ONLINE ISSN :3007-309X
PRINT ISSN :3007-3081

Journal of Medical & Health Sciences Review

CORRELATION OF Hba1C LEVELS WITH RETINAL CHANGES IN PATIENTS WITH DIABETIC RETINOPATHY

Dr Hafsa Imran Khan[1], Dr Umer Mushtaq[2], Dr Fajar Khalid[3], Dr Maryam Aslam[4], Dr Muhammad Rohail Tariq[5], Dr Ayesha Shahzad[6], Dr Muhammad Mustafa Imran[7]

[1]Indus Hospital & Health Network, Karachi, Pakistan
[2],[3]MBBS, Allama Iqbal Medical College, Lahore
[4],[6]Liaquat National Hospital, Karachi
[5],[7]Internal Medicine, Mayo Hospital Lahore

ARTICLE INFO

Keywords: Diabetic Retinopathy, Hba1c, Glycemic Control, Retinal Changes, Diabetes Mellitus, Vision Loss

Corresponding Author: Dr Umer Mushtaq, MBBS , Allama Iqbal Medical College, Lahore
Email: umermushtaq.aimc303@gmail.com

Acceptance Date: 1/7/25
Receive Date: 25/6/25
Publish Date: 04/7/25

ABSTRACT

Background: Diabetic retinopathy (DR) is a leading cause of vision loss among individuals with diabetes mellitus. Glycated hemoglobin (HbA1c) is widely used as a biomarker for long-term glycemic control.
Objective: This study aimed to evaluate the correlation between HbA1c levels and the severity of retinal changes in patients with diabetic retinopathy.
Methods: This was a cross-sectional analytical study conducted at Jinnah Hospital Lahore from Oct 2024 to March 2025. A total of 187 patients with a confirmed diagnosis of diabetic retinopathy were enrolled in the study. Each participant underwent a detailed clinical examination, including medical history, duration of diabetes, and current treatment modalities. Fundus examination was performed using slit-lamp biomicroscopy with a 90D lens or indirect ophthalmoscopy.
Results: The mean age of participants was 56.8 ± 9.7 years, and the average duration of diabetes was 11.2 ± 4.6 years. The overall mean HbA1c was 9.1 ± 1.7%. A significant positive correlation was observed between HbA1c levels and DR severity (Pearson's r = 0.614, $p < 0.001$). Mean HbA1c levels progressively increased with DR severity: 7.8 ± 1.2% in mild NPDR, 8.9 ± 1.3% in moderate NPDR, 9.6 ± 1.5% in severe NPDR, and 10.4 ± 1.6% in PDR (ANOVA F = 22.37, $p < 0.001$). Patients with diabetes duration >10 years had significantly higher HbA1c levels compared to those with

	≤10 years (p = 0.002). **Conclusion:** There is a significant correlation between poor glycemic control and the progression of diabetic retinopathy. HbA1c can serve as a reliable indicator not only for metabolic management but also for ophthalmologic risk assessment.

INTRODUCTION

Diabetic retinopathy (DR) is a progressive complex retinal condition attributable to perpetual harm to retinal microvasculature brought about by the long-term hyperglycemia in people with diabetes mellitus [1]. It is the most common cause of blindness in the adult population of the working age and it is a leading cause of optic disability all over the world. As the prevalence of type 2 diabetes mellitus (T2DM) is increasing with sedentary lifestyle, unhealthy food and rising life expectancy, the risk of diabetic retinopathy is also increasing exponentially [2]. As recent estimates conducted by the International Diabetes Federation have revealed, over 537 million adults already live with diabetes and quite a good number of them are likely to develop some form of retinopathy in the course of their lives unless glycemic control is well employed [3]. Glycated hemoglobin A1c (HbA1c) is the most widely used biomarker that is used to evaluate long term glycemic control as well as representing the mean concentration of plasma glucose over a time span of 2 to 3 months [4]. Almost all diabetic patients are advised by American Diabetes Association to keep their HbA1c level below 7%, to prevent and postpone the development of complications. Various seminal studies such as the Diabetes Control and Complications Trial (DCCT) and the United Kingdom Prospective Diabetes Study (UKPDS) have shown that tight glycemic control (ACHL lower levels) has shown significant reductions in the risk of developing and progressing microvascular complications including nephropathy, neuropathy, retinopathy [5][6]. The pathophysiological process has its roots in subtle damage to the retinal capillary caused by chronic hyperglycemia resulting in leakage and subsequent capillary loss and advanced neovascularization occurring due to ischemia [7]. Based on clinical evidence, diabetic retinopathy will be productively categorized as non-proliferative and proliferative. Non-proliferative diabetic retinopathy (NPDR) presents with such early retinal abnormalities as microaneurysms, retinal hemorrhages and hard exudates whereas proliferative diabetic retinopathy (PDR) has been described in association with neovascularization, vitreous hemorrhage and tractional retinal detachment [8]. The most common cause of visual impairment can be diabetic macular edema (DME) that can develop at any stage [9][10]. The magnitude and impact of these changes could be determined by fundoscopic, fundus photography, fluorescein angiography and optical coherence tomography (OCT) examination [11]. Nonetheless, these modalities of imaging are consumptive in terms of resources and may not be easily accessible in resource-constrained environments, at least in the rural areas or underdeveloped areas [12]. This highlights the importance of finding high-quality systemic markers that would be capable of signifying the danger and gravity of retinal damages. HbA1c is a parameter which is easy to measure and everybody measures it regularly so it is a possibility to find a surrogate marker in people who are at risk to develop retinal complications of diabetes [13]. Strong and

consistent relationship of HbA1c and the severity of DR would favour the enthusiasm to integration of the strict glycemic control as a strategy at the fore-front in reducing the DR prevention measures. In addition, it would serve as another low-cost, non-invasive screening device to triage patients who would undergo early ophthalmologic examination.

Objective

This study aimed to evaluate the correlation between HbA1c levels and the severity of retinal changes in patients with diabetic retinopathy.

Methodology

This was a cross-sectional analytical study conducted at Jinnah Hospital Lahore from Oct 2024 to March 2025. A total of 187 patients with a confirmed diagnosis of diabetic retinopathy were enrolled in the study.

Inclusion Criteria:

- Patients aged 18 years and above
- Diagnosed cases of type 1 or type 2 diabetes mellitus
- Presence of diabetic retinopathy confirmed on fundoscopic examination or retinal imaging
- Availability of a recent HbA1c report within the last three months

Exclusion Criteria:

- Patients with retinal disorders unrelated to diabetes (e.g., hypertensive retinopathy, retinal vein occlusion)
- History of recent ocular surgery or trauma
- Patients on long-term corticosteroid therapy
- Incomplete clinical or laboratory data

Data Collection Procedure:

Each participant underwent a detailed clinical examination, including medical history, duration of diabetes, and current treatment modalities. Fundus examination was performed using slit-lamp biomicroscopy with a 90D lens or indirect ophthalmoscopy. Diabetic retinopathy was graded according to the Early Treatment Diabetic Retinopathy Study (ETDRS) classification into mild, moderate, severe non-proliferative diabetic retinopathy (NPDR), and proliferative diabetic retinopathy (PDR). The most recent HbA1c level (within the past 3 months) was recorded from patient files or laboratory reports.

Statistical Analysis:

Data were entered and analyzed using SPSS version 26. Descriptive statistics were used to present demographic and clinical variables. The correlation between HbA1c levels and the severity of diabetic retinopathy was assessed using Pearson's correlation coefficient. A p-value of <0.05 was considered statistically significant.

Results

Among 187 diabetic patients, the mean age was 56.8 ± 9.7 years, with 102 males (54.5%) and 85 females (45.5%). The majority had type 2 diabetes (168, 89.8%), while only 19 (10.2%) had type 1. The average duration of diabetes was 11.2 ± 4.6 years, and the mean HbA1c was elevated at 9.1 ± 1.7%, indicating suboptimal glycemic control.

Table 1: Demographic and Clinical Characteristics of Study Participants (n = 187)

Variable	Category	Value
Mean Age (years)		56.8 ± 9.7
Gender	Male	102 (54.5%)
	Female	85 (45.5%)
Type of Diabetes	Type 1	19 (10.2%)
	Type 2	168 (89.8%)
Duration of Diabetes (years)		11.2 ± 4.6
HbA1c (%)		9.1 ± 1.7

Moderate non-proliferative diabetic retinopathy (NPDR) was the most common stage, affecting 61 patients (32.6%). This was followed by proliferative diabetic retinopathy

(PDR) in 45 patients (24.1%), mild NPDR in 42 (22.5%), and severe NPDR in 39 (20.9%). These findings reflect a significant proportion of patients with advanced retinopathy stages.

Table 2: Distribution of Diabetic Retinopathy Severity

Retinopathy Severity	Number of Patients (n)	Percentage (%)
Mild NPDR	42	22.5%
Moderate NPDR	61	32.6%
Severe NPDR	39	20.9%
PDR	45	24.1%

HbA1c levels increased progressively with retinopathy severity, from 7.8 ± 1.2% in mild NPDR to 10.4 ± 1.6% in PDR cases ($p < 0.001$), suggesting a strong association between poor glycemic control and retinopathy progression. Patients with diabetes for >10 years had higher mean HbA1c (9.5 ± 1.6%) compared to those with ≤10 years (8.6 ± 1.3%; $p = 0.002$), supporting duration as a risk factor for poorer control and complications.

Table 3: Mean HbA1c Levels by Retinopathy Severity

DR Severity	n	Mean HbA1c (%) ± SD	p-value
Mild NPDR	42	7.8 ± 1.2	< 0.001
Moderate NPDR	61	8.9 ± 1.3	
Severe NPDR	39	9.6 ± 1.5	
PDR	45	10.4 ± 1.6	
Duration of Diabetes			
≤ 10 years	82	8.6 ± 1.3	0.002
> 10 years	105	9.5 ± 1.6	

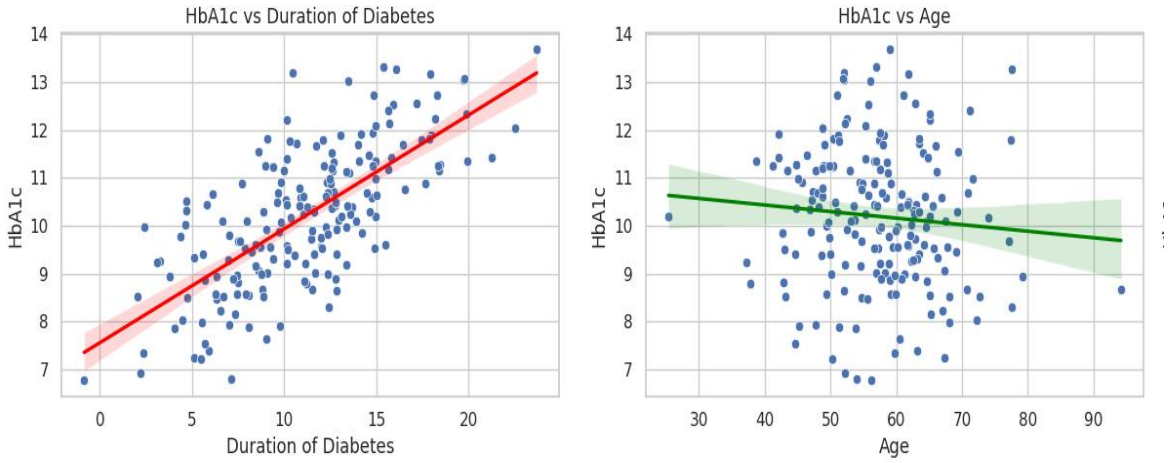

Figure 1: The left plot shows a strong positive correlation between HbA1c and duration of diabetes, indicating that glycemic control worsens with longer disease duration. The right plot shows a weak, non-significant negative correlation between HbA1c and age, suggesting age has little influence on HbA1c levels.

DISCUSSION

In this paper, the interrelation between the HbA1c and the severity of retinal alterations was studied in patients with diabetic retinopathy (DR), and the association was not only statistically significant but also positive. The conclusions confirm the hypothesis that severe glycemic control, which is indicated by an increased level of HbA1c, is highly related to the development of the advancement in the retinal microvascular damage. Patients with increased HbA1c always presented higher levels of hastened stages of DR whereby proliferative diabetic retinopathy (PDR) also had the highest average HbA1c (10.4 1.6 %) as compared to less severe DR categories like mild NPDR (7.8 1.2 percent). These findings are consistent with the earlier classic series of studies, including the Diabetes Control and Complications Trial (DCCT) and the UK Prospective Diabetes Study (UKPDS), which both showed that persistent hyperglycemia is a prominent causative factor of microvascular complications, including retinopathy [14][15]. The linear relationship of HbA1c with the DR stages demonstrated in this study empowers the pathophysiological framework whereby exposure to excessively high concentrations of blood glucose chronically causes thickening of the basement membrane, dysfunction of the endothelial cells, the loss of pericytes, and retinal ischemia, which eventually advances to PDR in the form of neovascularization. Interestingly, the analysis also indicated that patients whose duration with diabetes was more than 10 years recorded high levels of HbA1c compared to those with a shorter duration of the disease. This result is in line with the chronicity of diabetes and its long-term accretion on glycemic control and pattern of complications [16]. It emphasizes on early detection and intensive glycemic control in the first decade of the development of diabetes to reach the postponement of sight-threatening DR or prevention. Due to the cross-sectional nature of a study, however, causal interpretation cannot be done. Albeit strong connection between HbA1c and the severity of DR has been shown, it cannot be stated that high HbA1c by itself can be used to predict the development of that issue without considering other possible contributors to the problem, namely hypertension, dyslipidemia, smoking, genetic predisposition, and systemic inflammation [17]. Additionally, none of these patients had a small percentage of patients with a relatively controlled HbA1c, demonstrating moderate to severe DR, indicating that non-glycemic variables, including metabolic memory, oxidative stress, or undetermined comorbidities, may also be at play in the process of causing retinal injury. Clinical implications notwithstanding these limitations are enormous. HbA1c is also a relatively inexpensive, universal and widely available marker of glycemic control. Along with the evident connection with the severity of DR, periodic HbA1c tests would become a convenient instrument in the stratification of the screening ophthalmologic examinations. Individuals who have high levels of HbA1c levels (more than 9% particularly) should be considered and subjected to a thorough retinal assessment even when not exhibiting visual symptoms.

CONCLUSION

This study demonstrates a significant positive correlation between HbA1c levels and the severity of diabetic retinopathy among patients with diabetes mellitus. As HbA1c levels increased, the likelihood of more advanced retinal changes, ranging from mild NPDR to proliferative diabetic retinopathy, also rose. These findings reaffirm the critical role of sustained glycemic control in preventing or delaying the progression of diabetic retinopathy. Given that HbA1c is a routinely measured and accessible biomarker, it can serve as an effective tool not only for

monitoring metabolic control but also for risk stratification in ophthalmologic screening. Patients with higher HbA1c levels, particularly those above 9%, should be prioritized for early and regular retinal evaluations, even in the absence of visual symptoms.

REFERENCES

Aziz, K. M. (2018). Association of Diabetic Retinopathy and Maculopathy with Elevated HbA1c. *Blood Pressure, Serum Creatinine, Microalbuminuria, Spot Urine Protein, Nephropathy and Diabetic Kidney Disease An Experience from Data Analysis of*, *5*(1), 1-11.

Niveditha, H., Yogitha, C., Liji, P., Sundeep, S., Himamshu, N. V. V., Vinutha, B. V., & Pooja, P. (2013). Clinical correlation of HbA1c and diabetic nephropathy with diabetic retinopathy. *Journal of Evolution of Medical and Dental Sciences*, *2*(49), 9430-9436.

Ismail, S. A., Mutalib, H. A., & Ngah, N. F. (2019). HbA1c and retinal sensitivity in diabetics using microperimetry. *Journal of optometry*, *12*(3), 174-179.

Kim, Han Ul, Sung Pyo Park, and Yong-Kyu Kim. "Long-term HbA1c variability and the development and progression of diabetic retinopathy in subjects with type 2 diabetes." *Scientific Reports* 11, no. 1 (2021): 4731.

Diabetes Control and Complications Trial Research Group. (1995). The relationship of glycemic exposure (HbA1c) to the risk of development and progression of retinopathy in the diabetes control and complications trial. *Diabetes*, *44*(8), 968-983.

Geany, Putri Lenggo, Riski Prihatningtias, Arief Wildan, and Maharani Cahyono. "Correlation between HbA1c Levels and Severity of Diabetic Retinopathy." *Jurnal Kedokteran Diponegoro (Diponegoro Medical Journal)* 11, no. 5 (2022): 231-236.

Umayahara, Yutaka, Yohei Fujita, Hirotaka Watanabe, Noriko Kasai, Noritaka Fujiki, Masahiro Hatazaki, and Masafumi Koga. "Association of glycated albumin to HbA1c ratio with diabetic retinopathy but not diabetic nephropathy in patients with type 2 diabetes." *Clinical biochemistry* 50, no. 6 (2017): 270-273.

Kant, Dev, Jyoti Kumari, and Rajeev Kumar Singh. "Correlation of blood sugar and HbA1C levels in different stage of diabetes retinopathy: A hospital based prospective study." *International journal of health sciences* 6, no. S6 (2022): 1867-1876.

Temel, Emine, Gökçen Özcan, Özge Yanık, Sibel Demirel, Figen Batıoğlu, İrem Kar, and Emin Özmert. "Choroidal structural alterations in diabetic patients in association with disease duration, HbA1c level, and presence of retinopathy." *International ophthalmology* 42, no. 12 (2022): 3661-3672.

Wong, Bing Seng, Sharanjeet Sharanjeet-Kaur, Nor Fariza Ngah, and Rajan Rajasudha Sawri. "The correlation between hemoglobin A1c (HbA1c) and hyperreflective dots (HRD) in diabetic patients." *International Journal of Environmental Research and Public Health* 17, no. 9 (2020): 3154.

Andreasson, Rebecka, Charlotte Ekelund, Mona Landin-Olsson, and Charlotta Nilsson. "HbA1c levels in children with type 1 diabetes and correlation to diabetic retinopathy." *Journal of Pediatric Endocrinology and Metabolism* 31, no. 4 (2018): 369-374.

Güven, Dilek, Hakan Özdemir, and Berati Hasanreisoglu. "Hemodynamic alterations in diabetic retinopathy." *Ophthalmology* 103.8 (1996): 1245-1249.

Jiang, J., Liu, Y., Chen, Y., Ma, B., Qian, Y., Zhang, Z., ... & Xu, X. (2018). Analysis of changes in retinal thickness in type 2 diabetes without diabetic retinopathy. *Journal of diabetes research*, *2018*(1), 3082893.

Nanda, Prasanta Kumar, and Sabita Mohanta. "Correlation between HbA1c and Diabetic Retinopathy in Type 2 Diabetes Mellitus."

Matsushita, Yumi, Norio Takeda, Yosuke Nakamura, Natsuyo Yoshida-Hata, Shuichiro Yamamoto, Mitsuhiko Noda, Tetsuji Yokoyama, Tetsuya Mizoue, and Toru Nakagawa. "A comparison of the association of fasting plasma glucose and HbA1c levels with diabetic retinopathy in Japanese men." *Journal of diabetes research* 2020, no. 1 (2020): 3214676.

Rahman, M. O., & Kumar, S. (2025). A Study on Association of HbA1c Levels and Severity of Diabetic Retinopathy in the Patients of Diabetes Mellitus. *European Journal of Cardiovascular Medicine*, *15*(2).

Noma, H., Sakamoto, I., Mochizuki, H., Tsukamoto, H., Minamoto, A., Funatsu, H., ... & Mishima, H. K. (2004). Relationship between periodontal disease and diabetic retinopathy. *Diabetes Care*, *27*(2), 615-615.