RESEARCH PAPER

Correlation Between Hba1c Level and Severity of Diabetic Retinopathy at A Tertiary Health Care Centre

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ABSTRACT

Background: Diabetic retinopathy (DR) is one of the most common microvascular complications of diabetes mellitus and remains a leading cause of preventable blindness worldwide. Glycated hemoglobin (HbA1c) is a reliable indicator of long-term glycemic control and may serve as an important predictor of the severity of diabetic retinopathy. The present study evaluated the correlation between HbA1c levels and the severity of diabetic retinopathy among patients with Type 2 diabetes mellitus.

Methods: This hospital-based descriptive observational study included 100 patients with Type 2 diabetes mellitus attending the Department of Ophthalmology at a tertiary healthcare centre. Demographic details, duration of diabetes, HbA1c levels, comprehensive ophthalmic examination, and dilated fundus evaluation were recorded. Diabetic retinopathy was graded into different stages, and the presence of diabetic macular edema (DME) was assessed. Statistical analysis was performed using appropriate descriptive statistics, Chi-square/Fisher's exact test, and correlation analysis. A p-value <0.05 was considered statistically significant.

Results: The mean age of participants was 58.94 ± 10.00 years, and 66% were males. The mean duration of diabetes was 9.45 ± 5.68 years, while the mean HbA1c level was 8.12 ± 2.26%. Very poor glycemic control was observed in 36% of participants. Moderate non-proliferative diabetic retinopathy was the most common stage in both the right (48%) and left (49%) eyes. Diabetic macular edema was present in 16% of patients. HbA1c levels showed significant associations with right eye diabetic retinopathy (p=0.040), left eye diabetic retinopathy (p=0.018), diabetic macular edema (p=0.012), and HbA1c categories (p=0.001). Significant positive correlations were observed between HbA1c and right eye diabetic retinopathy (r=0.234, p=0.019) and left eye diabetic retinopathy (r=0.297, p=0.003).

Conclusion: Elevated HbA1c levels were significantly associated with increasing severity of diabetic retinopathy, highlighting HbA1c as an effective biomarker for assessing long-term glycemic control and predicting retinal complications. Regular HbA1c monitoring and periodic ophthalmic screening are essential for early detection, timely intervention, and prevention of vision-threatening diabetic retinopathy.

Keywords: Diabetic retinopathy; HbA1c; Type 2 diabetes mellitus; Glycemic control; Diabetic macular edema.

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1. INTRODUCTION

Diabetes mellitus (DM) is one of the most prevalent chronic non-communicable diseases worldwide and represents a major public health challenge due to its increasing incidence, long-term complications, and significant impact on quality of life. It is characterized by persistent hyperglycemia resulting from defects in insulin secretion, insulin action, or both. The global burden of diabetes has risen dramatically over the past few decades owing to rapid urbanization, sedentary lifestyles, unhealthy dietary habits, obesity, and increasing life expectancy. According to the International Diabetes Federation (IDF), hundreds of millions of adults are currently living with diabetes, and this number is expected to continue increasing in the coming years. India, often

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referred to as the "diabetes capital of the world," contributes substantially to the global diabetic population, making early diagnosis and prevention of diabetic complications a national healthcare priority.[1]

Among the chronic complications of diabetes, diabetic retinopathy (DR) is one of the most common and vision-threatening microvascular disorders. It develops as a consequence of prolonged hyperglycemia, leading to structural and functional damage of the retinal microvasculature. The pathological changes include loss of pericytes, thickening of the basement membrane, capillary occlusion, retinal ischemia, increased vascular permeability, and neovascularization. These alterations gradually impair retinal function and may ultimately result in irreversible visual loss if left untreated. Diabetic retinopathy remains one of the leading causes of preventable blindness among the working-age population worldwide and imposes a considerable socioeconomic burden on healthcare systems.[2,3]

The progression of diabetic retinopathy is generally classified into non-proliferative diabetic retinopathy (NPDR) and proliferative diabetic retinopathy (PDR). NPDR is further categorized into mild, moderate, and severe stages based on the extent of retinal microvascular abnormalities such as microaneurysms, retinal hemorrhages, cotton wool spots, venous beading, and intraretinal microvascular abnormalities. As the disease advances, retinal ischemia stimulates the production of vascular endothelial growth factor (VEGF), resulting in neovascularization and progression to proliferative diabetic retinopathy. Diabetic macular edema (DME) may occur at any stage and remains one of the most important causes of visual impairment in diabetic patients. Early identification of disease severity is therefore essential for timely intervention and prevention of irreversible blindness.[4,5]

Several risk factors influence the onset and progression of diabetic retinopathy, including duration of diabetes, poor glycemic control, hypertension, dyslipidemia, obesity, smoking, nephropathy, and genetic predisposition. Among these, chronic hyperglycemia has consistently been identified as the most significant modifiable risk factor. Persistent elevation of blood glucose promotes oxidative stress, inflammation, endothelial dysfunction, and accumulation of advanced glycation end products, all of which contribute to retinal microvascular damage. Consequently, maintaining optimal glycemic control has become the cornerstone for preventing or delaying the progression of diabetic retinopathy.[6,7]

Glycated hemoglobin (HbA1c) is regarded as the gold standard biochemical marker for assessing long-term glycemic control. It reflects the average blood glucose concentration over the preceding 8–12 weeks by measuring the percentage of hemoglobin irreversibly bound to glucose. Unlike single fasting or postprandial blood glucose measurements, HbA1c provides a comprehensive assessment of overall glycemic exposure and is less influenced by short-term fluctuations. Higher HbA1c values indicate poor metabolic control and have been strongly associated with an increased risk of microvascular complications, including diabetic retinopathy, diabetic nephropathy, and diabetic neuropathy. Therefore, HbA1c has emerged as an important prognostic indicator in diabetes management.[8]

Numerous epidemiological and clinical studies have demonstrated a positive association between elevated HbA1c levels and increasing severity of diabetic retinopathy [9]. Patients with poor glycemic control are more likely to develop advanced retinal lesions, diabetic macular edema, and proliferative disease than those with adequately controlled blood glucose levels. Large landmark trials have shown that intensive glycemic control significantly reduces both the incidence and progression of diabetic retinopathy. Nevertheless, variability exists among different populations regarding the strength of this association because of differences in ethnicity, duration of diabetes, associated systemic illnesses, and access to diabetic care [10]. Therefore, evaluation of this relationship in specific regional populations remains clinically relevant.

Understanding the correlation between HbA1c levels and the severity of diabetic retinopathy may facilitate early risk stratification, improve screening strategies, guide therapeutic decision-making, and enhance patient counseling regarding glycemic control. Identifying patients at greater risk for advanced retinal disease through a simple biochemical marker such as HbA1c can promote timely ophthalmic referral and intervention, thereby reducing the burden of vision loss. Hence, the present study aims to evaluate the correlation between HbA1c levels and the severity of diabetic retinopathy among patients attending a tertiary healthcare centre, providing evidence that may contribute to improved clinical management and prevention of diabetes-related visual disability.

2. METHODOLOGY

2.1 Study Design

The present study was conducted as a descriptive observational, hospital-based cross-sectional study.

2.2 Study Setting

The study was carried out in the Department of Ophthalmology at KLES Dr. Prabhakar Kore Hospital and Medical Research Centre, Belagavi, Karnataka.

2.3 Study Duration

The study was conducted over a period of four months after obtaining approval from the Institutional Ethics Committee.

2.4 Participants

Patients diagnosed with Type 2 diabetes mellitus who attended the Department of Ophthalmology during the study period were screened for eligibility. Participants

fulfilling the predefined inclusion criteria and providing written informed consent were enrolled in the study.

Inclusion Criteria

- Patients diagnosed with Type 2 diabetes mellitus.
- Patients aged 18 years and above.
- Patients attending the Ophthalmology Outpatient Department with or without visual complaints.
- Patients willing to provide written informed consent.

Exclusion Criteria

- Patients with Type 1 diabetes mellitus.
- Patients with gestational diabetes mellitus.
- Patients receiving long-term systemic corticosteroid therapy.
- Patients having dense cataract, corneal opacity, vitreous hemorrhage, or any ocular media opacity preventing adequate visualization of the fundus.
- Patients unwilling to participate in the study.

2.5 Study Sampling

Convenience sampling technique was adopted for participant recruitment. All consecutive patients with Type 2 diabetes mellitus attending the Ophthalmology OPD during the study period were screened for eligibility. Patients satisfying the inclusion and exclusion criteria were enrolled sequentially until the calculated sample size was attained. This sampling technique enabled recruitment of an adequate number of participants within the stipulated study duration while minimizing selection bias through consecutive enrollment.

2.6 Study Sample Size

The required sample size was calculated using the standard formula for estimating a single population proportion based on the prevalence of diabetic retinopathy.

Formula used:

$$n = Z^2 \times p \times q / d^2$$

where:

- **Z** = 1.96 at 95% confidence interval
- **p** = 64% (prevalence of diabetic retinopathy)
- **q** = 100 – p = 36%
- **d** = 15% allowable error

Based on these parameters, the minimum calculated sample size was approximately 100 participants. Therefore, a total of **100 patients** were included in the study.

2.7 Study Parameters

The study assessed a comprehensive range of demographic, clinical, and laboratory parameters for each participant. Demographic characteristics included age and gender. Clinical parameters comprised the duration of diabetes mellitus, history of treatment, visual acuity, findings of detailed ocular examination, fundus examination findings, severity of diabetic retinopathy, and the presence or absence of diabetic macular edema. The laboratory parameter evaluated was the glycated hemoglobin (HbA1c) level, which was estimated to assess long-term glycemic control. The primary outcome measure of the study was to determine the correlation between HbA1c levels and the severity of diabetic retinopathy among patients with Type 2 diabetes mellitus.

2.8 Study Procedure

After Institutional Ethics Committee approval, eligible patients attending the Ophthalmology OPD were approached for participation. The purpose, objectives, benefits, and procedures of the study were explained in their preferred language, and written informed consent was obtained prior to enrollment. Demographic details, medical history, duration of diabetes, treatment history, and associated systemic illnesses were recorded using a structured case record form.

Each participant underwent a comprehensive ophthalmic evaluation including measurement of visual acuity using a Snellen chart, anterior segment examination using slit-lamp biomicroscopy, intraocular pressure measurement by non-contact tonometry, and detailed dilated fundus examination after pharmacological pupillary dilatation. Retinal findings were documented carefully, and diabetic retinopathy was graded according to standard clinical classification into mild, moderate, severe, very severe NPDR, and proliferative diabetic retinopathy. The presence of diabetic macular edema was also assessed.

Venous blood samples were collected under aseptic precautions for estimation of HbA1c levels using standardized laboratory techniques. The obtained HbA1c values were recorded and subsequently correlated with the severity of diabetic retinopathy observed during ophthalmic examination.

2.9 Study Data Collection

Data were collected using a predesigned and pretested structured proforma. Information regarding demographic characteristics, medical history, duration of diabetes, treatment details, clinical examination findings, ophthalmological examination, retinal grading, and HbA1c values was documented at the time of patient evaluation. All collected data were reviewed for completeness and accuracy before entry into Microsoft Excel spreadsheets. Confidentiality of patient information was maintained throughout the study by assigning unique identification numbers to each participant.

2.10 Data Analysis

The collected data were entered into Microsoft Excel and analyzed using appropriate statistical software. Continuous variables such as age and HbA1c levels were expressed as mean ± standard deviation, whereas categorical variables were presented as frequencies and percentages. The association between HbA1c levels and severity of diabetic retinopathy was assessed using the Chi-square test or

Fisher's exact test wherever appropriate. Correlation analysis was performed to determine the relationship between HbA1c levels and grades of diabetic retinopathy. A p-value of less than 0.05 was considered statistically significant for all analyses.

2.11 Ethical Considerations

Prior to commencement of the study, ethical clearance was obtained from the Institutional Ethics Committee of Jawaharlal Nehru Medical College, KAHER, Belagavi. Written informed consent was obtained from all participants after explaining the objectives, procedures, possible benefits, and voluntary nature of participation.

3. RESULTS

Table 1. Distribution of Study Participants According to Gender (N = 100)

Gender	n	%
Male	66	66.0
Female	34	34.0
Total	**100**	**100.0**

Among the 100 study participants, the majority were males (66.0%), while females constituted 34.0% of the study population, indicating a male predominance.

Table 2. Distribution of Participants According to HbA1c Categories (N = 100)

HbA1c Category	n	%
Normal	20	20.0
Pre-diabetic	7	7.0
Good control	3	3.0
Fair control	16	16.0
Poor control	18	18.0
Very poor control	36	36.0
Total	**100**	**100.0**

Most participants (36.0%) had very poor glycemic control, followed by normal HbA1c (20.0%) and poor control (18.0%). Only 3.0% of participants had good glycemic control.

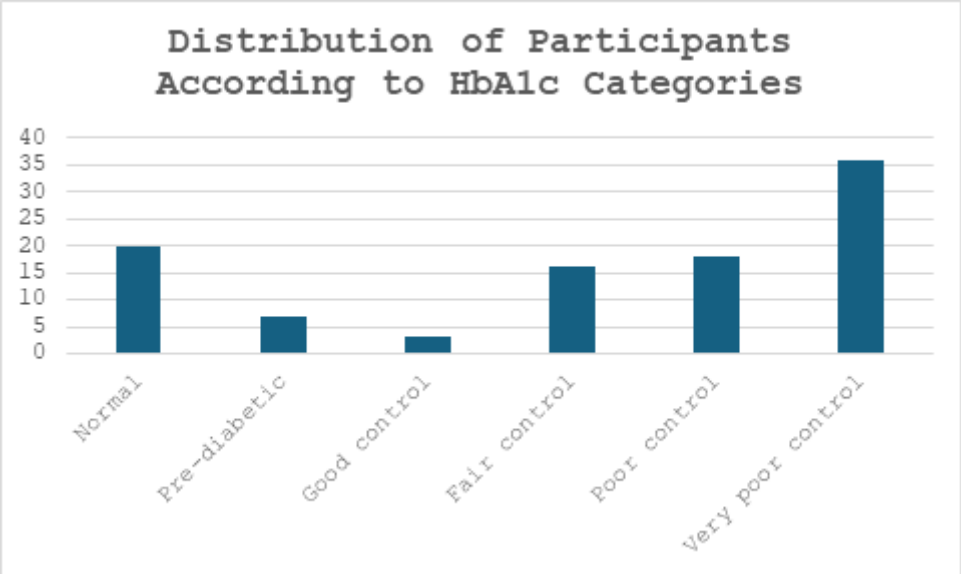


Table 3. Distribution of Severity of Diabetic Retinopathy in the Right Eye (N = 100)

Right Eye Diabetic Retinopathy	n	%
No diabetic retinopathy	9	9.0
Mild NPDR	18	18.0
Moderate NPDR	48	48.0
Severe NPDR	7	7.0
Very Severe NPDR	5	5.0
PDR	13	13.0
Total	**100**	**100.0**

Moderate non-proliferative diabetic retinopathy (NPDR) was the most common finding in the right eye (48.0%), whereas proliferative diabetic retinopathy (PDR) was observed in 13.0% of participants.

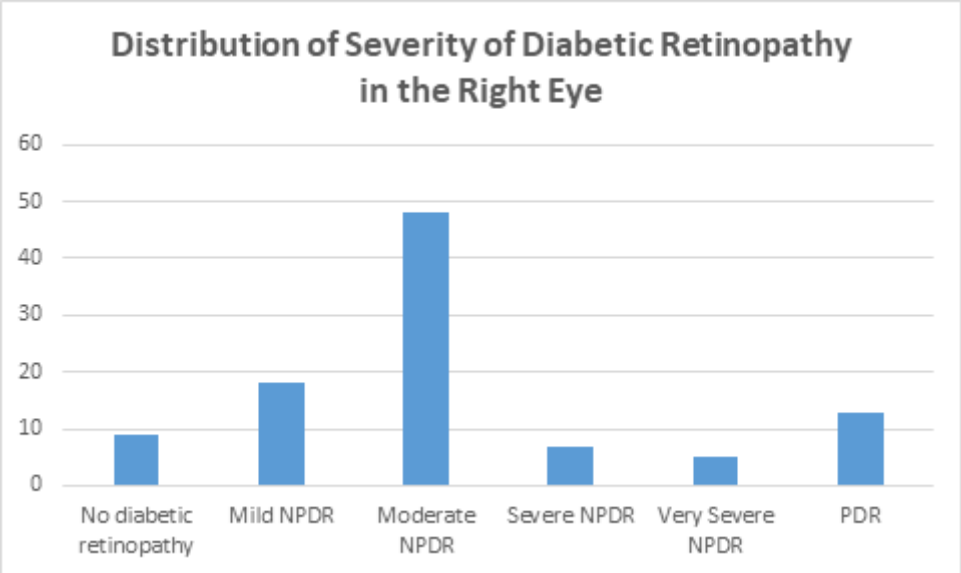


Table 4. Distribution of Severity of Diabetic Retinopathy in the Left Eye (N = 100)

Left Eye Diabetic Retinopathy	n	%
No diabetic retinopathy	6	6.0
Mild NPDR	19	19.0
Moderate NPDR	49	49.0
Severe NPDR	7	7.0
Very Severe NPDR	5	5.0
PDR	14	14.0
Total	**100**	**100.0**

Moderate NPDR was the predominant stage in the left eye (49.0%), followed by mild NPDR (19.0%). PDR was present in 14.0% of participants.

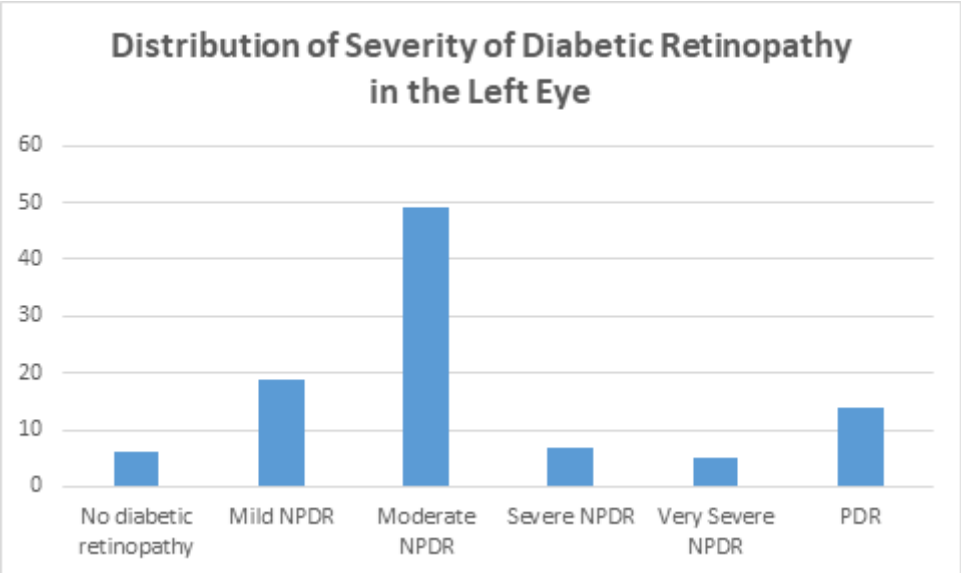


Table 5. Distribution of Diabetic Macular Edema, Hypertension and Hypertensive Retinopathy (N = 100)

Variable	Category	n	%
Diabetic Macular Edema	No	84	84.0
	Yes	16	16.0
Hypertension	No	42	42.0

	Yes	58	58.0
Hypertensive Retinopathy Changes	No	68	68.0
	Yes	32	32.0

Diabetic macular edema was present in 16.0% of participants. More than half (58.0%) were hypertensive, while hypertensive retinopathy changes were observed in 32.0% of patients.

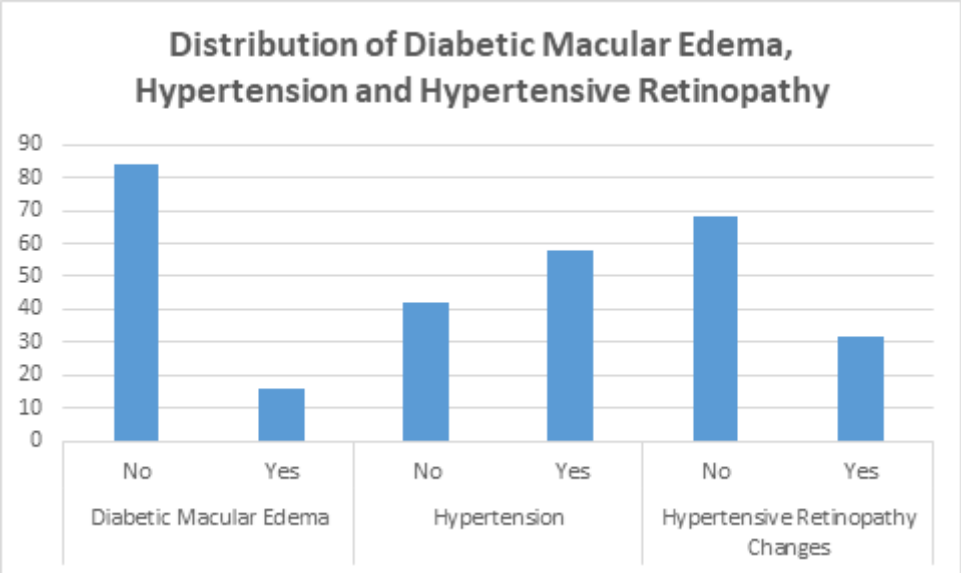


Table 6. Descriptive Statistics of Continuous Variables (N = 100)

Variable	Mean	SD	Median	Q1 (P25)	Q3 (P75)
Age (years)	58.94	10.00	58.5	53	64
Duration of Diabetes (years)	9.45	5.68	10	6	10
HbA1c (%)	8.12	2.26	8.2	6.25	10

The mean age of participants was 58.94 ± 10.00 years. The average duration of diabetes was 9.45 ± 5.68 years, while the mean HbA1c level was 8.12 ± 2.26%, indicating generally poor glycemic control.

Table 7. Comparison of Mean HbA1c Levels with Clinical Characteristics

Variables		Mean	SD	Median	Q1 (P25)	Q3 (P75)	p value
Gender (#)	Male	8.14	2.23	8.2	6.2	10	0.918
	Female	8.09	2.34	8.2	6.8	10	
HbA1c Category	Normal	5.03	0.89	5	4.25	5.3	0.001*
	Pre-diabetic	6.16	0.11	6.2	6	6.2	
	Good control	8.73	3.18	7	6.8	12.4	
	Fair control	7.38	0.34	7.2	7.2	7.5	
	Poor control	8.31	0.21	8.3	8.2	8.4	
	Very poor control	10.41	1.2	10	9.6	11	
Right Eye DR	No diabetic retinopathy	7.72	1.32	7.3	7.2	8.4	0.040*
	Mild NPDR	6.74	2.7	5.8	5	8.2	
	Moderate NPDR	8.44	2.24	8.75	7	10	
	Severe NPDR	8.14	2	8.1	7.2	10.2	
	Very Severe NPDR	7.82	1.96	8.3	6.3	9.4	
	PDR	9.25	1.7	8.4	8.2	10	
Left Eye DR	No diabetic retinopathy	6.58	2.79	5.15	5	7.2	0.018*
	Mild NPDR	6.99	2.59	6.8	5	8.2	
	Moderate NPDR	8.43	2.12	8.5	7.2	10	
	Severe NPDR	7.74	0.97	8	7.2	8.3	
	Very Severe NPDR	8.14	2.37	8.3	6.3	9.8	

	PDR	9.41	1.61	8.85	8.3	10.2	
DME (#)	No	7.88	2.29	8	6.1	9.9	0.012*
	Yes	9.41	1.57	9.25	8.25	10.1	
HTN (#)	No	7.65	2.41	7.25	5.3	9.3	0.071
	Yes	8.47	2.09	8.4	7.2	10	
Hypertensive Retinopathy Changes (#)	No	7.97	2.42	8	6.1	10	0.32
	Yes	8.45	1.87	8.45	7.2	10	

Significant at p < 0.05

Mean HbA1c levels showed statistically significant differences across HbA1c categories, right eye diabetic retinopathy, left eye diabetic retinopathy, and diabetic macular edema (p<0.05). No significant association was observed with gender, hypertension, or hypertensive retinopathy.

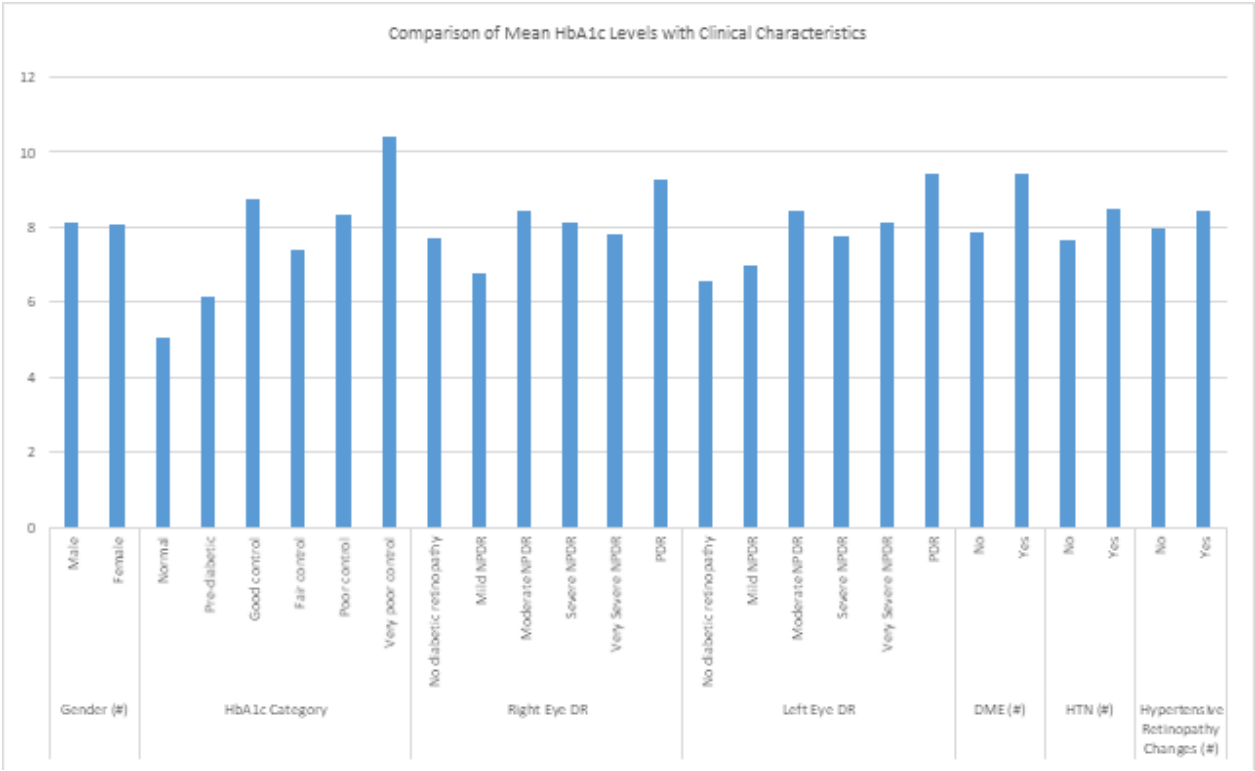


Table 8. Correlation Between HbA1c and Severity of Diabetic Retinopathy (N = 100)

Pair	Correlation Coefficient (r)	p value
HbA1c vs Right Eye DR	0.234	**0.019***
HbA1c vs Left Eye DR	0.297	**0.003***
Right Eye DR vs Left Eye DR	0.819	**0.001***

Significant at p < 0.05

HbA1c demonstrated a significant positive correlation with the severity of diabetic retinopathy in both eyes. A very strong positive correlation was observed between right and left eye diabetic retinopathy severity (r=0.819, p=0.001).

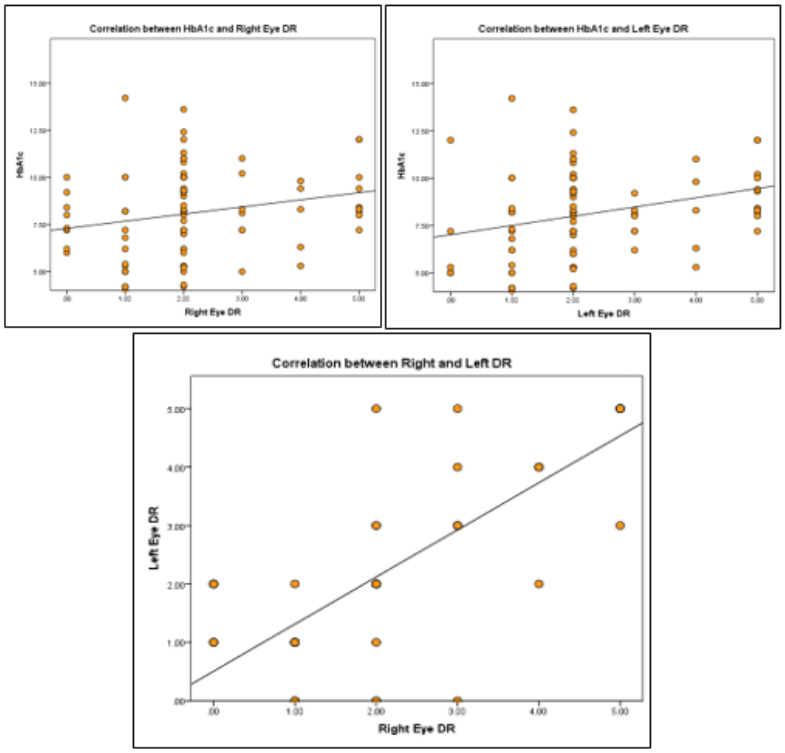
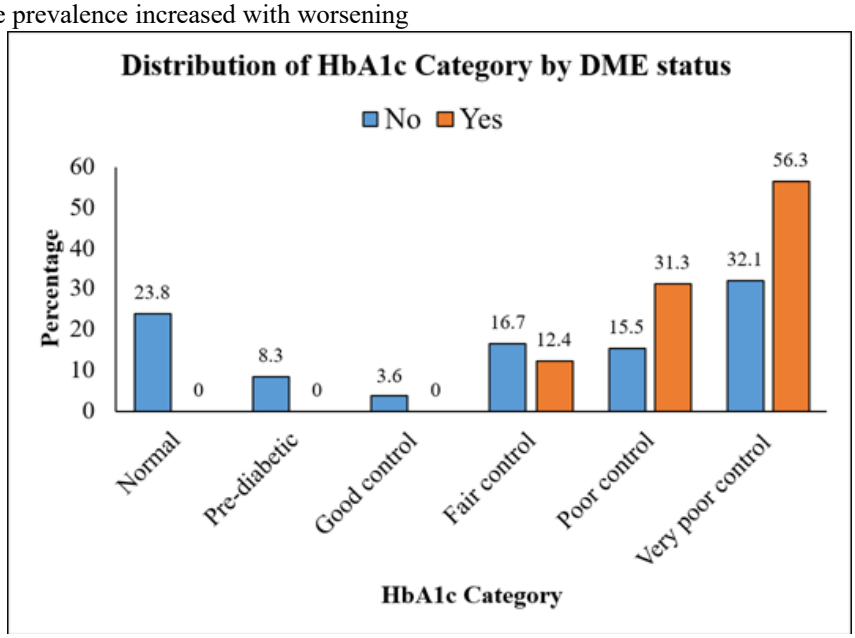


Table 9. Association Between HbA1c Categories and Diabetic Macular Edema (N = 100)

HbA1c Category	DME Absent n (%)	DME Present n (%)
Normal	20 (23.8)	0 (0.0)
Pre-diabetic	7 (8.3)	0 (0.0)
Good control	3 (3.6)	0 (0.0)
Fair control	14 (16.7)	2 (12.4)
Poor control	13 (15.5)	5 (31.3)
Very poor control	27 (32.1)	9 (56.3)

p = 0.078

Diabetic macular edema was more frequently observed among participants with poor and very poor glycemic control. Although the prevalence increased with worsening HbA1c categories, the association did not reach statistical significance (p=0.078).



4. DISCUSSION

The present hospital-based observational study was undertaken to evaluate the correlation between HbA1c levels and the severity of diabetic retinopathy (DR) among patients with Type 2 diabetes mellitus attending a tertiary healthcare centre. A total of 100 participants were included in the study. The findings demonstrated that poor glycaemic control, as reflected by elevated HbA1c levels, was associated with increasing severity of diabetic retinopathy, thereby emphasizing the importance of HbA1c as a reliable biomarker for long-term glycaemic control and prediction of retinal complications.

The demographic profile of the study showed that males constituted 66.0% of the study population, while females accounted for 34.0%. The mean age of the participants was 58.94 ± 10.00 years, indicating that diabetic retinopathy predominantly affected middle-aged and elderly individuals. The male predominance observed in the present study was comparable to the findings of Kant et al. [11], reported that 67% of patients with diabetic retinopathy were males, with the majority belonging to the 51–60-year age group. Similarly, Gaikwad et al. [12] reported 139 males and 84 females among 223 participants, also demonstrating a higher prevalence among males. In contrast, Jamshed et al. [13] observed a slight female predominance, with females constituting 54% and males 46% of the study population. Despite minor differences in gender distribution across studies, diabetic retinopathy was consistently found to occur more frequently in middle-aged individuals with longstanding diabetes.

The present study reported a mean duration of diabetes of 9.45 ± 5.68 years. Longer duration of diabetes has long been recognized as one of the strongest predictors of diabetic retinopathy because prolonged exposure to hyperglycaemia causes progressive retinal microvascular damage. Although the present study primarily focused on HbA1c correlation, the observed mean duration supports the chronic nature of retinal involvement. Similar observations were reported by Almutairi et al. [14], demonstrated that the duration of diabetes was significantly associated with diabetic retinopathy (p=0.001). Likewise, Kumar et al. [15] identified diabetes duration of ≥10 years as a major systemic risk factor contributing to increasing diabetic retinopathy severity. Gaikwad et al. [12] also concluded that both HbA1c levels and duration of diabetes were strongly correlated with disease severity.

Assessment of glycaemic control revealed a mean HbA1c level of 8.12 ± 2.26%, indicating generally poor metabolic control among the study participants. Categorization of HbA1c demonstrated that 36.0% of participants had very poor glycaemic control, 18.0% had poor control, 16.0% had fair control, while only 3.0% exhibited good glycaemic control and 20.0% had normal HbA1c values. These findings indicate that a substantial proportion of diabetic patients attending the tertiary care centre had inadequate glycaemic control, predisposing them to retinal complications. Comparable findings were reported by Gaikwad et al. [12], observed HbA1c levels greater than 10% in 83 patients, HbA1c between 8.0–9.9% in 83 patients, and HbA1c below 8% in only 57 patients, demonstrating that poor glycaemic control was common among patients with diabetic retinopathy. Similarly, Kant et al. [11] reported that 49.21% of patients had HbA1c levels between 6.5% and 8.5%, and increasing HbA1c levels were associated with progressive diabetic retinopathy. Jamshed et al. [13] further demonstrated that patients with grade 4 diabetic retinopathy had the highest HbA1c level of 11.5%, confirming that worsening glycaemic control parallels increasing retinal damage.

Evaluation of diabetic retinopathy severity showed that moderate non-proliferative diabetic retinopathy (NPDR) was the most common stage in both eyes, affecting 48.0% of right eyes and 49.0% of left eyes. Proliferative diabetic retinopathy (PDR) was present in 13.0% of right eyes and 14.0% of left eyes, whereas no diabetic retinopathy was observed in only 9.0% and 6.0% of right and left eyes, respectively. These findings suggest that many patients presented after the onset of moderate retinal damage, highlighting the need for earlier ophthalmic screening. In comparison, Kumar et al. [15] reported mild NPDR as the commonest presentation (33.3%), followed by moderate NPDR (29.4%), severe or very severe NPDR (19.6%), PDR without high-risk characteristics (9.8%), and high-risk PDR (7.8%). Gaikwad et al. [12] similarly reported 62 cases of mild NPDR, 45 cases of moderate NPDR, 32 severe NPDR, 13 very severe NPDR, 26 mild PDR, 20 high-risk PDR, and 16 cases of advanced diabetic eye disease. In contrast, Kant et al. [11] observed a relatively greater proportion of advanced disease, with PDR accounting for 37.7% of eyes and severe NPDR for 30.36%, suggesting later presentation of patients in their study. Almutairi et al. [14], however, reported a considerably lower prevalence of severe disease, with only 1.5% having PDR, reflecting differences in screening practices and disease burden across populations.

Diabetic macular edema (DME) was observed in 16.0% of participants in the present study. Although the association between HbA1c category and DME did not achieve statistical significance (p=0.078), patients with DME predominantly belonged to the poor and very poor glycaemic control categories. Specifically, 56.3% of patients with DME had very poor HbA1c levels and 31.3% had poor glycaemic control. These findings suggest a clinically meaningful trend indicating that worsening glycaemic control increases the likelihood of developing macular edema.

One of the principal objectives of the present study was to evaluate the association between HbA1c and diabetic retinopathy severity. Statistically significant differences in mean HbA1c values were observed across HbA1c categories (p=0.001), right eye diabetic retinopathy grades (p=0.040), left eye diabetic retinopathy grades (p=0.018), and diabetic macular edema (p=0.012). In contrast, gender

(p=0.918), hypertension (p=0.071), and hypertensive retinopathy changes (p=0.320) were not significantly associated with HbA1c levels. These findings indicate that retinal disease severity is more closely linked to glycaemic control than demographic variables.

Correlation analysis further strengthened these observations. HbA1c demonstrated a significant positive correlation with right eye diabetic retinopathy (r=0.234, p=0.019) and left eye diabetic retinopathy (r=0.297, p=0.003). Furthermore, an exceptionally strong correlation was observed between right and left eye diabetic retinopathy severity (r=0.819, p=0.001), reflecting the bilateral and symmetrical nature of diabetic retinal involvement. These findings are in close agreement with Kumar et al. [15], who reported a strong positive correlation between HbA1c and diabetic retinopathy severity (r=0.66, p<0.001). Gaikwad et al. [12] also demonstrated a statistically significant correlation between HbA1c levels and diabetic retinopathy severity (p<0.05). Similarly, Almutairi et al. [14] reported a significant association between HbA1c levels and diabetic retinopathy (p=0.040), while Jamshed et al. [13] concluded that patients with poor glycaemic control consistently exhibited more advanced diabetic retinopathy. Kant et al. [11] likewise concluded that increasing HbA1c levels and elevated blood glucose were major risk factors for progression of diabetic retinopathy and recommended routine HbA1c estimation for early identification of high-risk patients. The findings of the present study strongly support the established evidence that HbA1c is an important predictor of diabetic retinopathy severity. Increasing HbA1c levels were consistently associated with worsening retinal disease, and patients with poor glycaemic control demonstrated more advanced grades of diabetic retinopathy and a higher occurrence of diabetic macular edema. These observations, together with the findings of previous investigators, reinforce the importance of regular HbA1c monitoring, strict glycaemic control, periodic retinal screening, and timely ophthalmic intervention for preventing vision-threatening complications among patients with Type 2 diabetes mellitus.

CONCLUSION

The present study concluded that HbA1c levels have a significant positive correlation with the severity of diabetic retinopathy among patients with Type 2 diabetes mellitus. The study included 100 participants with a mean age of 58.94 ± 10.00 years, of whom 66% were males. The mean HbA1c level was 8.12 ± 2.26%, and the majority of patients (36%) had very poor glycaemic control. Moderate non-proliferative diabetic retinopathy was the most common stage observed in both the right (48%) and left (49%) eyes, while diabetic macular edema was present in 16% of patients. Significant associations were found between HbA1c levels and diabetic retinopathy severity in the right eye (p=0.040), left eye (p=0.018), diabetic macular edema (p=0.012), and HbA1c categories (p=0.001). Correlation analysis also demonstrated significant positive relationships between HbA1c and right eye diabetic retinopathy (r=0.234, p=0.019) as well as left eye diabetic retinopathy (r=0.297, p=0.003). These findings indicate that poor long-term glycaemic control is associated with more advanced retinal disease. Therefore, routine HbA1c monitoring, strict glycaemic control, and regular ophthalmic screening are essential for early detection, timely management, and prevention of vision-threatening complications of diabetic retinopathy, thereby improving visual outcomes and quality of life among patients with diabetes mellitus.

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