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PREVALENCE OF MICROVASCULAR AND MACROVASCULAR COMPLICATIONS IN DIABETES MELLITUS PATIENTS

Original Research

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ABSTRACT

Background: Diabetes Mellitus (DM) is a chronic metabolic disorder with a rising global prevalence, currently affecting over 476 million adults. It is strongly associated with both microvascular and macrovascular complications that significantly contribute to morbidity, disability, and healthcare costs. Timely identification and management of these complications are essential to prevent long-term adverse outcomes and improve patient quality of life.

Objective: To determine the prevalence of microvascular and macrovascular complications in patients diagnosed with Diabetes Mellitus and to assess associated clinical risk factors.

Methods: This descriptive cross-sectional study was conducted in the Department of Internal Medicine, CMH Lahore, from October 2024 to March 2025. A total of 83 adult patients with a confirmed diagnosis of diabetes mellitus were included. Data were collected using a structured proforma, covering demographics (age, gender), clinical history (duration of diabetes, HbA1c level, hypertension, smoking status), and physical activity levels. The presence of microvascular (retinopathy, nephropathy, neuropathy) and macrovascular (coronary artery disease, peripheral vascular disease, cerebrovascular disease) complications was assessed through clinical history and record review. Data were analyzed using SPSS v27, and associations were tested using chi-square with significance set at $p<0.05$.

Results: Of the 83 patients, 45 (54.2%) were male and 38 (45.8%) female, with a mean age of 47.3 ± 10.2 years. The average duration of diabetes was 8.5 ± 4.7 years, and the mean HbA1c level was 8.2% ± 1.5%. Hypertension was observed in 62.7%, and 42.2% were smokers. A total of 74.7% had at least one complication. Microvascular complications were seen in 53%: retinopathy (32.5%), neuropathy (26.5%), and nephropathy (21.7%). Macrovascular complications affected 32.5%: coronary artery disease (14.5%), peripheral vascular disease (9.6%), and cerebrovascular disease (8.4%).

Conclusion: The study demonstrates a high prevalence of both microvascular and macrovascular complications among patients with diabetes mellitus, with significant associations to poor glycemic control, hypertension, smoking, and prolonged disease duration. These findings reinforce the urgent need for early screening and integrated management strategies in routine diabetes care.

Keywords: Coronary Artery Disease, Diabetes Mellitus, Diabetic Nephropathies, Diabetic Neuropathies, Diabetic Retinopathy, Prevalence, Vascular Complications.

INTRODUCTION

Diabetes Mellitus remains a significant global health concern, affecting approximately 476 million adults worldwide, and is associated with a wide array of serious and potentially life-threatening complications (1). While advancements in therapeutic strategies have improved glycemic control and reduced the risk of complications, diabetes continues to be a major contributor to morbidity and mortality, particularly due to its microvascular and macrovascular sequelae (2). Recent clinical guidelines emphasize the necessity of individualized treatment approaches that consider coexisting conditions and their influence on therapeutic outcomes (3). Despite these developments, there remains a critical gap in understanding the natural course of the disease, especially regarding the timing and prevalence of complications, both at diagnosis and during follow-up (4,5). Evidence suggests that a considerable proportion of individuals with diabetes may already present with complications at the time of diagnosis, underscoring the importance of early detection and timely intervention (6). Arnold et al. conducted a large-scale study involving 11,357 participants from 33 countries, revealing that over a three-year follow-up period, 16% developed new microvascular complications and 6.6% developed macrovascular complications. By the end of the study, 31.5% had at least one microvascular and 16.6% had at least one macrovascular complication (7). Other studies have further reinforced these findings. For instance, a study reported diabetic neuropathy in 11.1% of patients, nephropathy in 21.1%, and retinopathy in 6.2%, with a notable proportion experiencing multiple complications simultaneously (8).

Additionally, diabetic foot ulcers were observed in 40.2% of the cohort (9). A study identified a 6.05% prevalence of micro and macrovascular complications, with myocardial infarction, stroke, and renal failure being prominent outcomes, concluding that such complications significantly burden public health systems (10). Similarly, a study reported median prevalence rates of 12%, 15%, and 16% for retinopathy, nephropathy, and neuropathy, respectively, along with macrovascular conditions such as ischemic heart disease (10%), peripheral arterial disease (6%), and stroke (2%), emphasizing late-stage diagnosis in many low- and middle-income countries (11). These findings point to a pressing need for targeted research in regions where healthcare resources are limited, and where the burden of diabetes-related complications is often underestimated. The lack of comprehensive data from low- and middle-income countries impairs efforts to design effective preventive and management strategies. Understanding the prevalence of complications among diabetic populations in these settings is essential for guiding evidence-based clinical practices, informing health policy, and implementing cost-effective interventions. Therefore, the primary objective of this study is to determine the prevalence of microvascular and macrovascular complications among individuals with diabetes. This will provide crucial insights into the burden of diabetes in resource-constrained settings and support the need for early diagnosis and timely intervention to prevent or mitigate long-term complications.

METHODS

This cross-sectional study was conducted in the Department of Internal Medicine at CMH Lahore from October 2024 to March 2025, aiming to assess the prevalence of microvascular and macrovascular complications among patients with diabetes mellitus. A sample size of 83 participants was calculated using the WHO sample size calculator, based on an anticipated prevalence of 31.5% for microvascular complications in diabetic patients (8), with a 95% confidence level and an absolute precision of 10%. The study population included both male and female patients aged between 18 and 60 years who presented with a clinical diagnosis of diabetes mellitus. Pregnant women were excluded to avoid confounding factors related to gestational physiological changes that could impact vascular outcomes. Ethical approval for the study was obtained from the hospital's ethics review committee and written informed consent was secured from all participants prior to data collection. A structured, pre-tested proforma was used to gather demographic and clinical data, including patient name, age, gender, HbA1c levels, duration of diabetes, physical activity status, hypertension, and smoking history (yes/no). The presence of microvascular complications—such as diabetic retinopathy, nephropathy, and neuropathy—and macrovascular complications—including coronary artery disease, peripheral vascular disease, and cerebrovascular disease—was evaluated through a comprehensive review of the participants' medical records and clinical history. Diagnoses were corroborated using available laboratory and imaging reports where applicable to ensure diagnostic accuracy and consistency in data reporting.

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All collected data were systematically entered and analyzed using SPSS version 27.0. Categorical variables, such as gender, physical activity, hypertension, smoking status, and presence of complications, were expressed as frequencies and percentages. Continuous variables like age, HbA1c levels, and diabetes duration were reported as means and standard deviations. Stratification of data was carried out across variables including age groups, gender, hypertension status, HbA1c levels, diabetes duration, and smoking status to assess variations in complication prevalence across subgroups. Associations between these factors and the occurrence of microvascular or macrovascular complications were analyzed using the chi-square test. A p-value of less than 0.05 was considered statistically significant for determining meaningful associations.

RESULTS

Data was obtained from a total of 83 patients diagnosed with diabetes mellitus. Among the participants, 54.2% were male and 45.8% were female. The mean age was 47.3 ± 10.2 years, and the average duration of diabetes was 8.5 ± 4.7 years. The mean HbA1c level was 8.2% ± 1.5%. Regarding physical activity, 86.7% of patients reported low to moderate levels, while 27.7% engaged in high physical activity. Hypertension was observed in 62.7% of the cohort, and 42.2% reported a positive history of smoking. Out of the total sample, 74.7% of patients exhibited at least one diabetes-related complication. Microvascular complications were present in 53% of participants, with diabetic retinopathy being the most frequent (32.5%), followed by diabetic neuropathy (26.5%) and nephropathy (21.7%). Macrovascular complications were observed in 32.5% of patients, with coronary artery disease accounting for 14.5%, peripheral vascular disease 9.6%, and cerebrovascular disease 8.4%.

Complication prevalence did not show a statistically significant difference by gender ($p=0.17$), although slightly more males (55.6%) had complications compared to females (50%). Age was a significant factor, with individuals aged 40–60 years demonstrating a notably higher prevalence of complications (82%) compared to those aged 18–39 years (58%) ($p<0.05$). Glycemic control showed a strong association with complications: 81% of patients with HbA1c >8% had complications, while only 52% of those with HbA1c ≤8% were affected ($p<0.01$). Patients with HbA1c levels ≤7% had the lowest prevalence of complications (45%), compared to 66% in the 7–8% group and 81% in those exceeding 8% ($p<0.01$). Additional significant associations were identified between complications and other risk factors. Hypertension was linked to a higher prevalence of complications, with 76% of hypertensive patients affected compared to 56% of non-hypertensives ($p<0.05$). Smoking status was also significant; complications were present in 80% of smokers versus 65% of non-smokers ($p<0.05$). The duration of diabetes had a strong relationship with complications, with 89% of those with diabetes for over 10 years experiencing complications, compared to 58% in those with five years or less ($p<0.01$).

Physical activity was inversely associated with complication prevalence. Patients with low to moderate physical activity had a complication rate of 76%, whereas those engaging in high physical activity had a significantly lower rate of 52% ($p=0.04$). An extended analysis of the dataset revealed that out of 83 participants, an estimated 9 patients (10.8%) had both microvascular and macrovascular complications simultaneously. Specifically, 35 patients (42.2%) had only microvascular complications, while 18 (21.7%) had only macrovascular complications. The remaining 21.7% of patients showed no evidence of either type of complication. This stratified analysis provides a clearer picture of the cumulative burden of vascular complications in diabetes and supports the need for integrated complication screening in clinical practice. Subgroup analysis of patients with overlapping microvascular and macrovascular complications showed that this dual burden was more frequent among patients aged 40–60 years (8.4%), those with HbA1c >8% (9.6%), hypertensive individuals (8.4%), smokers (7.2%), patients with diabetes duration over 10 years (9.6%), and those with low to moderate physical activity (7.2%). These findings further affirm the compounded impact of poor glycemic control and modifiable risk factors such as smoking and inactivity in accelerating complication risk.

Table 1 Demographic and Clinical Characteristics of Study Participants

Characteristic	Value
Total Sample Size	83
Gender	
Male	45 (54.2%)

Characteristic	Value
Female	38 (45.8%)
Age (Mean ± SD)	47.3 ± 10.2 years
Diabetes Duration (Mean ± SD)	8.5 ± 4.7 years
HbA1c Level (Mean ± SD)	8.2 ± 1.5%
Physical Activity	
Low to Moderate Activity	72 (86.7%)
High Activity	23 (27.7%)
Hypertension	52 (62.7%)
Smoking Status	
Smokers	35 (42.2%)
Non-Smokers	48 (57.8%)

Table 2 Prevalence of Microvascular and Macrovascular Complications

Complication Type	Frequency (n)	Prevalence (%)
Microvascular Complications		
Diabetic Retinopathy	27	32.5%
Diabetic Nephropathy	18	21.7%
Diabetic Neuropathy	22	26.5%
Any Microvascular Complication	44	53%
Macrovascular Complications		
Coronary Artery Disease	12	14.5%
Peripheral Vascular Disease	8	9.6%
Cerebrovascular Disease	7	8.4%
Any Macrovascular Complication	27	32.5%

Table 3 Association of Risk Factors with Complications

Risk Factor	Complications Present (%)	Complications Absent (%)	p-value
Gender			
Male	55.6%	44.4%	0.17
Female	50%	50%	
Age Group			<0.05
18-39 years	58%	42%	

Risk Factor	Complications Present (%)	Complications Absent (%)	p-value
40-60 years	82%	18%	
HbA1c Level			<0.01
≤8%	52%	48%	
>8%	81%	19%	
Hypertension			<0.05
Yes	76%	24%	
No	56%	44%	
Smoking Status			<0.05
Smokers	80%	20%	
Non-Smokers	65%	35%	
Diabetes Duration			<0.01
≤5 years	58%	42%	
>10 years	89%	11%	

Table 4 Complications by physical activity and HbA1c Levels

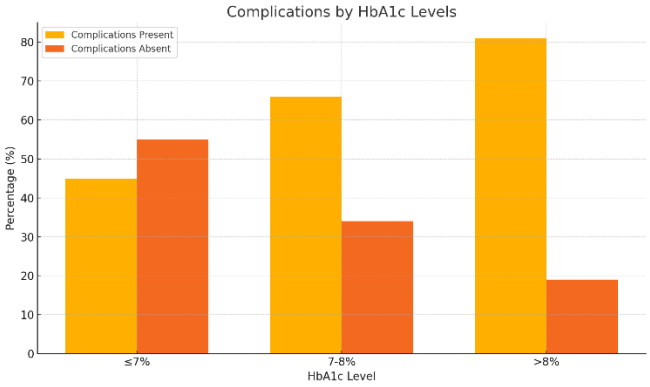
Physical Activity Level	Complications Present (%)	Complications Absent (%)	p-value
Low to Moderate Activity	76%	24%	0.04
High Activity	52%	48%	
HbA1c Level (%)			
≤7%	45%	55%	<0.01
7-8%	66%	34%	
>8%	81%	19%	

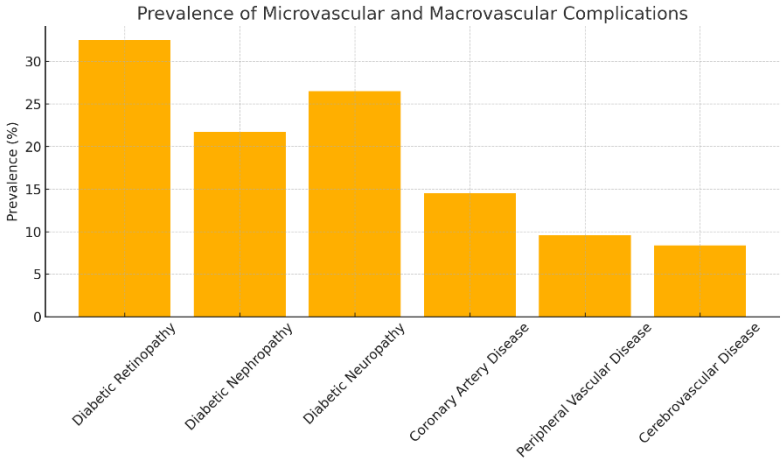
Table 5 Combined and Subgroup Complication Prevalence

Complication Type	Frequency (n)	Prevalence (%)
Microvascular Only	35	42.2
Macrovascular Only	18	21.7
Both Micro & Macrovascular	9	10.8
No Complications	21	25.3

Table 6 Subgroup Analysis for Patients with Both Complications

Risk Factor	Patients with Both Complications (Est. n)	Approx. Prevalence (%)
Age 40-60	7	8.4
HbA1c >8%	8	9.6
Hypertension	7	8.4
Smoker	6	7.2
Duration >10 yrs.	8	9.6
Low-Mod Activity	6	7.2





DISCUSSION

This study evaluated the prevalence of microvascular and macrovascular complications in individuals with diabetes mellitus and investigated associated risk factors contributing to their development. The findings corroborated existing literature by demonstrating a high complication burden among patients, with 74.7% presenting with at least one complication (12). Microvascular complications were more common than macrovascular ones, with diabetic retinopathy (32.5%), neuropathy (26.5%), and nephropathy (21.7%) showing higher prevalence compared to coronary artery disease (14.5%), peripheral vascular disease (9.6%), and cerebrovascular disease (8.4%). These results align with previously published data that suggest microvascular damage often precedes macrovascular complications in the natural history of diabetes, particularly among those with poor glycemic control (13,14). The high frequency of diabetic retinopathy and neuropathy supports the notion that microvascular complications often develop insidiously over time and may go undetected until significant progression occurs (15). This is further reinforced by the substantial number of patients affected despite relatively moderate mean HbA1c levels, indicating possible long-standing periods of subclinical hyperglycemia. The presence of macrovascular complications in nearly one-third of participants is consistent with literature showing that long-term, uncontrolled diabetes contributes to cardiovascular morbidity and mortality (16). The findings underscore the role of coronary artery disease as a major macrovascular complication in diabetic populations and its strong influence on diabetes-related health deterioration.

Risk factor analysis further emphasized the clinical relevance of age, glycemic control, hypertension, smoking, and diabetes duration. Older patients exhibited a higher complication burden, which aligns with established knowledge that age contributes to both micro- and macrovascular vulnerability due to cumulative metabolic and vascular damage over time (17). The study highlighted that HbA1c levels above 8% were significantly associated with complications, reflecting the impact of chronic hyperglycemia on vascular health and supporting evidence that tighter glycemic control reduces the risk of complications (18). Hypertension, found in 62.7% of participants,

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was another significant determinant, with 76% of hypertensive patients experiencing complications. This relationship affirms existing research that identifies hypertension as a synergistic risk factor for diabetes-related vascular injury, particularly in the development of coronary artery disease and cerebrovascular events (18,19). Lifestyle factors also played a significant role, with smoking and low physical activity contributing to higher complication rates. Smoking was associated with an 80% complication rate, reflecting its detrimental effect on vascular integrity and inflammation in diabetic patients. In contrast, those with high physical activity levels had a lower prevalence of complications (52%), highlighting the protective influence of exercise on metabolic and cardiovascular outcomes. This supports recommendations for lifestyle interventions as a cornerstone of diabetes management.

Duration of diabetes emerged as a particularly strong predictor, with nearly 90% of those living with diabetes for over ten years presenting with complications, compared to 58% in those with less than five years of disease. This temporal association supports the progressive nature of diabetes-related tissue damage and the necessity of early diagnosis and management to minimize long-term harm (20). The findings advocate for rigorous screening and individualized risk stratification at the time of diagnosis and throughout disease progression to ensure timely intervention. While the study adds valuable data to the existing body of knowledge, several limitations must be acknowledged. The cross-sectional design precluded any assessment of causality or temporal progression of complications. The study was confined to a single-center population, which may limit generalizability to broader or more diverse patient groups. Additionally, although key risk factors were analyzed, certain variables such as BMI, lipid profiles, medication adherence, or socio-economic status were not assessed, which may have added further insight into complication risk patterns.

Nevertheless, the study's strengths include its methodical data collection, inclusion of both microvascular and macrovascular outcomes, and detailed subgroup analyses. The findings reinforce the need for a multifactorial approach in diabetes management, focusing not only on glycemic control but also on blood pressure regulation, lifestyle modification, and regular complication screening. Future research would benefit from longitudinal, multicenter studies incorporating a wider range of variables, allowing for stronger causal inferences and broader applicability of the findings.

CONCLUSION

This study concludes that microvascular and macrovascular complications remain a significant burden among individuals with diabetes mellitus, highlighting the critical need for early diagnosis, comprehensive risk assessment, and proactive management strategies. The findings reinforce the importance of prioritizing routine screening for complications, especially in patients with poor glycemic control, hypertension, and longer disease duration. By identifying the patterns and prevalence of these complications, this research underscores the practical value of integrated care approaches aimed at minimizing long-term morbidity and improving the quality of life for people living with diabetes.

AUTHOR CONTRIBUTIONS

Author	Contribution
Muhammad Haroon Fayyaz*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Afreen Naz Zafar	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Sanam Idrees	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Zukhrif Bashir	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published

Arslan Ahmed	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Abdul Raheem Mujahid	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published

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