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EFFECTS OF TIME DURATION AND DISEASE MANAGEMENT IN PATIENTS WITH STAGES OF DIABETIC RETINOPATHY: A CROSS-SECTIONAL STUDY

Original Research

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ABSTRACT

Background: Diabetic retinopathy (DR) remains the leading cause of vision loss among adults with diabetes mellitus, with its progression strongly influenced by disease duration and management practices. Chronic hyperglycemia and associated vascular injury accelerate the transition from non-proliferative to proliferative stages, while treatment adherence and lifestyle modifications can modify this risk. Understanding the interaction of duration, medication, and diet with DR stages is essential for effective prevention and management.

Objective: The objective of this study was to evaluate the impact of diabetes duration, medication use, and dietary adherence on the severity of diabetic retinopathy among adult patients.

Methods: A cross-sectional study was conducted at the diabetes clinic of Gurki Teaching Hospital, Lahore, over a four-month period. A total of 385 type 2 diabetes patients aged 40–95 years with at least 10 years of disease history and confirmed DR were enrolled through non-probability convenience sampling. Exclusion criteria included type 1 diabetes, incomplete records, ocular trauma, or non-diabetic retinal disorders. Data on demographics, medication adherence, and diet compliance were collected through medical records and patient reports. Retinal imaging (OCT and fundus photography) classified DR severity as mild, moderate, or severe NPDR. Data were analyzed using SPSS version 26.0, and associations were tested through chi-square analysis.

Results: Among 385 patients, 63.9% were female and 36.1% male, with a mean age of 62.7 years (SD = 8.5). In the 10–15 year diabetes group, 94.0% exhibited mild to moderate NPDR, while 62.4% of those with 16–25 years had severe NPDR. All patients with more than 25 years of diabetes presented with severe NPDR ($p < 0.000$). Medication adherence was high, with 60.3% on combined oral and insulin therapy, but dietary non-adherence was widespread at 60.3%, most evident in the 10–15 year group (62.7%, $p < 0.000$).

Conclusion: The study concludes that diabetes duration beyond 15 years is a critical predictor of severe retinopathy, while persistent dietary non-adherence worsens disease outcomes despite pharmacological intensification. Early and sustained adherence to both medical and dietary interventions during the first 15 years is vital to mitigate progression of vision-threatening DR.

Keywords: Diabetic Diet, Diabetic Retinopathy, Diabetes Mellitus, Non-Proliferative Diabetic Retinopathy, Proliferative Diabetic Retinopathy, Retinal Diseases, Vision Disorders.

INTRODUCTION

Diabetic retinopathy (DR) represents one of the most devastating complications of diabetes mellitus, affecting nearly one in three individuals with the disease and remaining the leading cause of vision loss among working-age adults worldwide (1). Its burden extends far beyond vision impairment, as affected individuals report reduced quality of life, diminished physical, emotional, and social wellbeing, and an increased reliance on healthcare services. Current global estimates indicate that approximately 90 million people live with DR, including 17 million with proliferative diabetic retinopathy (PDR), 21 million with diabetic macular edema (DME), and 28 million with vision-threatening disease. Alarmingly, the prevalence of DR is expected to double by 2025 unless more effective preventive and therapeutic strategies are implemented (2,3). The condition is almost inevitable among individuals with type 1 diabetes after two decades of disease, while up to two-thirds of those with type 2 diabetes also develop some degree of retinopathy. Often referred to as a "silent complication," DR is asymptomatic in its early stages, yet chronic hyperglycemia progressively damages retinal microvasculature, leading to microaneurysms, fluid leakage, and hemorrhages that impair visual clarity. If left untreated, DR can progress from nonproliferative stages (NPDR), which range from mild to severe, to the advanced proliferative stage, characterized by fragile neovascularization induced by retinal hypoxia. Without prompt recognition and treatment, such neovascularization often leads to recurrent hemorrhages and profound vision loss (4-6).

Despite advances in therapeutic modalities—including laser photocoagulation, intravitreal anti-VEGF therapy, corticosteroid administration, and surgical interventions such as vitrectomy—no current treatment fully reverses the underlying pathological process. Nevertheless, when detected and treated early, over 90% of patients can preserve functional vision, underscoring the importance of systematic screening and early intervention programs (7,8). Furthermore, adherence to treatment and strict control of modifiable risk factors, including glycemia, blood pressure, and lipid levels, remain essential in halting disease progression. Risk factors such as prolonged disease duration, hypertension, nephropathy, obesity, pregnancy, and genetic predisposition exacerbate the likelihood of DR development, while non-adherence to medication contributes significantly to poor glycemic control and worse visual outcomes (9). In recent years, the potential role of diet in influencing DR development and progression has gained attention. Nutritional interventions, especially those focusing on Mediterranean dietary patterns, high intake of fruits, vegetables, and fish, and reduced caloric consumption, appear to reduce the risk of DR. Although emerging evidence suggests that specific dietary components—such as selenium, vitamin B6, vitamin B2, choline, and whole grains—may confer protective benefits, systematic reviews addressing comprehensive dietary approaches remain limited (10,11). Integrating nutritional guidance into diabetes management may therefore offer a cost-effective, non-pharmacological strategy to prevent or delay DR onset and progression. Given the substantial individual and public health burden of DR, there is an urgent need to better understand how timelines of disease progression and management strategies influence patient outcomes across different stages of retinopathy. This study is designed to evaluate the effects of disease trajectory and management interventions in patients with varying stages of diabetic retinopathy, with the ultimate goal of informing more effective prevention and treatment approaches.

METHODS

The study employed a cross-sectional design and was conducted at the diabetes clinic of Gurki Teaching Hospital, Lahore. The total duration of the study was four months, commencing after approval of the synopsis by the institutional ethical review committee. Ethical clearance was obtained prior to data collection, and informed written consent was secured from all participants to ensure voluntary participation and confidentiality of information in accordance with ethical research principles. A sample size of 385 participants was recruited using a non-probability convenience sampling technique. The target population consisted of patients with a documented history of type 2 diabetes mellitus for ten years or more. Inclusion criteria required participants to be aged above 40 years, diagnosed with type 2 diabetes for at least ten years, and confirmed to have diabetic retinopathy on retinal imaging. Exclusion criteria were patients with type 1 diabetes, incomplete medical records, non-diabetic retinal disorders, and those with a history of ocular surgery or trauma, as these could confound the assessment of diabetic retinopathy.

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Data were prospectively collected from eligible participants. Information was obtained regarding adherence to prescribed dietary guidelines and medication regimens, with adherence verified through prescription records, pharmacy refills, and physician notes. Glycemic control was assessed using annual HbA1c levels recorded in patient files. Retinal imaging, including optical coherence tomography (OCT) and fundus photography, was performed to confirm the diagnosis of diabetic retinopathy, classify its severity as mild, moderate, severe, or proliferative, and evaluate disease progression (12,13). Historical medical records were reviewed to determine the duration of diabetes, consistency of treatment adherence, and prior therapeutic interventions such as insulin use or laser therapy. Patients with incomplete dietary or medication records, or inadequate retinal imaging data, were excluded to maintain data reliability. All collected data were entered and analyzed using the Statistical Package for Social Sciences (SPSS) version 26.0. Descriptive statistics were used to summarize baseline demographic and clinical characteristics, while inferential statistics were applied to explore associations between disease duration, treatment adherence, and stages of diabetic retinopathy. Correlations and comparative analyses were conducted to identify significant predictors and management gaps contributing to disease progression.

RESULTS

A total of 385 patients with type 2 diabetes mellitus of at least ten years' duration were included in the study. Among them, 36.1% were male and 63.9% were female, with a mean gender coding value of 1.64 (SD = 0.48). The mean age of participants was 62.7 years (SD = 8.5), ranging from 48 to 95 years, with the majority falling between 56 and 65 years of age. With regard to diabetes duration, 65.5% of patients had been diagnosed for 10 to 15 years, 28.3% for 16 to 25 years, and 6.2% for 25 to 35 years. The assessment of medication use demonstrated that in the 10–15-year group, oral hypoglycemic agents were most frequently prescribed (126 out of 252; 50%), whereas combined therapy with both oral agents and insulin became increasingly common in the 16–25-year (93 out of 109; 85.3%) and 25–35-year (24 out of 24; 100%) groups. Insulin-only therapy was observed in 4 patients from the 10–15-year group and 3 patients from the 16–25-year group, while a small number of patients in the 10–15-year group (n=7) reported no treatment. Dietary adherence was limited in the earlier disease stage but increased with longer disease duration. In the 10–15-year group, only 94 patients (37%) reported using dietary charts, compared to 36 patients (33%) in the 16–25-year group and 23 patients (96%) in the 25–35-year group. Despite an overall total of 153 participants (39.7%) adhering to dietary guidance, the majority of those with diabetes for less than 25 years (231/361) did not follow a prescribed diet plan. Regarding retinopathy severity, a clear progression was observed with increasing disease duration. Among patients with 10–15 years of diabetes, mild non-proliferative diabetic retinopathy (NPDR) was most common (142 out of 252; 56%), with 97 cases of moderate NPDR (38.5%) and 13 cases of severe NPDR (5.2%). In the 16–25-year group, severe NPDR predominated (69 out of 109; 63%), followed by moderate NPDR in 32 patients (29.4%) and mild NPDR in 8 patients (7.3%). Notably, all patients with 25–35 years of diabetes (24/24; 100%) presented with severe NPDR. No cases of advanced diabetic macular edema (ADEM) were recorded in any group.

Table 1: Demographic Distribution of Patients by Gender with Mean and Standard Deviation

Mean	Std. Deviation	Male	Female
1.6390	.48093	36.1	63.9

Table 2: Age Distribution of Patients with Mean, Standard Deviation, and Range

N	Mean	Std. Deviation	Minimum	Maximum
385	62.6519	8.51031	48.00	95.00

Table 3: Association of Diabetes Duration with Types of Medication Usage among Patients

Duration of Diabetes	Oral	Insulin	Both oral and insulin	No oral and insulin	Total
10 to 15 Years	126	4	115	7	252
16 to 25 Years	13	3	93	0	109
26 to 35 Years	0	0	24	0	24
	139	7	232	7	385

Table 4: Association of Diabetes Duration with Dietary Adherence among Patients

Duration of Diabetes	Using diet chart (Yes)	Using diet chart (No)	TOTAL
10 to 15 Years	94	158	252
16 to 25 Years	36	73	109
26 to 35 Years	23	1	24
	153	233	385

Table 5: Association of Diabetes Duration with Stages of Diabetic Retinopathy

Duration of Diabetes	Mild NPDR	Moderate NPDR	Severe NPDR	Total
10 to 15 Years	142	97	13	252
16 to 25 Years	8	32	69	109
26 to 35 Years	0	0	24	24
	150	128	107	385

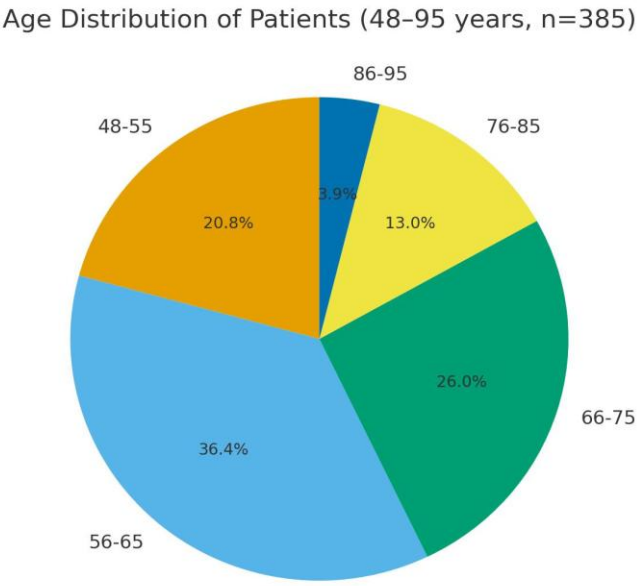

Figure 2 Age Distribution Patients (48-95 Years, n=385)

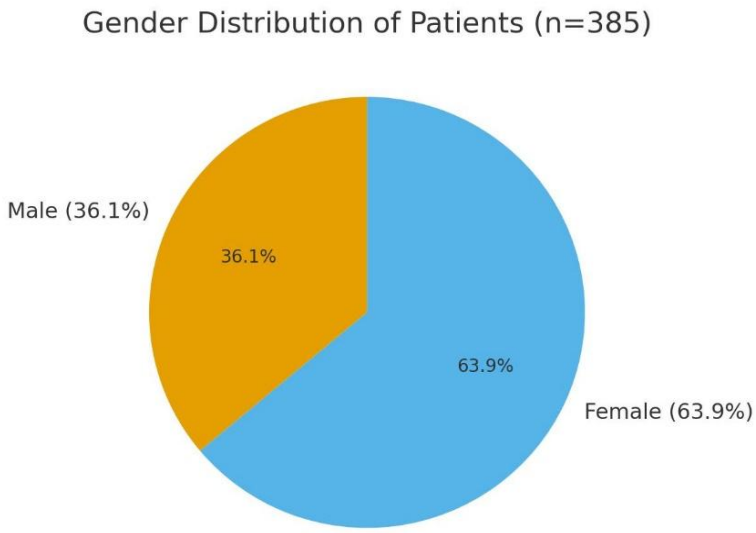

Figure 2 Gender Distribution of Patients (n=385)

DISCUSSION

The present study highlights the significant association between the duration of type 2 diabetes and the severity of diabetic retinopathy (DR). Findings demonstrated that patients with a history of 10–15 years of diabetes predominantly exhibited mild non-proliferative diabetic retinopathy (NPDR), while those with 16–25 years of disease duration showed a marked increase in severe NPDR, and all patients with more than 25 years of diabetes were found to have severe NPDR. This indicates a clear temporal gradient, where prolonged exposure to chronic hyperglycemia substantially increases the risk of progressive microvascular retinal damage. Such observations align with earlier large-scale cohort analyses, which have shown that each additional year of diabetes contributes to a significant increment in DR risk, particularly after a critical inflection point in disease duration (14). The observed rise in severe NPDR beyond 15 years of diabetes reflects the cumulative effect of advanced glycation end-product deposition, oxidative stress, and microvascular endothelial dysfunction, processes known to drive the pathogenesis of DR (15). The analysis of treatment modalities further emphasized the

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influence of disease duration on therapeutic requirements. In earlier stages of diabetes, oral hypoglycemic agents were the predominant mode of management, while in patients with longer disease duration, particularly those exceeding 15 years, combined insulin and oral hypoglycemic therapy became overwhelmingly necessary. This shift reflects progressive β-cell exhaustion and declining endogenous insulin secretion, consistent with previous reports indicating that prolonged diabetes often necessitates intensification of pharmacological management (16-18). However, the paradox observed in the present findings, where severe NPDR continued to escalate despite intensive pharmacological interventions, underscores the limited impact of glucose-lowering therapy on halting the microvascular complications once structural retinal damage has been established. This phenomenon is supported by evidence that chronic hyperglycemia activates inflammatory and angiogenic pathways, including interleukin-1β and NF-κB signaling, which perpetuate retinal vascular damage independent of glycemic correction (19).

Dietary adherence emerged as another critical determinant of DR progression. Although diet modification is central to comprehensive diabetes management, adherence was notably low in patients with a shorter duration of disease, with only 37.3% of individuals in the 10–15 year group following dietary recommendations. Alarmingly, dietary adherence declined drastically in patients with longer disease duration, with only 4.2% of those with more than 25 years of diabetes maintaining dietary compliance. This trend of "dietary fatigue" has been reported in previous longitudinal studies, which observed that reduced adherence to nutritional guidance significantly increases the risk of DR through mechanisms such as dyslipidemia and postprandial hyperglycemia (20). The findings from the present study reinforce the notion that behavioral factors are critical in determining visual outcomes and should be prioritized alongside pharmacological interventions. Glycemic control, assessed through HbA1c levels, was identified in the methodology as a key variable; however, the specific values and statistical associations with disease duration and treatment adherence were not reported. This represents a major limitation, as HbA1c remains the most reliable biomarker for assessing long-term glycemic status and has been consistently linked to DR risk and progression (21). The absence of detailed HbA1c results limits the ability to fully interpret how metabolic control influenced retinopathy outcomes in the present cohort. Future studies should provide comprehensive analysis of HbA1c trends, particularly across different durations of diabetes and levels of adherence, to better establish causality and identify thresholds predictive of severe retinopathy.

Another limitation of this study lies in its cross-sectional design, which precludes temporal or causal inferences. Although prospective data collection was described, the study duration of four months restricts the capacity to evaluate long-term changes or confirm progression patterns. Additionally, the use of non-probability convenience sampling may limit the generalizability of findings to the wider diabetic population. Self-reported dietary adherence and reliance on medical records also introduce the potential for recall and documentation biases. Despite these limitations, the study has notable strengths. It includes a relatively large sample size of 385 patients, employs objective imaging modalities such as optical coherence tomography and fundus photography to confirm DR stages, and explores both clinical and behavioral factors influencing disease severity. The integration of medication use and dietary adherence provides a more holistic understanding of the multifactorial contributors to DR progression. The findings emphasize that the course of DR is not solely a function of disease duration but results from the interplay of metabolic dysregulation, microvascular injury, and patient-related behavioral factors. Intensification of pharmacological treatment appears insufficient to halt disease progression once advanced microvascular damage has occurred, underscoring the importance of early and sustained lifestyle modifications. Future longitudinal studies should investigate the impact of strict glycemic control, dietary adherence, and integrated multidisciplinary interventions on delaying or mitigating the severity of DR, with a focus on the critical window between 8 and 15 years of diabetes duration when preventive strategies may be most effective.

CONCLUSION

This study highlights that the duration of diabetes plays a pivotal role in the progression of diabetic retinopathy, with longer disease duration strongly associated with more advanced stages of retinopathy. Although pharmacological management, particularly insulin-based regimens, becomes increasingly necessary as the disease advances, these measures alone do not appear sufficient to halt retinal damage once it is established. At the same time, adherence to dietary guidelines declines with longer disease duration, underscoring a critical gap in long-term self-management. These findings emphasize that effective control of diabetic retinopathy requires not only timely medical interventions but also sustained commitment to lifestyle and dietary modifications. Early screening, patient education, and integrated care strategies are therefore essential to reduce the risk of vision-threatening complications and improve overall quality of life in individuals living with long-standing diabetes.

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AUTHOR CONTRIBUTION

Author	Contribution
Umara Gul*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Shahzaib Shareef	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
Muhammad Shahzaib	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Salman Haidar	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Ruhullah	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published

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