Original Article

# Clinical profile and magnitude of diabetic retinopathy: An electronic medical record–driven big data analytics from an eye care network in India

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**Purpose:** This study aimed to describe the clinical profile and magnitude of diabetic retinopathy (DR) in patients presenting to a multitier eye hospital network in India. **Methods:** This cross-sectional hospital-based study included 263,419 individuals with diabetes mellitus (DM) presenting between February 2012 and February 2021 (9-year period). The data were collected using an electronic medical record (EMR). Patients with a clinical diagnosis of DR in at least one eye were included in the analysis. Severe nonproliferative DR/proliferative DR/diabetic macular edema (DME) were considered sight-threatening DR (STDR). **Results:** In the study period, 25% ($n$ = 66,913) were new patients diagnosed with DR. The majority of patients were males (70%). The mean age of the patients was 57 ± 10 years. The risk factors for DR were increased age: 30 to 50 years (odds ratio [OR] = 2.42), and 51 to 70 years (OR = 3.02), increased duration of DM: 6 to 10 years (OR = 2.88) and >10 years (OR = 6.52), blindness (OR = 2.42), male gender (OR = 1.36), lower socioeconomic status (OR = 1.43), and rural habitation (OR = 1.09). STDR was seen in 58% ($n$ = 38,538) of examined patients. Risk factors for STDR were increased age 31 to 50 years (OR = 3.51), increased duration of DM: 6 to 10 years (OR = 1.23) and >10 years (OR = 1.68), blindness (OR = 3.68), male gender (OR = 1.12), and higher socioeconomic status (OR = 1.09). **Conclusion:** Every fourth person with DM was found to have DR, and every second person with DR had STDR in this study cohort. These real-world big data might provide greater insight into the current status of DR. Additional big data from similar EMR-based sources will help in planning and resource allocation.

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Diabetes mellitus (DM) is a group of metabolic disorders characterized by high blood sugar over a prolonged time. India is ranked second behind China in the world today, with 77 million people with diabetes.[1] Additionally, 43.9 million people are undiagnosed with diabetes in India. Diabetic retinopathy (DR) is the most common microvascular complication of diabetes that can lead to irreversible blindness. It occurs both in type 1 and type 2 diabetes and is strongly related to glycemic control and the duration of diabetes.[2] Other risk factors that contribute to the development of diabetic retinopathy include hypertension, nephropathy, and dyslipidemia.[3,4] More than 90% of the patients with type 1 diabetes are at a lifetime risk of developing DR, and it is around 50% to 60% in people with type 2 diabetes.[5] The retinopathy progresses from the mild nonproliferative stage to the moderate and severe stage before the development of abnormal blood vessels in the proliferative stage, leading to complications such as persistent vitreous hemorrhage or tractional retinal detachment causing severe visual impairment.[6] Recent studies have shown a rising prevalence of diabetic macular edema (DME); it is twice more common than proliferative diabetic retinopathy (PDR) as a cause of visual impairment in people with type 2 DM.[6] Timely detection and treatment of sight-threatening diabetic retinopathy (STDR) are required to prevent avoidable blindness through patient education, appropriate referral, and policy implementation.[7] There is a lack of real-world data of estimated DR burden assessed through electronic medical record (EMR) big data analysis from India. In this communication, we have analyzed the clinical profile and magnitude of DR at a large multitier ophthalmology network in India using a large data set using EMR-driven analytics.

## Methods

This cross-sectional observational hospital-based study included patients between February 2012 and February 2021 to an ophthalmology network spread across four adjacent states (Telangana, Andhra Pradesh, Odisha, and Karnataka) of India.[8] A standard consent form for electronic data

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privacy was filled by the patient or the parents/guardians of the patient (for minors) at the time of registration. None of the data used for analysis had identifiable parameters of the patient. The study adhered to the Declaration of Helsinki and was approved by the Institutional Ethics Committee. The clinical data of each patient who underwent a comprehensive ophthalmic examination using a standardized template were entered into a browser-based EMR system (eye Smart EMR) by trained ophthalmic personnel and supervised by an ophthalmologist.[9]

### Subjects

In the study period, 2,735,194 new patients of all ages were examined in the tertiary and secondary centers of the network. It included 263,419 individuals with DM. The eyeSmart EMR was initially screened for patients with a final ophthalmic diagnosis of DR in one or both eyes made by an ophthalmologist. A total of 66,913 records of patients who had the clinical diagnosis of DR were identified and were complete with the record of visual acuity, symptoms, signs, and management plan. Clinical diagnosis of DM was based on the combination of self-reported DM/physician evaluation captured from the EMR database. Clinical diagnosis of DR was the final diagnosis made by retina specialists based on the combination of ophthalmic evaluation and investigations. DR diagnosis was made after fundus biomicroscopy, indirect ophthalmoscopy, and ancillary tests. The ancillary retinal tests included optical coherence tomography, angiography, and fluorescein angiography. Mild and moderate nonproliferative

**Table 1: Comparative of people with DM with No DR and DR**

| Parameter | No DR | % | DR | % | *P* |
|---|---|---|---|---|---|
| Total Patients | 196,506 | | 66,913 | | |
| Age (years) | 57.14±11.91 | | 56.97±9.78 | | |
| Male | 114,727 | 71 | 46,547 | 29 | <0.001 |
| Female | 81,779 | 80 | 20,366 | 20 | <0.001 |
| Paying | 170,078 | 75 | 57,268 | 25 | <0.001 |
| Nonpaying | 26,428 | 73 | 9,645 | 27 | <0.001 |
| Urban | 103,047 | 76 | 31,868 | 24 | <0.001 |
| Rural | 68,968 | 73 | 25,920 | 27 | <0.001 |
| Metropolitan | 24,491 | 73 | 9,125 | 27 | <0.001 |
| Duration of DM | | | | | |
| 1-5 years | 71,536 | 92 | 6,319 | 8 | <0.001 |
| 6-10 years | 34,144 | 81 | 7,844 | 19 | <0.001 |
| >10 years | 26,468 | 67 | 12,784 | 33 | <0.001 |
| Occupation | | | | | |
| Agriculture related | 14,237 | 69 | 6,513 | 31 | <0.001 |
| Office goers (Government/Private) | 45,176 | 64 | 25,828 | 36 | <0.001 |
| Homemaker | 52,831 | 77 | 15,548 | 23 | <0.001 |
| Manual Labor | 10,766 | 77 | 3,275 | 23 | <0.001 |
| Retired | 20,265 | 66 | 10,379 | 34 | <0.001 |
| Student | 1,695 | 85 | 303 | 15 | <0.001 |
| Presenting Visual Acuity | | | | | |
| Mild or No Visual Impairment - 0 | 119,672 | 81 | 27,526 | 19 | <0.001 |
| Moderate Visual Impairment - 1 | 27,767 | 67 | 13,571 | 33 | <0.001 |
| Severe Visual Impairment - 2 | 7,613 | 62 | 4,679 | 38 | <0.001 |
| Blindness - 3 | 27,852 | 68 | 13,314 | 32 | <0.001 |
| Blindness - 4 | 6,895 | 76 | 2237 | 24 | 0.04 |
| Blindness - 5 | 3,469 | 72 | 1318 | 28 | <0.001 |
| Undetermined or Unspecified | 3,238 | 43 | 4268 | 57 | NA |
| NSTDR | 0 | 0 | 28375 | 100 | <0.001 |
| STDR | 0 | 0 | 38538 | 100 | <0.001 |
| Ocular Comorbidities | | | | | |
| Cataract | 68,264 | 77 | 19990 | 23 | <0.001 |
| Glaucoma | 8,826 | 76 | 2781 | 24 | <0.001 |
| AMD | 1,408 | 83 | 297 | 17 | <0.001 |
| Venous Occlusions | 3,347 | 80 | 837 | 20 | <0.001 |
| Cataract Surgery | 26,150 | 82 | 5759 | 18 | <0.001 |

DM=Diabetes mellitus; DR=Diabetic retinopathy; NSTDR=Non-sight-threatening diabetic retinopathy, STDR=Sight-threatening diabetic retinopathy, AMD=Age-related macular degeneration

DR (NPDR) were considered as non–sight-threatening DR (N-STDR), and severe NPDR/proliferative DR (PDR)/ diabetic macular edema (DME) were considered as sight-threatening DR (STDR).

### Data retrieval and processing

The data of 124,153 eyes of 66,913 new patients included in this study were retrieved from the EMR database and segregated in a single excel sheet. The columns included the data on demographics, clinical presentation, visual acuity, ophthalmic diagnosis, and blood investigations and were exported for analysis. The excel sheet with the required data was then used for analysis using the appropriate statistical software. Standardized definitions were used for occupation and geographic categorization.[10] Patients with paying status were considered as belonging to higher socioeconomic strata and those with nonpaying status as belonging to low socioeconomic strata. The paying patients paid for their services, and the nonpaying patients did not pay for their services. Visual impairment (VI) was classified according to the World Health Organization guidelines.[11]

### Statistical analysis

Descriptive statistics using mean ± standard deviation and median with interquartile range (IQR) were used to analyze the demographic data. Chi-square test (StataCorp, 2015, Stata Statistical Software: Release 14. TX, StataCorp LP) was used for univariate analysis to detect the significant differences in the distribution of demographic features between patients with DR and the overall population. Logistic regression was performed for the binary outcome, presence of STDR, with the listed predictors. The following predictors were included: age, gender, socioeconomic status, presenting visual acuity, cataract, age-related macular degeneration (AMD), glaucoma, venous occlusions, cataract surgery, an intravitreal injection given/not given, occupation, and urban–rural–metropolitan habitat. Odds ratios (ORs) and 95% confidence intervals were calculated using R software (Version 3.5.1). Statistical significance, in this case, was reached at an alpha level of 0.01.

## Results

### Hospital-based prevalence

In this cohort, 9.6% (263,419 of 2,735,194 new patients) of people were detected to have DM, and 25.4% (66,913 of 263,419 with DM) of people were detected to have DR. The study included 124,153 eyes of 66,913 patients with DR. The decade-wise age-adjusted prevalence of DM and DR is shown in Fig. 1. The age-adjusted prevalence of DR (17.4%) and DM (6.2%) was the highest among the 51 to 70 years age group.

### Demography

The mean age of the patients with DR was 57 ± 10 years, and the median age was 57 (IQR: 51–64) years. There were 46,547 (70%) male and 20,366 (30%) female patients with DR. Table 1 shows a baseline comparison of demographic and ocular risk factors between Individuals with no DR and DR.

### Geography and socioeconomic status

In this cohort, 61.3% ($n$ = 40,993) of people with DR were from urban districts and metropolitan regions. The overall prevalence of DR was equally distributed between the three regions: urban, metropolitan, and rural [Table 1]. A majority of patients (85.6%; $n$ = 57,268) paid for the services (upper socioeconomic class), and the overall prevalence of DR was significantly higher ($P < 0.00001$) in this class of patients [Table 1].

### State-wise distribution

Table 2 shows the state-wise distribution of patients with DR. The majority were from Andhra Pradesh (37.6%; $n$ = 25,178), followed by Telangana (29.5%; $n$ = 19,722) and Odisha (20%; $n$ = 13,426).

### Occupation

The overall prevalence of DR in the office goers (government/ private related sector; 39%; $n$ = 25,828) was significantly higher ($P < 0.00001$) than in other professions.

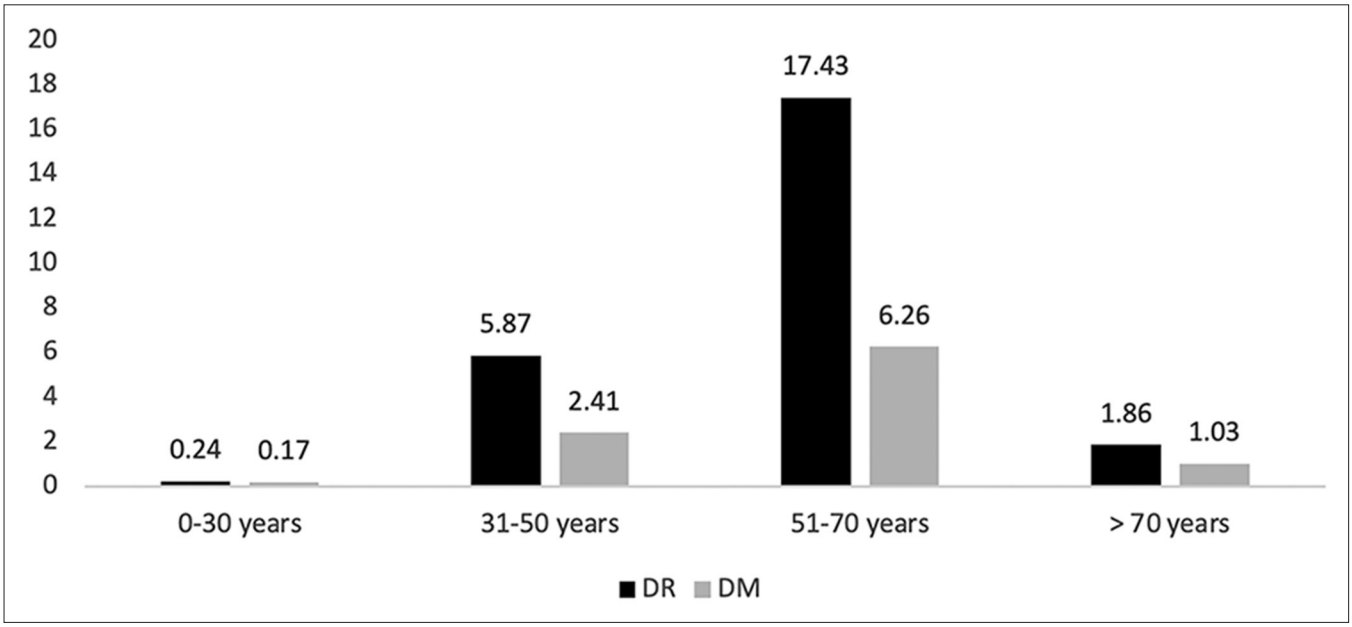


**Figure 1:** Decade-wise age-adjusted prevalence of DM and DR

### Laterality and type

The DR was bilateral in 85.5% ($n$ = 57,240) and unilateral in 14.5% ($n$ = 9,673) people; 59.6% ($n$ = 39,925) of people had NPDR, 40.3% ($n$ = 26,988) of people had PDR and 57.6% ($n$ = 38,538) of people had STDR. Thus, in the entire cohort of people with DM, the prevalence of any DR, NPDR, PDR, and STDR was 2.44%, 1.45%, 0.98%, and 1.41%, respectively.

### Presenting visual acuity

The majority, 61.5% ($n$ = 41,184) of patients with any DR and 52.6% ($n$ = 20,285) of patients with STDR, had mild to moderate visual impairment (20/20 to 20/200) on presentation. Blindness (<20/400 – No perception of light) was recorded in 25.2% ($n$ = 16,869) of patients with any DR and 22.2% ($n$ = 14,837) of patients with STDR.

### Risk factors associated with the presence of DR [Table 3]

The risk factors for DR increased with age: 30–50 years (OR = 2.42), 51–70 years (OR = 3.02); increased duration of DM: 6–10 years (OR = 2.88) and >10 years (OR = 6.52); blindness (OR = 2.42); male gender (OR = 1.36), office goers (OR = 1.47), lower socioeconomic class (nonpaying patients; OR = 1.43); and rural habitat (OR = 1.09).

**Table 2: State-wise distribution of patients with diabetic retinopathy**

| State | % | Number |
|---|---|---|
| Andaman and Nicobar Islands | 0.01% | 4 |
| Andhra Pradesh | 37.63% | 25,178 |
| Arunachal Pradesh | 0.01% | 5 |
| Assam | 0.61% | 407 |
| Bihar | 0.25% | 166 |
| Chhattisgarh | 0.77% | 517 |
| Delhi | 0.05% | 36 |
| Goa | 0.02% | 14 |
| Gujarat | 0.07% | 45 |
| Haryana | 0.02% | 15 |
| Himachal Pradesh | 0.00% | 3 |
| Jammu and Kashmir | 0.03% | 21 |
| Jharkhand | 0.56% | 378 |
| Karnataka | 1.63% | 1,093 |
| Kerala | 0.04% | 24 |
| Madhya Pradesh | 0.42% | 283 |
| Maharashtra | 2.59% | 1,730 |
| Manipur | 0.01% | 5 |
| Meghalaya | 0.01% | 5 |
| Mizoram | 0.00% | 2 |
| Nagaland | 0.00% | 1 |
| Odisha | 20.07% | 13,426 |
| Pondicherry | 0.02% | 11 |
| Punjab | 0.01% | 6 |
| Rajasthan | 0.09% | 63 |
| Sikkim | 0.01% | 4 |
| Tamil Nadu | 0.07% | 47 |
| Telangana | 29.47% | 19,722 |
| Tripura | 0.23% | 152 |
| Uttar Pradesh | 0.27% | 178 |
| Uttarakhand | 0.02% | 13 |
| West Bengal | 5.02% | 3,359 |
| | 100.00% | 66,913 |

### Sight-threatening diabetic retinopathy [Table 4]

A subset analysis was performed in 38,538 patients with STDR. The average age was 57 ± 9 years, and it was more common in males (71%). The majority of them belonged to a higher socioeconomic class (paying patients 85%; and urban geography 48%). The regression analysis [Table 5] showed that the risk increased with age: 31–50 years (OR = 3.51), increased duration of DM: 6–10 years (OR = 1.23) and >10 years (OR = 1.68), blindness (OR = 3.68), male gender (OR 1.12), agriculture occupation (OR = 1.11), and higher socioeconomic (paying) status (OR = 1.09).

### Ocular comorbidities

Cataract was the most common ocular comorbidity (29.8%, $n$ = 19,990 people; 37,206 eyes). The others included glaucoma, AMD, and retinal vein occlusions [Table 1]. Regression analysis [Tables 3 and 5] revealed a reduced risk of DR and STDR associated with the aforementioned ocular comorbidities.

### Interventions

The most common intervention for people with DR was panretinal photocoagulation in 21% people (26,513 eyes), followed by intravitreal injections in 11% of people (13,987 eyes). The common intraocular surgeries were cataract surgery (8.6%; 5,759 people; 10,304 eyes) and vitreoretinal surgery (5.4%; 3,626 people; 7,027 eyes). Intravitreal bevacizumab more common intravitreal therapy (80%; $n$ = 11,159 eyes); the others included intravitreal triamcinolone (IVTA) in 9% ($n$ = 1,320) and ranibizumab in 5% ($n$ = 670) eyes.

### Blood and urine investigations

The blood investigations of the patients were analyzed where available, comparing the distribution in N-STDR and STDR. The average random blood sugar level was 235 ± 192 mg/dL, fasting blood sugar was 156 ± 68 mg/dL, postprandial blood sugar (PPBS) was 254 ± 91 mg/dL, blood urea was 74 ± 31 mg/dL, serum creatinine was 2.55 ± 0.07 mg/dL, and urine spot microalbumin was 137 ± 99 mg. A detailed listing of all the blood and urine investigations comparing N-STDR and DR are listed in the Supplementary Table.

## Discussion

This study sought to describe the clinical profile and magnitude of diabetic retinopathy in a large cohort of patients presenting to a multitier eye hospital network in India using EMR-driven big data analytics. The network treats patients who pay or do not pay for the service and is spread over both city and rural locations in four states in India. The primary purpose of the study was to determine the real-world relative proportion and demographic profile of DR in the clinical care setting.

In this hospital-based study, the overall prevalence of DM was 10%. The overall prevalence of DR was 2.4% of all eye diseases diagnosed between 2012 and 2021 (a 9-year period). The overall prevalence of DR was 25% in people with DM. The retinopathy was predominantly bilateral (86%) and was more commonly seen in males (70%) in this study cohort.

**Table 3: Logistic regression analysis of factors associated with presence of diabetic retinopathy**

| | Odds Ratio | 95% Confidence Interval | | *P* |
|---|---|---|---|---|
| | | Lower Bound | Upper Bound | |
| Age (Reference: 0-30 years) | | | | |
| 31-50 years | 2.42 | 2.17 | 2.71 | <0.001 |
| 51-70 years | 3.02 | 2.70 | 3.37 | <0.001 |
| >70 years | 1.64 | 1.46 | 1.84 | <0.001 |
| Male | 1.36 | 1.31 | 1.40 | <0.001 |
| Payer Status (Reference: Paying) | | | | |
| Nonpaying | 1.43 | 1.38 | 1.47 | <0.001 |
| District Status (Reference: Urban) | | | | |
| Rural | 1.09 | 1.07 | 1.12 | <0.001 |
| Metropolitan | 1.01 | 0.98 | 1.04 | 0.424 |
| Occupation (Reference: Agriculture Related) | | | | |
| Office goers (Government/Private sector) | 1.47 | 1.42 | 1.52 | <0.001 |
| Homemaker | 0.96 | 0.91 | 1.00 | 0.065 |
| Manual Labor | 0.64 | 0.61 | 0.67 | <0.001 |
| Retired | 1.40 | 1.34 | 1.46 | <0.001 |
| Student | 1.05 | 0.89 | 1.23 | 0.557 |
| Duration of Diabetes | | | | |
| 6-10 years | 2.88 | 2.77 | 2.99 | <0.001 |
| >10 years | 6.52 | 6.27 | 6.77 | <0.001 |
| Visual Acuity (Reference: Mild or No Visual Impairment - 0) | | | | |
| Moderate Visual Impairment - 1 | 2.60 | 2.53 | 2.67 | <0.001 |
| Severe Visual Impairment - 2 | 3.21 | 3.08 | 3.35 | <0.001 |
| Blindness | 2.42 | 2.36 | 2.48 | <0.001 |
| Ocular comorbidities | | | | |
| Venous Occlusions | 0.46 | 0.42 | 0.50 | <0.001 |
| Cataracts | 0.77 | 0.75 | 0.79 | <0.001 |
| AMD | 0.55 | 0.48 | 0.63 | <0.001 |
| Glaucoma | 0.78 | 0.75 | 0.82 | <0.001 |
| Cataract Surgery | 0.48 | 0.47 | 0.50 | <0.001 |

AMD = Age-related macular degeneration

The prevalence of DR at 25% was higher than 21% reported in a nationwide opportunistic community screening,[12] and lower than 32.3% from another tertiary-based facilities study across India.[13] The methodologies of these studies are different, and unlike the two other studies of a limited period (6–12 months), the current study analyzed data for 9 years from four tertiary and 20 rural eye centers. The current study also showed a higher prevalence of DR in a rural community than reported in one south Indian state (Tamil Nadu).[14] The increasing prevalence of DR in a rural community is a matter of concern and calls for a suitable change in DR screening strategies. Male gender as a risk factor for DR (OR = 1.36) and STDR (OR = 1.12) seen in the present study could be biased due to possibly more males presenting to the hospital. But other investigators have also reported a higher risk of DR in the male gender.[13-15] Our observation of a higher risk of DR with increased age and longer duration of DM is not new.[13-16] The higher risk of any DR in a lower socioeconomic class of people is possibly due to poverty (poor glycemic control) and ignorance (poor health-seeking behavior). It has been observed in other countries too.[17,18] But incidentally, higher economic status had a higher risk of developing STDR. This knowledge will help customized DR risk reduction strategies.

Office goers were found to be a risk factor (OR = 1.09) for the presence of DR and agriculture occupation as a risk factor (OR = 1.11) for the presence of STDR. These differences in occupational risk factors for DR and STDR are contrasting. Office goer occupation may suggest an underlying sedentary lifestyle for the development of DR, whereas the agricultural occupation as a risk factor for STDR suggests lack of treatment facilities in rural areas.

In this study, more than 60% of people with any DR had a presenting visual acuity of mild to moderate visual impairment, but more than 25% of people also were blind at presentation [Table 1]. More people with STDR were blind than people with N-STDR (STDR: 32.5%, 12,538 of 38,538; N-STDR: 15.3%, 4,331 of 28,375). This knowledge is important to create

**Table 4: Comparison of patients with non-sight-threatening (N-STDR) and sight-threatening diabetic retinopathy (STDR)**

| Parameter | N-STDR | % | STDR | % | *P* |
|---|---|---|---|---|---|
| Total Patients | 28,375 | 42 | 38,538 | 58 | |
| Age (years) | 57.93±10.28 | | 56.27±9.33 | | |
| Male | 19,109 | 41 | 27,438 | 59 | <0.00001 |
| Female | 9,266 | 45 | 11,100 | 55 | <0.00001 |
| Paying | 24,580 | 43 | 32,688 | 57 | 0.07 |
| Nonpaying | 3,795 | 39 | 5,850 | 61 | <0.00001 |
| Urban | 13,340 | 42 | 18,528 | 58 | 0.1 |
| Rural | 11,025 | 43 | 14,895 | 57 | 0.72 |
| Metropolitan | 4,010 | 44 | 5,115 | 56 | 0.01 |
| Occupation | | | | | |
| Agriculture Related | 2,478 | 38 | 4,035 | 62 | <0.00001 |
| Office goers (Government/Private) | 10,451 | 40 | 15,377 | 60 | <0.00001 |
| Homemaker | 6,912 | 44 | 8,636 | 56 | <0.00001 |
| Manual Labor | 1,324 | 40 | 1,951 | 60 | 0.02 |
| Retired | 4,958 | 48 | 5,421 | 52 | <0.00001 |
| Duration of Diabetes | | | | | |
| 1-5 years | 3,093 | 49 | 3,226 | 51 | <0.00001 |
| 6-10 years | 3,623 | 46 | 4,221 | 54 | <0.00001 |
| >10 years | 5,305 | 41 | 7,479 | 59 | <0.00001 |
| Presenting Visual Acuity | | | | | |
| Mild or No Visual Impairment - 0 | 16,305 | 59 | 11,221 | 41 | <0.00001 |
| Moderate Visual Impairment - 1 | 4,507 | 33 | 9,064 | 67 | <0.00001 |
| Severe Visual Impairment - 2 | 1,263 | 27 | 3,416 | 73 | <0.00001 |
| Blindness - 3 | 3,329 | 25 | 9,985 | 75 | <0.00001 |
| Blindness - 4 | 601 | 27 | 1,636 | 73 | <0.00001 |
| Blindness - 5 | 401 | 30 | 917 | 70 | <0.00001 |
| Undetermined or Unspecified | 1,969 | 46 | 2,299 | 54 | <0.00001 |
| Ocular comorbidities | | | | | |
| Cataract | 10,833 | 54 | 9,157 | 46 | <0.00001 |
| Glaucoma | 1,195 | 43 | 1,586 | 57 | 0.55 |
| AMD | 228 | 77 | 69 | 23 | <0.00001 |
| Venous Occlusions | 609 | 73 | 228 | 27 | <0.00001 |
| Interventions | | | | | |
| PRP | 2,511 | 18 | 11,487 | 82 | <0.00001 |
| Intravitreal Injections | 1,146 | 15 | 6,337 | 85 | <0.00001 |
| Vitreoretinal Surgery | 299 | 8 | 3,327 | 92 | <0.00001 |
| Cataract Surgery | 2,715 | 47 | 3,044 | 53 | <0.00001 |

AMD = Age-related macular degeneration; PRP = Panretinal photocoagulation

awareness that individuals with diabetes require regular DR screening.

Available blood parameters of study cohorts suggest deranged glycemic control (fasting and random blood sugars) in patients with DR and STDR. Poor glycemic control is a known risk factor associated with STDR.[13,14] Deranged renal functions, evidenced from urine microalbuminuria, were more in individuals with STDR. Individuals with micro- and macroalbuminuria are more likely to have DR than those without albuminuria.[19]

Glaucoma and AMD are known to protect people from severe DR and STDR partially.[20,21] We also observed the same in our cohort. Cataract surgery showed a low association of DR and STDR in our study. This is not aligned with observations in other countries. A study in Taiwan has reported a link between cataract surgery and the development of NPDR, but no differences were observed in the progression of PDR/DME following cataract surgery.[22] An EMR-based real-world study from the United Kingdom reported that the rate of treatment requiring DME increases in severity for all grades of DR (higher risk with moderate and severe NPDR). It reported worsening of DME within a year of cataract surgery, with a peak at 3 to 6 months.[23]

## Study limitations

The hospital data are the greatest limitations of this study. Therefore, the study results cannot be generalized to the

**Table 5: Logistic regression analysis of factors associated with presence of STDR**

| | Odds Ratio | 95% Confidence Interval | | *P* |
|---|---|---|---|---|
| | | Lower Bound | Upper Bound | |
| Age (Reference: 0-30 years) | | | | |
| 31-50 years | 3.51 | 2.78 | 4.43 | <0.001 |
| 51-70 years | 3.30 | 2.62 | 4.15 | <0.001 |
| >70 years | 2.03 | 1.60 | 2.58 | <0.001 |
| Male | 1.12 | 1.05 | 1.20 | 0.001 |
| Payer Status (Reference: Nonpaying) | | | | |
| Paying | 1.09 | 1.03 | 1.15 | 0.002 |
| District Status (Reference: Urban) | | | | |
| Metropolitan | 0.92 | 0.87 | 0.97 | 0.002 |
| Rural | 0.97 | 0.93 | 1.01 | 0.126 |
| Occupation (Reference: Office goers (Governement/Private sector) | | | | |
| Agriculture Related | 1.11 | 1.04 | 1.18 | 0.002 |
| Homemaker | 1.01 | 0.94 | 1.09 | 0.741 |
| Manual Labor | 0.98 | 0.89 | 1.07 | 0.642 |
| Retired | 0.92 | 0.87 | 0.97 | 0.002 |
| Student | 0.52 | 0.37 | 0.72 | 0.002 |
| Duration of Diabetes | | | | |
| 6-10 years | 1.23 | 1.14 | 1.32 | <0.001 |
| >10 years | 1.68 | 1.57 | 1.80 | <0.001 |
| Visual Acuity (Reference: Mild or No Visual Impairment - 0) | | | | |
| Moderate Visual Impairment - 1 | 2.86 | 2.73 | 3.00 | <0.001 |
| Severe Visual Impairment - 2 | 3.42 | 3.17 | 3.69 | <0.001 |
| Blindness | 3.68 | 3.51 | 3.86 | <0.001 |
| Ocular Comorbidities | | | | |
| Cataracts | 0.54 | 0.52 | 0.57 | <0.001 |
| Glaucoma | 0.73 | 0.66 | 0.80 | <0.001 |
| Venous Occlusions | 0.08 | 0.06 | 0.09 | <0.001 |
| AMD | 0.22 | 0.16 | 0.29 | <0.001 |
| Interventions | | | | |
| PRP | 3.88 | 3.68 | 4.09 | <0.001 |
| Intravitreal Injections | 5.00 | 4.64 | 5.39 | <0.001 |
| Vitreoretinal Surgery | 3.96 | 3.46 | 4.53 | <0.001 |
| Cataract Surgery | 0.60 | 0.56 | 0.64 | <0.001 |

NSTDR = Non-sight-threatening DR, STDR = Sight-threatening DR, PRP = Panretinal photocoagulation

population. We did not have uniform data of systemic risk parameters (e.g., blood pressure measurements) and biochemical risk factors for the entire study cohort.

### Study strength

Big data obtained from EMR-based analytics of DR and STDR in the Indian population over 9 years is the biggest strength. The United States and the United Kingdom have the largest EMR registries covering various DR-related research issues.[23,24] A similar large EMR database–reported analytics on DR is unavailable in India.

## Conclusion

In conclusion, this study describes the epidemiology and clinical presentation of DR in 2.7 million new patients presenting to multitier ophthalmology hospital networks in India. The findings show that DR is a common disease affecting patients seeking eye care in India. Every fourth person among people with DM has DR and every second person among people with DR is a person with STDR in this hospital-based study cohort. The risk factors for DR found in this study, such as an increase in age, longer duration of DM, male gender, rural habitation, and lower socioeconomic status, can be considered while designing targeted DR screening programs. The magnitude and risk factors described in this decade-long study may help develop targeted guidelines for DR screening and referral in India.

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**Conflicts of interest**

There are no conflicts of interest.

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**Supplementary Table: Biochemical profile with sight-threatening diabetic retinopathy (STDR) and non-sight-threatening diabetic retinopathy (N-STDR)**

| Blood Investigations | *n* | Mean | SD | N-STDR | SD | STDR | SD | Units | *P* |
|---|---|---|---|---|---|---|---|---|---|
| Random Blood Sugar | 8,404 | 235 | 192 | 192 | 96 | 205 | 101 | mg/dL | <0.001 |
| Blood Urea | 6,777 | 74 | 31 | 30 | 16 | 37 | 24 | mg/dL | <0.001 |
| Serum Creatinine | 7,041 | 2.55 | 0.07 | 1.19 | 0.78 | 1.49 | 1.18 | mg/dL | <0.001 |
| Hemoglobin | 7,514 | 8.09 | 2.22 | 12.82 | 2.00 | 12.01 | 2.10 | g/dL | <0.001 |
| MCH | 6,032 | 28.3 | 6.44 | 28.71 | 8.04 | 28.15 | 5.64 | pg | 0.002 |
| MCHC | 6,032 | 33.47 | 2.43 | 33.45 | 1.72 | 33.48 | 2.68 | g/dL | 0.65 |
| MCV | 6,032 | 84.33 | 21.28 | 84.74 | 8.05 | 84.16 | 24.76 | fl | 0.34 |
| RBC Count | 6,032 | 4.39 | 0.97 | 4.57 | 1.04 | 4.32 | 0.94 | million cell | <0.001 |
| WBC count | 6,032 | 8.26 | 4.84 | 8.17 | 4.11 | 8.30 | 5.11 | x109/L | 0.347 |
| Urine Spot Microalbumin | 960 | 137 | 99 | 111 | 99 | 143 | 97 | mg | <0.001 |
| HCT | 4,194 | 36.98 | 6.2 | 38.90 | 5.82 | 36.23 | 6.19 | % | <0.001 |
| MPV | 4,024 | 8.26 | 1.15 | 8.13 | 1.03 | 8.32 | 1.20 | fl | <0.001 |

MCH=Mean corpuscular hemoglobin; MCHC= Mean corpuscular hemoglobin concentration; MCV=Mean corpuscle volume; RBC=Red blood cell; WBC=White blood cell; HCT=Hematocrit; MPV=Mean platelet volume