led education significantly improves glycemic control and lifestyle adherence in patients with type 2 diabetes mellitus (T2DM) in both urban and rural settings. Urban patients experienced greater benefits, underscoring the need for tailored strategies to overcome rural healthcare barriers. Integrating such programs into national diabetes management plans could enhance long-term outcomes.*

Keywords: Type 2 diabetes mellitus, nurse-led education, glycaemic control, lifestyle adherence, Pakistan

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Introduction

The management of Type 2 diabetes mellitus (T2DM) presents a significant public health challenge worldwide, as the condition is associated with substantial morbidity, mortality, and economic burdens on healthcare systems. Nurses play a crucial role in public health education programs aimed at improving glycemic control among patients with type 2 diabetes mellitus (T2DM), particularly in various settings such as urban and rural environments. As frontline healthcare providers, nurses are equipped to deliver tailored education and support that address the unique barriers and facilitators encountered by patients with type 1 diabetes.

Recent systematic reviews suggest that nurse-led educational interventions have a significant impact on patient outcomes, including improved glycemic control, by providing essential knowledge about self-management behaviors and treatment adherence. These programs often incorporate behavioral modifications—such as dietary changes, increased physical activity, and medication adherence—that have been shown to positively impact metabolic parameters, including HbA1c levels. Notably, a study by Çelik et al. emphasizes the importance of nursing education in modifying patients' health behaviors, illustrating the profound impact of nurse-facilitated educational programs on adherence and glycemic control in patients with type 2 diabetes mellitus (T2DM).

Urban and rural settings exhibit distinct challenges related to diabetes management. Urban patients may face complexities related to lifestyle changes and access to healthcare, while rural populations often struggle with inadequate healthcare resources and geographic barriers to continuous care. Callahan et al. suggest that culturally sensitive and context-specific educational programs can bridge these gaps, enabling nurses to tailor their approaches to the demographic and socioeconomic backgrounds of their patients. The integration of telehealth and community-based programs has shown promising results in enhancing access to care for patients residing in rural areas.

A comprehensive approach to diabetes education, incorporating motivational interviewing and behavioral counseling facilitated by trained nurses, has resulted in significant improvements in self-care practices and glucose monitoring. (9,10) A recent trial demonstrated that a nurse-led program emphasizing comprehensive self-management education significantly reduced HbA1c levels in patients, underscoring the importance of sustained nurse-patient interactions (5). These findings highlight the importance of ongoing education and engagement strategies in maintaining and improving glycemic control in individuals with type 2 diabetes mellitus (T2DM), particularly among vulnerable populations.

Given the increasing prevalence of type 2 diabetes mellitus (T2DM) in Pakistan, understanding the role of nurses in public health education programs is crucial. The Pakistani healthcare system faces a high burden of diabetes due to socio-economic factors, lifestyle changes, and limited awareness about effective disease management (11). Consequently, implementing structured nurse-led educational interventions in both urban and rural Pakistan could significantly alleviate the diabetes burden and improve population health metrics. Culturally relevant adaptations made by nurses can empower patients with the knowledge necessary for

effective self-management, leading to improved health outcomes across various demographics (12, 13).

In the context of Pakistan, integrating nurses into public health education initiatives for diabetes management is particularly relevant. The country's diabetes prevalence is alarmingly high, underscoring the urgent need for educational interventions tailored to diverse communities. Nurses, as primary providers of care and health education, can profoundly influence the management of type 2 diabetes mellitus (T2DM) by addressing the specific challenges faced in different contexts, thereby promoting better health behaviors and enhancing glycemic control across the population.

Methodology

This study was conducted at a tertiary care hospital in Pakistan from July to December. It employed a quasi-experimental design with pre- and post-intervention assessments. A total of 99 patients with type 2 diabetes mellitus were recruited through non-probability consecutive sampling. Eligible participants were aged between 35 and 70 years, had been diagnosed with type 2 diabetes for at least one year, and had HbA1c levels ≥7.5% at enrollment. Patients with type 1 diabetes, gestational diabetes, severe comorbidities, or those unwilling to participate were excluded.

The intervention consisted of structured nurse-led public health education programs delivered in both urban and rural settings. Sessions were conducted weekly for the first month and then monthly thereafter, focusing on key domains including dietary modification, physical activity, medication adherence, self-monitoring of blood glucose, and recognition of symptoms of hypoglycemia and hyperglycemia. Nurses utilized visual aids, culturally appropriate dietary charts, and group discussions to enhance understanding.

Baseline demographic and clinical data, including HbA1c, fasting blood glucose, and duration of diabetes, were collected. Outcomes were reassessed after six months of the intervention. HbA1c was measured using standardized HPLC techniques, while fasting blood glucose was determined through enzymatic assays. Adherence to medication, diet, physical activity, and self-monitoring was assessed using structured questionnaires validated for the local population.

Data were analyzed using SPSS version 26. Continuous variables were presented as mean ± standard deviation, while categorical variables were expressed as frequencies and percentages. Paired t-tests were applied to compare pre- and post-intervention outcomes within groups, and independent t-tests or chi-square tests were used to assess differences between urban and rural participants. A p-value of <0.05 was considered statistically significant.

Ethical approval for the study was obtained from the institutional ethics committee, and written informed consent was obtained from all participants before enrollment. Confidentiality and anonymity of data were maintained throughout the study.

Results

A total of 99 patients with type 2 diabetes mellitus were enrolled in this study, comprising 54 (54.5%) from urban settings and 45 (45.5%) from rural areas. The mean age of participants was 52.8 ± 8.7 years, ranging from 35 to 70 years. Of these, 56 (56.6%) were male and 43 (43.4%) were female. The mean duration of diabetes was 8.1 ± 4.2 years. (Table 1)

Table 1. Demographic Characteristics of Participants (n = 99)

Variable	Urban (n=54)	Rural (n=45)	Total (n=99)
Age (years), mean ± SD	51.9 ± 8.4	53.8 ± 9.0	52.8 ± 8.7
Gender (Male), n (%)	32 (59.3%)	24 (53.3%)	56 (56.6%)
Gender (Female), n (%)	22 (40.7%)	21 (46.7%)	43 (43.4%)
Duration of diabetes (years), mean ± SD	7.6 ± 3.9	8.7 ± 4.4	8.1 ± 4.2
Baseline HbA1c (%), mean ± SD	9.4 ± 1.2	9.8 ± 1.5	9.6 ± 1.4

After the nurse-led education program, both groups showed significant improvement in glycaemic control. HbA1c levels decreased more in the urban group (from 9.4% to 7.8%) than in the rural group (from 9.8% to 8.3%), with the between-group difference at 6 months being statistically significant (p = 0.04). Mean HbA1c reduction was similar between groups (~1.5–1.6%). Fasting blood glucose levels also improved in both groups, with a greater reduction in the urban group (p = 0.03). (Table 2)

Table 2. Effect of Nurse-Led Education on Glycaemic Control

Outcome	Urban (n=54)	Rural (n=45)	p-value
HbA1c baseline (%)	9.4 ± 1.2	9.8 ± 1.5	0.12
HbA1c after 6 months (%)	7.8 ± 1.0	8.3 ± 1.3	0.04*
Mean reduction in HbA1c (%)	–-1.6 ± 0.6	–-1.5 ± 0.7	0.49
Fasting blood glucose baseline (mg/dl)	182.4 ± 32.5	188.6 ± 35.8	0.28
Fasting blood glucose after 6 months (mg/dl)	142.2 ± 25.4	152.9 ± 28.7	0.03*

*p < 0.05 considered statistically significant

Regarding lifestyle and adherence outcomes, improvements were observed across all measured behaviors. Medication adherence, physical activity, and dietary compliance increased in both groups, although differences between urban and rural participants were not statistically significant. However, regular self-monitoring of blood glucose was significantly more common in the urban group (68.5% vs. 48.9%, p = 0.04). (Table 3)

Table 3. Adherence and Lifestyle Outcomes After Nursing Intervention

Variable	Urban (n=54)	Rural (n=45)	p-value
Medication adherence improved, n (%)	47 (87.0%)	36 (80.0%)	0.32
Increased physical activity, n (%)	39 (72.2%)	28 (62.2%)	0.28
Improved dietary compliance, n (%)	44 (81.5%)	31 (68.9%)	0.14
Regular self-monitoring of blood glucose, n (%)	37 (68.5%)	22 (48.9%)	0.04*

*p < 0.05 considered statistically significant

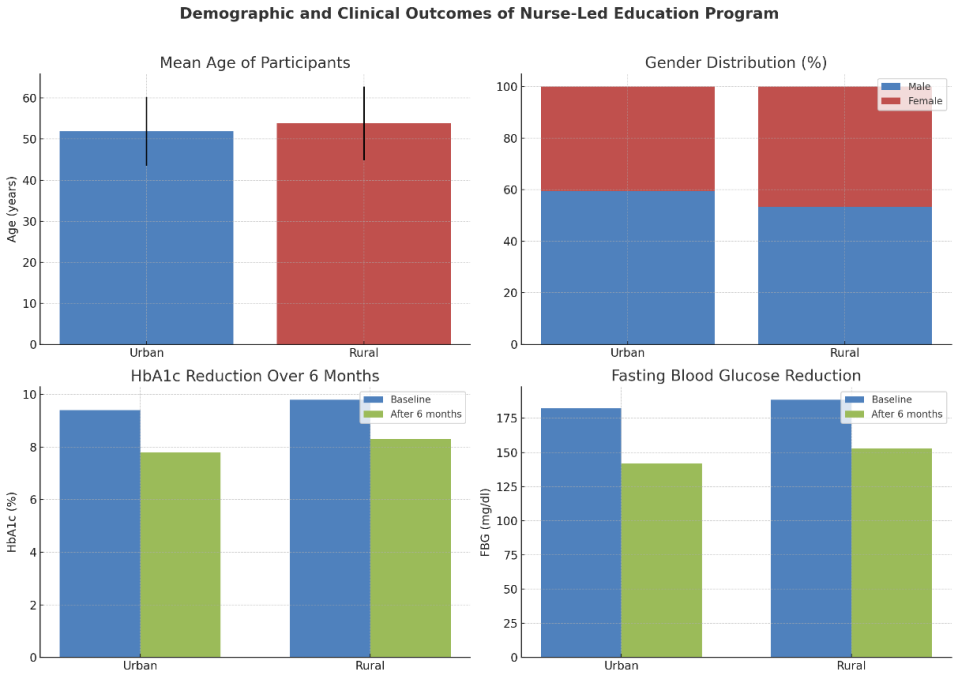

Figure 1: Demographics (age and gender) alongside clinical improvements (HbA1c and fasting blood glucose) for urban and rural participants.

Discussion

The results from our study, which assessed the effectiveness of nurse-led education on glycemic control in patients with Type 2 diabetes mellitus (T2DM), reveal important insights, particularly in contrasting urban and rural settings. In Table 2 of our findings, we observed a statistically significant reduction in HbA1c levels in both the urban group (from 9.4% to 7.8%) and the rural group (from 9.8% to 8.3%), with a notable difference between groups ($p = 0.04$). This finding is consistent with Jiang et al., who reported improved glycemic control from nurse-led educational interventions that foster effective self-management behaviors (Jiang et al., 14). Moreover, the mean reduction in HbA1c was approximately 1.6% across both groups, aligning with the reductions noted in literature discussing the role of structured nursing interventions in managing diabetes outcomes.

In terms of fasting blood glucose levels, both urban and rural populations experienced improvements; however, the reduction was more pronounced in the urban group ($p = 0.03$). This reinforces findings suggesting that urban populations often exhibit better diabetes management outcomes due to increased access to healthcare services and educational resources. The more profound impact on the urban cohort may reflect the complex interplay of resources available in metropolitan areas that facilitate better compliance with diabetes care guidelines.

The lifestyle and adherence outcomes presented in Table 3 indicate improvements in medication adherence, physical activity, and dietary compliance within both groups. Notably, regular self-monitoring of blood glucose was statistically more prevalent among urban participants (68.5% vs. 48.9%, $p = 0.04$). This disparity reflects observed trends that adherence to diabetes self-care practices is often influenced by access to healthcare facilities capable of supporting patient education and follow-up, particularly in urban settings (15). It is crucial to emphasize that while improvements in diet, exercise, and medication adherence were observed across both demographics, the significance of urban benefits highlights the ongoing challenges faced in rural areas regarding healthcare resources and access to education.

Moreover, our findings align with the systemic barriers identified in existing literature. The work by Ramos et al. discusses disparities in health outcomes associated with urban and non-urban healthcare settings, emphasizing that rural patients often face prolonged delays in accessing necessary care interventions (16). This divergence may explain the higher rates of self-monitoring in urban areas and suggests an urgent need for tailored interventions for rural patients that account for their unique challenges.

Thus, our study supports the existing literature, which emphasizes the efficacy of nurse-led educational programs in improving glycemic control among patients with diabetes. The significant differences noted between urban and rural outcomes also underscore the importance of addressing the systemic inequalities that impact patient self-management and adherence to treatment protocols. With T2DM posing an escalating public health challenge, particularly in Pakistan, there is a pressing need for continued development and adaptation of intervention strategies that effectively bridge these urban-rural divides.

Conclusion

Nurse-led educational interventions significantly enhanced glycaemic control, medication adherence, and self-care behaviors among patients with type 2 diabetes mellitus (T2DM) in both urban and rural Pakistan. While urban participants achieved slightly better outcomes, especially in blood glucose control and self-monitoring, the results underscore the importance of expanding and adapting such programs to overcome healthcare access barriers in rural communities. These findings support the integration of structured nurse-led education into national diabetes management strategies to improve long-term outcomes.

Declarations

Data Availability statement

All data generated or analysed during the study are included in the manuscript.

Ethics approval and consent to participate

Approved by the department concerned. (IRBEC-24)

Consent for publication

Approved

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Conflict of interest

The authors declared the absence of a conflict of interest.

Author Contribution

SP (Head Nurse)
Manuscript drafting, Study Design,
SS
Conception of Study, Development of Research Methodology Design,
SK
Review of Literature, Data entry, Data analysis, and drafting articles.
SA
manuscript review, critical input, Conception of Study

All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the integrity of the study.

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