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# Prevalence and Determinants of Poor Glycemic Control and Their Association with Lifestyle Factors and Diabetes-Related Complications among Adults with Type 2 Diabetes: A Cross-Sectional Study

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## Abstract

*Introduction:* Diabetes mellitus of type 2 is a rapidly growing metabolic disorder throughout the world and poor glycemic control has a significant role in the development of diabetes associated complications.
*Objective:* To examine the prevalence and risk factors for sub-optimal glycemic control and its relationship with lifestyle and diabetes complications amongst adults with T2DM.
*Methodology:* This is a cross sectional analytical study that was carried out for a period of one year, from January 2025 to December 2025. A consecutive sampling method was used to select 420 adult patients who were diagnosed with T2DM. The data collection involved in this study was carried out by means of structured questionnaire and also medical record study. HbA1c was used as an indicator of glycemic control and poor control was defined as HbA1c >7%. Chi-square test and multivariable logistic regression were applied for analysis.
*Results:* Out of 420 patients, 264 (62.86%) had poor glycemic control, while 156 (37.14%) had good control. Sedentary lifestyle, smoking, and unhealthy diet were significantly associated with poor glycemic control ($p<0.05$). Poor control was also higher among patients with longer diabetes duration and higher BMI. Diabetic neuropathy was the most common complication (33.81%), followed by retinopathy (28.10%) and nephropathy (22.86%). Regression analysis identified sedentary lifestyle, obesity, smoking, longer disease duration, and presence of complications as independent predictors of poor glycemic control.
*Conclusion:* Poor glycemic control is highly prevalent among type 2 diabetes patients and is strongly associated with modifiable lifestyle factors and diabetes-related complications.
*Keywords:* Type 2 diabetes mellitus, glycemic control, HbA1c, lifestyle factors, diabetes complications

## Introduction

One of the most common chronic metabolic diseases in the world, Type 2 diabetes mellitus (T2DM) is a significant public health problem because of its rising prevalence, need to be managed over life, and high burden in terms of morbidity and mortality [1,2]. The disease involves continuous hyperglycemia due to insulin resistance and gradual failure of the pancreatic beta-cells leading to impaired glucose metabolism and to long-term damage of several organ systems [3]. Urbanization, population ageing, sedentary behavior, poor diets and overweight and obesity have contributed to the rapid increase in the prevalence of T2DM. Although there have been improvements in drug treatment and diabetes management, it is still a challenge for a significant number of patients to reach and hold optimal glycemic control [4].

The poor glycemic control, which is typically determined by measuring glycated hemoglobin (HbA1c), is a major risk factor for a variety of clinical complications [5]. Diabetic retinopathy, diabetic nephropathy, and diabetic neuropathy are microvascular complications, and coronary artery disease, cerebrovascular disease, and peripheral arterial

disease are macrovascular complications, all of which are caused by persistent hyperglycemia [6,7]. Such complications can seriously reduce quality of life, result in increased health services consumption and raise the risk of disability and early death. It is therefore a cornerstone of diabetes care to maintain good glycemic control [8].

A variety of demographic, clinical, behavioral, and lifestyle factors are known to interact to influence the achievement of optimal glycemic control [9]. Several factors have been found to be significant influences on glycemic status, including dietary patterns, physical activity, adherence to medications, smoking, sleep habits, psychological stress and body weight [10]. Furthermore, patients' clinical characteristics, such as disease duration, comorbid conditions, the treatment strategy and socioeconomic factors can influence metabolic control and account for further differences in patient outcomes [11]. Pharmacological treatment is complemented by lifestyle modification as an integral part of the treatment of T2DM, which can enhance insulin sensitivity, help manage body weight and decrease cardiovascular risk. However, compliance with the recommended behaviors are limited in many populations, leading to poor diabetes control and an increased risk for chronic complications [12].

Awareness of the rates of glycemic control and risk factors for poor metabolic control will help in designing interventions and improving diabetes management approaches. Second, assessing lifestyle behaviors, glycemic status, and diabetes-related complications offers useful insight into potentially modifiable risk factors which could lead to enhanced long-term clinical outcomes.

### Research Objective
To examine the prevalence and risk factors for sub-optimal glycemic control and its relationship with lifestyle and diabetes complications amongst adults with T2DM.

## Methodology
### Study Design and Setting
The current study was cross-sectional analytical study and was carried out in the Lady Reading Hospital, Peshawar, among T2DM out patients diabetic clinics of adults.

### Study Duration
This study was conducted during 12 months starting from January 2025 and ended in December 2025.

### Study Population
The study population comprised of adult patients with T2DM attending the Diabetic Out Patient Department during the study period.

### Sample Size
The sample size was calculated based on a standard sample size formula for prevalence studies at a 95% confidence level, 5% margin of error and 50% assumed prevalence rate for poor glycemic control. At least 384 samples were needed. The final sample size was reduced to 420 and 10% was added to cover non-response and missing data.

### Sampling Technique
A non-probability consecutive sampling technique was used and all patients who visited the outpatient diabetic clinic were included until the desired sample size was reached.

### Eligibility Criteria
Adult patients (age 18 and above) with known T2DM for a minimum of one year were recruited for the study. Diabetes mellitus Type 1 and gestational diabetes, severe psychiatric illness and incomplete medical records were not included in this study.

### Data Collection Procedure
The data were gathered by a structured and pretested questionnaire. Patient interviews and a review of medical records were used to gather data on sociodemographic factors, lifestyle factors (food choices, physical activity, smoking status, duration of diabetes, adherence with diabetes medication, and diabetes-related complications).

### Assessment of Glycemic Control
Glycated hemoglobin (HbA1c) was used as a measure of glycemic control and the most recent HbA1c reading recorded in the medical record was used. HbA1c greater than 7.0% was considered as poor glycemic control.

### Study Variables
The dependent variable was glycemic control status, categorized as good or poor. Independent variables included lifestyle factors such as physical activity, dietary habits, smoking status, and body mass index, along with clinical factors including duration of diabetes and presence of complications.

### Statistical Analysis
Data were statistically analyzed using the most suitable software. All continuous variables were presented as mean ± SD, and categorical variables as frequencies and percentages. Chi-square test was used to determine the association between independent variables and glycemic control, and multivariable logistic regression analysis was conducted to determine independent determinants of poor glycemic control. Statistically significant P values were considered to be those with p value $< 0.05$.

### Ethical Considerations
Prior to the start of the study, the institutional review board of Lady Reading Hospital, Peshawar, approved the study. All participants gave their written informed consent and confidentiality and anonymity of patient information were maintained throughout the study.

## Results
The study included 420 patients with T2DM (Table 1). The majority were aged 41–60 years (52.62%), followed

by those aged >60 years (32.62%) and 18–40 years (14.76%), with a male predominance (55.00% vs 45.00% females). Most participants were overweight (44.29%) or obese (32.38%), while 23.33% had normal BMI. Regarding diabetes duration, 40.95% had disease for <5 years, 37.62% for 5–10 years, and 21.43% for >10 years.

**Table 1:** Baseline Characteristics of Study Participants (N = 420)

| Variable | Category | Frequency (n) | Percentage (%) |
|---|---|---|---|
| Age (years) | 18–40 | 62 | 14.76 |
| | 41–60 | 221 | 52.62 |
| | >60 | 137 | 32.62 |
| Gender | Male | 231 | 55.00 |
| | Female | 189 | 45.00 |
| BMI (kg/m²) | Normal | 98 | 23.33 |
| | Overweight | 186 | 44.29 |
| | Obese | 136 | 32.38 |
| Duration of diabetes | <5 years | 172 | 40.95 |
| | 5–10 years | 158 | 37.62 |
| | >10 years | 90 | 21.43 |

The prevalence of glycemic control status showed that 62.86% (n=264) of patients had poor glycemic control (HbA1c >7%), while 37.14% (n=156) had good control (Figure 1).

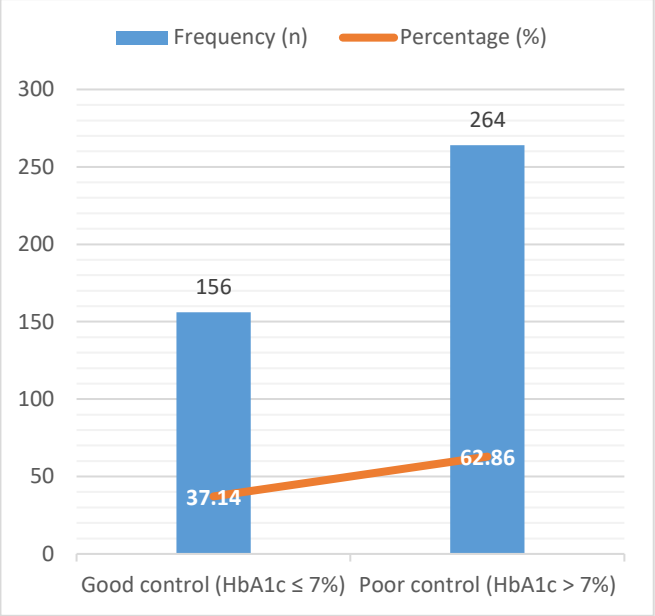


**Figure 1:** Prevalence of Glycemic Control Status among Participants (N = 420)

Lifestyle factors demonstrated significant associations with poor glycemic control (Table 2). Sedentary individuals had a higher proportion of poor control (65.15% vs 47.92% in active patients, $\chi^2$=18.45, p<0.001). Similarly, smokers showed higher poor control (71.01% vs 62.88% in non-smokers, $\chi^2$=22.67, p<0.001), and those with unhealthy diet patterns also had worse glycemic outcomes (66.67% vs 53.01%, $\chi^2$=12.33, p=0.001).

**Table 2:** Association between Lifestyle Factors and Poor Glycemic Control (Chi-square Analysis)

| Variable | Category | Poor Control n (%) | Good Control n (%) | $\chi^2$ value | p-value |
|---|---|---|---|---|---|
| Physical activity | Active | 92 (47.92) | 100 (64.10) | 18.45 | <0.001 |
| | Sedentary | 172 (65.15) | 56 (35.90) | | |
| Smoking status | Smoker | 98 (71.01) | 40 (25.64) | 22.67 | <0.001 |
| | Non-smoker | 166 (62.88) | 116 (74.36) | | |
| Diet pattern | Healthy | 88 (53.01) | 104 (66.67) | 12.33 | 0.001 |
| | Unhealthy | 176 (66.67) | 52 (33.33) | | |

Clinical factors were also significantly associated. Patients with diabetes duration ≥5 years had higher poor control (71.76% vs 45.35%, $\chi^2$=19.52, p<0.001), shown in table 3. Overweight/obese individuals showed greater poor control (68.22% vs 42.86% in normal BMI, $\chi^2$=24.11, p<0.001), and those with complications had markedly higher poor control (76.36% vs 47.06%, $\chi^2$=31.48, p<0.001, Table 3).

**Table 3:** Association between Clinical Factors and Glycemic Control (Chi-square Analysis)

| Variable | Category | Poor Control n (%) | Good Control n (%) | $\chi^2$ value | p-value |
|---|---|---|---|---|---|
| Duration of diabetes | <5 years | 78 (45.35) | 94 (54.65) | 19.52 | <0.001 |
| | ≥5 years | 186 (71.76) | 74 (28.24) | | |
| BMI | Normal | 42 (42.86) | 56 (57.14) | 24.11 | <0.001 |
| | Overweight/Obese | 222 (68.22) | 104 (31.78) | | |
| Complications | Present | 168 (76.36) | 52 (23.64) | 31.48 | <0.001 |
| | Absent | 96 (47.06) | 108 (52.94) | | |

Regarding complications, diabetic neuropathy was the most common (33.81%), followed by retinopathy (28.10%), nephropathy (22.86%), coronary artery disease (20.95%), and stroke (12.86%) (Figure 2).

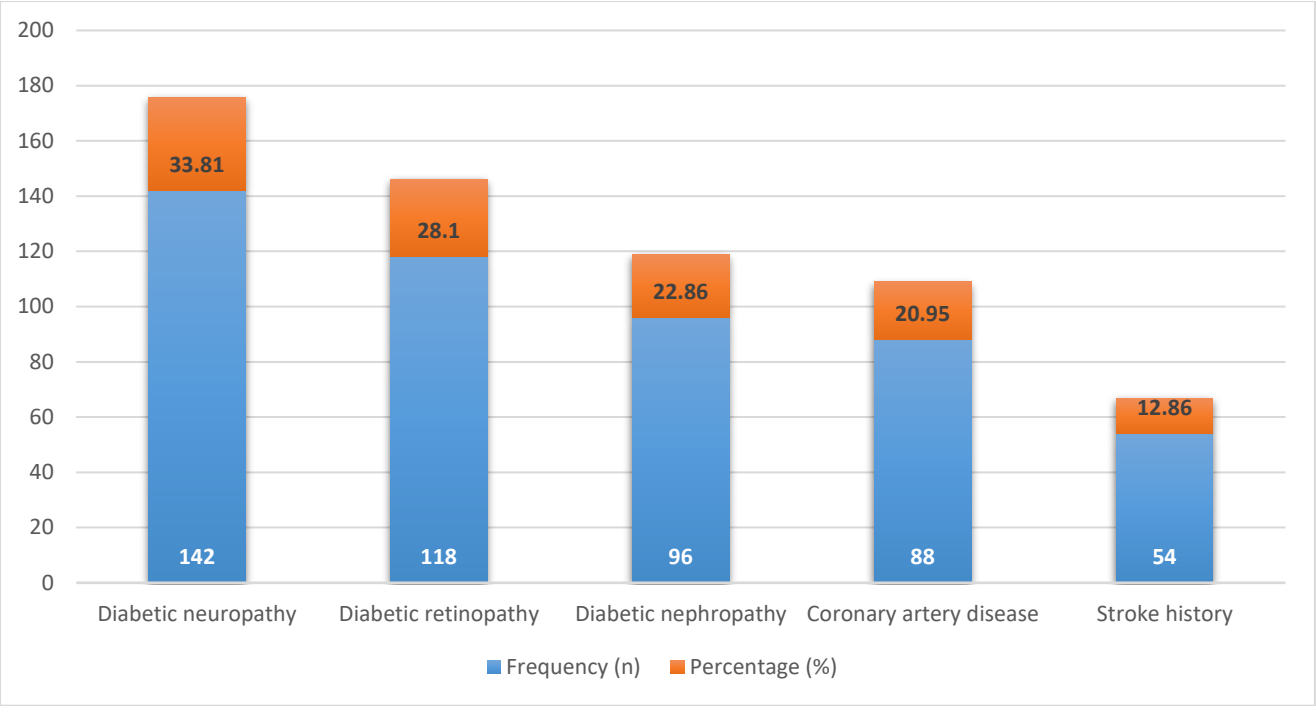


**Figure 2:** Diabetes-Related Complications among Participants (N = 420)

Multivariable logistic regression identified independent predictors of poor glycemic control (table 4). Sedentary lifestyle (AOR=2.41, 95% CI: 1.52–3.82), smoking (AOR=2.18, 95% CI: 1.31–3.64), unhealthy diet (AOR=1.87, 95% CI: 1.19–2.94), duration ≥5 years (AOR=2.63, 95% CI: 1.68–4.11), overweight/obesity (AOR=2.95, 95% CI: 1.89–4.60), and presence of complications (AOR=3.42, 95% CI: 2.12–5.51) were all significantly associated with poor glycemic control (all p<0.05, Table 4).

**Table 4:** Multivariable Logistic Regression Analysis for Determinants of Poor Glycemic Control

| Variable | Adjusted OR | 95% CI | p-value |
|---|---|---|---|
| Sedentary lifestyle | 2.41 | 1.52–3.82 | <0.001 |
| Smoking | 2.18 | 1.31–3.64 | 0.003 |
| Unhealthy diet | 1.87 | 1.19–2.94 | 0.006 |
| Duration ≥5 years | 2.63 | 1.68–4.11 | <0.001 |
| Overweight/Obesity | 2.95 | 1.89–4.60 | <0.001 |
| Presence of complications | 3.42 | 2.12–5.51 | <0.001 |

## Discussion

In this study, 62.86% (n=264/420) of patients with T2DM had poor glycemic control with 37.14% (n=156/420) having good glycemic control. This high prevalence is similar to that of a large meta-analysis of low- and middle-income countries that found that only about 69% of T2DM patients achieved adequate glycemic control, suggesting that poor metabolic control is a common problem in this type of health care [13]. Our results also showed that despite treatment, low glycemic control is extremely common in South Asian populations.

In our study, sedentary lifestyle was found to be a significant association with poor glycemic control (65.15% vs 47.92%, $\chi^2$=18.45, p<0.001) and was an independent risk factor (AOR=2.41, p<0.001). A systematic review and meta-analysis found that physical inactivity was significantly related to greater HbA1c levels and worse metabolic outcomes [14]. Further, physical activity interventions reportedly led to the largest HbA1c reduction than diet or combined interventions in a South Asian meta-analysis, further emphasizing the role of physical activity in glycemic control [15].

Smoking was another important factor in our study with poor control being higher among smokers (71.01% vs 62.88%, p<0.001) and increased odds (AOR=2.18, p=0.003). This is consistent with the results of systematic reviews demonstrating that smoking increases insulin resistance, oxidative stress and deteriorates glycemic parameters in T2DM patients [16]. These associations have been continuously documented in observation studies in Pakistan and other LMICs.

Dietary pattern also strongly affected the dietary pattern, unhealthy diet was associated with poor control (66.67% vs 53.01%, p=0.001) and was an independent risk factor (AOR=1.87). In line with this, the results are consistent with the evidence that poor dietary habits are associated with clinically significant poor HbA1c control, and that dietary changes result in clinically meaningful HbA1c reductions [14]. This underscores the importance of nutritional practices in the management of diabetes.

The association of poor glycemic control with clinical variables was significant, as longer duration of diabetes (AOR=2.95) and higher BMI (AOR=1.65) were associated with poor glycemic control. The association of poor glycemic control with clinical variables was significant, longer duration of diabetes (AOR=2.95) and higher BMI (AOR=1.65) being associated with poor glycemic control. These results are in line with previous studies documenting that insulin resistance and progressive β-cell dysfunction increase with disease duration and obesity, which are important factors for uncontrolled diabetes in the South Asian population [17].

Lastly, poorly controlled diabetes was significantly more present in poorly controlled patients (76.36% vs 47.06%, p<0.001); and the strongest predictor of poor glycemic control (AOR=3.42). In a multicenter study performed in Pakistan, higher HbA1c was strongly associated with neuropathy, retinopathy and cardiovascular disease was reported [18]. This suggests that chronic hyperglycemia is a direct link to microvascular and macrovascular complications, with the need to optimize glycaemia at an early stage.

### Strengths and Limitations

The present study has a number of strengths: The sample size was relatively adequate; A pre-tested and structured questionnaire was used to ensure the reliability of the findings, and the assessment of glycemic control was done using objective indicators (recent HBA1C) which constitutes another strength for the present study. The addition of lifestyle and clinical variables, and multivariate logistic regression analysis, enabled a thorough investigation of independent factors associated with poor glycemic control. Furthermore, the study was carried out in the tertiary care hospital setting which enhanced access to a wide spectrum of diabetic population. There are also some drawbacks to the study. The cross-sectional design means that it is difficult to draw causal inferences between the risk factors and glycemic control. Self-report of lifestyle factors may lead to recall bias and reporting bias. Moreover, the results of the study may be limited to the larger population of diabetics in other parts of the country and primary care centers.

## Conclusion

It shows that glycemic control is very poor in adults with T2DM and is significantly linked to lifestyle factors and T2DM associated complications. Important contributors to the inadequate glycemic control were identified as sedentary behavior, unhealthy dietary habits, smoking, increased body weight, longer disease duration and the presence of complications. The results indicate the need for better lifestyle modification, patient education and frequent monitoring to improve the metabolic control and decrease the burden of diabetes-related complications in clinical practice.

### Author Contributions

All authors contributed equally to the conception and design of the study, data collection, analysis and interpretation of data, drafting and critical revision of the manuscript, and approved the final version for publication. All authors meet the authorship criteria of the ICMJE and agree to be accountable for all aspects of the work.

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### Declarations

*Ethical statement*: Prior to the start of the study, the institutional review board of Lady Reading Hospital, Peshawar, approved the study. All participants gave their written informed consent and confidentiality and anonymity of patient information were maintained throughout the study.

*Competing interests*: The authors declare that they have no known competing interests.

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