

Risk Factors Associated with Diabetic Retinopathy among Patients with Type 2 Diabetes Mellitus in a Tertiary Care Hospital in Bangladesh

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ARTICLE INFO

Received: 17 September 2026
Accepted: 23 September 2026
Published Online: 3 October 2026

DOI: 10.5281/zenodo.23114249

Volume: 10, Number: 3, Page: 714-718

e-ISSN: 2789-5912
ISSN: 2617-0817

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ABSTRACT

Background: Diabetic retinopathy remains a leading cause of preventable blindness worldwide, with a disproportionately higher burden in low- and middle-income countries. Identifying modifiable risk factors is essential for early detection and timely intervention. **Objective:** To identify the risk factors associated with diabetic retinopathy among patients with type 2 diabetes mellitus attending a tertiary care hospital in Bangladesh. **Methods Materials:** This prospective cohort study enrolled 63 patients with type 2 diabetes mellitus via purposive sampling at the Department of Ophthalmology, Chattogram Maa-O-Shishu Hospital Medical College, Chattogram, Bangladesh, from January to December 2024. All participants underwent comprehensive ocular examination, including dilated fundoscopy. Demographic, clinical, and biochemical data were recorded. Data were analyzed using SPSS version 23.0. **Results:** Among 63 patients, diabetic retinopathy was present in 20 (31.7%). Significant risk factors included longer duration of diabetes ($p=0.001$), poor glycemic control ($\text{HbA1c} >7.0\%$) ($p=0.003$), hypertension ($p=0.012$), and dyslipidemia ($p=0.021$). Age and sex showed no significant association. Multivariate analysis identified diabetes duration and HbA1c as independent predictors. **Conclusion:** Longer diabetes duration and poor glycemic control are the most significant modifiable risk factors for diabetic retinopathy in this Bangladeshi cohort. Regular screening and strict glycemic control remain cornerstone strategies for preventing vision loss.

Keywords: Diabetic retinopathy, Glycemic control, Hypertension, Risk factors, Type 2 diabetes mellitus

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INTRODUCTION

Diabetes mellitus has emerged as one of the most pressing global public health challenges of the twenty-first century, with its prevalence reaching pandemic proportions across all regions of the world [1]. The International Diabetes Federation estimates that 10.5% of the world's adult population currently lives with diabetes, accounting for more than half a billion individuals, with projections indicating a sharp rise to nearly 800 million by 2045 [2]. This escalating burden is not confined to high-income nations; in absolute terms, there are now more individuals with diabetes living in the developing world than in established developed countries [2]. Among the myriad complications of diabetes, diabetic retinopathy stands as a particularly devastating microvascular end-organ complication, occurring in 30% to 40% of all diabetic individuals [3]. A recent meta-analysis estimated that the current global prevalence of diabetic retinopathy is approximately 103 million individuals, a figure projected to rise to 161 million by 2045 [4]. The rates of increase in diabetic retinopathy prevalence are disproportionately higher in low- and middle-income regions, including South Asia, where they far outstrip the projected rates in high-income regions such as Europe and North America [5]. Diabetic

retinopathy remains one of the leading causes of blindness worldwide among adults aged 20 to 74 years [6]. The condition is characterized by progressive damage to the retinal microvasculature, driven primarily by chronic hyperglycemia, which triggers a cascade of metabolic, hemodynamic, and inflammatory pathways culminating in capillary basement membrane thickening, pericyte loss, and endothelial dysfunction [3]. If left untreated, diabetic retinopathy can progress from non-proliferative stages to vision-threatening proliferative diabetic retinopathy and diabetic macular edema, resulting in irreversible visual impairment [7]. The World Health Organization recommends regular diabetic retinopathy screening alongside prompt treatment for those who need it as an effective strategy to reduce vision impairment and blindness [8]. The pathogenesis of diabetic retinopathy is multifactorial, with multiple systemic risk factors contributing to its development and progression. Prolonged duration of diabetes is consistently identified as one of the most robust predictors of diabetic retinopathy, with the prevalence rising substantially after ten years of disease duration [9]. Poor glycemic control, reflected by elevated hemoglobin A1c levels, is another critical determinant, with every 1% decrease in HbA1c corresponding to a 40% reduction

in diabetic retinopathy risk [10]. Hypertension and dyslipidemia have also been implicated as important modifiable risk factors, though the strength of these associations varies across populations [11]. A growing body of evidence underscores the synergistic effect of these risk factors, such that individuals with concurrent poor glycemic control, hypertension, and dyslipidemia face exponentially higher risks of developing sight-threatening complications [12]. In Bangladesh, the diabetes burden is particularly alarming. The country has one of the highest diabetes prevalence rates in the world, with diabetes or prediabetes being diagnosed in 35% of those over the age of 35 years [13]. Hospital-based studies from Bangladesh have reported diabetic retinopathy prevalence ranging from 18.8% to 38.2% among diabetic populations, with longer diabetes duration, poor glycemic control, hypertension, and smoking identified as key modifiable risk factors [11]. Despite these emerging data, comprehensive prospective evaluations of risk factors specifically among patients with type 2 diabetes mellitus in Bangladeshi tertiary care settings remain limited. Given the escalating diabetes epidemic in Bangladesh and the paucity of prospective data on diabetic retinopathy risk factors, this study was designed to identify the risk factors

associated with diabetic retinopathy among patients with type 2 diabetes mellitus attending a tertiary care hospital in Dhaka. By systematically evaluating demographic, clinical, and biochemical parameters, this investigation aims to inform evidence-based screening strategies and guide targeted interventions to reduce the burden of preventable blindness in this population.

METHODS & MATERIALS

This prospective cohort study was conducted at the Department of Ophthalmology, Chattogram Maa-O-Shishu Hospital Medical College, Chattogram, Bangladesh, over 12 months from January 2024 to December 2024. A total of 63 patients with type 2 diabetes mellitus attending the outpatient department were enrolled using purposive sampling.

Inclusion criteria: Patients of either sex, aged 18 years or older, with a confirmed diagnosis of type 2 diabetes mellitus for at least one year, and who provided written informed consent were included in the study.

Exclusion criteria: Patients with type 1 diabetes mellitus, gestational diabetes, preexisting ocular pathology unrelated to diabetes, or a history of ocular surgery or laser photocoagulation were excluded. Patients with media opacities precluding adequate fundus examination were also excluded.

Study procedure: All participants underwent a comprehensive ophthalmic evaluation including best-corrected visual acuity assessment, slit-lamp biomicroscopy, and dilated fundus examination using indirect ophthalmoscopy. Fundus photographs were obtained using a non-mydriatic retinal camera. Diabetic retinopathy was diagnosed and classified according to the International Clinical Diabetic Retinopathy Disease Severity Scale [14,15]. Demographic data, medical history, and biochemical parameters including hemoglobin A1c, fasting blood glucose, lipid profile, and blood pressure were recorded.

Data analysis: Statistical analyses were performed using SPSS software version 23.0 (IBM Corp., Armonk, NY, USA). Categorical variables were expressed as frequencies and percentages, while continuous variables were presented as means with standard deviations. Bivariate analysis was performed using the chi-square test and independent samples t-test. Multivariate logistic regression was employed to identify independent risk factors. A p-value of less than 0.05 was considered statistically significant.

RESULT

A total of 63 patients with type 2 diabetes mellitus were enrolled in this prospective study. All participants completed the clinical evaluation protocol. The mean age of the cohort was 54.2 ± 10.5 years, with a range of 28 to 76 years. Male patients comprised 36 (57.1%) of the study population, while females accounted for 27 (42.9%). The mean duration of diabetes was 8.5 ± 5.6 years. Baseline demographic and clinical characteristics are summarized in (Table I).

Table I
Baseline demographic and clinical characteristics of study participants.

Characteristic	Value
Total patients, n	63
Age (years), mean ± SD	54.2 ± 10.5
Age range (years)	28 – 76
Male, n (%)	36 (57.1)
Female, n (%)	27 (42.9)
Duration of diabetes (years), mean ± SD	8.5 ± 5.6
HbA1c (%), mean ± SD	8.1 ± 1.9
Systolic blood pressure (mmHg), mean ± SD	138.4 ± 16.2
Diastolic blood pressure (mmHg), mean ± SD	84.6 ± 10.3
Body mass index (kg/m²), mean ± SD	26.8 ± 4.2

SD, standard deviation; HbA1c, hemoglobin A1c.

Among the 63 patients, diabetic retinopathy was detected in 20 patients (31.7%). The severity distribution of diabetic retinopathy is presented in Table II and illustrated in Figure 1. Mild non-

proliferative diabetic retinopathy was the most common severity grade, observed in 9 patients (45.0%), followed by moderate NPDR in 5 patients (25.0%), severe NPDR in 3 patients (15.0%), and proliferative

diabetic retinopathy in 3 patients (15.0%). Diabetic macular edema was present in 6 patients (30.0%) among those with DR.

Table II
Severity distribution of diabetic retinopathy among affected patients (n=20).

Severity Grade	n (%)
Mild non-proliferative DR	9 (45.0)
Moderate non-proliferative DR	5 (25.0)
Severe non-proliferative DR	3 (15.0)
Proliferative DR	3 (15.0)

DR, diabetic retinopathy.

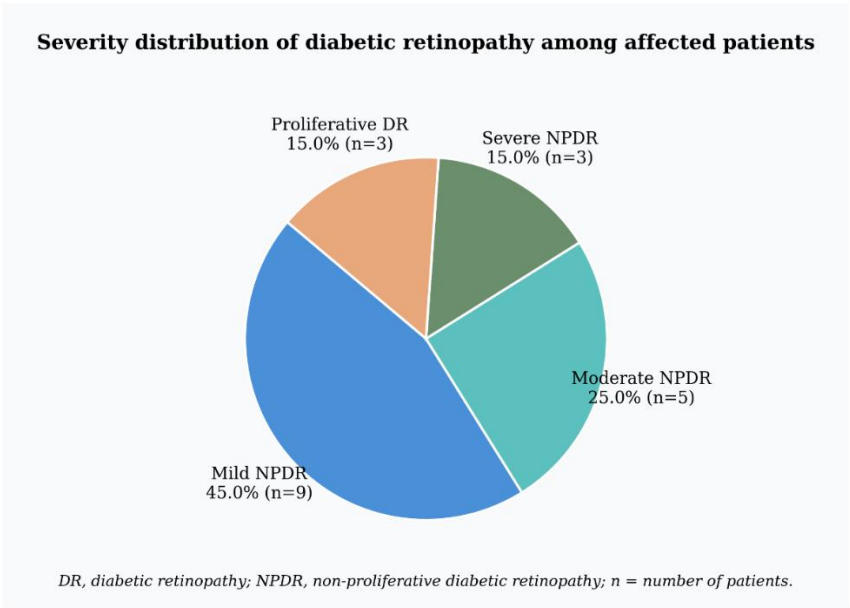


Figure 1 Severity distribution of diabetic retinopathy among affected patients.

Figure 1 shows the distribution of diabetic retinopathy severity grades among 20 patients with DR. Mild non-proliferative DR was the most common (45.0%), followed by moderate NPDR (25.0%), severe NPDR (15.0%), and proliferative DR (15.0%).

Comparison of clinical and biochemical parameters between patients with and without diabetic retinopathy is presented in Table III. Patients with DR had significantly longer duration of diabetes (12.4 ± 5.9 vs. 6.6 ± 4.3 years, $p = 0.001$) and higher HbA1c levels (9.2 ± 1.8 vs. $7.6 \pm 1.7\%$, $p = 0.003$). Hypertension was significantly more prevalent in the DR group (70.0% vs. 39.5%, $p = 0.012$), as was dyslipidemia (65.0% vs. 34.9%, $p = 0.021$). No significant differences were observed for age ($p = 0.092$), sex ($p = 0.352$), or body mass index ($p = 0.183$) between the two groups.

Table III
Comparison of characteristics between patients with and without diabetic retinopathy.

Characteristic	DR present (n=20)	DR absent (n=43)	p-value
Age (years), mean $\pm$ SD	56.8 $\pm$ 9.8	53.0 $\pm$ 10.7	0.092
Male, n (%)	10 (50.0)	26 (60.5)	0.352
Duration of diabetes (years), mean $\pm$ SD	12.4 $\pm$ 5.9	6.6 $\pm$ 4.3	0.001
HbA1c (%), mean $\pm$ SD	9.2 $\pm$ 1.8	7.6 $\pm$ 1.7	0.003
Hypertension, n (%)	14 (70.0)	17 (39.5)	0.012
Dyslipidemia, n (%)	13 (65.0)	15 (34.9)	0.021
Body mass index (kg/m ²), mean $\pm$ SD	27.5 $\pm$ 4.6	26.4 $\pm$ 4.0	0.183

Data were analyzed using the independent samples t-test for continuous variables and the chi-square test for categorical variables. DR, diabetic retinopathy; SD, standard deviation; HbA1c, hemoglobin A1c.

Multivariate logistic regression analysis was performed to identify independent risk factors for diabetic retinopathy, adjusting for potential confounders including age, sex, and body mass index. The results are presented in Table IV. Duration of diabetes (adjusted OR 1.24; 95% CI 1.09–1.42; $p = 0.001$) and HbA1c (adjusted OR 1.52; 95% CI 1.14–2.03; $p = 0.003$) emerged as independent predictors of diabetic retinopathy. Hypertension showed a borderline independent association (adjusted OR 2.18; 95% CI 0.98–4.86; $p = 0.053$), while dyslipidemia did not reach statistical significance in the multivariate model (adjusted OR 1.89; 95% CI 0.82–4.35; $p = 0.132$).

Table IV
Multivariate logistic regression analysis for independent predictors of diabetic retinopathy.

Predictor	Adjusted OR	95% CI	p-value
Duration of diabetes (per year)	1.24	1.09 – 1.42	0.001
HbA1c (per 1% increase)	1.52	1.14 – 2.03	0.003
Hypertension	2.18	0.98 – 4.86	0.053
Dyslipidemia	1.89	0.82 – 4.35	0.132

Data were analyzed using multivariate binary logistic regression adjusted for age, sex, and body mass index. OR, odds ratio; CI, confidence interval; HbA1c, hemoglobin A1c.

DISCUSSION

This prospective study of 63 patients with type 2 diabetes mellitus at a tertiary care hospital in Dhaka demonstrates that diabetic retinopathy affects nearly one-third of the cohort (31.7%), with mild non-proliferative diabetic retinopathy being the most common severity grade (45.0%). The findings confirm that longer duration of diabetes and poor glycemic control are the most significant independent predictors of diabetic retinopathy, while hypertension and dyslipidemia showed significant associations in bivariate analysis but did not retain independent predictive value in the multivariate model. The prevalence of diabetic retinopathy observed in this study (31.7%) is consistent with previously reported rates from Bangladesh and neighboring regions. A hospital-based cohort study, involving patients with type 2 diabetes mellitus, reported a diabetic retinopathy prevalence of 29.4% [16]. Similarly, a cross-sectional study documented a prevalence of 18.8% among asymptomatic type 2 diabetic individuals, with the prevalence rising to 40% among those with a known diabetes duration of 15 years or more [17]. The slightly higher prevalence in the present cohort may reflect differences in patient selection, with a higher proportion of patients with longer disease duration and poorer glycemic control. The strong association between longer duration of diabetes and diabetic retinopathy observed in this study (adjusted OR 1.24 per year; $p = 0.001$) aligns with extensive evidence from the literature. A systematic review and meta-analysis confirmed that longer duration of diabetes illness was a significant determinant of diabetic retinopathy (AOR 3.83, 95% CI 1.17–12.55) [18]. Similarly, a comprehensive meta-analysis found that duration of diabetes exceeding 10 years showed a moderate positive association with diabetic retinopathy risk (OR 1.41, 95% CI 0.89–2.23) [19]. The biological plausibility of this association is well-established, as chronic hyperglycemia progressively damages retinal microvasculature through cumulative metabolic and hemodynamic insults [3]. Poor glycemic control, reflected by elevated hemoglobin A1c levels, emerged as the second independent predictor of diabetic retinopathy in this cohort (adjusted OR 1.52 per 1% increase; $p = 0.003$). This finding corroborates the well-recognized relationship between glycemic control and microvascular complications. Another study reported that poor glycemic control was the strongest determinant of diabetic retinopathy (AOR 4.36, 95% CI 1.47–12.90) [18]. A big study on patients with type 2 diabetes mellitus demonstrated that higher HbA1c variability was associated with an increased risk of retinopathy (relative risk 1.48, 95% CI 1.24–1.78) [20].

Another prospective study has shown that every 1% decrease in HbA1c corresponds to a 40% reduction in diabetic retinopathy risk [21], underscoring the critical importance of stringent glycemic control. Hypertension demonstrated a significant association with diabetic retinopathy in bivariate analysis (70.0% vs. 39.5%, $p = 0.012$) but showed only a borderline independent association in multivariate analysis (adjusted OR 2.18, 95% CI 0.98–4.86; $p = 0.053$). This finding is consistent with the variable strength of association reported in the literature. A systematic review and meta-analysis identified comorbid hypertension as a significant determinant of diabetic retinopathy (AOR 2.04, 95% CI 1.07–3.89) [18]. However, a meta-analysis reported that while hypertension was identified as a potential risk factor, the association was not statistically significant across all included studies [19]. A systematic review and meta-analysis on visit-to-visit variability of blood pressure concluded that increased blood pressure variability significantly increased the relative risk for the development of retinopathy [22]. The borderline significance in the multivariate model may reflect the relatively modest sample size or the confounding effects of other covariates. Dyslipidemia was significantly associated with diabetic retinopathy in bivariate analysis (65.0% vs. 34.9%, $p = 0.021$) but did not retain independent predictive value in multivariate analysis (adjusted OR 1.89, 95% CI 0.82–4.35; $p = 0.132$). This finding is consistent with the somewhat inconsistent literature on the relationship between serum lipids and diabetic retinopathy. A systematic review and meta-analysis found that higher levels of total cholesterol, triglycerides, and low-density lipoprotein cholesterol at baseline were associated with later onset of diabetic retinopathy, though no significant difference was observed in high-density lipoprotein cholesterol levels between patients with and without diabetic retinopathy [23]. Another study indicated a possible association between atherogenic lipid indices and the presence and severity of diabetic retinopathy, with an observed gradient from non-proliferative to proliferative diabetic retinopathy [24]. The loss of significance in multivariate analysis in the present study may be attributable to the smaller sample size or the strong collinearity between dyslipidemia and other metabolic risk factors. The severity distribution of diabetic retinopathy in this cohort with mild non-proliferative diabetic retinopathy being the most common (45.0%), followed by moderate non-proliferative diabetic retinopathy (25.0%), severe non-proliferative diabetic retinopathy (15.0%), and proliferative diabetic retinopathy (15.0%) reflects the

typical pattern observed in hospital-based diabetic populations. The relatively high proportion of proliferative diabetic retinopathy (15.0%) is concerning, as this sight-threatening stage requires prompt intervention with laser photocoagulation or intravitreal anti-vascular endothelial growth factor therapy to prevent blindness. The presence of diabetic macular edema in 30.0% of patients with diabetic retinopathy further underscores the substantial burden of vision-threatening complications in this cohort.

LIMITATIONS

This study has several limitations, including its single-center design, purposive sampling technique, modest sample size of 63 patients, and the absence of long-term follow-up data to assess disease progression and treatment outcomes.

CONCLUSION

Diabetic retinopathy affects nearly one-third of type 2 diabetes mellitus patients in this Bangladeshi cohort, with mild non-proliferative diabetic retinopathy being the most common presentation. Longer duration of diabetes and poor glycemic control are the most significant independent predictors, while hypertension and dyslipidemia show important associations in bivariate analysis. These findings reinforce the critical importance of early diagnosis, stringent glycemic control, regular ophthalmic screening, and comprehensive management of modifiable risk factors to prevent vision-threatening complications and reduce the burden of preventable blindness.

RECOMMENDATION

Regular diabetic retinopathy screening and strict glycemic control should be prioritized for all type 2 diabetes patients. Future multicenter prospective studies with larger sample sizes and longitudinal follow-up are essential to validate these findings and optimize screening protocols in Bangladesh.

CONFLICT OF INTEREST

The authors declare no conflicts of interest. No funding was received for this study. The corresponding author had full access to all data and final responsibility for the decision to submit for publication.

AI DECLARATION

Artificial intelligence tools contributed marginally to manuscript preparation and development. All core scientific content was human-verified.

FUNDING

No funding sources

ETHICAL APPROVAL

The study was approved by the Institutional Ethics Committee

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