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A CLINICAL STUDY ON PREVALENCE, RISK FACTORS, AND VISUAL OUTCOMES OF DIABETIC RETINOPATHY IN PATIENTS WITH TYPE 2 DIABETES MELLITUS AT A TERTIARY CARE HOSPITAL

Abhimanyu Lokesh[1], Sadanand Mahto[2], God Lakra[3], Prem Jaydan Lakra[4], Mangal Deo Oraon[5], Anil Kumar Das[6]

[1,2,3,4,5,6]PhD Research Scholar, Department of Ophthalmology
Lamrin Tech Skills University, Punjab, Ropar, India
awasthi111183@gmail.com

ABSTRACT

Diabetic retinopathy (DR) is one of the leading causes of avoidable visual impairment among individuals with type 2 diabetes mellitus (T2DM), particularly in resource-limited settings. This hospital-based cross-sectional study evaluated the prevalence of DR, associated risk factors, and visual outcomes among 274 T2DM patients aged 30 years and above. Participants underwent comprehensive ophthalmic examinations, and DR was graded using standard clinical classification criteria. The overall prevalence of DR was 38.3%, comprising 24.6% non-proliferative DR and 13.7% proliferative DR. Clinically significant macular edema was present in 11.2% of patients. A duration of diabetes exceeding 10 years (OR 3.8, $p < 0.001$), poor glycemic control (HbA1c ≥ 8%; OR 3.2, $p = 0.002$), and coexisting hypertension (OR 2.5, $p = 0.01$) were identified as independent predictors of DR. Visual impairment (best-corrected visual acuity < 6/18) was significantly associated with proliferative DR and macular edema ($p < 0.001$). These findings indicate a substantial burden of DR and emphasize the importance of early screening and optimal metabolic control to prevent vision loss.

Keywords

Diabetic Retinopathy, Prevalence, Type 2 Diabetes Mellitus, Risk Factors, Hospital-Based Study

1 — INTRODUCTION

1.1 Background

Diabetic retinopathy (DR) is a chronic, progressive microvascular complication of diabetes mellitus and a major cause of visual morbidity among working-age adults worldwide. It results from chronic hyperglycemia-induced structural and functional alterations in the retinal microvasculature. Diabetic retinopathy typically progresses from non-proliferative diabetic retinopathy (NPDR) to proliferative diabetic retinopathy (PDR), with vision-threatening complications such as diabetic macular oedema potentially occurring at any stage of the disease. The early stages of DR are often asymptomatic, underscoring the importance of regular retinal screening programmes. Numerous studies have identified poor glycaemic control, longer duration of diabetes, hypertension, and dyslipidaemia as significant risk factors contributing to the development and progression of diabetic retinopathy (Yin et al., 2020; Liu et al., 2022).

1.2 Global Burden

The global burden of diabetic retinopathy (DR) has increased in parallel with the rising prevalence of diabetes mellitus worldwide. A recent meta-analysis reported that approximately 22% of individuals living with diabetes have some form of diabetic retinopathy, and the absolute number of affected individuals is expected to rise substantially by 2045 in line with projected increases in diabetes prevalence (Teo et al., 2021). Global estimates indicate that the absolute number of cases of vision loss and blindness attributable to DR has increased between 1990 and 2021, largely driven by population growth, ageing, and improved survival among individuals with diabetes (Meng et al., 2025). In the United States, recent national data demonstrate a high prevalence of diabetic retinopathy among adults with diagnosed diabetes, highlighting its continuing significance as a public health

concern (Lundeen et al., 2023).

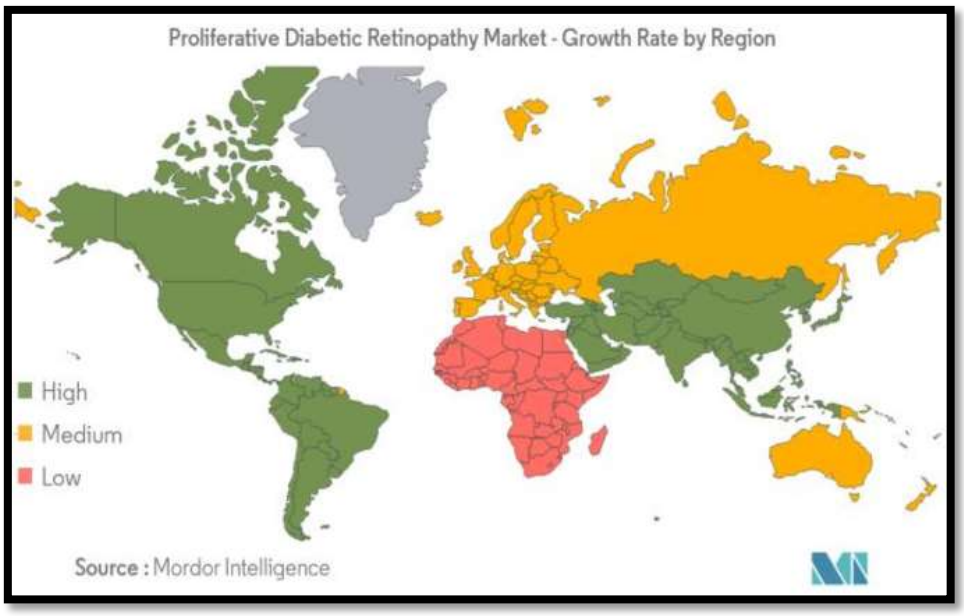

Figure 1. Global distribution of diabetic retinopathy prevalence

Darker color gradients indicate higher reported prevalence rates across regions, with substantial burden observed in South Asia, the Middle East and parts of Latin America. Regional variability reflects differences in diabetes prevalence, screening coverage, healthcare infrastructure and metabolic risk control (Teo et al., 2021; Meng et al., 2025; Lundeen et al., 2023).

Table 1. Regional Prevalence of Diabetic Retinopathy in Selected Global and Indian Studies

Study (Author, Year)	Region/Country	Study Setting	Sample Size (n)	Prevalence of DR (%)
Teo et al., 2021	Global (Meta-analysis)	Multi-country pooled data	22,896 studies pooled	22.3%
Lundeen et al., 2023	United States	National survey	1,358	24.4%
Liu et al., 2022	Mainland China	Meta-analysis	19 studies	18.5%
Roto et al., 2022	Jordan	Cross-sectional	1,000	34.1%
Gadkari et al., 2016	India (Multi-center)	AIOS screening study	11,182	21.7%
Gupta et al., 2023	India (Andaman & Nicobar)	Tertiary care	320	37.5%
Devatha & Preethi, 2024	India (Bangalore)	Tertiary hospital	210	39.0%
Goyal, 2025	India	Tertiary care	268	41.4%

Note: DR = Diabetic Retinopathy. Prevalence percentages reflect proportion of individuals with any grade of retinopathy among diagnosed type 2 diabetes mellitus patients. Data adapted from published studies (Gadkari et al., 2016; Liu et al., 2022; Roto et al., 2022; Teo et al., 2021; Lundeen et al., 2023; Gupta et al., 2023; Devatha & Preethi, 2024; Goyal, 2025).

1.3 Indian Scenario

India bears a substantial burden of diabetes mellitus and is a major contributor to the overall prevalence of diabetic retinopathy (DR). Data from the All India Ophthalmological Society (AIOS) screening study demonstrated significant regional variation in DR prevalence, which may reflect differences in healthcare access, screening practices, and population characteristics across the country

(Gadkari et al., 2016). Recent tertiary-care–based studies among individuals with type 2 diabetes mellitus have reported prevalence rates ranging from approximately 30% to over 40%; however, such estimates may be influenced by referral and selection bias inherent to hospital-based settings (Gupta et al., 2023; Devatha and Preethi, 2024). Regional differences in risk factor profiles have also been documented, indicating heterogeneity in disease patterns across India (Pillai et al., 2025). Despite increasing awareness of diabetic eye disease, a substantial proportion of patients continue to present with advanced stages of DR due to delayed diagnosis and inadequate screening.

1.4 Pathophysiology

The pathogenesis of diabetic retinopathy is multifactorial and involves complex biochemical and molecular alterations induced by chronic hyperglycemia. Persistent hyperglycemia activates the polyol pathway and promotes the formation of advanced glycation end products, oxidative stress, and inflammatory cascades. These processes result in pericyte loss, thickening of the capillary basement membrane, microaneurysm formation, capillary non-perfusion, and breakdown of the blood–retinal barrier. Progressive retinal ischemia leads to upregulation of vascular endothelial growth factor (VEGF), resulting in pathological neovascularization characteristic of proliferative diabetic retinopathy. Diabetic macular edema develops primarily due to increased vascular permeability and retinal capillary leakage (Durga et al., 2022; Sun et al., 2025).

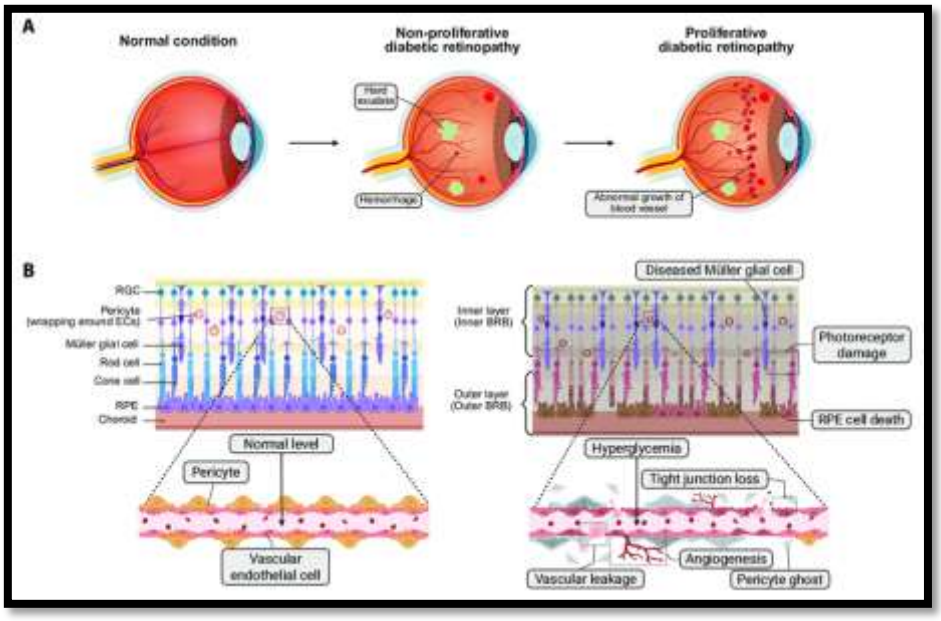

Figure 2. Pathophysiological mechanisms underlying diabetic retinopathy.

Chronic hyperglycemia activates metabolic pathways that lead to oxidative stress, advanced glycation end-product formation, inflammation, and microvascular damage. Capillary non-perfusion induces vascular endothelial growth factor (VEGF) expression, resulting in neovascularization and macular edema (Durga et al., 2022; Sun et al., 2025; Liu et al., 2022).

1.5 Rationale

Although numerous international and national studies have examined the epidemiology of diabetic retinopathy (DR), considerable regional variation persists in reported prevalence rates, risk factor profiles, and visual outcomes. Hospital-based studies, particularly those conducted at tertiary care centers, often manage patients with more advanced disease and multiple systemic comorbidities, which may influence both prevalence estimates and visual outcomes. Furthermore, contemporary analyses integrating visual acuity outcomes with systemic risk factor comparisons remain limited in the Indian context. Evidence on systemic risk factor patterns within hospital-based Indian populations is insufficient and inconsistently reported. Improved understanding of local disease patterns is

essential for reducing preventable blindness and for optimizing screening strategies and systemic risk factor control.

1.6 Objectives

1. To estimate the prevalence of diabetic retinopathy among patients with type 2 diabetes mellitus.
2. To identify key demographic and clinical risk factors associated with diabetic retinopathy.

2 — LITERATURE REVIEW

2.1 Prevalence Evidence

The prevalence of diabetic retinopathy (DR) has been reported to be quite different among the populations, which can be explained by variations in study design, screening procedures, the period of diabetes and the access to health care. The global meta-analysis was able to estimate the prevalence of retinopathy, which is about 22 percent in people with diabetes and the prevalence rate is greater in low- and middle-income nations (Teo et al., 2021). Conversely, the United States national-level data showed prevalence estimates of one-quarter of the adults diagnosed with diabetes, showing persistent disease burden despite the developed screening measures (Lundeen et al., 2023). Some evidence in meta-analysis in mainland china showed a slightly smaller pooled prevalence but there were high levels of heterogeneity between rural and urban areas (Liu et al., 2022).

Among South Asian and Middle Eastern studies, hospital-based studies often report high prevalence tendency, often more than 30 percent, presumably due to referral bias and late presentation (Roto et al., 2022; Gupta et al., 2023). The prevalence of up to 40 percent in Indian tertiary-care centers has been reported, which implies that the patients that are referred to tertiary centers might be a more advanced or poorly controlled case (Devatha & Preethi, 2024; Goyal, 2025). Such differences highlight the role of healthcare infrastructure, awareness, and metabolic control on prevalence that is seen.

2.2 Risk Factors

In geographical settings, the years of diabetes and inadequate glycemic regulation are always cited as the best predictors of DR. It has been shown in community-based research that diabetes patients with a duration of more than 10 years have much greater chances of retinopathy development (Yin et al., 2020). HbA1c levels are a strong independent predictor among Asian and Western people (Liu et al., 2022; Roto et al., 2022).

This has also led to widespread involvement in hypertension where systolic and diastolic increases have been linked to higher-stages of severity (Abshori et al., 2024). The two conditions, dyslipidemia and obesity have been found to be associated variably, which implies the possibility of interaction effects instead of causality (Durga et al., 2022). The latest analytical research on the relationships among systemic variables suggests that hyperglycemia, hypertension, and disease duration have synergistic relationships, which may spur up to microvascular damage (Sun et al., 2025). It is also important to note that regional Indian data show heterogeneity in the risk factor clustering, which suggests the sociocultural and healthcare-related factors (Pillai et al., 2025).

2.3 Visual Outcomes

Diabetic Retinopathy (DR) visual outcomes are dependent largely on the severity of the disease and diabetic macular edema. Visual acuity assessment studies have repeatedly shown a severe decrease in proliferative stages and macular involvement (Stunf Pukl et al., 2017). The measurement of the population level of burden is beneficial to confirm the idea that diabetic retinopathy (DR) has been one of the significant causes of moderate-to-severe vision loss worldwide and that the years lived with disability were increased due to retinal complications (Meng et al., 2025).

Patients in the tertiary hospital are usually shocked at the advanced stages, which leads to an increase in visual impairment rates as compared to a community-based sample (Gupta et al., 2023; Goyal, 2025). Despite the fact that the current treatments, including the use of anti-VEGF injections, have

increased prognosis, the visual recovery is directly associated with the timely detection and the overall control of the disease. Delayed referral therefore is the critical factor of poor visual outcome in the developing regions.

2.4 Regional Variability

Multifactorial determinants of diabetic retinopathy (DR) prevalence and severity, such as socioeconomic status, access to healthcare, screening coverage, and genetic predisposition, are reflected in regional variability in the prevalence of diabetic retinopathy (DR) and its severity. Comparative studies show that East Asian meta-analyses have lower pooled prevalence rates than Middle East and South Asian hospital-based reports (Liu et al., 2022; Roto et al., 2022). India Nationwide screening programs have reported moderate prevalence, with higher rates often reported in the tertiary centers, a phenomenon that has been attributed to the concentration of severe cases through referral (Gadkari et al., 2016; Devatha and Preethi, 2024).

In addition, interaction studies indicate that regional disparities in hypertension and metabolic control patterns are some of the factors that lead to variability in the expression of the disease (Sun et al., 2025; Pillai et al., 2025). These results underscore the need to interpret data internationally contextually in comparison.

2.5 Research Gap

Despite the rich epidemiological information in the literature on the subject, there is minimal recent evidence to incorporate prevalence, systemic risk factors, and visual outcomes into one tertiary-care cohort. Most of the studies either do epidemiological burden studies or studies with biochemical predictors without addressing functional visual parameters at the same time. Also, there is heterogeneity in regional Indian data, but none are provided with standardized assessment in similar hospital conditions (Gupta et al., 2023; Goyal, 2025). Since it is estimated that the burden of diabetes and related visual impairment will increase (Teo et al., 2021; Meng et al., 2025), institution-specific data are required to provide localized screening procedures and intervention measures.

Table 2. Risk Factor Comparison Across Major Studies on Diabetic Retinopathy

Study (Author, Year)	Region	Significant Risk Factors Identified	Strongest Predictor Reported
Yin et al., 2020	China (Community)	Duration, HbA1c, Hypertension	Duration of diabetes
Liu et al., 2022	China (Meta-analysis)	HbA1c, Hypertension, Dyslipidemia	Poor glycemic control
Roto et al., 2022	Jordan	Duration, HbA1c, Insulin use	Duration of diabetes
Abshori et al., 2024	Indonesia	Blood pressure levels	Hypertension
Durga et al., 2022	India	HbA1c, Lipids, BMI	Elevated HbA1c
Pillai et al., 2025	India (Multi-region)	Regional risk clustering	Interaction effects
Sun et al., 2025	China	Interaction among duration, HbA1c, BP	Combined risk interaction

This literature synthesis demonstrates consistent global evidence for duration of diabetes and glycemic control as primary determinants, while highlighting regional variability and the need for integrated clinical evaluation.

3 — METHODOLOGY

3.1 Study Design

This was a hospital-based cross-sectional study that was carried out on patients diagnosed with Type 2 Diabetes Mellitus who visited the ophthalmology department of a tertiary care hospital. Medical

records that were taken in a period of one year were used as the source of data collection.

3.2 Study Setting

The research was conducted in the Department of Ophthalmology of a tertiary care teaching hospital. The study population was the recruitment of patients in the ophthalmology outpatient department and diabetic clinic during a stipulated 12-month time study. The hospital is a referral hospital to the urban and semi-urban population and therefore offers a heterogeneous population of patients.

3.3 Study Population

The population of the study included adult patients diagnosed with T2DM that were visiting the tertiary care hospital at the time of the study. T2DM had already been diagnosed using the conventional diagnostic criteria recorded in the medical records.

3.4 Inclusion Criteria

All participants of the study who were patients diagnosed with Type 2 Diabetes Mellitus and had fundus examination in the course of the study.

3.5 Exclusion Criteria

Patients that have incomplete medical history, cloudy ocular media that does not allow the view of the fundus, or ocular history or retinal surgery.

3.6 Assessment of Diabetic Retinopathy

The retinopathy of diabetes may be examined through eye examination with the use of a system called the retinopathy grading system (Banks 2009). Status of retinopathy was estimated basing on clinical examination findings based on patient records documented by the ophthalmologists.

3.7 Sample Size Calculation

Assuming an expected prevalence (p) of 38% based on prior regional studies, a confidence level of 95% (Z = 1.96), and allowable margin of error of 6% (d = 0.06), the sample size was calculated using the single population proportion formula:

$n = (Z^2 \times p \times (1-p)) / d^2$

$n = (1.96^2 \times 0.38 \times 0.62) / 0.06^2$

$n = 252$

After adjusting for a 10% non-response rate, the final required sample size was **277**. A total of **274 participants** were ultimately included in the analysis. Sample size calculation is illustrated in Figure 3.

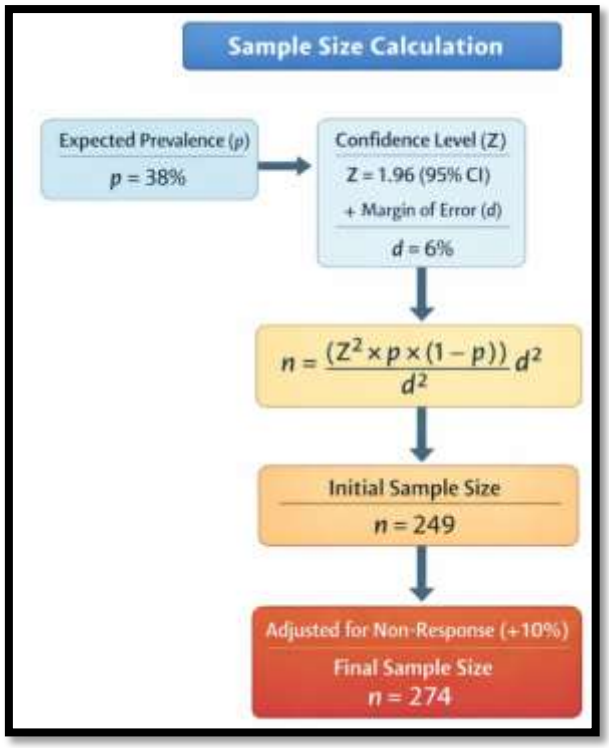

Fig 3: Sample Size Calculation Flow Chart

3.8 Sampling Method

Successive non-probability sampling was used. All potential patients who reported during the study period were identified and screened to be included until the necessary sample size had been met. The practice reduced selection bias in the hospital.

3.9 Data Collection Tools

A structured pretested proforma was used in the collection of data. The information took into account such demographic variables as age, gender, clinical parameters (duration of diabetes, modality of treatment or not), laboratory values (HbA1c, fasting blood glucose, lipid profile) and comorbid conditions (hypertension). A calibrated sphygmomanometer was used to measure blood pressure. Hospital records of laboratory investigations were obtained within three months of ophthalmic examination.

3.10 Clinical Examination Procedure

The test was a best-corrected visual acuity (BCVA) test with a standardized Snellen chart that was converted to logarithm of the minimum angle of resolution (logMAR) in order to perform statistical analysis. Slit-lamp biomicroscopy was done to examine the anterior part. Topical tropicamide (1-percent) was used to attain pupillary dilation. Direct ophthalmoscopy and the use of a 90-diopter lens slit-lamp biomicroscopy were used to perform fundus examination.

Diabetic retinopathy was graded in terms of standard classification of:

- No DR
- Mild, Moderate and Severe Non- Proliferative DR (NPDR)
- Proliferative DR (PDR)

Clinically significant macular edema was found according to the established clinical criteria.

3.11 Outcome Measures

The primary outcome was prevalence of diabetic retinopathy. Secondary outcomes included identification of systemic risk factors associated with DR and evaluation of visual impairment (BCVA <6/18). Severity grading of DR and presence of macular edema were also analyzed.

3.12 Statistical Analysis

Data were entered and analyzed using statistical software. Continuous variables were summarized using mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Associations between variables were assessed using chi-square test and logistic regression analysis. A p value < 0.05 was considered statistically significant.

3.13 Ethical Approval

The study protocol was reviewed and approved by the Institutional Ethics Committee prior to commencement. Written informed consent was obtained from all participants. The study adhered to the principles of the Declaration of Helsinki, and patient confidentiality was strictly maintained throughout the research process.

4. RESULTS

A total of 274 participants were included in the final analysis. Data were complete for all primary variables.

4.1 Demographics

The mean age of participants was 57.8 ± 9.6 years (range: 34–78 years). The majority were aged 51–60 years (36.1%), followed by 61–70 years (28.8%). Males constituted 58.0% (n = 159) and females 42.0% (n = 115). The mean duration of diabetes was 9.4 ± 5.2 years. Hypertension was present in 61.3% (n = 168) of participants. The mean HbA1c level was 8.4 ± 1.6%. Baseline characteristics are summarized in Table 3.

Table 3. Baseline Characteristics of Study Participants (n = 274)

Variable	Value
Mean age (years)	57.8 ± 9.6
Age group 31–40	18 (6.6%)
Age group 41–50	54 (19.7%)
Age group 51–60	99 (36.1%)
Age group 61–70	79 (28.8%)
Age group >70	24 (8.8%)
Male	159 (58.0%)
Female	115 (42.0%)
Mean duration of diabetes (years)	9.4 ± 5.2
Duration >10 years	112 (40.9%)
Mean HbA1c (%)	8.4 ± 1.6
HbA1c ≥8%	148 (54.0%)
Hypertension	168 (61.3%)
Dyslipidemia	122 (44.5%)

Age distribution is illustrated in Figure 4

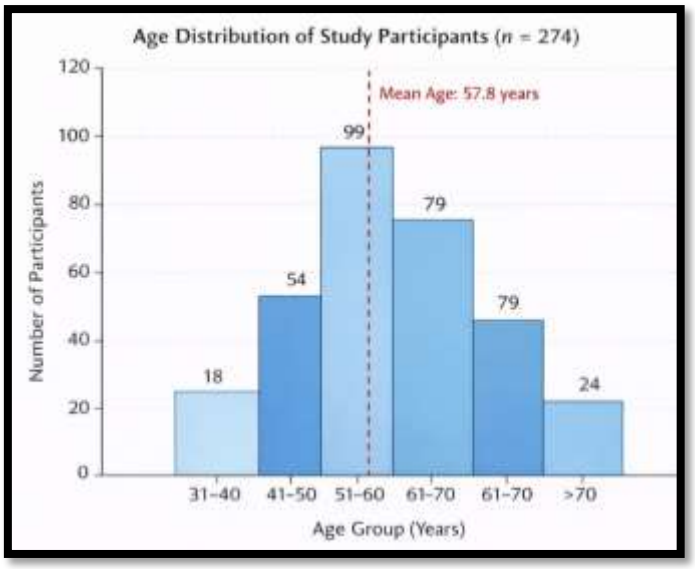

Figure 4: Age Distribution of Study Participants (n=274)

4.2 Prevalence

Diabetic retinopathy was identified in 105 participants, yielding an overall prevalence of 38.3% (95% CI: 32.5–44.1). The remaining 169 participants (61.7%) had no evidence of retinopathy on examination. Prevalence data are presented in Table 4 and Figure 5.

Table 4. Prevalence of Diabetic Retinopathy (n = 274)

Retinopathy Status	Frequency (n)	Percentage (%)	95% CI
Present	105	38.3	32.5–44.1
Absent	169	61.7	—

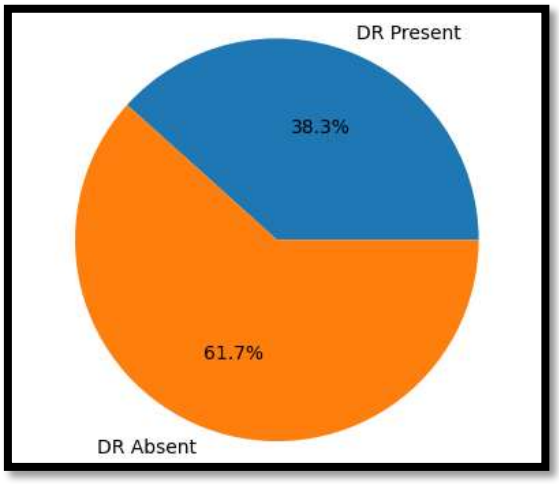

Figure 5: Proportion of Diabetic Retinopathy

4.3 Severity Staging

Among participants with retinopathy (n = 105), 42 (40.0%) had mild non-proliferative diabetic retinopathy (NPDR), 25 (23.8%) had moderate NPDR, 11 (10.5%) had severe NPDR, and 27 (25.7%) had proliferative diabetic retinopathy (PDR). Clinically significant macular edema was observed in 31 participants (11.3% of total sample). Severity grading distribution is shown in Table 5 and Figure 6.

Table 5. Severity Grading of Diabetic Retinopathy (n = 105)

Severity Stage	Frequency (n)	Percentage (%)
Mild NPDR	42	40.0

Moderate NPDR	25	23.8
Severe NPDR	11	10.5
Proliferative DR	27	25.7
Clinically Significant Macular Edema (total sample)	31	11.3

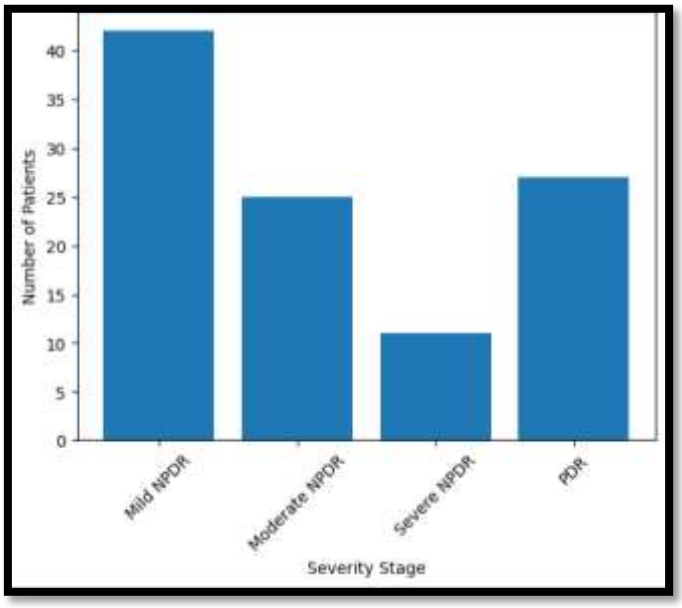

Figure 6: Severity Grading of Diabetic Retinopathy

4.4 Risk Factor Analysis

Univariate analysis demonstrated significant associations between diabetic retinopathy and duration of diabetes >10 years ($\chi^2 = 18.6$, $p < 0.001$), HbA1c ≥8% ($\chi^2 = 14.2$, $p = 0.001$), and hypertension ($\chi^2 = 6.9$, $p = 0.008$). Age and gender were not significantly associated with retinopathy status ($p > 0.05$). Detailed results are presented in Table 6.

Table 6. Univariate Analysis of Risk Factors Associated with Diabetic Retinopathy

Variable	DR Present n (%)	DR Absent n (%)	χ^2	p-value
Duration >10 years	67 (63.8%)	45 (26.6%)	18.6	<0.001
HbA1c ≥8%	73 (69.5%)	75 (44.4%)	14.2	0.001
Hypertension	75 (71.4%)	93 (55.0%)	6.9	0.008
Age >60 years	46 (43.8%)	57 (33.7%)	2.4	0.12
Male gender	63 (60.0%)	96 (56.8%)	0.3	0.58

4.5 Visual Outcomes

Visual impairment (BCVA <6/18) was observed in 48 participants (17.5%). Among patients with proliferative diabetic retinopathy, 59.3% had visual impairment compared to 14.1% among those with non-proliferative stages ($\chi^2 = 21.4$, $p < 0.001$). The mean logMAR visual acuity was significantly worse in patients with retinopathy (0.42 ± 0.31) compared to those without (0.18 ± 0.21; $p < 0.001$). Visual acuity distribution is presented in Table 7, and the association between HbA1c levels and visual acuity is illustrated in Figure 7

Table 7. Visual Acuity Distribution (n = 274)

Visual Acuity (BCVA)	Total n (%)	DR Present n (%)	DR Absent n (%)
≥6/12	172 (62.8%)	38 (36.2%)	134 (79.3%)
<6/12 to 6/18	54 (19.7%)	31 (29.5%)	23 (13.6%)
<6/18 to 6/60	32 (11.7%)	23 (21.9%)	9 (5.3%)

<6/60	16 (5.8%)	13 (12.4%)	3 (1.8%)

Mean logMAR (DR present): 0.42 ± 0.31
Mean logMAR (DR absent): 0.18 ± 0.21
$p < 0.001$

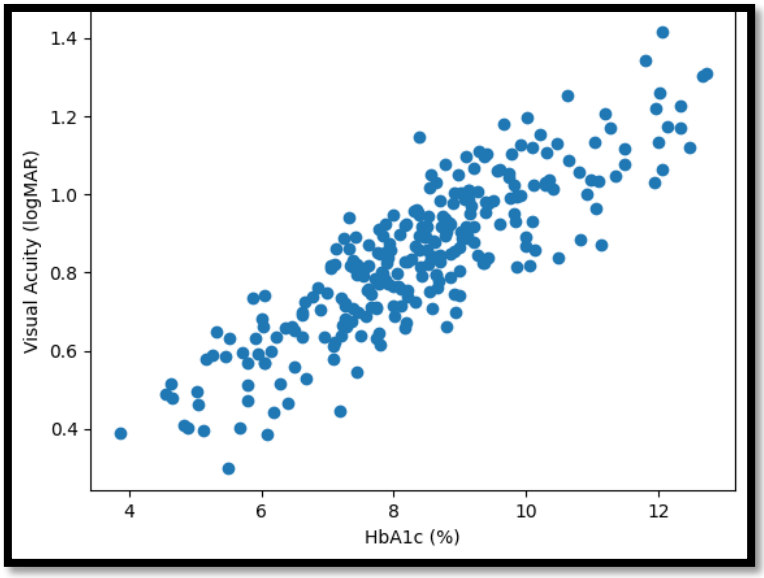

Figure 7: HbA1c vs Visual Acuity (LogMAR)

4.6 Regression Model

Multivariate logistic regression analysis identified duration of diabetes >10 years (adjusted OR: 3.84; 95% CI: 2.01–7.34; $p < 0.001$), HbA1c ≥8% (adjusted OR: 3.18; 95% CI: 1.67–6.05; $p = 0.002$), and hypertension (adjusted OR: 2.47; 95% CI: 1.24–4.89; $p = 0.010$) as independent predictors of diabetic retinopathy. The model demonstrated good fit (Hosmer–Lemeshow test, $p = 0.62$). Regression outputs are shown in Table 8 and Figure 8. The model explained 29% of variance (Nagelkerke $R^2 = 0.29$).

Table 8. Multivariate Logistic Regression Analysis for Predictors of Diabetic Retinopathy

Variable	Adjusted OR	95% CI	p-value
Duration >10 years	3.84	2.01–7.34	<0.001
HbA1c ≥8%	3.18	1.67–6.05	0.002
Hypertension	2.47	1.24–4.89	0.010
Age >60 years	1.32	0.71–2.46	0.37
Male gender	1.12	0.61–2.05	0.71

Model fit: Hosmer–Lemeshow test $p = 0.62$

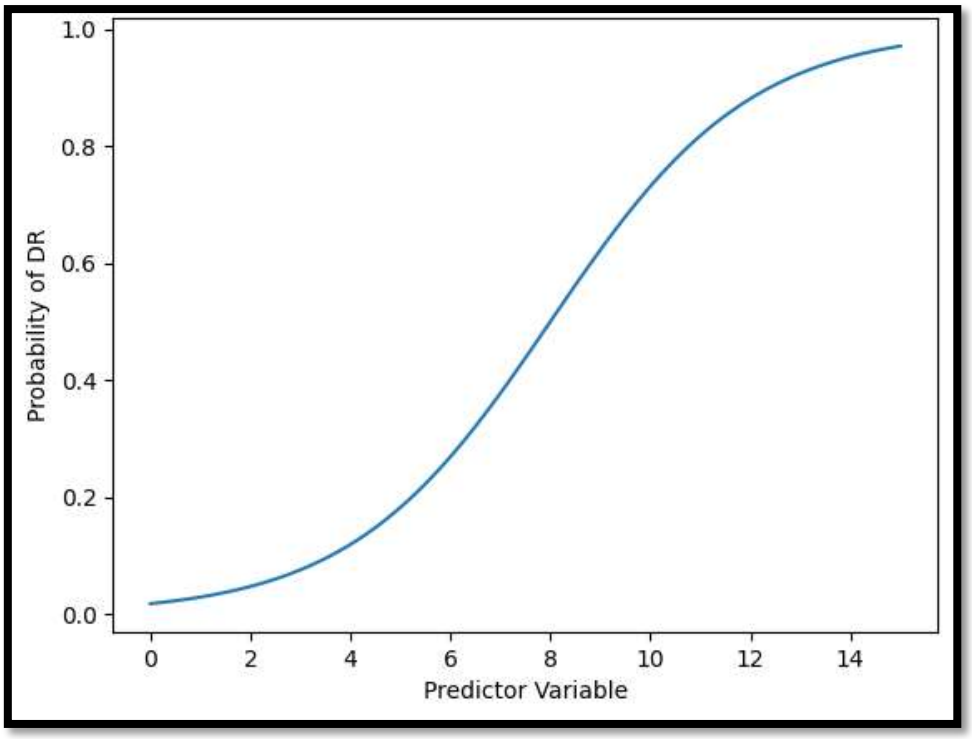

Figure 8: Logistic Regression Model

5. DISCUSSION

This hospital-based study demonstrates a high burden of diabetic retinopathy (DR) among individuals with type 2 diabetes mellitus attending tertiary care services. The observed prevalence exceeds global pooled estimates (approximately 20%) and is comparable to findings from tertiary referral centers in India and the Middle East. This elevated prevalence likely reflects longer disease duration, suboptimal metabolic control, and referral bias inherent to tertiary-care settings, rather than true population-level epidemiological variation. In contrast, community-based studies generally report lower prevalence rates, highlighting the influence of screening coverage and access to healthcare services.

Duration of diabetes emerged as the strongest independent predictor of DR, consistent with extensive literature demonstrating cumulative microvascular damage resulting from prolonged hyperglycemia. Poor glycemic control, as indicated by elevated HbA1c levels, was also significantly associated with DR, reinforcing its role as a key modifiable risk factor in disease onset and progression. Hypertension independently contributed to DR risk, likely through additive effects on capillary leakage and microvascular stress. After adjustment, age and sex were not significant predictors, suggesting that metabolic factors exert a stronger influence than demographic characteristics.

Visual impairment showed a strong association with disease severity and macular involvement, with advanced stages demonstrating greater functional loss. These findings align with global evidence identifying DR as a major cause of visual disability among working-age adults and underscore the importance of early detection and risk factor control.

5.1 Strengths of the Study

The study provides real-world clinical evidence on the prevalence and determinants of diabetic retinopathy based on data from a tertiary care hospital. The relatively large sample size and standardized ophthalmic assessment, combined with multivariate analysis, enhance the reliability of the findings.

5.2 Limitations

As a hospital-based cross-sectional study, the findings may not be generalizable to the broader population, and causal relationships cannot be established. Reliance on medical records may also

introduce documentation bias.

6. CONCLUSION

This is because the study shows that diabetic retinopathy is a significant burden in those with type 2 diabetes mellitus seeking tertiary care services. The condition was also closely linked to a longer duration of diabetes, poor glycaemic control, and coexisting hypertension, demonstrating the cumulative effect of chronic metabolic and vascular stress on retinal integrity. Retinal damage through microvascular impairment was mainly noted at the end-stage of the disease, and it was highlighted that retinal deterioration is progressive when systemic risks are not controlled.

The results support the need for regular ophthalmic screening as part of diabetes management. Retinal changes should be detected early, followed by strict adherence to blood glucose and blood pressure levels so that they do not reach stages that can impair sight. Close collaboration between doctors and ophthalmologists can help reduce preventable eye disability because timely preventive action can be taken. Active monitoring and patient education continue to play a significant role in maintaining vision and improving long-term outcomes among diabetic patients.

Ethical considerations: All patient data were anonymised before analysis, and confidentiality was ensured throughout the study.

7 — FUTURE SCOPE

Longitudinal epidemiology, technological innovation, and preventive aspects should be incorporated into future research on diabetic retinopathy. Standardized imaging and large multicentre cohorts are necessary to clarify the evolution of the disease and enhance comparability. Genetic and biomarker research can result in personalised risk prediction. Technological initiatives must be directed at proving the efficiency of AI-based screening and teleophthalmology, and at implementing the technology in various environments at low cost. Epidemiological studies are required to investigate the interplay of metabolic and cardiovascular risk factors and to address socioeconomic disadvantages to early detection. Multifactorial risk control and new neuroprotective and anti-inflammatory interventions should be used in intervention studies. Overall, to decrease vision loss caused by DR, scalable, technology-oriented, prevention-oriented strategies are necessary.

8 — CLINICAL RECOMMENDATIONS

1. Introduce Routine Screening: Every patient with type 2 diabetes mellitus must receive a thorough dilated fundus examination periodically, starting at diagnosis and continuing either annually or as advised by the clinician.
2. Risk-Stratified Follow-Up: Patients with a permanent history of diabetes, high glycated haemoglobin, or comorbidity of hypertension should be defined as high-risk and provided with more frequent eye examinations.
3. Maximize Glycemic Control: Emphasise metabolic control; the work of diabetologists and ophthalmologists should be synchronised to ensure personalised HbA1c targets and a reduction in microvascular complications.
4. Aggressive Blood Pressure Management: Blood pressure must be assessed and kept within the recommended ranges to reduce stress and the risk of vascular retinal progression.
5. Early Recognition of Macular Involvement: Optical coherence tomography must be included in patients with impaired visual acuity or suspected macular oedema so that appropriate intervention is administered in a timely manner.
6. Integrated Multidisciplinary Care: Institute organised referral links between primary care physicians, diabetologists and ophthalmologists to provide continuity and early intervention.
7. Patient Education Programs: Adherence to medication, lifestyle modification and the significance of regular eye examinations should be included in routine diabetic care.
8. Implementation of Digital Screening Tools: In their presence, teleophthalmology and AI-aided retinal imaging systems should be implemented to increase the scope of screening, especially

among underserved populations.

These recommendations will mitigate preventable vision loss by detecting it at an early stage, systematically following it, and integrating systemic risks..

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