ORIGINAL RESEARCH

Awareness of the Association between Glycosylated Haemoglobin(Hba1c) and Diabetic Retinopathy Severity in Type 2 Diabetes Patients: A Cross-Sectional Study

[1]Dr. Zeveri Dhiren Sanat Kumar, [2]Dr. Nandlal Choudhary

[1]Associate Professor, Department of Ophthalmology, Major SD Singh Medical College, Farrukhabad Uttar Pradesh, India
[2]Associate Professor, Department of Biochemistry, Major SD Singh Medical College, Farrukhabad Uttar Pradesh, India
Corresponding author: Dr. Nandlal Choudhary
Associate Professor, Department of Biochemistry, Major SD Singh Medical College, Farrukhabad Uttar Pradesh, India

Received: 02May, 2015 Accepted: 11June, 2015 Published: 23 June, 2015

ABSTRACT
Background: Diabetic retinopathy (DR) is a leading cause of vision loss in individuals with type 2 diabetes mellitus (T2DM), with its severity closely linked to glycemic control. Glycosylated haemoglobin (HbA1c) is a key biomarker used to assess long-term blood glucose levels. Despite this, patient awareness regarding the relationship between HbA1c and DR progression remains inadequately explored in clinical settings.
Aim: To evaluate the awareness of the association between HbA1c levels and the severity of diabetic retinopathy among patients with T2DM.
Material and Methods: This cross-sectional, observational study was conducted in the Department of Ophthalmology at a tertiary care hospital and included 110 T2DM patients aged ≥40 years. All participants underwent detailed clinical assessment, fundus examination based on ETDRS classification, and HbA1c measurement. A structured, pre-validated questionnaire was administered to assess awareness regarding HbA1c and DR. Data were analyzed using SPSS 21.0; chi-square test and ANOVA were applied, with $p < 0.05$ considered statistically significant.
Results: The mean HbA1c was 8.3 ± 1.4%, and 65.45% of patients had some form of DR. HbA1c levels increased significantly with DR severity ($p < 0.001$). Awareness regarding the role of HbA1c in diabetes monitoring was present in 60% of participants, while only 46.36% recognized its link to DR progression. A statistically significant inverse association was observed between awareness and DR severity ($p < 0.001$), with higher awareness among patients without DR.
Conclusion: Poor glycemic control is significantly associated with increased severity of diabetic retinopathy. However, awareness regarding the importance of HbA1c in preventing DR remains limited. Educational interventions and routine retinal screening are essential to mitigate the risk of vision-threatening complications in T2DM patients.

Keywords: Diabetic Retinopathy, HbA1c, Type 2 Diabetes Mellitus, Awareness, Glycemic Control

INTRODUCTION

Diabetes mellitus (DM) is a chronic metabolic disorder characterized by persistent hyperglycemia resulting from defects in insulin secretion, insulin action, or both. Globally, the prevalence of diabetes was estimated to be 180 million in 2000 and is projected to rise to 300 million by 2025. In India, the situation is particularly alarming, with the World Health Organization predicting an increase from 19 million adults with diabetes in 1995 to 80 million by 2030.[1]

Diabetic retinopathy (DR) is one of the most common microvascular complications of

diabetes and a leading cause of visual impairment and blindness among working-age adults. The global prevalence of DR among individuals with diabetes ranges from 26% to 52%, while in India, it is approximately 34%.[2] DR often progresses silently, affecting individuals over years or decades, with symptoms manifesting only in advanced stages. Therefore, early detection and timely intervention are crucial to prevent vision loss.

Glycosylated hemoglobin (HbA1c) is a well-established marker for long-term glycemic control, reflecting average blood glucose levels over the preceding two to three months. The American Diabetes Association recommends maintaining HbA1c levels below 7% to reduce the risk of diabetic complications, including DR.[3] Elevated HbA1c levels have been associated with the onset and progression of DR, making it a critical parameter in diabetes management.[4]

Despite the significance of HbA1c in managing diabetes and preventing complications, studies have shown a lack of awareness among patients regarding its role. For instance, a study conducted in Australia reported that only 17% of participants understood the concept of HbA1c, and 49% had heard of the HbA1c test.[5] Similarly, research from Singapore indicated that higher education levels, younger age, and longer duration of diabetes were associated with greater awareness of HbA1c.[6] In Brazil, a population-based study found that 85.5% of individuals with diabetes did not know their HbA1c levels.[7]

AIM AND OBJECTIVES

This study aims to evaluate the awareness of the association between glycosylated haemoglobin (HbA1c) levels and the severity of diabetic retinopathy among individuals with type 2 diabetes mellitus in a hospital setting. Understanding this awareness gap and identifying factors influencing it can inform targeted educational interventions and help design effective strategies for early detection and prevention of diabetic eye disease.

MATERIALS AND METHODS

Study Design

This was a hospital-based, cross-sectional observational study conducted to evaluate the awareness regarding the association between glycosylated haemoglobin (HbA1c) and the severity of diabetic retinopathy (DR) in individuals with Type 2 Diabetes Mellitus (T2DM).

Study Population

A total of 110 patients diagnosed with T2DM were enrolled using consecutive sampling. All patients were aged ≥ 40 years, had a confirmed diagnosis of T2DM for at least one year, and had undergone HbA1c testing within the past three months.

Study Place

The study was carried out in the Department of Ophthalmology Department of Ophthalmology in collaboration withDepartment of Biochemistry, Major SD Singh Medical college, farrukhabad Uttar Pradesh, India, providing access to a diverse diabetic population.

Study Duration

The study was carried out over a period of six months, from November 2014 to April 2015 after receiving Institutional Ethics Committee approval, allowing sufficient time for recruitment, evaluation, and analysis.

Inclusion Criteria

Individuals aged 40 years and above.

Confirmed diagnosis of Type 2 Diabetes Mellitus for at least one year.

Recent HbA1c test results (within the last three months).

Willingness to undergo fundus examination and complete the awareness questionnaire.

Capability to comprehend the questionnaire and provide informed consent.

Exclusion Criteria

Patients with Type 1 Diabetes Mellitus or gestational diabetes.

Presence of co-existing ocular pathologies like glaucoma, uveitis, or media opacities hindering fundus visualization.

History of retinal laser therapy or intraocular surgery in the last six months.

Individuals with cognitive impairments or psychiatric conditions affecting questionnaire reliability.

Ethical Considerations

The study protocol was approved by the Institutional Ethics Committee (IEC). All participants provided written informed consent prior to inclusion. Patient confidentiality was maintained, and participation was entirely voluntary.

Study Procedure

Upon enrollment, a detailed clinical and demographic profile was documented for each participant, including:

- Age, gender, duration of diabetes.
- Treatment history and comorbidities.
- Recent HbA1c values (from lab reports).

All subjects underwent a comprehensive ophthalmic evaluation:

- Visual acuity assessed using Snellen's chart.
- Anterior segment examination using slit-lamp biomicroscopy.
- Intraocular pressure measured via Goldmann applanation tonometry.
- Dilated fundus examination performed with a 90D lens and indirect ophthalmoscopy.

The severity of diabetic retinopathy was graded for each eye as per the ETDRS classification, categorizing DR into:

1. No DR
2. Mild NPDR
3. Moderate NPDR
4. Severe NPDR
5. Proliferative DR

Following the ocular examination, participants completed a structured, pre-validated awareness questionnaire, available in their local language. The questionnaire assessed knowledge about:

- The significance of HbA1c in diabetes monitoring.
- The association between glycaemic control and DR.
- Target HbA1c values for optimal diabetic control.
- The recommended frequency of ophthalmic evaluations.

Outcome Measures

The primary outcome was the association between:

- HbA1c levels,
- severity of diabetic retinopathy, and
- awareness levels regarding diabetic eye care.

Statistical Analysis

Data were compiled in Microsoft Excel and analyzed using SPSS version 21.0:

- Categorical variables: Expressed as frequencies and percentages.
- Chi-square test: Used to identify associations between awareness and DR severity.
- ANOVA: Applied for comparison of HbA1c values across different DR severity grades.
- P-value < 0.05: Considered statistically significant.

RESULTS

Table 1: Demographic and Clinical Profile of Study Participants (n = 110)

Variable	Number (%) or Mean ± SD
Age (years)	56.4 ± 9.3
Gender	
Male	62 (56.36%)
Female	48 (43.64%)
Duration of Diabetes (years)	8.6 ± 4.7
HbA1c (%)	8.3 ± 1.4
Hypertension (Comorbidity)	68 (61.82%)
Dyslipidaemia	41 (37.27%)

Table 1 shows the study included 110 participants diagnosed with type 2 diabetes mellitus (T2DM). The mean age of the study population was 56.4 ± 9.3 years, indicating a predominantly middle-aged cohort. Of these, 62 (56.36%) were male and 48 (43.64%) were female. The average duration of diabetes among participants was 8.6 ± 4.7 years, suggesting long-standing disease in many cases. The mean HbA1c level was found to be 8.3 ± 1.4%, reflecting poor overall glycaemic control in the majority of patients. Regarding comorbid conditions, hypertension was present in 68 patients (61.82%), while dyslipidaemia was noted in 41 (37.27%), both of which are known to compound the risk of diabetic retinopathy progression.

Table 2: Distribution of Participants Based on Severity of Diabetic Retinopathy (DR)

DR Severity	Number of Patients (%)
No Diabetic Retinopathy	38 (34.55%)
Mild Non-Proliferative DR	24 (21.82%)
Moderate Non-Proliferative DR	19 (17.27%)

Severe Non-Proliferative DR	15 (13.64%)
Proliferative DR	14 (12.73%)

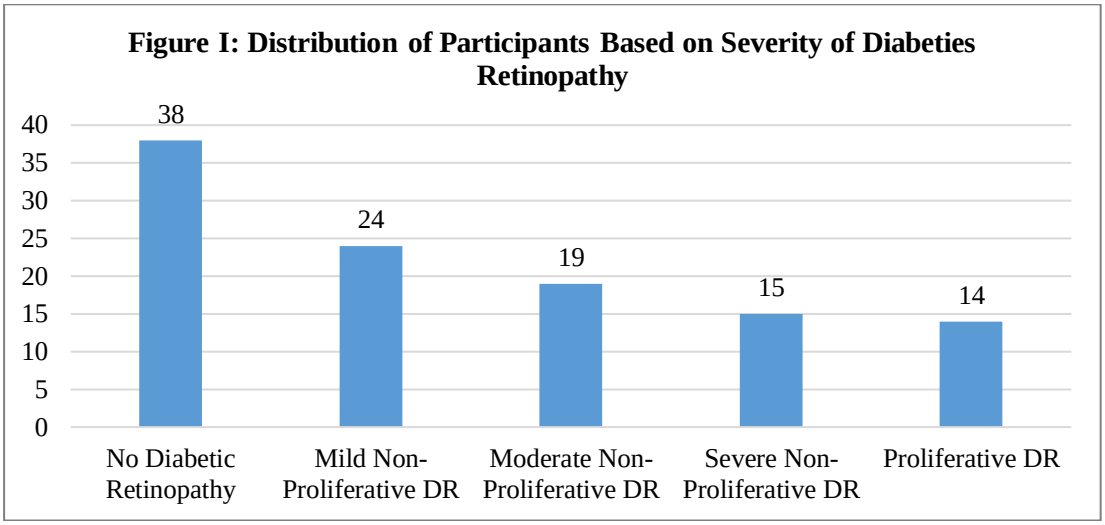

Table 2, figure I shows the assessment of diabetic retinopathy which revealed that 38 patients (34.55%) had no signs of DR, while 72 patients (65.45%) had some degree of retinopathy. Among those with DR, mild non-proliferative DR (NPDR) was observed in 24 patients (21.82%), moderate NPDR in 19 (17.27%), severe NPDR in 15 (13.64%), and proliferative DR (PDR) in 14 (12.73%). These findings highlight a significant burden of retinal complications among T2DM patients attending the hospital, with nearly one in eight having progressed to the proliferative stage. The gradual increase in retinopathy severity across the cohort aligns with longer disease duration and poorer glycaemic profiles, as explored in the next table.

Table 3: Mean HbA1c Levels Across Different DR Severity Grades

DR Severity	Mean HbA1c (%) ± SD	p-value
No DR	7.3 ± 0.8	< 0.001
Mild NPDR	8.0 ± 0.9	
Moderate NPDR	8.5 ± 1.1	
Severe NPDR	9.1 ± 1.2	
Proliferative DR	9.4 ± 1.3	

Table 3 showedthe mean HbA1c levels have a clear positive correlation with the severity of diabetic retinopathy. Patients with no DR had the lowest mean HbA1c level of 7.3 ± 0.8%, while those with mild, moderate, severe NPDR, and PDR had progressively higher HbA1c levels of 8.0 ± 0.9%, 8.5 ± 1.1%, 9.1 ± 1.2%, and 9.4 ± 1.3%, respectively. The overall ANOVA p-value was < 0.001, indicating this trend was statistically significant. This supports the hypothesis that poor glycaemic control is strongly associated with the progression of retinal damage in diabetic individuals.

Table 4: Awareness of HbA1c and Diabetic Retinopathy (DR) Association Among Participants (n = 110)

Awareness Parameter	Aware n (%)	Not Aware n (%)	p-value
Role of HbA1c in monitoring diabetes	66 (60.00%)	44 (40.00%)	0.032
Poor HbA1c control linked with worsening of diabetic retinopathy	51 (46.36%)	59 (53.64%)	< 0.001
Target HbA1c value for diabetic control	39 (35.45%)	71 (64.55%)	0.004
Need for regular eye check-up in diabetics	74 (67.27%)	36 (32.73%)	0.021

Awareness that DR can lead to permanent vision loss	47 (42.73%)	63 (57.27%)	0.008
Knowledge that DR progression can occur even in absence of visual symptoms	44 (40.00%)	66 (60.00%)	0.006
Belief that good glycaemic control can prevent DR progression	58 (52.73%)	52 (47.27%)	0.017

Table 4 shows theawareness levels among the study population were suboptimal. Only 66 patients (60.00%) were aware of the role of HbA1c in monitoring diabetes, and even fewer—51 patients (46.36%)—understood the link between poor HbA1c control and DR progression. Awareness about the recommended target HbA1c was present in just 39 (35.45%) participants. However, 74 patients (67.27%) recognized the need for regular eye check-ups, indicating relatively better awareness in that domain. Notably, awareness that DR can cause permanent vision loss (42.73%), that progression can occur even without visual symptoms (40.00%), and that good glycaemic control can prevent progression (52.73%) were all suboptimal. Most of these awareness parameters had p-values less than 0.05, confirming that lack of knowledge was significantly associated with poorer clinical profiles and DR presence.

Table 5: Association Between Awareness of HbA1c–DR Link and Severity of Diabetic Retinopathy

Awareness of HbA1c–DR Link	No DR (n = 38)	Any DR (n = 72)	Total (n = 110)	p-value
Aware	28 (73.68%)	23 (31.94%)	51 (46.36%)	< 0.001
Not Aware	10 (26.32%)	49 (68.06%)	59 (53.64%)	

Table 5 showsa striking finding was the inverse relationship between awareness and the severity of diabetic retinopathy. Among the 38 participants without DR, 28 (73.68%) were aware of the link between HbA1c and DR, whereas among the 72 participants with any stage of DR, only 23 (31.94%) demonstrated such awareness. This difference was highly significant ($p < 0.001$). Conversely, 49 (68.06%) of the DR group were unaware of the HbA1c–DR relationship compared to only 10 (26.32%) in the non-DR group. This strongly indicates that patients with poor awareness are at higher risk of developing DR, potentially due to inadequate glycaemic monitoring and lack of routine eye evaluations.

DISCUSSION

The present study included 110 patients with type 2 diabetes mellitus, with a mean age of 56.4 years and mean diabetes duration of 8.6 years. The average HbA1c was 8.3%, and a significant proportion had comorbidities like hypertension (61.82%) and dyslipidaemia (37.27%). These values align with findings by Rani et al (2009), who reported a mean diabetes duration of 9 years and noted that systemic hypertension and lipid abnormalities were independently associated with the presence of diabetic retinopathy.[8] Similarly, Pradeepa et al (2008) identified hypertension as a key risk factor for DR in their South Indian cohort.[9] In our study, male patients constituted 56.36%, which was consistent with the gender distribution reported by Singh et al (2021), who found a slight male preponderance in their diabetic population with retinopathy.[10]

In our study population, 65.45% of participants had some form of diabetic retinopathy, with 21.82% having mild NPDR, 17.27% moderate NPDR, 13.64% severe NPDR, and 12.73% proliferative DR.These rates are also comparable to the population-based data by Raman et al (2011), where 61.8% of patients with poorly controlled diabetes developed DR, highlighting the magnitude of the burden even in non-specialist settings. The progressive increase in severity reflects the natural course of the disease in the absence of adequate control and follow-up.[10]

Mean HbA1c levels in our study increased proportionally with DR severity: 7.3% in patients without DR, 8.0% in mild NPDR, 8.5% in moderate NPDR, 9.1% in severe NPDR, and 9.4% in PDR. This pattern showed statistical significance ($p < 0.001$). Hou et al (2011) reported a similar trend, with HbA1c levels exceeding 8.0% significantly increasing the risk for DR development in Chinese T2DM patients.[11] Anitha et al (2008) also confirmed the role of elevated glycation indices in advancing

retinopathy stages, suggesting a metabolic threshold beyond which retinal damage becomes irreversible or progressive.[12]

Regarding awareness, only 60% of our patients were aware of the role of HbA1c in monitoring diabetes, and just 46.36% knew of its link to DR progression. Knowledge of the target HbA1c was limited to 35.45%. Do et al.[13] (2006) reported that less than 50% of patients receiving ophthalmic care knew their HbA1c value, while Sanjay et al (2013) observed that only 42% understood its role in DR development. Our study further revealed that only 40% knew that DR can progress without visual symptoms and 42.73% were aware that it may cause permanent vision loss.[14]These figures are similar to those reported by Annunziata et al (2012), who found widespread gaps in glycaemic literacy and its relationship with long-term complications among T2DM patients.[15]

A strong inverse association was observed between awareness and DR severity. Among patients without DR, 73.68% were aware of the HbA1c–DR relationship, compared to only 31.94% in those with DR ($p < 0.001$). This trend was identical to the findings of Sanjay et al.[14] (2013), where patients who were aware had significantly lower rates of DR. Anitha et al.[12] (2008) also supported the role of patient education in preventing DR progression, showing that informed patients had better glycaemic control and fewer complications. The marked difference in awareness between the two groups in our study reflects the critical need for structured diabetes education programs in routine ophthalmology and endocrinology outpatient settings.

LIMITATIONS OF THE STUDY

- Single-centre design may limit generalizability to broader populations.
- Cross-sectional nature prevents establishment of causality.
- Self-reported awareness can be subject to recall bias and social desirability bias.
- Exclusion of individuals with ocular comorbidities may overlook associations in more complex cases.
- The questionnaire, though pre-validated, may still lack cultural adaptation for certain subpopulations.

CONCLUSION

This hospital-based study highlights a significant association between poor glycaemic control, reflected by elevated HbA1c levels, and the severity of diabetic retinopathy in type 2 diabetic individuals. Despite this, awareness regarding the role of HbA1c in predicting and preventing diabetic retinopathy remains suboptimal. Strengthening patient education and promoting regular retinal screening are essential to reduce the burden of vision-threatening complications.

REFERENCES

1. World Health Organization. Global Report on Diabetes. 2000.
2. Early Treatment Diabetic Retinopathy Study Research Group. Grading diabetic retinopathy from stereoscopic color fundus photographs—an extension of the modified Airlie House classification: ETDRS report number 10. *Ophthalmology*. 1991;98:786–806.
3. American Diabetes Association. Standards of medical care in diabetes—2014. *Diabetes Care*. 2014;37(Suppl 1):S14–S80.
4. American Diabetes Association. Standards of medical care in diabetes—2014. *Diabetes Care*. 2014;37(Suppl 1):S14–S80.
5. Wang S, Tikellis G, Wong N, Wong TY, Wang JJ. Lack of knowledge of glycosylated hemoglobin in patients with diabetic retinopathy. *Diabetes Res Clin Pract*. 2008;81:e15–e17.
6. Sanjay S, Chin YC, Sun Y, Ong EL, Au Eong KG. Awareness of HbA1c and its relationship with diabetic retinopathy among adult diabetic patients attending a tertiary ophthalmic center. *Diabetes Care*. 2013;36(1):e1.
7. Annunziata K, et al. Lack of awareness of HbA1c levels among patients with type 2 diabetes in Brazil. *Diabetes Research and Clinical Practice*. 2012;96(3):e1–e3.
8. Rani PK, Raman R, Chandrakantan A, Pal SS, Perumal GM, Sharma T. Risk factors for diabetic retinopathy in a self-reported rural population with diabetes. J Postgrad Med. 2009;55(2):92–6. doi:10.4103/0022-3859.48787.
9. Pradeepa R, Aneetha B, Mohan V, Ganesan A, Rema M. Risk factors for diabetic retinopathy in a South Indian type 2 diabetic population – the Chennai Urban Rural Epidemiology Study (CURES) Eye Study 4.

Diabet Med. 2008;25(5):536–42. doi:10.1111/j.1464-5491.2008.02423.x.

10. Raman R, Verma A, Pal SS, Gupta A, Vaitheeswaran K, Sharma T. Influence of glycosylated haemoglobin on sight-threatening diabetic retinopathy: a population-based study. Diabetes Res ClinPract. 2011;92(2):168–73. doi:10.1016/j.diabres.2011.01.006.
11. Hou JN, Bi YF, Xu M, Huang Y, Li XY, Wang WQ, et al. The change points of HbA1c for detection of retinopathy in Chinese type 2 diabetic patients. Diabetes Res ClinPract. 2011;91(3):401–5. doi:10.1016/j.diabres.2010.11.029.
12. Anitha B, Sampathkumar R, Balasubramanyam M, Rema M. Advanced glycation index and its association with severity of diabetic retinopathy in type 2 diabetic subjects. J Diabetes Complications. 2008;22(4):261–6. doi:10.1016/j.jdiacomp.2007.05.005.
13. Do DV, Nguyen QD, Bressler NM, Schachat AP, Solomon SD, Melia M, et al. Haemoglobin A1c awareness among patients receiving eye care at a tertiary ophthalmic center. Am J Ophthalmol. 2006;141(5):951–3. doi:10.1016/j.ajo.2005.11.057.
14. Sanjay S, Chin YC, Sun Y, Ong EL, Au Eong KG. Awareness of HbA1c and its relationship with diabetic retinopathy among adult diabetic patients attending a tertiary ophthalmic center. Diabetes Care. 2013;36(1):1–3. doi:10.2337/dc12-1320.
15. Annunziata K, Pomerantz D, DiBonaventura M, Follador W. Patient access, HbA1c knowledge, and health outcomes among type 2 diabetes patients in Brazil. Kantar Health. 2012;32:8540.