

Effect of Vitamin D Deficiency on the Progression of Diabetic Retinopathy – A Cross-Sectional Study in a Tertiary Care Hospital

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ABSTRACT

Background: Diabetic retinopathy is one of the most common microvascular complications of diabetes mellitus and a major cause of visual impairment worldwide. Vitamin D plays an important role in immune regulation, vascular health and anti-inflammatory processes and its deficiency has been suggested to contribute to the development and progression of diabetic complications. This study aimed to evaluate the effect of vitamin D deficiency on the progression of diabetic retinopathy. **Methods & Materials:** This cross-sectional observational study was conducted in the Department of Ophthalmology and Community Ophthalmology at Bangladesh Medical University and at Bangladesh Eye Hospital over a six-month period from July 2025 to December 2025. **Results:** The majority of participants were aged 50–59 years (32.5%). Vitamin D deficiency was observed in 42.5% of patients, while 27.5% had insufficient levels and 30.0% had sufficient vitamin D levels. Moderate NPDR was the most common stage of diabetic retinopathy (30%), followed by mild NPDR (25%) and severe NPDR (22.5%). Patients with vitamin D deficiency showed relatively higher proportions of moderate and severe NPDR. However, the association between vitamin D status and severity of diabetic retinopathy was not statistically significant ($p = 0.793$). **Conclusion:** Vitamin D deficiency was common among patients with diabetic retinopathy, but no significant association was found between vitamin D status and the severity of diabetic retinopathy. Further large-scale studies are recommended to clarify the potential role of vitamin D in the progression of diabetic retinopathy.

Keywords: Diabetic retinopathy, Vitamin D deficiency, Non-proliferative diabetic retinopathy, Diabetic macular edema, Diabetes mellitus.

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INTRODUCTION

Diabetes mellitus is a chronic metabolic disorder characterized by persistent hyperglycemia resulting from defects in insulin secretion, insulin action, or both [1]. The global prevalence of diabetes has increased rapidly over the past few decades, making it a major public health concern. Long-term uncontrolled diabetes leads to several microvascular and macrovascular complications, among which diabetic retinopathy is one of the most common and serious ocular complications [2]. Diabetic retinopathy is a progressive microvascular disease of the retina and remains a leading cause of visual impairment and preventable blindness among working-age adults worldwide. The condition develops due to prolonged hyperglycemia that damages the retinal microvasculature, leading to capillary leakage, retinal ischemia and neovascularization [3].

The severity of diabetic retinopathy is generally classified into different stages, including mild, moderate and severe non-proliferative diabetic retinopathy (NPDR) and proliferative diabetic retinopathy (PDR) [4]. Diabetic macular edema (DME) may occur at any stage and is a major cause of vision loss. Several risk factors have been identified for the development and progression of diabetic retinopathy, including duration of

diabetes, poor glycemic control, hypertension, dyslipidemia and obesity [5]. However, recent studies have suggested that nutritional and metabolic factors may also influence the development and progression of retinal microvascular damage in diabetic patients [6].

Vitamin D is a fat-soluble vitamin that plays an essential role in calcium metabolism, bone health, immune regulation and cellular growth. In recent years, increasing attention has been given to the extra-skeletal effects of vitamin D, including its role in cardiovascular health, immune function and metabolic diseases [7]. Vitamin D is believed to have anti-inflammatory, anti-angiogenic and antioxidative properties, which may influence the pathogenesis of diabetic microvascular complications [8]. Deficiency of vitamin D has been associated with increased inflammation, endothelial dysfunction and impaired vascular regulation, which are important mechanisms involved in the development of diabetic retinopathy [9].

Several epidemiological studies have reported a potential association between low serum vitamin D levels and the presence or severity of diabetic retinopathy [10,11]. Patients with vitamin D deficiency have been observed to have a higher prevalence of advanced stages of retinopathy, including

proliferative diabetic retinopathy and diabetic macular edema. It has been suggested that vitamin D may play a protective role in maintaining retinal vascular integrity and reducing pathological angiogenesis [12]. However, the relationship between vitamin D deficiency and the progression of diabetic retinopathy remains controversial, as some studies have reported inconsistent findings [13]. Understanding the association between vitamin D status and the severity of diabetic retinopathy may provide valuable insight into potential modifiable risk factors for this vision-threatening condition. Identification of such factors may contribute to improved preventive strategies and better clinical management of patients with diabetes. Therefore, the present study was conducted to evaluate the effect of vitamin D deficiency on the progression of diabetic retinopathy.

METHODS & MATERIALS

This cross-sectional observational study was conducted in the Department of Ophthalmology and Community Ophthalmology at Bangladesh Medical University and at Bangladesh Eye Hospital. The study was carried out over a six-month period from July 2025 to December 2025. A total of 40 patients diagnosed with diabetic retinopathy were included in this study. Patients attending the ophthalmology outpatient department during the study period were selected using purposive sampling based on the eligibility criteria. After obtaining informed consent, demographic and clinical information such as age, sex, duration of diabetes and relevant clinical findings were recorded using a structured data collection sheet. All participants underwent a detailed ophthalmic examination including visual acuity assessment, slit lamp biomicroscopy and fundus examination. The severity of diabetic retinopathy was categorized into mild non-proliferative diabetic retinopathy (NPDR), moderate NPDR, severe NPDR, proliferative diabetic retinopathy (PDR) and diabetic macular edema (DME) based on standard clinical findings. Serum vitamin D levels were measured and categorized as deficient (<20 ng/mL), insufficient (20–30 ng/mL) and sufficient (>30 ng/mL).

Patients with diagnosed diabetes mellitus presenting with diabetic retinopathy, aged 30 years and above and who were willing to participate and provide informed consent were included in the study. Patients with other retinal diseases, those who had received vitamin D supplementation within the last three months, patients with ocular media opacity preventing proper fundus examination and patients with systemic conditions affecting vitamin D metabolism were excluded from the study.

All collected data were checked for completeness and entered into a computer database for analysis. Statistical analysis was performed using IBM SPSS Statistics. Descriptive statistics such as frequency and percentage were used to summarize the variables. The Chi-square test was applied to determine the association between vitamin D status and the severity of diabetic retinopathy. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Table I shows the age distribution of the study participants. The majority of the patients were in the 50–59 years age

group 13 (32.5%), followed by 40–49 years 9 (22.5%) and 60–69 years 8 (20.0%). Smaller proportions were observed in the 30–39 years and ≥70 years groups, each comprising 5 (12.5%) of the participants.

Table – I: Distribution of Study Participants by Age Group (n = 40)

Age Group (Years)	Frequency (n)	Percentage (%)
30–39	5	12.5
40–49	9	22.5
50–59	13	32.5
60–69	8	20.0
≥70	5	12.5
Total	40	100

Table II shows the distribution of participants according to serum vitamin D status. The majority of patients had vitamin D deficiency (<20 ng/mL) 17 (42.5%), followed by sufficient levels (>30 ng/mL) 12 (30.0%) and insufficient levels (20–30 ng/mL) 11 (27.5%).

Table – II: Distribution of Participants by Serum Vitamin D Status (n = 40)

Vitamin D Status	Frequency (n)	Percentage (%)
Deficient (<20 ng/mL)	17	42.5
Insufficient (20–30 ng/mL)	11	27.5
Sufficient (>30 ng/mL)	12	30.0
Total	40	100

Table III shows the distribution of participants according to the severity of diabetic retinopathy. The majority of patients had moderate NPDR 12 (30%), followed by mild NPDR 10 (25%) and severe NPDR 9 (22.5%). Proliferative diabetic retinopathy was observed in 6 (15%) patients, while diabetic macular edema was present in 3 (7.5%) of the study participants.

Table – III: Distribution of Participants by Severity of Diabetic Retinopathy (n = 40)

Severity of Diabetic Retinopathy	Frequency (n)	Percentage (%)
Mild NPDR	10	25
Moderate NPDR	12	30
Severe NPDR	9	22.5
Proliferative DR	6	15
Diabetic Macular Edema	3	7.5
Total	40	100

Table IV shows the association between vitamin D status and the severity of diabetic retinopathy. Among patients with vitamin D deficiency, moderate NPDR 6 (15.0%) and severe NPDR 5 (12.5%) were more frequently observed. In the insufficient group, the majority had moderate NPDR 4 (10.0%), while among those with sufficient vitamin D, mild NPDR 5 (12.5%) was more common. However, the association between vitamin D status and severity of diabetic retinopathy was not statistically significant (p = 0.793).

Table – IV: Association Between Vitamin D Status and Severity of Diabetic Retinopathy (n = 40)

Vitamin D Status	Mild NPDR	Moderate NPDR	Severe NPDR	PDR	DME	p value
Deficient	2 (5.0%)	6 (15.0%)	5 (12.5%)	3 (7.5%)	1 (2.5%)	0.793
Insufficient	3 (7.5%)	4 (10.0%)	2 (5.0%)	1 (2.5%)	1 (2.5%)	
Sufficient	5 (12.5%)	2 (5.0%)	2 (5.0%)	2 (5.0%)	1 (2.5%)	
Total	10 (25.0%)	12 (30.0%)	9 (22.5%)	6 (15.0%)	3 (7.5%)	

DISCUSSION

Diabetic retinopathy is a common microvascular complication of diabetes mellitus and remains a leading cause of visual impairment. The present cross-sectional study evaluated the association between vitamin D deficiency and the severity of diabetic retinopathy among diabetic patients. In this study, the majority of the participants were within the 50–59 years age group 13 (32.5%), followed by 40–49 years 9 (22.5%) and 60–69 years 8 (20.0%). This age distribution reflects the typical age pattern of diabetic retinopathy, which generally occurs in middle-aged and older adults due to prolonged exposure to hyperglycemia and metabolic disturbances. Similar findings have been reported in previous studies where increasing age and duration of diabetes were associated with a higher risk of diabetic retinopathy, as described by Trott et al. who identified several modifiable and non-modifiable factors contributing to the development of diabetic retinopathy [14].

In the present study, vitamin D deficiency was observed in 17 (42.5%) patients, while 11 (27.5%) had insufficient levels and 12 (30.0%) had sufficient vitamin D levels. The high prevalence of vitamin D deficiency among the participants is consistent with earlier reports. Islam et al. described vitamin D deficiency as a widespread nutritional problem in many populations, with a substantial proportion of adults exhibiting low serum vitamin D levels [15]. Similarly, Majumder et al. reported a considerable prevalence of vitamin D deficiency among patients attending tertiary hospitals, suggesting that inadequate sun exposure, dietary factors and lifestyle habits may contribute to low vitamin D status [16]. In addition, Junaid et al. demonstrated that vitamin D deficiency is frequently observed among individuals with type 2 diabetes and may contribute to various metabolic and cardiovascular complications [17].

Regarding the severity of diabetic retinopathy, the current study found that moderate NPDR was the most common stage 12 (30%), followed by mild NPDR 10 (25%), severe NPDR 9 (22.5%), proliferative diabetic retinopathy 6 (15%) and diabetic macular edema 3 (7.5%). These findings suggest that a large proportion of patients presented with intermediate stages of the disease rather than advanced proliferative stages. Similar patterns have been reported in previous research where moderate NPDR constituted the largest proportion of diabetic retinopathy cases. Ruamviboonsuk and Grzybowski highlighted that diabetic retinopathy usually progresses gradually from mild and moderate non-proliferative stages before reaching proliferative disease if not adequately controlled [18].

The association between vitamin D status and the severity of diabetic retinopathy was also evaluated in the present study. Among patients with vitamin D deficiency, higher proportions were observed in moderate NPDR 6 (15.0%) and severe NPDR 5 (12.5%). Patients with insufficient vitamin D levels mainly presented with moderate NPDR 4 (10.0%), while mild NPDR 5 (12.5%) was more common among individuals with sufficient vitamin D levels. Despite this trend, the statistical analysis showed that the association between vitamin D status and the severity of diabetic retinopathy was not statistically significant ($p = 0.793$).

These findings are consistent with several previous studies reporting inconsistent or non-significant associations between vitamin D levels and diabetic retinopathy. For example, Huang et al. reported that there was no clear causal relationship between serum vitamin D levels and diabetic retinopathy using Mendelian randomization analysis [19]. Similarly, Rehman et al. found that although vitamin D deficiency was common among diabetic patients, the direct association with

diabetic retinopathy severity was not always statistically significant [20]. In addition, Ahi et al. reported that vitamin D status may influence glycemic control and metabolic parameters, but its relationship with microvascular complications such as diabetic retinopathy remains complex [21].

The potential biological mechanisms linking vitamin D and diabetic retinopathy have been discussed in several studies. Vitamin D is believed to have anti-inflammatory, antioxidative and anti-angiogenic effects, which may help maintain retinal vascular integrity and reduce microvascular damage. Milluzzo et al. and Cappellani et al. suggested that nutrients and micronutrients, including vitamin D, may play supportive roles in the management of diabetic retinopathy by modulating inflammation and oxidative stress [22,23]. Furthermore, Li et al. emphasized that vitamin D may influence glucose metabolism and endothelial function, which are important factors in the pathogenesis of diabetic complications [24].

LIMITATIONS

This study had several limitations that should be considered while interpreting the findings. First, the sample size was relatively small ($n = 40$), which may limit the statistical power of the study and affect the generalizability of the results. Second, the cross-sectional design of the study does not allow the establishment of a causal relationship between vitamin D deficiency and the progression of diabetic retinopathy. In addition, some potential confounding factors such as dietary habits, sunlight exposure and duration or control of diabetes were not extensively evaluated, which may also influence serum vitamin D levels and the development of diabetic retinopathy.

CONCLUSION

In conclusion, vitamin D deficiency was commonly observed among patients with diabetic retinopathy in this study. Patients with lower vitamin D levels tended to present with comparatively more advanced stages of diabetic retinopathy. However, the statistical analysis did not demonstrate a significant association between vitamin D status and the severity of diabetic retinopathy. These findings suggest that although vitamin D may have a potential role in the progression of diabetic retinopathy, further large-scale and longitudinal studies are required to clarify this relationship and to explore the possible benefits of maintaining adequate vitamin D levels in diabetic patients.

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CONFLICTS OF INTEREST

There are no conflicts of interest.

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