



Research Article

Screening of Diabetic Retinopathy in Rural and Tribal Communities in Dahod District, Gujarat: A Cross-Sectional Study

Dr. Abhishek S Bhagora^{1*}, Dr. Jignasha Sureshchandra Bhabhor², Dr. Prapti Kanaiyalal Nisarta³

¹Associate Professor, Department of Ophthalmology, Zydus Medical College and Hospital, Dahod, Gujarat, India.

²Assistant Professor Department of Ophthalmology, Zydus Medical College and Hospital, Dahod, Gujarat, India.

³Assistant Professor, Department of Ophthalmology, Zydus Medical College and Hospital, Dahod, Gujarat, India.

Correspondence:

Dr. Abhishek S Bhagora.

Email: abhi02556@gmail.com

Received: 09-08-2026

Revised: 23-08-2026

Accepted: 02-09-2026

Published: 06-10-2026

DOI: 10.61336/ijmmas.22-04-01

Abstract: Background: Diabetic retinopathy (DR) is a major microvascular complication of diabetes mellitus and an important cause of preventable visual impairment. Early retinal disease may remain asymptomatic, making systematic screening particularly important in underserved rural and tribal communities. This study assessed the prevalence and severity of DR and evaluated associated demographic and clinical risk factors among diabetic individuals in Dahod district, Gujarat. **Aim:** To determine the prevalence of diabetic retinopathy and compare its occurrence and associated risk factors among individuals with diabetes mellitus residing in rural and tribal communities of Dahod district, Gujarat. **Materials and Methods:** A community-based cross-sectional observational study was conducted over six months in selected rural and tribal communities of Dahod district. There were 200 people with diabetes mellitus in all, 100 of whom were from rural areas and 100 of whom were tribal. Using a suitable community-based retinal examination technique, participants received ocular examination, fundus evaluation, and visual acuity testing. When accessible, portable/non-mydriatic fundus photography was used. Non-proliferative DR and proliferative DR were categorized as mild, moderate, or severe. Multivariable logistic regression, odds ratios with 95% confidence intervals, and chi-square/Fisher's exact tests were used to evaluate relationships between DR and clinical or demographic variables. Statistical significance was defined as a p-value of less than 0.05. **Results:** Among 200 participants, 27 (13.5%) had DR. The prevalence was 12.0% among rural participants and 15.0% among tribal participants, with no statistically significant difference between the groups ($\chi^2=0.36$, $p=0.548$). Mild NPDR was the most common stage, accounting for 15 (55.6%) of the 27 DR cases, followed by moderate NPDR in 7 (25.9%), severe NPDR in 2 (7.4%), and PDR in 3 (11.1%). 5 (2.5%) of the subjects had sight-threatening DR. DR was more common in those over 60 than in those under 60 (17.5% vs. 11.9%; OR=1.75, 95% CI: 1.02–3.01; $p=0.021$), and hypertension was similarly substantially linked to DR (19.5% vs. 9.3%; OR=2.36, 95% CI: 1.02–5.43; $p=0.014$). DR occurred in 5.3%, 11.1%, and 28.8% of people with diabetes duration <5, 5–10, and >10 years, respectively ($p<0.001$), indicating a substantial gradient in diabetes duration. Compared to regulated glycaemia, poor glycemic control was linked to a greater incidence of DR (22.3% vs. 5.7%; $p<0.001$). In multivariable analysis, poor glycemic management (adjusted OR=3.96, 95% CI: 1.59–9.86; $p=0.003$) and diabetes duration >10 years (adjusted OR=5.82, 95% CI: 2.14–15.82; $p<0.001$) continued to be independently linked to DR. **Conclusion:** Diabetic retinopathy was identified in 13.5% of diabetic individuals screened in rural and tribal communities of Dahod district. Tribal participants had a little greater prevalence, but this difference was not statistically significant. The greatest independent predictors of DR were poor glycemic management and a longer duration of diabetes. In underprivileged groups, community-based screening, proper referral, and better diabetes control may help identify and treat DR earlier.

Keywords: Diabetic retinopathy; Diabetes mellitus; Rural population; Tribal population; Diabetic eye screening; Non-proliferative diabetic retinopathy; Glycaemic control; Fundus photography.

Copyright @ 2026: This is an open-access article distributed under the terms of the Creative Commons Attribution license which permits unrestricted use, distribution and reproduction in any medium for non-commercial use (NonCommercial, or CC-BY-NC) provided the original author and source are credited.

INTRODUCTION

Diabetes mellitus (DM) is a major chronic metabolic disorder and an increasingly important public health problem in India. Multiple organ-related microvascular and macrovascular problems might arise from persistent hyperglycemia. Diabetic retinopathy (DR) is one of the most significant microvascular consequences since, in its early stages, retinal vascular damage may not present any symptoms, but it gradually raises the risk of blindness and visual impairment. Systematic retinal screening has become a crucial part of diabetic management as a significant portion of the visual loss linked to DR can be avoided with prompt identification and adequate treatment [1,2]. Chronic metabolic and microvascular alterations linked to diabetes lead to the development of diabetic retinopathy. Endothelial dysfunction, pericyte loss, increased retinal vascular permeability, capillary closure, and retinal ischemia are all consequences of persistent hyperglycemia. Non-proliferative diabetic retinopathy (NPDR) and proliferative diabetic retinopathy (PDR) are the two major clinical categories of DR. While PDR is marked by retinal neovascularization and has a significantly higher risk of vitreous hemorrhage and tractional retinal detachment, NPDR may proceed from mild to severe illness. One major cause of central visual impairment is diabetic macular

edema (DME), which can develop at various stages of DR. Poor glycemic management and longer diabetes duration raise the risk of DR, and other systemic variables such as hypertension may accelerate the disease's progression [2, 3]. Due to its vast and growing diabetic population, India has a significant burden of diabetic retinopathy. The National Survey of Blindness and Visual Impairment, which was carried out between 2015 and 2019, revealed a substantial prevalence of diabetic retinopathy and sight-threatening diabetic retinopathy among individuals with diabetes, underscoring the necessity of better screening and access to diabetic eye care services [1]. Additionally, nationally representative data has shown that diabetic retinopathy adds to India's visual impairment burden, highlighting the significance of early detection and treatment of retinal illness [4].

Crucially, diabetic retinopathy is not limited to people who live in cities or receive tertiary care. More than 42,000 people from 10 states and one union territory participated in the SMART India population-based screening survey, which showed significant variance in DR and vision-threatening DR based on domicile, diabetes status, and socioeconomic variables [5]. These results highlight the need of expanding diabetic eye screening into underprivileged and rural areas in addition to specialized institutions.

Regular diabetic retinopathy screening may be hampered in rural areas by a number of factors, such as the distance from ophthalmic facilities, transportation challenges, financial limitations, a shortage of qualified eye care specialists, and a lack of knowledge about asymptomatic retinal disease. Due to these difficulties, presentation may be postponed until vision impairment has already occurred. In indigenous societies, where settlements may be geographically spread and access to specialized healthcare may be more restricted, the issue may be more pertinent.

The viability of community-based diabetic retinopathy screening in rural and tribal communities is clearly supported by data from Western India. For the purpose of screening for diabetic retinopathy in rural and tribal areas, a community-based cross-sectional study assessed non-mydratic fundus photography as an alternative to indirect ophthalmoscopy. In populations that may normally have restricted access to ophthalmology care, the study showed the potential use of non-mydratic fundus photography as a practical and logistically convenient screening method [6]. This finding is especially pertinent to the current study carried out in Gujarat's Dahod area. The prevalence of diabetic retinopathy in rural and tribal diabetic populations has been further illustrated by recent data from Maharashtra. Using a portable non-mydratic fundus camera to screen known diabetics, Jain et al. found that the prevalence of DR was 5.67% in 776 rural participants and 7.73% in 711 tribal participants. A clinically significant percentage of people with DR had sight-threatening illness. The significance of focused screening and effective diabetic care in underprivileged groups is supported by the identification of longer duration of diabetes and poor glycemic control as key risk factors [7].

Teleophthalmology and portable retinal cameras can improve community-based screening. Digital retinal images can be acquired at community screening sites, subcenters, or primary healthcare facilities. Trained graders or ophthalmologists can then evaluate the images. Screening at primary health centers was linked to higher screening uptake than screening at community health centers, according to an Indian research assessing screening near patients' homes. Participation in diabetic retinopathy screening was also considerably increased by health education [8]. These results imply that community knowledge and accessibility are crucial elements of effective screening initiatives.

Large-scale rural screening programs have also assessed the use of non-mydratic fundus photography. The viability of retinal imaging within decentralized diabetic eye-care services was supported by a district-wide rural diabetes eye-care model that showed good agreement between trained graders and retinal experts [9]. In a similar vein, extensive telescreening data from India has shown that retinal imaging can detect a significant proportion of people with DR and sight-threatening conditions, as well as offer information about significant risk variables including age and diabetes duration [10].

While universal periodic screening is ideal, identifying those who are more vulnerable might assist maximize the resources that are available. Diabetic retinopathy has been linked in Indian studies to aging, a longer history of diabetes, high blood pressure, and poor glycemic management [3,11]. While preserving access to screening for the larger diabetes community, screening systems that take these criteria into account may assist prioritize those who need an immediate ocular evaluation. Gujarat's Dahod district is home to sizable rural and tribal populations, making it a crucial location for assessing community-based diabetic retinopathy screening.

Planning accessible eye care services, however, still requires locally pertinent data on the prevalence of DR and the distinctions between rural and tribal diabetic populations. In order to assess the frequency and severity of diabetic retinopathy across both communities, the current study was created to screen 200 people with diabetes mellitus, 100 of whom were rural and 100 of whom were tribal. Additionally, the study assesses the association between DR and significant clinical and demographic variables, such as age, the length of diabetes, glycemic control, and hypertension. The results might

aid in the creation of suitable community-based diabetic retinopathy screening and referral programs for Gujarat's underprivileged communities.

AIMS AND OBJECTIVE

AIM

To determine the prevalence of diabetic retinopathy and compare its occurrence and associated risk factors among individuals with diabetes mellitus residing in rural and tribal communities of Dahod district, Gujarat.

OBJECTIVES

1. To screen individuals with diabetes mellitus residing in rural and tribal communities of Dahod district for diabetic retinopathy.
2. To determine the prevalence of diabetic retinopathy among the study participants.
3. To compare the prevalence of diabetic retinopathy between rural and tribal diabetic populations.
4. To classify diabetic retinopathy according to its clinical severity.
5. To determine the occurrence of sight-threatening diabetic retinopathy among the screened participants.
6. To study the association between diabetic retinopathy and demographic factors, particularly age and sex.
7. To assess the association between diabetic retinopathy and duration of diabetes mellitus.
8. To assess the relationship between diabetic retinopathy and glycaemic control.
9. To determine the association between diabetic retinopathy and hypertension.
10. To identify participants requiring referral for comprehensive ophthalmological evaluation and further management.

MATERIALS AND METHODS

Study Design

A community-based cross-sectional observational study was conducted to determine the prevalence of diabetic retinopathy and evaluate its association with selected demographic and clinical risk factors among diabetic individuals residing in rural and tribal communities.

Study Setting

The study was conducted in selected rural and tribal communities of Dahod district, Gujarat, India. Community-based screening was adopted to facilitate access to diabetic eye-care services among individuals who may have limited access to hospital-based ophthalmic screening.

Study Duration

The study was conducted over a period of 6 months.

Study Population

The study population comprised individuals with a known diagnosis of diabetes mellitus residing in the selected rural and tribal communities of Dahod district.

Sample Size

A total of 200 participants were included in the study.

The participants were equally divided into two groups:

- Group I – Rural group: 100 participants
- Group II – Tribal group: 100 participants

Thus, the total sample size was N=200.

Sampling Technique

Eligible participants were recruited from selected rural and tribal communities during community-based screening activities. Participants fulfilling the eligibility criteria and providing informed consent were enrolled until the predetermined sample size of 200 was achieved.

Inclusion Criteria

Participants were included if they fulfilled the following criteria:

1. Individuals with a known diagnosis of diabetes mellitus.
2. Individuals residing in the selected rural or tribal communities of Dahod district.
3. Individuals willing to undergo diabetic retinopathy screening.
4. Participants willing to provide informed consent.
5. Individuals available for examination during the study period.

Exclusion Criteria

Participants were excluded if they fulfilled any of the following criteria:

1. Individuals unwilling to participate or unable to provide informed consent.
2. Individuals unable to undergo the required ocular examination.
3. Individuals with acute ocular conditions interfering with retinal assessment.
4. Individuals with incomplete clinical information required for analysis.
5. Individuals in whom retinal examination was not possible because of significant media opacity or other ocular conditions, unless they could be documented as having an ungradable examination and referred for further assessment.

Data Collection

A structured data collection proforma was used to record demographic, systemic and ocular information.

The following variables were documented:

- Age
- Sex
- Rural or tribal residence
- Duration of diabetes mellitus
- Type of diabetes, where available
- Antidiabetic treatment
- History of hypertension
- Glycaemic control
- Previous ophthalmic examination
- Previous diagnosis of diabetic retinopathy
- Previous retinal treatment
- Visual symptoms
- Visual acuity
- Fundus examination findings

3.11 Assessment of Visual Acuity

Presenting visual acuity was assessed separately for each eye using a standardized visual acuity chart at the appropriate testing distance. Visual acuity findings were documented for both eyes.

Participants with reduced visual acuity were further assessed to determine the possible relationship between visual impairment and diabetic retinal disease or other ocular conditions.

Ocular and Fundus Examination

A basic ocular examination was performed for all participants. Posterior segment assessment was carried out using an appropriate fundus examination protocol.

Where available, retinal photographs were obtained using a portable/non-mydratic fundus camera suitable for community-based screening.

The retinal examination specifically assessed for:

- Microaneurysms
- Retinal haemorrhages
- Hard exudates
- Cotton-wool spots
- Venous abnormalities
- Intraretinal microvascular abnormalities
- Neovascularization
- Macular abnormalities suggestive of diabetic macular oedema

Both eyes were examined whenever technically feasible.

Classification of Diabetic Retinopathy

Based on retinal findings, participants were categorized into:

1. No diabetic retinopathy
2. Mild non-proliferative diabetic retinopathy (NPDR)
3. Moderate NPDR
4. Severe NPDR
5. Proliferative diabetic retinopathy (PDR)
6. Diabetic macular oedema/maculopathy, where identified

Participants with severe NPDR, PDR, suspected diabetic macular oedema, markedly reduced vision or other potentially sight-threatening retinal abnormalities were considered for referral to an ophthalmology/retina service.

Assessment of Risk Factors

The relationship between diabetic retinopathy and selected risk factors was assessed.

The principal variables evaluated were:

- Age
- Sex
- Rural/tribal residence
- Duration of diabetes
- Glycaemic control
- Hypertension
- Antidiabetic treatment

For analytical purposes, diabetes duration was categorized into <5 years, 5–10 years and >10 years. Age was categorized into clinically relevant age groups, including participants aged ≥60 years.

Statistical Analysis

The collected data were entered into a computerized database and analysed using appropriate statistical software. While categorical data were displayed as frequencies and percentages, continuous variables were summarized using mean ± standard deviation (SD). The percentage of individuals identified with diabetic retinopathy (DR) out of all those examined was used to determine the prevalence of DR. The Pearson chi-square test was used to evaluate the relationship between categorical variables, including rural/tribal residency, age group, sex, duration of diabetes, hypertension, glycemic control, and DR status. When the anticipated cell frequency was low, Fisher's exact test was employed. To ascertain the degree of correlation between certain risk variables and diabetic retinopathy, odds ratios (ORs) with matching 95% confidence intervals (CIs) were computed. Where appropriate, binary logistic regression analysis was planned to identify factors independently associated with diabetic retinopathy after adjustment for potential confounding variables. A two-tailed p-value <0.05 was considered statistically significant.

Statistical Significance

The following interpretation was used:

- p <0.05: statistically significant
- p ≥0.05: not statistically significant
- p <0.01: highly statistically significant
- p <0.001: very highly statistically significant

All statistical analyses were performed using the total study population of 200 participants, with specific comparisons made between the rural and tribal groups.

RESULTS

Baseline Sociodemographic Characteristics

A total of 200 individuals with diabetes mellitus were included in the study, with 100 participants each from rural and tribal communities. The study population's average age was 52.4 ± 11.3 years. The mean age of the tribal group was 53.2 ± 11.5 years, compared to 51.6 ± 11.1 years for the rural group. There was no statistically significant difference in the two groups' mean ages (p=0.315). In all, there were 88 (44.0%) female participants and 112 (56.0%) male participants. There was no statistically significant difference between the two groups (p=0.776), with male participants making up 55.0% of the rural group and 57.0% of the tribal group. Most participants were between the ages of 50 and 59 (33.5%), followed by those over 60 (28.5%). Twelve percent of the study's participants were under forty years old.

Table 1: Sociodemographic Characteristics of the Study Population (N=200)

Variable	Rural (n=100)	Tribal (n=100)	Total (N=200)	Test statistic	p-value
Age, years, mean ± SD	51.6 ± 11.1	53.2 ± 11.5	52.4 ± 11.3	t=1.01	0.315
Age group, n (%)				χ ² =0.97	0.809
<40 years	13 (13.0)	11 (11.0)	24 (12.0)		
40–49 years	28 (28.0)	24 (24.0)	52 (26.0)		
50–59 years	32 (32.0)	35 (35.0)	67 (33.5)		
≥60 years	27 (27.0)	30 (30.0)	57 (28.5)		
Sex, n (%)				χ ² =0.08	0.776
Male	55 (55.0)	57 (57.0)	112 (56.0)		

Female	45 (45.0)	43 (43.0)	88 (44.0)		
--------	-----------	-----------	-----------	--	--

SD: Standard deviation; χ^2 : Chi-square test; t: independent-samples t-test.

Table 1 demonstrates that the two study groups were broadly comparable with respect to age and sex. The mean age was 51.6 ± 11.1 years in the rural group and 53.2 ± 11.5 years in the tribal group, with no statistically significant difference ($p=0.315$). Similarly, males constituted 55.0% of the rural group and 57.0% of the tribal group ($p=0.776$). The distribution of age categories was also comparable between the groups ($p=0.809$).

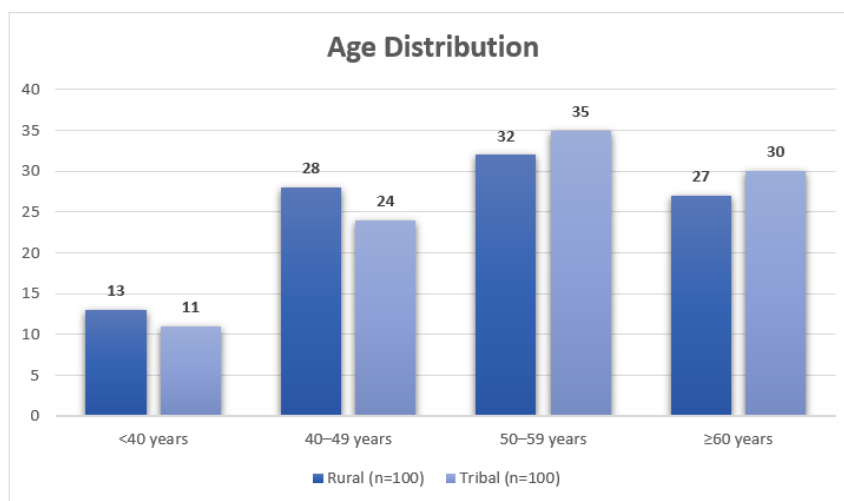


Figure 1A: Age distribution

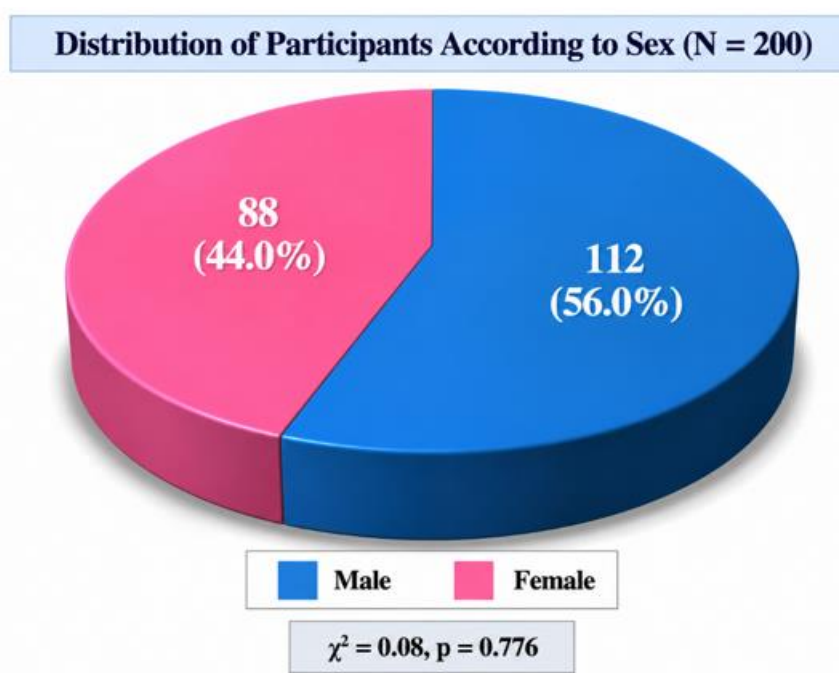


Figure 1B: Gender distribution

Diabetes-Related and Systemic Characteristics

The mean duration of diabetes was 7.1 ± 5.2 years in the overall population. Participants from rural areas had a mean length of 6.6 ± 4.8 years, whereas those from tribal areas had a mean duration of 7.6 ± 5.5 years; this difference was not statistically significant ($p=0.173$). In all, 76 (38.0%) of the individuals had diabetes for less than five years, 72 (36.0%) between five to ten years, and 52 (26.0%) for more than ten years. Of the participants, 82 (41.0%) had hypertension. Although the difference was not statistically significant ($p=0.393$), it was more common in the rural group (44.0%) than in the tribal group (38.0%). 94 individuals (47.0%) had poor glycemic control. The percentage was 50.0% among tribal individuals and 44.0% among rural participants; there was no statistically significant difference between the categories ($p=0.396$).

Table 2: Diabetes-Related and Systemic Characteristics of Study Participants (N=200)

Variable	Rural (n=100)	Tribal (n=100)	Total (N=200)	Test statistic	p-value
Duration of diabetes, years, mean $\pm$ SD	6.6 $\pm$ 4.8	7.6 $\pm$ 5.5	7.1 $\pm$ 5.2	t=1.37	0.173
Duration of diabetes, n (%)				$\chi^2=2.09$	0.351
<5 years	42 (42.0)	34 (34.0)	76 (38.0)		
5–10 years	35 (35.0)	37 (37.0)	72 (36.0)		
>10 years	23 (23.0)	29 (29.0)	52 (26.0)		
Hypertension, n (%)				$\chi^2=0.73$	0.393
Present	44 (44.0)	38 (38.0)	82 (41.0)		
Absent	56 (56.0)	62 (62.0)	118 (59.0)		
Glycaemic control, n (%)				$\chi^2=0.72$	0.396
Controlled	56 (56.0)	50 (50.0)	106 (53.0)		
Poorly controlled	44 (44.0)	50 (50.0)	94 (47.0)		

SD: Standard deviation; χ^2 : Chi-square test.

The distribution of diabetes duration was comparable between rural and tribal participants ($p=0.351$). 23.0% of rural and 29.0% of tribal individuals had diabetes for more than ten years. There was no statistically significant difference in the prevalence of hypertension between rural and tribal subjects (44.0% and 38.0%, respectively; $p=0.393$). 50.0% of tribal individuals and 44.0% of rural participants had poor glycemic control; the difference was not statistically significant ($p=0.396$).

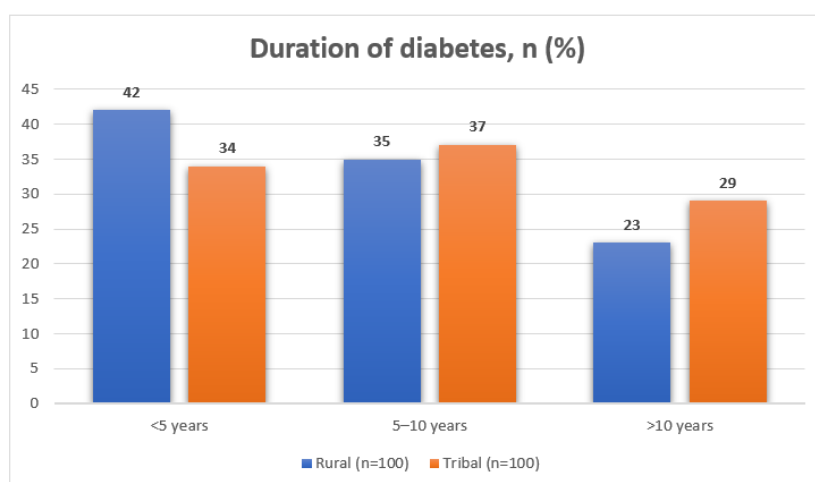


Figure 2:

Prevalence and Severity of Diabetic Retinopathy

Of the 200 individuals who underwent screening, 27 (13.5%) had diabetic retinopathy, whereas 173 (86.5%) showed no signs of DR. 12 (12.0%) of the rural participants and fifteen (15.0%) of the tribal participants had DR. There was no statistically significant difference in prevalence between participants from rural and tribal areas ($\chi^2=0.36$, $p=0.548$). Mild NPDR was the most common grade among the 27 DR participants, occurring in 15 (55.6%) of them, followed by moderate NPDR in 7 (25.9%). Two (7.4%) had severe NPDR, and three (11.1%) had proliferative diabetic retinopathy. Two rural and three tribal individuals made up the total of five participants (2.5%) with sight-threatening diabetic retinopathy.

Table 3: Prevalence and Severity of Diabetic Retinopathy According to Study Group (N=200)

Retinal status	Rural (n=100)	Tribal (n=100)	Total (N=200)	χ^2 /Fisher's exact	p-value
No DR	88 (88.0%)	85 (85.0%)	173 (86.5%)	0.36	0.548
Any DR	12 (12.0%)	15 (15.0%)	27 (13.5%)		
Mild NPDR	7 (7.0%)	8 (8.0%)	15 (7.5%)	0.08	0.777
Moderate NPDR	3 (3.0%)	4 (4.0%)	7 (3.5%)	0.15	0.698
Severe NPDR	1 (1.0%)	1 (1.0%)	2 (1.0%)	Fisher's exact	>0.999
PDR	1 (1.0%)	2 (2.0%)	3 (1.5%)	Fisher's exact	0.562
Sight-threatening DR	2 (2.0%)	3 (3.0%)	5 (2.5%)	Fisher's exact	0.651

DR: Diabetic retinopathy; NPDR: Non-proliferative diabetic retinopathy; PDR: Proliferative diabetic retinopathy.

Diabetic retinopathy was identified in 27 (13.5%) of the 200 participants. Tribal people had a slightly greater prevalence (15.0% vs. 12.0%) than rural participants, although this difference was not statistically significant ($p=0.548$). The most prevalent DR grade in both groups was mild NPDR. There was no statistically significant difference ($p=0.651$) between the 2.0% of rural and 3.0% of tribal participants who had sight-threatening DR.

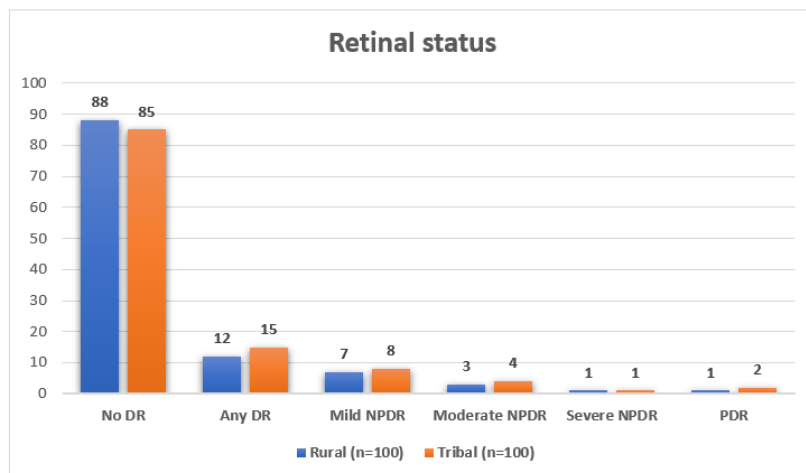


Figure 3: Retinal status

Association of Demographic and Systemic Risk Factors with Diabetic Retinopathy

Participants aged ≥ 60 years had a higher frequency of DR compared with younger participants. In contrast to 17 of 143 (11.9%) individuals under 60, DR was found in 10 of 57 (17.5%) those over 60. There was a statistically significant correlation ($\chi^2=5.32$, $p=0.021$). Twelve (13.6%) girls and fifteen (13.4%) males had DR. Sex and DR did not significantly correlate ($p=0.965$). Although living in a tribal area was linked to a numerically greater frequency of DR than living in a rural area, the difference was not statistically significant ($p=0.548$). DR was seen in 16 (19.5%) individuals with hypertension compared to 11 (9.3%) individuals without hypertension ($\chi^2=6.04$, $p=0.014$), indicating a strong correlation between hypertension and DR.

Table 4: Association of Demographic and Systemic Factors with Diabetic Retinopathy (N=200)

Risk factor	DR present n (%)	DR absent n (%)	OR (95% CI)	χ^2 /Fisher's exact	p-value
Age ≥ 60 years	10 (17.5%)	47 (82.5%)	1.75 (1.02–3.01)	5.32	0.021
Age <60 years	17 (11.9%)	126 (88.1%)	Reference		
Male sex	15 (13.4%)	97 (86.6%)	0.98 (0.43–2.20)	0.00	0.965
Female sex	12 (13.6%)	76 (86.4%)	Reference		
Tribal residence	15 (15.0%)	85 (85.0%)	1.29 (0.56–2.97)	0.36	0.548
Rural residence	12 (12.0%)	88 (88.0%)	Reference		
Hypertension present	16 (19.5%)	66 (80.5%)	2.36 (1.02–5.43)	6.04	0.014
Hypertension absent	11 (9.3%)	107 (90.7%)	Reference		

DR: Diabetic retinopathy; OR: odds ratio; CI: confidence interval.

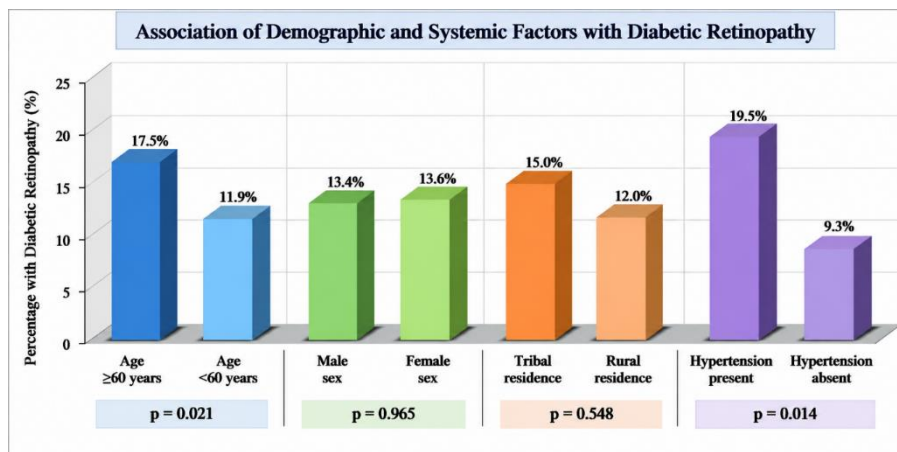


Figure 4: Association of Demographic and Systemic Factors with Diabetic Retinopathy (N=200)

Association of Duration of Diabetes and Glycaemic Control with Diabetic Retinopathy

As diabetes duration increased, there was a noticeable rise in the prevalence of diabetic retinopathy. 4 (5.3%) individuals with diabetes for less than five years had DR, compared to eight (11.1%) individuals with diabetes for five to ten years and fifteen (28.8%) individuals with diabetes for more than ten years. There was a statistically significant correlation ($\chi^2=15.42$, $p<0.001$) between the duration of diabetes and DR. DR was much more common in those with poor glycemic control than in those with managed diabetes. Compared to 6 (5.7%) individuals with managed glycemia, DR was found in 21 (22.3%) people with poor glycemic control. There was a statistically significant difference ($\chi^2=13.05$, $p<0.001$).

Table 5: Association of Diabetes-Related Factors with Diabetic Retinopathy (N=200)

Diabetes-related factor	DR present n (%)	DR absent n (%)	OR (95% CI)	χ^2 /Fisher's exact	p-value
Duration <5 years	4 (5.3%)	72 (94.7%)	Reference		
5–10 years	8 (11.1%)	64 (88.9%)	2.25 (0.65–7.82)		
>10 years	15 (28.8%)	37 (71.2%)	7.30 (2.32–22.98)	15.42	<0.001
Poor glycaemic control	21 (22.3%)	73 (77.7%)	4.74 (1.96–11.46)	13.05	<0.001
Controlled glycaemia	6 (5.7%)	100 (94.3%)	Reference		

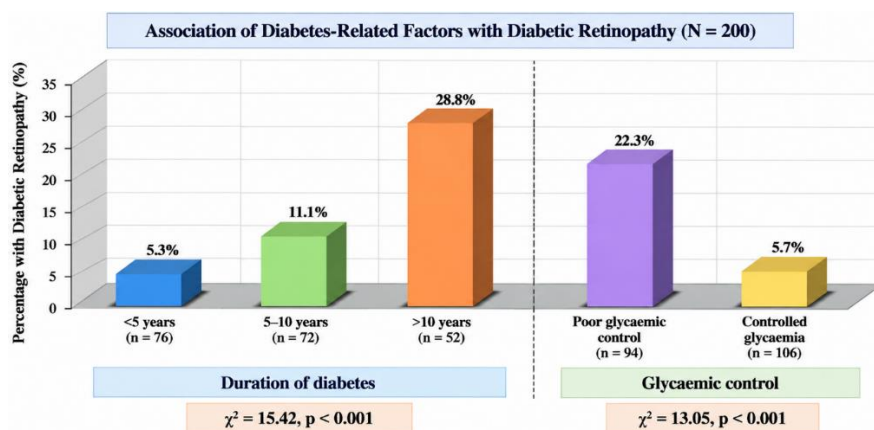


Figure 5: Association of Diabetes-Related Factors with Diabetic Retinopathy

Logistic Regression Analysis

Variables demonstrating clinical relevance or significant association in the univariable analysis were considered for multivariable logistic regression. Age ≥ 60 years, hypertension, diabetes duration >10 years, and poor glycemic control were among the factors included to the model. After correction, poor glycemic control and a diabetes duration of more than ten years continued to be independently linked to diabetic retinopathy. After correction, the statistical strength of the favorable connection with hypertension decreased.

Table 6: Multivariable Logistic Regression Analysis of Factors Associated with Diabetic Retinopathy

Variable	Adjusted OR	95% CI	p-value
Age ≥ 60 years	1.63	0.74–3.59	0.224
Hypertension	1.91	0.88–4.16	0.101
Diabetes duration >10 years	5.82	2.14–15.82	<0.001
Poor glycaemic control	3.96	1.59–9.86	0.003
Tribal residence	1.21	0.52–2.83	0.659

Multivariable logistic regression demonstrated that diabetes duration >10 years was independently associated with diabetic retinopathy, with participants having longer diabetes duration showing approximately six-fold higher adjusted odds of DR compared with those with shorter duration. Poor glycaemic control was also independently associated with DR (adjusted OR=3.96, 95% CI: 1.59–9.86; $p=0.003$). Age ≥ 60 years and hypertension showed positive associations but did not remain statistically significant after adjustment. Tribal residence was not independently associated with diabetic retinopathy.

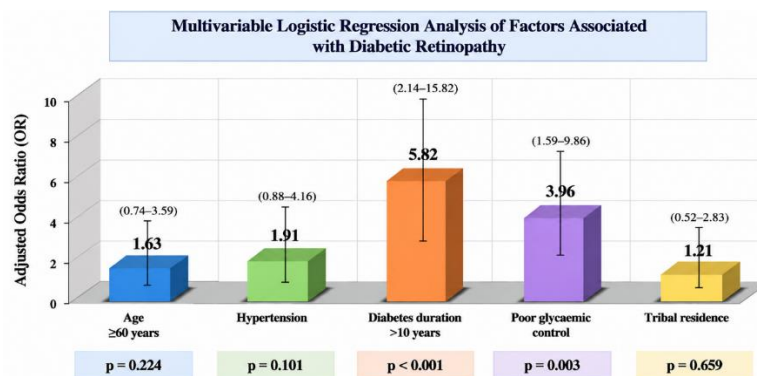


Figure 6: Multivariable Logistic Regression Analysis of Factors Associated with Diabetic Retinopathy

DISCUSSION

Diabetic retinopathy (DR) is a major microvascular complication of diabetes and an important cause of preventable visual impairment. In this cross-sectional research, 200 diabetics from rural and tribal populations in Gujarat's Dahod area were evaluated for DR. Both groups were equally represented. In all, 27 individuals (13.5%) had DR, whereas 86.5% showed no signs of retinopathy. Tribal participants had a somewhat higher prevalence than rural participants (15.0% vs. 12.0%), however this difference was not statistically significant ($\chi^2=0.36$, $p=0.548$) (Table 3). This result is mostly consistent with the SMART India research, which found that 12.5% of Indians with diabetes had DR [12]. Geographical location alone may not be a significant factor of DR incidence, according to a comprehensive analysis of Indian research that found similar frequency amongst rural and urban populations [13].

In rural and tribal diabetic communities in Maharashtra, the prevalence of DR was 5.67% and 7.73%, respectively, according to Jain et al. [7]. The prevalence seen in this study was greater. This variance may be explained by variations in the research population, length of diabetes, glycemic management, screening technique, and sample size. Crucially, the Maharashtra study also found that poor glycemic control and a prolonged history of diabetes were important risk factors [3]. The viability of community-based retinal screening employing non-mydriatic fundus photography is further supported by data from rural and tribal Gujarat [14].

The rural and tribal groups had similar baseline characteristics. Overall, the mean age was 52.4 ± 11.3 years, and there was no discernible difference between individuals from rural and tribal areas ($p=0.315$). In a similar vein, age groups and sex distribution were similar (Table 1). Additionally, there were no discernible changes between the two groups in terms of diabetes duration, hypertension, or glycemic control (Table 2). This comparison supports the idea that significant baseline differences between the groups did not significantly influence variations in DR prevalence. With 15 out of 27 patients (55.6%) having mild NPDR, the most common grade of retinopathy was followed by moderate NPDR (25.9%), severe NPDR (7.4%), and PDR (11.1%) (Table 3). In all, 2.5% of subjects had sight-threatening DR. Larger population-based studies that demonstrate that early-stage DR accounts for the majority of diagnosed cases are consistent with the preponderance of non-proliferative disease [2,14]. Tribal participants had somewhat higher rates of sight-threatening DR than rural participants (3.0% vs. 2.0%), but this difference was not statistically significant ($p=0.651$). On univariable analysis, DR was substantially correlated with age ≥ 60 years. DR affected 17.5% of individuals over 60 and 11.9% of those under 60 (OR=1.75, 95% CI: 1.02–3.01; $p=0.021$) (Table 4). However, following correction, this link was not maintained ($p=0.224$) (Table 6), indicating that age may partially reflect other characteristics such the duration of diabetes. There was no correlation between sex and DR ($p=0.965$), which is in line with data showing that sex differences in DR vary among groups [2].

In univariable analysis, there was a substantial correlation between hypertension and DR. 19.5% of individuals with hypertension and 9.3% of participants without hypertension had DR (OR=2.36, 95% CI: 1.02–5.43; $p=0.014$) (Table 4). After correction, however, hypertension lost statistical significance (adjusted OR=1.91, $p=0.101$) (Table 6). In Indian communities, similar correlations between high blood pressure and DR have been shown [3].

The duration of diabetes and glycemic control showed the highest correlations. The frequency of DR gradually rose from 5.3% among those with diabetes for less than five years to 11.1% among those with five to ten years and 28.8% among those with more than ten years ($p<0.001$) (Table 5). After correction, diabetes duration longer than ten years was still independently linked to DR (adjusted OR=5.82, 95% CI: 2.14–15.82; $p<0.001$) (Table 6). This result is in line with a large body of research showing that one of the most powerful predictors of DR is a longer duration of diabetes [5,3]. DR was also closely linked to poor glycemic management. The prevalence was 22.3% for those with poor glycemic control and 5.7% for those with managed glycaemia (OR=4.74, 95% CI: 1.96–11.46; $p<0.001$) (Table 5). After correction, the link was still significant (adjusted OR=3.96,

95% CI: 1.59–9.86; $p=0.003$) (Table 6). These results are in line with the SMART India study and previous Indian research that found hyperglycemia to be a significant modifiable risk factor for DR [12,7,3].

Overall, the results highlight that DR affects both rural and tribal diabetic populations, with long-term diabetes and poor glycemic control being particularly significant factors. Early diagnosis and referral in underprivileged groups may be facilitated by community-based screening using portable retinal imaging in conjunction with better glycemic and systemic risk-factor management [6,11]. The results should not be extrapolated to all Gujarati rural and tribal groups due to the cross-sectional design and limited sample size, which makes it impossible to establish causal correlations.

CONCLUSION

This cross-sectional study demonstrates that diabetic retinopathy is an important ocular complication among diabetic individuals in rural and tribal communities of Dahod district, Gujarat. DR was found in 13.5% of those who were tested; the frequency was similar among individuals from rural and tribal areas (12.0% vs. 15.0%). Although sight-threatening DR was also found, mild NPDR was the most prevalent stage, highlighting the significance of early identification. The major predictors of DR were increasing diabetes duration and poor glycemic management, which continued to be independently linked following multivariable analysis. On univariable analysis, hypertension and advanced age were linked to DR; however, these associations were not significant after adjustment. These results encourage the use of portable retinal imaging and suitable referral channels for the development of easily accessible community-based diabetic retinopathy screening. Retinal screening may help with early detection and lower the risk of preventable visual impairment when combined with improved glycemic management and routine diabetes treatment.

LIMITATIONS OF THE STUDY

The study had a relatively small sample size of 200 participants and was conducted in a single district of Gujarat, which may limit generalizability to other rural and tribal populations. Although correlations between risk variables and diabetic retinopathy can be found using the cross-sectional approach, causal linkages cannot be established. The recruitment of participants from the chosen community screening population may have led to selection bias. Variations in therapy and follow-up may also have had an impact on the duration of diabetes and glycemic control. To evaluate the course of the illness and determine the temporal associations between risk factors and diabetic retinopathy, longitudinal studies including larger, geographically varied populations are necessary.

REFERENCES

1. Vashist P, Senjam SS, Gupta V, Manna S, Gupta N, Shamanna BR, et al. Prevalence of diabetic retinopathy in India: Results from the National Survey 2015-19. *Indian J Ophthalmol.* 2021;69(11):3087-3094. doi:10.4103/ijo.IJO_1310_21.
2. Teo ZL, Tham YC, Yu M, Chee ML, Rim TH, Cheung N, et al. Global prevalence of diabetic retinopathy and projection of burden through 2045: systematic review and meta-analysis. *Ophthalmology.* 2021;128(11):1580-1591.
3. Sen S, Ramasamy K, Vignesh TP, Kannan NB, Sivaprasad S, Rajalakshmi R, et al. Identification of risk factors for targeted diabetic retinopathy screening to urgently decrease the rate of blindness in people with diabetes in India. *Indian J Ophthalmol.* 2021;69(11):3156-3164. doi:10.4103/ijo.IJO_496_21.
4. Vashist P, Senjam SS, Gupta V, Gupta N, Shamanna BR, Wadhwani M, et al. Blindness and visual impairment and their causes in India: results of a nationally representative survey. *PLoS One.* 2022;17(7):e0271736. doi:10.1371/journal.pone.0271736.
5. Prevalence of diabetic retinopathy in India stratified by known and undiagnosed diabetes, urban-rural locations, and socioeconomic indices: results from the SMART India population-based cross-sectional screening study. *Lancet Glob Health.* 2022. PMID:36327997.
6. Gajiwala UR, Choudhary M, Natarajan S, et al. Non-mydriatic fundus photography as an alternative to indirect ophthalmoscopy for screening of diabetic retinopathy in community settings: a comparative pilot study in rural and tribal India. *BMJ Open.* 2022. PMID:35396308.
7. Jain P, Shukla AK, Singh S, Sheikh AM, Malwe G. Assessment of prevalence and need for screening of diabetic retinopathy using non-mydriatic fundus camera in rural and tribal diabetic populations in Maharashtra. *Indian J Ophthalmol.* 2024;72(Suppl 4):S676-S678. doi:10.4103/IJO.IJO_2570_23.
8. Effect of health education and screening location on compliance with diabetic retinopathy screening in a rural population in Maharashtra. *Indian J Ophthalmol.* 2020. PMID:31937729.
9. Analysis of yield of retinal imaging in a rural diabetes eye care model. *Indian J Ophthalmol.* 2018. PMID:29380765.
10. Magnitude and Determinants of Diabetic Retinopathy Among Indian Diabetic Patients Undergoing Telescreening in India. *Ophthalmic Epidemiol.* 2022. PMID:33999730.
11. Gupta V, Vardhan Azad S, Vashist P, Senjam SS, Kumar A. Diabetic retinopathy screening in the public sector in India: What is needed? *Indian J Ophthalmol.* 2022;70(3):759-767. doi:10.4103/ijo.IJO_1298_21.

12. Raman R, Vasconcelos JC, Rajalakshmi R, Prevost AT, Ramasamy K, Mohan V, et al. Prevalence of diabetic retinopathy in India stratified by known and undiagnosed diabetes, urban-rural locations, and socioeconomic indices: results from the SMART India population-based cross-sectional screening study. *Lancet Glob Health*. 2022;10(12):e1764-e1773. doi:10.1016/S2214-109X(22)00411-9.
13. Brar AS, Sahoo J, Behera UC, Jonas JB, Sivaprasad S, Das T. Prevalence of diabetic retinopathy in urban and rural India: a systematic review and meta-analysis. *Indian J Ophthalmol*. 2022;70(6):1945-1955. doi:10.4103/ijo.IJO_2206_21.
14. Yau JWY, Rogers SL, Kawasaki R, Lamoureux EL, Kowalski JW, Bek T, et al. Global prevalence and major risk factors of diabetic retinopathy. *Diabetes Care*. 2012;35(3):556-564. doi:10.2337/dc11-1909.