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ORIGINAL ARTICLE

Clinical Evaluation of Glycemic Control and Its Role in Diabetic Complication Patterns Among Patients with Type 2 Diabetes Mellitus

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ABSTRACT

Background: Poor glycemic control is a major burden of microvascular and macrovascular complications associated with type 2 diabetes mellitus (T2DM) in Pakistan. Glycemic control and its relation to complications in government hospital settings are currently poorly described.

Aims and Objectives: This study aimed to find out the glycemic control and its correlation with Diabetic complications in T2DM patients who were attending Lady Reading Hospital MTI Peshawar, Pakistan.

Methodology: A cross-sectional observational study was conducted from June 2022 to June 2023. Convenience sampling was conducted such that a total of 100 adult T2DM patients (≥30 years, duration ≥1 year) were enrolled. Structured interviews were performed, and a medical record review was conducted for demographic and clinical data. HbA1c was obtained and classified as good (<7%), moderate (7–7.9%), or poor (≥8%) to determine glycemic control. Clinical examination and records were used to assess diabetic complications (retinopathy, neuropathy, nephropathy, and cardiovascular disease). Pearson's correlation and logistic regression were carried out in SPSS version 25.0 for statistical analysis.

Results: Age at diagnosis was 55.6 ± 10.2 years; 52% were female. Only 12% had good glycemic control, and 64% had poor control (HbA1c ≥8%). Neuropathy 42%, retinopathy 36%, nephropathy 28%, and cardiovascular disease 22%, respectively, are complication rates. Complications were significantly correlated with higher HbA1c, retinopathy (r =0.42), neuropathy (r =0.39), nephropathy (r =0.34), and cardiovascular disease (r =0.28) (all p <0.01). As an independent predictor, poor control was confirmed by logistic regression.

Conclusion: Glycemic control was poor and complicated, reflecting the urgent need for better diabetes care, education, and regular screening in public hospitals.

Keywords: Type 2 diabetes mellitus, HbA1c, diabetic complications, neuropathy, retinopathy, nephropathy, Pakistan

INTRODUCTION

Type 2 Diabetes Mellitus (T2DM) poses as a critical public health issue globally, where it represents up to 90% of all diabetes cases. According to the International Diabetes Federation (IDF), in 2021, around 537 million adults were living with diabetes (projected to be 643 million in 2030). The diabetes epidemic in Pakistan has reached alarming levels with a national prevalence of 26.7% in adults aged 20–79 years, which puts the country in the third position in the global diabetes ranking after China and India. Factors that contribute to this surge in Pakistan are the rapid urbanization, sedentary lifestyles, unhealthy dietary patterns, obesity, increasing life expectancy, high consanguinity, and family history of diabetes [1].

Type 2 diabetes is a progressive metabolic disorder of insulin resistance, impaired insulin secretion, and chronic hyperglycemia. Persistent hyperglycemia without adequate management results in a variety of devastating microvascular complications, including diabetic retinopathy, nephropathy, and neuropathy, and macrovascular complications, including ischemic heart disease, stroke, and peripheral arterial disease. These complications have a serious negative impact on quality of life, are associated with increased healthcare costs, and contribute to premature morbidity and mortality [2].

Long-term glucose regulation and risk of complications are evaluated by glycemic control, which is usually measured by glycated hemoglobin (HbA1c). However, it is beyond question that stringent glycemic control in studies such as the Diabetes Control and Complication Trial (DCCT) and the UK Prospective Diabetes Study (UKPDS) acutely and significantly reduces the incidence and progression of microvascular and macrovascular complications [3]. Most adults with T2DM are advised by the American Diabetes Association and other international guidelines to achieve an HbA1c target of below 7 percent to prevent complications and improve survival [4].

Despite the availability of strong evidence and evidence-based treatment guidelines, optimal glycemic control in Pakistan remains a formidable challenge. Poor glycemic control is due to a lack of awareness, low health literacy, financial constraints, lack of availability of diabetes medications and monitoring supplies, poor adherence to medications, irregular follow-up visits, and an overloaded public healthcare system. Patients from lower socioeconomic groups who need to rely on government hospitals are not only vulnerable to uncontrolled diabetes but also its complications as well [5].

It is a huge burden of diabetes complications in Pakistan. Diabetic nephropathy is the most common cause of end-stage renal disease in the country, and retinopathy is one of the leading causes of blindness. Foot ulcers and amputations are common complications associated with diabetic neuropathy, and it is cardiovascular disease that accounts for the most deaths among diabetic patients [6]. However, there is no published data about the association between glycemic control and the prevalence of these complications in the population attending government hospitals in Pakistan. There are major knowledge gaps for patients in the public healthcare sector because most available studies are either from private sector hospitals or small community-based surveys [7].

The present study aimed to determine the glycemic control status and to find out the relation between glycemic control and diabetic complications prevalent among T2DM patients visiting the main government hospitals in Pakistan[8]. Through this underserved population, the study intends to develop critical insights into national health strategy, improve bedside management, and ultimately, reduce the diabetes burden of morbidity and mortality in Pakistan. About poor glycemic control, it is crucial to understand how far it has gone and to what extent it relates to complications, so that targeted interventions, such as better screening programs, patient education programs, better access to medication, and the establishment of multidisciplinary management within the public health system, can be developed [9].

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MATERIALS AND METHODS

This is a cross-sectional observational study conducted during one year, June 2022 to June 2023, at Lady Reading Hospital, MTI Peshawar, Pakistan. Located in one of the country's largest tertiary care public hospitals, Lady Reading Hospital serves a wide catchment area from Khyber Pakhtunkhwa province, covering urban as well as rural populations of patients. In a government healthcare context, the busy outpatient diabetic clinics of the hospital were an appropriate place to assess the glycemic control and its relation to diabetic complications.

The study consisted of 100 adult patients who were confirmed to have type 2 diabetes mellitus (T2DM) for at least one year. The diabetic outpatient department was used as a source of patients, and they were selected consecutively using a convenience sampling approach. We included patients aged 30 years or older with a T2DM diagnosis according to ADA guidelines and willing and able to provide written informed consent. Patients were excluded if they had type 1 diabetes, gestational diabetes, steroid-induced diabetes, severe cognitive impairment, or incomplete medical records.

Structured questionnaire, review of medical records, and laboratory investigation were used to collect data. The sociodemographic data included age, sex, marital status, education level, occupation, and socioeconomic status. Disease duration, body mass index (BMI), smoking status, comorbid conditions (such as hypertension or dyslipidemia), family history of diabetes, and information on the diabetes management (oral hypoglycemic agents, insulin, combination therapy) and the frequency of blood glucose monitoring were also provided as clinical information.

Glycated hemoglobin (HbA1c) was measured, which reflects average blood glucose levels over the preceding two to three months, and was used to assess glycemic control. Blood samples were obtained and analyzed in the hospital's central laboratory using standardized and validated enzymatic assays. According to ADA recommendations, HbA1c values were categorized as good control (<7%), moderate control (7–7.9%), or poor control (≥8%). Assessment of diabetic complications was made through clinical examination and documented diagnoses in patient records. Fundoscopic examination by an ophthalmologist diagnosed diabetic retinopathy, 10-g monofilament test, and patient history were used to examine neuropathy, microalbuminuria, or elevated serum creatinine tested for nephropathy, and history of diabetic disease, ECG findings, or previous hospital admissions for ischemic events identified the presence of cardiovascular disease.

The study was approved by the institutional review board . After being briefed on the purpose and procedures of the study, all participants gave written informed consent. Confidentiality of the patient as well as privacy of data was strictly maintained during the period of research.

SPSS version 25.0 was used for statistical analysis. Means with SD (continuous), and frequencies and percentages (categorical) were used to report continuous and categorical variables, respectively. The relationship between levels of HbA1c and diabetic complications was evaluated using Pearson's correlation coefficient. Independent predictors of complications were determined by logistic regression analysis, controlling for confounding variables such as age, sex, duration of diabetes, and comorbid conditions. All analyses had a p-value less than 0.05, considered statistically significant.

RESULTS

The study included a total of 100 adult patients of type 2 diabetes mellitus (T2DM) at Lady Reading Hospital MTI, Peshawar, Pakistan, between June 2022 and June 2023. The patient's mean age was 55.6 ± 10.2 years, and 52% of patients were females (n = 52) and 48% males (n = 48), ensuring balanced gender distribution. Table 1 shows the demographic and clinical characteristics. The duration of diabetes was 8.7 ± 5.1 years. Most patients were overweight or obese (BMI 27.3 ± 3.5 kg/m²). Current smokers were 22%, and males accounted for the majority of smokers (39.6% vs 5.8% in females). The prevalence of hypertension in the cohort was 64%, and dyslipidemia was 48%. Of 62% of patients on oral hypoglycemic agents, 28% were on insulin therapy, and 10% were on combination therapy. Only 38% of patients reported regular self-monitoring of blood glucose; thus, there was a huge gap in diabetes self-care practices.

Table 1: Demographic and Clinical Characteristics of Study Participants (n = 100)

Variable	Total (n = 100)	Male (n = 48)	Female (n = 52)
Age (years), mean ± SD	55.6 ± 10.2	56.2 ± 10.8	55.1 ± 9.8
Duration of diabetes (years), mean ± SD	8.7 ± 5.1	9.1 ± 5.3	8.3 ± 4.9
BMI (kg/m²), mean ± SD	27.3 ± 3.5	26.9 ± 3.6	27.7 ± 3.4
Current smokers, n (%)	22 (22%)	19 (39.6%)	3 (5.8%)
Hypertension, n (%)	64 (64%)	30 (62.5%)	34 (65.4%)
Dyslipidemia, n (%)	48 (48%)	24 (50%)	24 (46.1%)
Oral hypoglycemic therapy, n (%)	62 (62%)	28 (58.3%)	34 (65.4%)
Insulin therapy, n (%)	28 (28%)	15 (31.3%)	13 (25%)
Combination therapy, n (%)	10 (10%)	5 (10.4%)	5 (9.6%)
Self-monitoring of glucose, n (%)	38 (38%)	20 (41.7%)	18 (34.6%)

Table 2: Glycemic Control Based on HbA1c Levels

Glycemic Control Category	Total (%)	Male (%)	Female (%)	Mean HbA1c (%) ± SD
Good control (<7%)	12 (12%)	5 (10.4%)	7 (13.5%)	6.6 ± 0.2
Moderate control (7–7.9%)	24 (24%)	10 (20.8%)	14 (26.9%)	7.5 ± 0.3
Poor control (≥8%)	64 (64%)	33 (68.8%)	31 (59.6%)	8.9 ± 0.5

Table 2 shows the distribution of glycemic control. Good glycemic control (HbA1c <7%) was achieved by only 12% of patients, moderate control (HbA1c 7–7.9%) by 24%, and the majority (64%) had poor glycemic control (HbA1c ≥8%). Across the cohort, the mean HbA1c was 8.4 ± 1.3%, which overall indicates a degree of poor glucose regulation.

Table 3 outlines the prevalence of diabetic complications. The most common complication was diabetic neuropathy in 42%, retinopathy in 36%, nephropathy in 28%, and cardiovascular disease in 22%. However, cardiovascular disease occurred more often in males, presumably because of higher smoking rates, but the distribution of complications between males and females was similar.

Table 3: Prevalence of Diabetic Complications by Gender

Complication	Total (%)	Male (%)	Female (%)
Retinopathy	36 (36%)	18 (37.5%)	18 (34.6%)
Neuropathy	42 (42%)	21 (43.8%)	21 (40.4%)
Nephropathy	28 (28%)	14 (29.2%)	14 (26.9%)
Cardiovascular disease	22 (22%)	12 (25%)	10 (19.2%)

Table 4 shows correlation analysis indicating that there is a significant association between the presence of all the major

diabetic complications and higher HbA1c levels. In particular, Pearson's correlation coefficients were 0.42 for retinopathy (p <0.001), 0.39 for neuropathy (p <0.001), 0.34 for nephropathy (p =0.001), and 0.28 for cardiovascular disease (p =0.006). This suggests that the presence of complications is strongly linked with worsening glycemic control.

Table 4: Correlation Between HbA1c and Diabetic Complications

Complication	Correlation coefficient (r)	p-value
Retinopathy	0.42	<0.001
Neuropathy	0.39	<0.001
Nephropathy	0.34	0.001
Cardiovascular disease	0.28	0.006

After adjusting for age, sex, duration of diabetes, BMI, hypertension, and dyslipidemia, poor glycemic control (HbA1c ≥8%) was an independent predictor of diabetic complications using multivariate logistic regression analysis. In particular, poor control was associated with a 3.4 (95% CI: 1.7–6.7, p<0.001), 3.1 (95% CI: 1.6–5.9, p =0.001), 2.7 (95% CI: 1.3–5.5, p =0.004), and 2.3 (95% CI: 1.1–4.8, p =0.02) increased risk of retinopathy, neuropathy, nephropathy, and cardiovascular disease, respectively. After adjustment, these associations persisted, indicating an important role of glycemic control in the prevention of diabetes related complications.

Overall, this study demonstrates that most of the patients with T2DM visiting Lady Reading Hospital MTI, Peshawar, have poor glycemic control as well as a high burden of microvascular and macrovascular complications. By including both genders, a meaningful comparison could be made, and it was shown that both men and women are equally vulnerable to poor outcomes when glycemic control is not well achieved. However, the data also underline the need for better diabetes care, patient education, and regular screening in this population.

DISCUSSION

This study aimed to evaluate the glycemic control and its correlation with diabetic complications in patients with type 2 diabetes mellitus (T2DM) attending Lady Reading Hospital MTI, Peshawar, Pakistan. Our results showed that there was poor glycemic control in the majority of patients, with two-thirds (64%) of patients having HbA1c levels ≥8%, and poor diabetes management in the public health care setting. These results are consistent with previous reports in Pakistan and other low and middle-income countries where barriers to healthcare, low health literacy, financial barriers, and poor adherence to treatment regimens lead to suboptimal diabetes control. [10].

Microvascular complications were prevalent in the study population, with neuropathy (42%), retinopathy (36%), and nephropathy (28%) being the most common. 22% of the patients had cardiovascular disease as a major macrovascular complication. Consistent with previous international studies suggesting that poor glycemic control accelerates the progression of both microvascular and macrovascular complications, these results are consistent with [11]. Consistent with a role for sustained hyperglycemia in the pathogenesis of diabetic tissue damage, the present study confirmed a strong positive correlation between elevated HbA1c levels and all assessed complications [12].

One notable observation was that the glycemic control and its complications had no sex differences. However, male patients had a slightly higher prevalence of cardiovascular disease, probably because they smoked more, but had similar complication rates to female patients overall. This highlights the importance of targeted interventions in both sexes, and especially in cardiovascular risk reduction in men [13].

Logistic regression analysis indeed showed that poor glycemic control was independently associated with the risk of diabetic complications, even after controlling for the effects of confounding factors, including age, sex, duration of diabetes, BMI, hypertension, and dyslipidemia. This emphasizes the importance of high target glycemic levels for diabetes care [14].

The low proportion of patients (38%) self-monitoring their blood glucose further demonstrates the lack of patients' education and access to basic diabetes care resources. Insulin or combination therapy has been shown in previous studies to be associated with improved glycemic outcomes when patients are self-monitoring. This gap needs to be urgently addressed through patient counseling, improved access to glucose monitoring devices, and implementation of structured diabetes education programs [15].

However, some limitations of this study should be noted. Design of the cross sections does not allow for causal inferences, and a single center may limit the generalizability of the findings to other settings in Pakistan. In addition, complication rates using hospital-based data may be inflated, as these patients attend tertiary centres where they may be more advanced in their disease. Further work on the temporal relationships between glycemic control and complication development is needed, and future longitudinal multicenter studies are recommended [16, 17].

CONCLUSION

Finally, this study suggests that patients with T2DM in Pakistan have an extremely high burden of poor glycemic control and diabetes related complications seen in a large Pakistani government hospital. Strong correlation of elevated HbA1c levels with microvascular and macrovascular complications, and poor glycemic control as an independent predictor of these outcomes was noted. The findings highlight the need for improved diabetes management strategies, including increased glycemic monitoring, more frequent screening for complications, and total diabetes education. Reduction of morbidity and mortality related to T2DM requires addressing these issues at the public level of healthcare in Pakistan.

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