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Co-Relation Of Hba1c Level With Severity Of Diabetic Retinopathy: A Cross-Sectional Study In Ghazipur, UP

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Abstract-

Introduction- Diabetes mellitus is a major public health problem in India, with diabetic retinopathy (DR) being a leading cause of preventable blindness. Poor glycaemic control, reflected by elevated HbA1c levels, is strongly linked to DR development and progression. This study evaluates the association between HbA1c levels and DR severity in a regional Indian population

Material and Method- This hospital-based cross-sectional study was conducted over 12 months at a tertiary care centre in Ghazipur, Uttar Pradesh. A total of 250 adults with type 2 diabetes mellitus (≥5-year duration) were enrolled. Diabetic retinopathy was graded using standard clinical criteria, and HbA1c levels were estimated by HPLC to assess correlation with retinopathy severity.

Result- Diabetic retinopathy was present in 102 patients (40.8%). Among these, mild NPDR was the most common (33.3%), followed by moderate NPDR (29.4%), severe or very severe NPDR (19.6%), PDR without high-risk criteria (9.8%), and PDR with high-risk criteria (7.8%). Mean HbA1c levels increased progressively with DR severity, from 6.8 ± 0.7% in patients without DR to 10.1 ± 1.2% in high-risk PDR. Pearson correlation revealed a strong positive correlation between HbA1c and DR severity ($r = 0.66$, $p < 0.001$). Systemic risk factors significantly associated with DR included longer duration of diabetes (≥10 years), poor glycaemic control (HbA1c >8%), hypertension, dyslipidaemia, and insulin therapy. Smoking was not significantly associated with DR.

Conclusion- Poor glycaemic control is strongly associated with increasing severity of diabetic retinopathy. Longer diabetes duration, hypertension, dyslipidaemia, and insulin therapy further contribute to DR risk. Early screening, stringent glycaemic control, and comprehensive management of systemic risk factors are crucial to prevent vision-threatening complications, especially in resource-limited settings.

Keywords- Diabetes mellitus, Diabetic retinopathy, Glycated haemoglobin; HbA1c, severity, Non-proliferative diabetic retinopathy; Proliferative diabetic retinopathy etc.

Introduction-

Diabetes mellitus (DM) is one of the most prevalent non-communicable diseases globally and poses a major public health challenge, particularly in low- and middle-income countries such as India. According to recent estimates, India harbours one of the largest populations of individuals with diabetes, with a steadily rising burden attributable to urbanisation, sedentary lifestyle, and dietary transitions [1]. Chronic hyperglycaemia in diabetes leads to a spectrum of microvascular complications, among which diabetic retinopathy (DR)

remains the most common and visually disabling manifestation [2]. Diabetic retinopathy is a progressive retinal microangiopathy characterised by capillary basement membrane thickening, pericyte loss, microaneurysm formation, and retinal ischemia. Clinically, DR ranges from mild non-proliferative diabetic retinopathy (NPDR) to advanced proliferative diabetic retinopathy (PDR), which is associated with sight-threatening complications such as vitreous haemorrhage and tractional retinal detachment [3]. DR is a leading cause of preventable blindness among working-age adults, and early detection remains crucial for timely intervention [4].

Glycated haemoglobin (HbA1c) is a well-established biomarker reflecting average blood glucose levels over the preceding 8–12 weeks and is widely used to assess long-term glycaemic control. Several landmark trials, including the Diabetes Control and Complications Trial (DCCT) and the UK Prospective Diabetes Study (UKPDS), have demonstrated a strong association between poor glycaemic control and the development as well as progression of DR [5,6]. Elevated HbA1c levels have been consistently correlated with increased prevalence and severity of DR, underscoring its role as an important predictor of retinal damage [7]. Despite substantial evidence at the global and national levels, the magnitude and pattern of association between HbA1c and DR severity may vary across regions due to differences in healthcare access, awareness, socioeconomic status, and screening practices [8]. In India, particularly in semi-urban and rural districts such as Ghazipur in eastern Uttar Pradesh, systematic data on DR severity in relation to glycaemic control remain limited. Many patients present late, often with advanced disease, due to inadequate routine ophthalmic screening and poor diabetes monitoring [9].

Understanding the correlation between HbA1c levels and the severity of DR in this regional context is essential for identifying high-risk individuals, strengthening preventive strategies, and promoting integrated diabetes and eye care services. Such evidence can assist clinicians in emphasising strict glycaemic control and regular retinal evaluation to reduce visual morbidity [10,11]. Therefore, the present cross-sectional study was undertaken to assess the correlation between HbA1c levels and the severity of diabetic retinopathy among patients attending a healthcare facility in Ghazipur, Uttar Pradesh.

Material and Method-

The present hospital-based cross-sectional study was conducted in the Department of Ophthalmology in collaboration with the Department of Medicine at a tertiary care healthcare facility in Ghazipur district, Uttar Pradesh. The study duration extended over a period of twelve months i.e. from January 2023 to December 2023. The objective was to assess the correlation between glycaemic control, as measured by glycated haemoglobin (HbA1c), and the severity of diabetic retinopathy among patients with diabetes mellitus. The study protocol was approved by the Institutional Ethics Committee. Informed consent was taken from all the participants. Confidentiality of patient information was maintained throughout the study, and participation was entirely voluntary. The study included adult patients aged 30 years and above with a confirmed diagnosis of type 2 diabetes mellitus, attending the outpatient or inpatient services during the study period. A sample size was calculated based on expected prevalence of diabetic retinopathy and feasibility within the study period, and consecutive eligible patients were enrolled using a convenient sampling method. A total of 250 patients were included in the study considering inclusion and exclusion criteria. Patients with a minimum duration of diabetes of five years were included in the study. Individuals with other retinal pathologies such as hypertensive retinopathy, retinal vein occlusion, age-related macular degeneration, or media opacities precluding fundus examination were excluded. Patients with a history of ocular trauma, prior retinal laser therapy, vitreoretinal surgery, or systemic conditions such as anaemia and haemoglobinopathies that could affect HbA1c estimation were also excluded.

After obtaining informed written consent, demographic details including age, sex, duration of diabetes, and treatment history were recorded using a structured proforma. A thorough ophthalmic examination was performed for all participants. Best-corrected visual acuity was assessed using a Snellen chart, followed by slit-lamp examination of the anterior segment. Pupillary dilatation was achieved using 1% tropicamide, and fundus evaluation was carried out using direct and indirect ophthalmoscopy. Classification of Diabetes Retinopathy is based on Early Treatment Diabetic Retinopathy Study (ETDRS). NPDR was classified into mild NPDR, moderate NPDR, and severe/very severe NPDR. PDR was graded as PDR without high risk

criteria (Early PDR) and PDR with high risk criteria. Venous blood samples were collected under aseptic precautions for estimation of HbA1c. HbA1c levels were measured using a standardized high-performance liquid chromatography (HPLC) method in the hospital central laboratory. Glycaemic control was categorised based on HbA1c levels as good (<7%), moderate (7–8%), and poor (>8%). Data were entered in Microsoft Excel and analysed using Statistical Package for the Social Sciences (SPSS) software. Descriptive statistics were expressed as mean and standard deviation for continuous variables and percentages for categorical variables. The correlation between HbA1c levels and severity of diabetic retinopathy was assessed using appropriate statistical tests. A p-value of less than 0.05 was considered statistically significant.

Result-

Table 1 describes the demographic and clinical profile of the 250 study participants with diabetes mellitus included in the study. The majority of participants were in the 50–59 years age group (82 patients, 32.8%), followed by those aged ≥60 years (79 patients, 31.6%), indicating a predominance of middle-aged and elderly individuals. Males constituted 139 patients (55.6%), while 111 patients (44.4%) were females. With respect to the duration of diabetes, most participants had diabetes for 10–14 years (96 patients, 38.4%), followed by ≥15 years in 80 patients (32.0%), reflecting a substantial proportion with long-standing disease. Assessment of glycaemic control based on HbA1c levels showed that poor glycaemic control (HbA1c >8.0%) was present in 114 patients (45.6%), whereas moderate control (HbA1c 7.0–8.0%) was seen in 79 patients (31.6%) and good control (HbA1c <7.0%) in 57 patients (22.8%). Diabetic retinopathy was detected in 102 patients (40.8%), while 148 patients (59.2%) had no evidence of retinopathy. Diabetic retinopathy was present in a total of 102 patients (40.8%). The relatively high prevalence of diabetic retinopathy in this cohort, along with the large proportion of patients with poor glycaemic control and longer duration of diabetes, provides a suitable background for evaluating the relationship between HbA1c levels and the severity of diabetic retinopathy in this population.

Table 1: Distribution of study participants by demographic and clinical variables

Variable	Category	n (%)
Age (years)	30–39	32 (12.8%)
	40–49	57 (22.8%)
	50–59	82 (32.8%)
	≥60	79 (31.6%)
Gender	Male	139 (55.6%)
	Female	111 (44.4%)
Duration of diabetes (years)	5–9	74 (29.6%)
	10–14	96 (38.4%)
	≥15	80 (32.0%)
Glycaemic control (GC) based on HbA1c Levels	Good GC (HbA1c < 7.0)	57 (22.8%)
	Moderate GC (HbA1c 7.0 – 8)	79 (31.6%)
	Poor GC (HbA1c > 8.0)	114 (45.6%)
Diabetic retinopathy	Present	102 (40.8%)
	Absent	148 (59.2%)

Table 2 shows that out of those with diabetic retinopathy, non-proliferative diabetic retinopathy (NPDR) was the most common presentation. Mild NPDR was observed in 34 patients (33.3%), followed by moderate NPDR in 30 patients (29.4%) and severe or very severe NPDR in 20 patients (19.6%). Proliferative diabetic retinopathy (PDR) was identified in a smaller proportion of patients, with PDR without high risk criteria (Early PDR) PDR seen in 10 patients (9.8%) and PDR with high risk criteria PDR in 8 patients (7.8%).

Table 2: Severity of Diabetic Retinopathy (n=102)

Severity of Diabetic Retinopathy	Category	n(%)
Non- proliferative diabetic retinopathy (NPDR)	Mild	34 (33.3%)
	Moderate	30 (29.4%)
	Severe/Very severe	20 (19.6%)
Proliferative diabetic retinopathy (PDR)	PDR without high risk criteria	10 (9.8%)
	PDR with high risk criteria	8 (7.8%)
Total DR cases		102 (100%)

Table 3 depicts that the mean HbA1c level among patients without diabetic retinopathy was 6.8 ± 0.7%. In contrast, progressively higher mean HbA1c levels were observed with increasing severity of diabetic retinopathy. Among patients with non-proliferative diabetic retinopathy, the mean HbA1c was 7.4 ± 0.8% in mild NPDR, 8.1 ± 0.9% in moderate NPDR, and 8.8 ± 1.0% in severe/very severe NPDR. Patients with proliferative diabetic retinopathy demonstrated the highest HbA1c levels, with a mean of 9.3 ± 1.1% in PDR without high risk criteria and 10.1 ± 1.2% in PDR with high risk criteria. Overall, a stepwise increase in mean HbA1c was noted with worsening severity of diabetic retinopathy.

Table 3- Mean HbA1c Levels Across Severity of Diabetic Retinopathy

Severity of DR			HbA1c (Mean±SD) (%)
Diabetic retinopathy absent			6.8±0.7
Diabetic retinopathy Present	Non- proliferative diabetic retinopathy (NPDR)	Mild	7.4±0.8
		Moderate	8.1±0.9
		Severe/Very severe	8.8±1.0
	Proliferative diabetic retinopathy (PDR)	PDR without high risk criteria	9.3±1.1
		PDR with high risk criteria	10.1±1.2

Table 4 shows the association between HbA1c levels and the severity of diabetic retinopathy (DR) among 250 patients with diabetes. Out of these, 102 patients had DR, while 148 patients had no evidence of retinopathy. The table preserves the original distribution of DR severity while adjusting the totals for the larger sample size. Among patients with HbA1c <7% (n = 51), the majority (43 patients, 84.3%) had no DR. Only a small proportion had mild NPDR (6 patients, 11.7%) or moderate NPDR (2 patients, 3.9%), and there were no cases of severe or very severe NPDR or PDR in this group. In the HbA1c 7–8% group (n = 79), DR was more frequent. DR was absent in 42 patients (55.2%), while mild NPDR occurred in 16 patients (21.0%), moderate NPDR in 10 patients (13.1%), severe or very severe NPDR in 6 patients (7.8%), and PDR without high-risk criteria in 2 patients (2.6%). Among patients with HbA1c >8% (n = 123), only 63 patients (51.2%) had no DR, while the remaining 60 patients (48.8%) exhibited varying degrees of retinopathy. Mild NPDR was seen in 12 patients (9.7%), moderate NPDR in 18 patients (14.6%), severe or very severe NPDR in 14 patients (11.3%), PDR without high-risk criteria in 8 patients (6.5%), and PDR with high-risk criteria in 8 patients (6.5%). Overall, the table demonstrates a clear trend of increasing prevalence and severity of DR with rising HbA1c levels, highlighting the strong association between poor glycaemic control and progression of diabetic retinopathy. The p-value (<0.001) indicates that this association is statistically significant. Pearson correlation analysis shown in table 4, demonstrated a strong positive correlation between HbA1c levels and the severity of diabetic retinopathy, with a correlation coefficient (r) of 0.66. This association was statistically highly significant ($p < 0.001$), indicating that increasing HbA1c levels were significantly associated with greater severity of diabetic retinopathy.

Table 4: Association between HbA1c category and severity of DR

Severity of DR			HbA1c <7 n(%)	HbA1c 7–8 n(%)	HbA1c >8 n(%)	N
DR absent			43 (84.3%)	42 (55.2%)	63 (51.2%)	148
DR present	NPDR	Mild	6 (11.7%)	16 (21.0%)	12 (9.7%)	34
		Moderate	2 (3.9%)	10 (13.1%)	18 (14.6%)	30
		Severe/Very severe	0 (0%)	6 (7.8%)	14 (11.3%)	20
	PDR	PDR without high risk criteria	0 (0%)	2 (2.6%)	8 (6.5%)	10
		PDR with high risk criteria	0 (0%)	0 (0%)	8 (6.5%)	8
Total			**51 (100%)**	**76 (100%)**	**123 (100%)**	**250**
p-value			**<0.001**			

Figure 1 illustrates the distribution of systemic risk factors among the study participants. A substantial proportion of patients had a longer duration of diabetes, with 121 patients (48.4%) having diabetes for ≥10 years. Poor glycaemic control, defined as HbA1c >8%, was observed in 85 patients (34.0%). Hypertension was present in 116 patients (46.4%), while dyslipidaemia was noted in 87 patients (34.8%). Insulin therapy was being used by 85 patients (34.0%), and 51 patients (20.4%) reported a history of smoking.

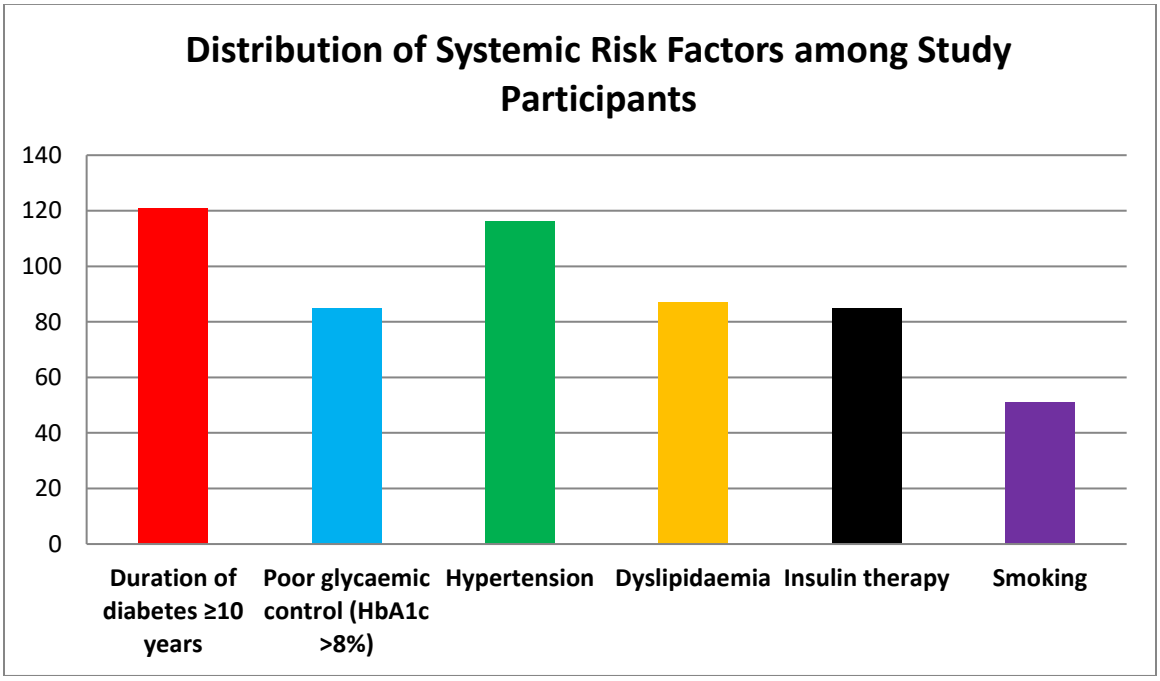

Figure 1- Distribution of systemic risk factors among study participants

Table 5 compares systemic risk factors between patients with and without diabetic retinopathy. A higher proportion of patients with diabetic retinopathy had a duration of diabetes ≥10 years (72.5%) compared to those without retinopathy (31.8%), and this difference was statistically significant ($p < 0.001$). Poor glycaemic control (HbA1c >8%) was observed in 62.7% of patients with diabetic retinopathy versus 14.2% of those without, showing a highly significant association ($p < 0.001$). Hypertension was present in 60.8% of patients with diabetic retinopathy compared to 36.5% of patients without retinopathy ($p = 0.02$). Dyslipidaemia was more frequent among patients with diabetic retinopathy (47.1%) than in those without (26.4%), which was statistically significant ($p = 0.04$). Similarly, insulin therapy was more common in the

diabetic retinopathy group (45.1%) than in the non-retinopathy group (26.4%), with a significant association ($p = 0.04$). Although smoking was more prevalent among patients with diabetic retinopathy (27.5%) than those without (15.5%), this difference did not reach statistical significance ($p = 0.18$). Overall, these findings indicate that longer duration of diabetes, poor glycaemic control, hypertension, dyslipidaemia, and insulin therapy are significant systemic risk factors associated with diabetic retinopathy in this cohort, whereas smoking did not show a significant association.

Table 5- Systemic risk factors associated with DR

Systemic Risk Factor	DR Present (n = 102)	DR Absent (n = 148)	Total (n = 250)	p-value
Duration of diabetes ≥10 years	74 (72.5%)	47 (31.8%)	121 (48.4%)	**<0.001**
Poor glycaemic control (HbA1c >8%)	64 (62.7%)	21 (14.2%)	85 (34.0%)	**<0.001**
Hypertension	62 (60.8%)	54 (36.5%)	116 (46.4%)	**0.02**
Dyslipidaemia	48 (47.1%)	39 (26.4%)	87 (34.8%)	**0.04**
Insulin therapy	46 (45.1%)	39 (26.4%)	85 (34.0%)	**0.04**
Smoking	28 (27.5%)	23 (15.5%)	51 (20.4%)	0.18

Discussion-

The present cross-sectional study evaluated the correlation between HbA1c levels and the severity of diabetic retinopathy (DR) among 250 patients with diabetes mellitus from Ghazipur, Uttar Pradesh. The study demonstrated a strong and statistically significant association between poor glycaemic control and increasing severity of DR, highlighting the central role of chronic hyperglycaemia in the pathogenesis and progression of diabetic retinal microvascular damage. The majority of participants were aged 50–59 years (32.8%) and ≥60 years (31.6%), reflecting the cumulative impact of long-standing diabetes on microvascular complications. Male predominance (55.6%) observed in the study aligns with prior Indian studies by Raman et al. [12] and Shah et al. [13], which reported a higher prevalence of DR among males, potentially due to longer disease duration and differences in healthcare-seeking behavior. In contrast, population-based studies from developed countries often report near-equal gender distribution, suggesting that sociocultural and access-related factors in rural and semi-urban India may influence these findings.

Duration of diabetes was strongly associated with DR, with 72.5% of patients with DR having diabetes for ≥10 years. This finding is consistent with the RAAB6+DR study [14] and other epidemiological data [15], which identify long-standing diabetes as a primary predictor of DR development. Poor glycaemic control was highly prevalent in this cohort, with 45.6% of participants exhibiting HbA1c >8%. Mean HbA1c levels increased progressively with DR severity, from 6.8 ± 0.7% in patients without DR to 10.1 ± 1.2% in those with high-risk PDR. This stepwise trend indicates a clear dose–response relationship between hyperglycaemia and DR severity. Categorical analysis also revealed that patients without DR predominantly had good glycaemic control, whereas poor control was concentrated in advanced stages of DR, particularly severe and very severe NPDR and PDR. These findings are in agreement with landmark trials such as DCCT [16] and UKPDS [15] and recent multicentric studies demonstrating that HbA1c >8% substantially increases the risk of sight-threatening retinopathy [13]. Similar gradients have been reported by Zheng et al. [17] and Yau et al. [18], supporting the biological plausibility of our findings. Pearson correlation analysis confirmed a strong positive correlation between HbA1c and DR severity ($r = 0.66$, $p < 0.001$), comparable to prior systematic reviews and longitudinal studies [14,16], reinforcing the role of HbA1c as a reliable surrogate marker for chronic glycaemic exposure and retinal risk. Analysis of systemic risk factors revealed that hypertension, dyslipidaemia, insulin therapy, and longer duration of diabetes were significantly associated with DR, supporting the multifactorial nature of the disease, where metabolic and haemodynamic factors synergistically contribute to retinal damage [19]. Smoking, although more prevalent among patients with DR (27.5%) than those without (15.5%), did not reach statistical significance, possibly due to underreporting or limited sample size.

Overall, the study provides region-specific evidence that poor glycaemic control, as reflected by elevated HbA1c, is strongly associated with increasing severity of diabetic retinopathy. These findings emphasize the importance of stringent glycaemic control, early retinal screening, and comprehensive management of systemic risk factors to prevent vision-threatening complications, particularly in resource-limited settings such as eastern Uttar Pradesh

Conclusion-

In this cross-sectional study of 250 patients with diabetes mellitus from Ghazipur, Uttar Pradesh, diabetic retinopathy was observed in 40.8% of participants. The severity of retinopathy showed a strong positive correlation with HbA1c levels, highlighting poor glycaemic control as the most significant predictor of disease progression. Longer duration of diabetes, hypertension, dyslipidaemia, and insulin therapy were also identified as significant systemic risk factors associated with diabetic retinopathy, whereas smoking was not significantly associated in this cohort. These findings underscore the importance of stringent glycaemic control, early and regular retinal screening, and comprehensive management of systemic risk factors to prevent vision-threatening complications. Targeted interventions addressing modifiable risk factors can help reduce the burden of diabetic retinopathy, particularly in resource-limited settings like eastern Uttar Pradesh.

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References

1. International Diabetes Federation. IDF Diabetes Atlas. 10th ed. Brussels: IDF; 2021.
2. Cheung N, Mitchell P, Wong TY. Diabetic retinopathy. Lancet. 2010;376(9735):124–136.
3. Wilkinson CP, Ferris FL, Klein RE, et al. Proposed international clinical diabetic retinopathy disease severity scale. Ophthalmology. 2003;110(9):1677–1682.
4. Yau JWY, Rogers SL, Kawasaki R, et al. Global prevalence and major risk factors of diabetic retinopathy. Diabetes Care. 2012;35(3):556–564.
5. The Diabetes Control and Complications Trial Research Group. The effect of intensive treatment of diabetes on the development and progression of long-term complications. N Engl J Med. 1993;329:977–986.
6. UK Prospective Diabetes Study (UKPDS) Group. Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment. Lancet. 1998;352:837–853.
7. Stratton IM, Adler AI, Neil HA, et al. Association of glycaemia with macrovascular and microvascular complications of type 2 diabetes. BMJ. 2000;321:405–412.
8. Raman R, Rani PK, Reddi Rachepalle S, et al. Prevalence of diabetic retinopathy in India. Ophthalmology. 2009;116(2):311–318.
9. Gadkari SS, Maskati QB, Nayak BK. Prevalence of diabetic retinopathy in India: The All India Ophthalmological Society survey. Indian J Ophthalmol. 2016;64(1):38–44.
10. Klein R, Klein BEK, Moss SE. The Wisconsin Epidemiologic Study of Diabetic Retinopathy. Ophthalmology. 1984;91:1464–1474.
11. Aiello LP, Gardner TW, King GL, et al. Diabetic retinopathy. Diabetes Care. 1998;21(1):143–156
12. Raman R, Paul PG, Chhablani J, et al. Prevalence and risk factors for diabetic retinopathy in South India. Indian J Ophthalmol. 2022;70(5):1596–1602.
13. Shah N, Prajna L, Shantha GP, et al. Glycaemic control and severity of diabetic retinopathy in India. Diabetes Res Clin Pract. 2023;195:110072.
14. Sabanayagam C, Xu D, Ting DSJ, et al. Incidence and progression of diabetic retinopathy: a systematic review. Lancet Diabetes Endocrinol. 2021;9(1):29–47.
15. Cheung N, Wong TY, Silva PS. Diabetic retinopathy: global prevalence, major risk factors, and public health challenges. Lancet Diabetes Endocrinol. 2023;11(3):200–212.

16. Wong TY, Sabanayagam C, Thaung U, et al. Diabetic retinopathy and systemic risk factors. Prog Retin Eye Res. 2023;92:101109
17. Zheng Y, He M, Congdon N. The worldwide epidemic of diabetic retinopathy. Indian J Ophthalmol. 2024;72(2):344–351.
18. Yau JWY, Rogers SL, Kawasaki R, et al. Global epidemiology of diabetic retinopathy. Diabetes Care. 2022;45(3):592–600.
19. Khalifa O, Elalaily R, Elbadry H. Systemic risk factors and diabetic retinopathy progression. J Clin Med. 2023;12(9):3050.