Factors protecting against diabetic retinopathy in a geriatric Indian cohort

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Purpose: Diabetic retinopathy (DR) is a potentially sight-threatening complication of diabetes mellitus. The majority of cases are in older adults. This study aims to evaluate modifiable and nonmodifiable protective factors against DR in a geriatric Indian population. **Methods:** This retrospective observational study uses data from a multitiered ophthalmology network to evaluate several demographic and clinical variables against diabetic retinopathy and visual acuity. **Results:** Our data show that high myopia, the female sex, and no cataract surgery are associated with lower prevalence of DR (OR = 0.21, 0.65, and 0.76, respectively; *P* < 0.001). We also found that among those with DR, people categorized as payers, retirees, and those living in urban or metropolitan areas have better visual acuity (OR = 0.65, 0.65, 0.83, and 0.73, respectively; *P* < 0.001). Among those with DR, females, presence of cataracts, and no cataract surgery had lower associations with sight-threatening DR (STDR) (OR = 0.68, 0.37, and 0.76, respectively; *P* < 0.001). Prevalence of DR decreased in older age groups while controlling for DM duration. **Conclusion:** It is probable that high myopia, the female sex, and better glycemic control are protective against DR and STDR in our study cohort of adults over 60 years of age. It is possible that occupations involving manual labor, delayed cataract surgery, and living past the age of 70 are also protective against DR.

Key words: Big data, diabetic retinopathy, electronic medical records, geriatric ophthalmology, India

Diabetic retinopathy (DR), a potentially visually disabling condition may burden both the individual and the society from loss of independence, economic productivity, and worsened overall health.[1-3] DR affects a substantial proportion of people with DM in India; it is estimated to arise in approximately 1 in every 5 people with diabetes.[4,5] Older patients have been shown to make up the majority of these cases, with age being an important risk factor for DR.[5,6] Longer duration of diabetes,[4-8] poor blood sugar control,[4,7,8] and presence of other diabetic microvascular complications are the other implicated risks.[6] Studies have suggested that the significance of each of these risks differs in geriatric populations.[7,9,10] There has also been research on protective factors against DR with less consistent results and no focus specifically on geriatric populations.[11-13] This study aims to identify the protective factors for DR in a geriatric population in India.

Methods

This retrospective, observational study included all new patients older than 60 years of age who presented to an eye facility that is part of a multitier ophthalmology network in 200 geographical locations spread across four states (Telangana, Andhra Pradesh, Odisha, and Karnataka) of India from August 2010 through April 2020.[14] Though most belonged to the abovementioned states, there was representation from all states of India.

Patients filled out a standard consent form for electronic data privacy at the time of registration. No identifiable parameters of patient information were used in data analysis. Institutional ethics committee approval was waived for the study. The study followed the Tenets of the Declaration of Helsinki for human research.

The clinical data of each subject who underwent a comprehensive ophthalmic examination was entered into a browser-based electronic medical records system (eyeSmart EMR) by uniformly trained ophthalmic personnel supervised by an ophthalmologist using a standardized template.[15] The data points extracted for the study included demographic details, socioeconomic status (based on their ability to pay for the care), systemic illnesses, and ocular disease distribution. The history and duration of DM were extracted using the finite-state machine modeling algorithm.[16] We categorized subjects geographically into rural, metropolitan, or urban areas in accordance with the National Sample Survey Organization (NSSO) as described in the methods of Garrigan *et al.*[17]

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In total, 25,338 patients aged 60 years and older diagnosed with diabetic retinopathy in one or both eyes presented to the network during the study period and were included in this study. Patients with severe nonproliferative diabetic retinopathy, proliferative diabetic retinopathy, or diabetic macular edema (DME) were considered to have sight-threatening DR (STDR).[18] Data were retrieved from the EMR database and segregated in a single excel sheet (Microsoft XL®). Data on patient demographics, clinical presentation, ocular diagnosis, and treatment modalities were included. All information was extracted from the baseline visit. The excel sheet was then used for statistical analysis. Standardized definitions were used for occupation, socioeconomic status, and geographic distribution.[19] The visual acuity (VA) was classified according to the WHO guidelines.[20]

Statistical methods

Independent two-sample t-tests were performed on mean lab values for patients with versus without DR. Lab values include hemoglobin A1c (HbA1c), blood sugar values, blood urea nitrogen (BUN) and serum creatinine (SCr), and several blood count measurements.

Subjects were grouped based on the duration of DM (1–5 years, 6–10 years, and >10 years), and age-adjusted prevalence was calculated for any DR and for STDR.

Multiple logistic regression (MLR) was performed for the binary outcome, presence of any DR. Predictors include age; gender; socioeconomic status (paying vs. nonpaying); occupation; urban–rural–metropolitan distribution; active cataract; high myopia; self-reported history of cholesterolemia, hypertension (HTN), or coronary artery disease (CAD); history of cataract surgery; self-reported insulin use; and presenting VA. To better assess these relationships in our geriatric population, interactions between age and several comorbidities (cataracts, HTN, Cholesterolemia, and CAD) were run and removed from the model if they were nonsignificant. Odds ratios (OR), and 99% confidence intervals were calculated using R software (version 3.5.1). A second regression model was run on a subset of the subjects for which diabetes duration was available. Among subjects with DR, MLRs were run for presence of STDR and presenting VA. STDR was operationalized as severe nonproliferative DR, proliferative DR, and diabetic macular edema (DME). Poor VA was operationalized as VA >20/200. For all models, an alpha level of 0.01 was assigned.

Results

Of the 116039 patients with DM over the age of 60 years old attending our multitier ophthalmic network, 22% of subjects had a diagnosis of DR (N = 25338). STDR accounted for 46% (N = 11835) of the subjects with DR. Table 1 shows the demographic and clinical profiles of our study population. The majority of patients with DR were men (70%). The best-represented age group in our dataset was the youngest category (60–70 years); this stratum represented the majority of our cases of DR (83%). Information on the duration of DM was available for 62% of subjects (N = 71515).

Biochemical parameters

Supplemental Table 1 shows the average laboratory values for patients with versus without DR and associated standard deviations (SD). The average random blood sugar was 35 mg/dL higher in patients with DR than in those without ($P < 0.001$). The A1c followed this trend as well; patients with DR had 0.57% higher glycosylated hemoglobin levels in their bloodstreams ($P = 0.001$), although this data

Table 1: Demographic and clinical profile of study population

	DR (%)*	No DR (%)[†]
Sex		
Male	17802 (70)	54400 (60)
Female	7536 (30)	36301 (40)
Age Categories		
60-70 years	20951 (83)	67712 (75)
71-80 years	4040 (16)	20041 (22)
81-90 years	335 (1)	2810 (3)
91-100 years	12 (0)	138 (0)
Socioeconomic Status		
Paying	21813 (86)	75614 (83)
Nonpaying	3525 (14)	15087 (17)
Geography		
Urban	12787 (50)	45074 (50)
Rural	8838 (35)	32775 (36)
Metropolitan	3713 (15)	12852 (14)
Occupation		
Retired	11084 (44)	19598 (22)
Home Maker	5257 (21)	23873 (26)
Govt/Private Service	4050 (16)	10425 (11)
Agriculture related	2253 (9)	7640 (8)
Not Available/Not Applicable	1801 (7)	24694 (27)
Manual Labor	893 (4)	4471 (5)
Ocular Comorbidities		
Cataract	15660 (62)	65656 (72)
High Myopia	72 (0)	949 (1)
Cataract Surgery	3917 (15)	18027 (20)
Systemic Diseases		
Hypertension	10274 (40)	51378 (57)
Cholesterolemia	303 (1)	1460 (2)
Coronary Artery Disease	2032 (8)	8674 (10)
Insulin Use		
Insulin Prescription	5077 (4)	7434 (6)
DM Duration		
0-5 years	2171 (8)	27289 (30)
6-10 years	3155 (12)	16114 (18)
>10 years	6823 (27)	15963 (18)
DR Category		
NSTDR	13503 (53)	N/A
STDR	11835 (47)	N/A

*Number of subjects with the condition/total cases of DM with DR. [†]Number of subjects with the condition/total cases of DM without DR

only represented 645 subjects. Kidney function tests were higher, on average, in patients with diabetic eye disease than in those without DR. Serum creatinine (SCr) and blood urea nitrogen (BUN) were 0.25 and 6.39 mg/dL higher, respectively ($P < 0.001$ for both).

Our dataset provides evidence that patients with DR have lower average hemoglobin, hematocrit, and red blood cell (RBC) count ($P < 0.001$). The data also showed a statistically distinct, albeit clinically insignificant, shift in the makeup of the white blood cell content between groups ($P < 0.001$).

Demographics

Women had lower odds of having any DR or STDR than men ($P < 0.001$) while controlling for predictors outlined in our methods, including DM duration [Tables 2 and 3]. There was insufficient evidence to claim a mediating effect of gender on VA among patients with DR ($P = 0.272$) [Table 4].

DR appeared to have lower prevalence among nonpayers ($P < 0.001$), although this association did not remain significant in the model that accounted for DM duration ($P = 0.061$). For subjects with DR, those categorized as payers were likely to have better overall VA (OR = 0.65, $P < 0.001$).

The odds of having any DR varied based on occupation. Manual labor, work in agriculture, and retirees were associated with decreased prevalence of DR compared to work in the government or private sector ($P < 0.001$). However, among subjects with DR, those working in the private sector
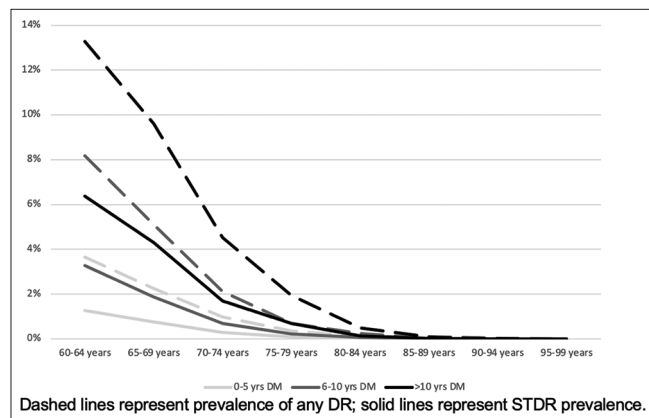

Dashed lines represent prevalence of any DR; solid lines represent STDR prevalence.

Figure 1: Prevalence of NSTDR and STDR grouped by age and DM duration

and retirees were the least likely to suffer severe visual impairment (VI) ($P < 0.001$). When DM duration was accounted for, the data still suggested that manual labor was associated with lower rates of DR although there was no longer adequate evidence to make the claim ($P = 0.049$).

Comorbidities

Subjects with high myopia were 75% less likely to have any form of DR ($P < 0.001$), and even less likely to have STDR (OR = 0.19, $P < 0.001$). This remained consistent when controlling for DM duration. However, among those with DR, subjects with high myopia had much worse VA (OR = 10.32, $P < 0.001$).

Not having undergone cataract surgery was associated with lower odds of DR (OR = 0.90, $P < 0.001$), although this association was weakened when accounting for DM duration (OR = 0.94, $P = 0.022$). For subjects with DR, patients that had undergone cataract surgery were more likely to suffer severe VI (OR = 1.42, $P < 0.001$) and STDR (OR = 1.31, $P < 0.001$). Among those with DR, presence of cataracts was associated with lower rates of a sight-threatening variant (OR = 0.37, $P < 0.001$) as was HTN (OR = 0.87, $P < 0.001$). Cholesterolemia was associated with better VA among subjects with DR (OR = 0.70, $P = 0.008$).

Aging

Age-adjusted prevalence data [Fig. 1] showed older age to be associated with lower rates of DR and STDR in our geriatric population, controlling for DM duration. The trends in both DR and STDR are similar. The biggest drop-off in prevalence occurs before the age of 70 for all trendlines.

Several interaction variables were built into the first model [Table 2] to assess the relationship between comorbidities and DR at different ages. The blood pressure (BP) by age interaction term was significant ($P < 0.001$), providing evidence that people with diabetes and hypertension age differently

Table 2: Logistic regression model of factors protective against presence of DR

	Odds Ratio	99% Confidence Interval	P
Female	0.65	0.61-0.69	<0.001
Payer Status (Reference: Nonpaying)			
Paying	1.08	1.02-1.14	<0.001
Occupation (Reference: Government Employed/Private Sector)			
Agriculture	0.83	0.76-0.90	<0.001
Home Maker	0.97	0.89-1.06	0.367
Manual Labor	0.69	0.61-0.77	<0.001
Retired	0.92	0.86-0.98	<0.001
Presence of High Myopia	0.25	0.18-0.34	<0.001
No Cataract Surgery	0.90	0.86-0.94	<0.001
No Insulin Use	0.37	0.35-0.39	<0.001
Interaction: Age and Hypertension	0.99	0.98-1.00	<0.001
Visual Acuity (Reference: Mild or No Visual Impairment 0)			
Moderate VI 1	1.44	1.38-1.52	<0.001
Severe VI 2	1.67	1.55-1.80	<0.001
Blindness 3	1.50	1.42-1.59	<0.001
Blindness 4	1.11	1.00-1.23	0.014
Blindness 5	1.11	0.96-1.28	0.071

*VA Classifications: Mild or no VI 0: 20/20-20/70, Moderate VI 1: >20/70-20/200, Severe VI 2: >20/200-20/400, Blindness 3: >20/400-20/1200, Blindness 4: >20/1200-Perception of light, Blindness 5: No perception of light

than people with diabetes alone; this interaction alters the predictive abilities of both age and BP on odds of DR. This interaction became insignificant when accounting for DM duration ($P = 0.089$). We did not observe strong evidence from this dataset of moderating effects of coronary artery disease (CAD), hypercholesterolemia, or cataract status on the relationship between DR and age.

Duration of DM

Our study provides evidence that a shorter duration of DM is associated with a lower prevalence of any DR [Fig. 1 and Supplemental Table 2]. Subjects with DM for 0–5 years had 80% lower odds and subjects with DM for 6–10 years had 51% lower odds of having DR than those with DM for >10 years ($P < 0.001$). Fig. 1 also shows that subjects with later-onset DM have a lower prevalence of DR, while controlling for DM duration.

Table 3: Logistic regression model predictors associated with presence of STDR among subjects with DR

	Odds Ratio	99% Confidence Interval	P
Age	0.97	0.97-0.98	<0.001
Female	0.69	0.61-0.78	<0.001
High Myopia	0.19	0.09-0.42	<0.001
Cataracts	0.37	0.33-0.40	<0.001
No Cataract Surgery	0.76	0.70-0.83	<0.001
No Insulin Use	0.64	0.59-0.70	<0.001
Hypertension	0.87	0.81-0.93	<0.001
Visual Acuity (Reference: Mild or No Visual Impairment 0)*			
Moderate VI 1	2.09	1.90-2.29	<0.001
Severe VI 2	3.7	3.24-4.23	<0.001
Blindness 3	4.4	3.95-4.89	<0.001
Blindness 4	5.06	4.14-6.19	<0.001
Blindness 5	7.51	5.6-10.09	<0.001

*VA Classifications: 0: 20/20-20/70, Moderate VI 1: >20/70-20/200, Severe VI 2: >20/200-20/400, Blindness 3: >20/400-20/1200, Blindness 4: >20/1200 to Perception of light, Blindness 5: No perception of light

Discussion

In this study, we tried to determine protective factors against DR in an Indian geriatric cohort attending a multitier ophthalmology network within the last decade.

Age

Previous research into the association between age and DR has been consistent in younger populations, showing that DR prevalence increases with age.[5,6] However, studies performed among older adults have suggested the two have a more complex relationship.[9-11,21] We found older age to be associated with a lower prevalence of DR in our study population. For the prevalence of a chronic disease to decrease at older age strata, it is probable that subjects with DR at younger ages are dying earlier.[22] The steep drop-off in DR prevalence prior to age 70 aligns well with the average life expectancy of 70 years in India. After the age of 70, the slopes flatten, representing lower DR prevalence. Among those who survive past the age of 70, developing DR appears to become less of a concern. The Oulu Eye Study found low prevalence of DR among adults over age 70, even amid a high prevalence of DM.[21] Liu et al.[11] found an association between age and lower rates of DR (OR = 0.95, $P < 0.001$) in their study population of people with DM for >10 years. Our findings align well with this value ($OR_{DR} = 0.95$, $OR_{STDR} = 0.97$, $P < 0.001$). Although this trend appears counterintuitive, it is likely that subjects within the older strata lived healthier lives or had better genetics, leading to improved glycemic control and reduced vascular damage. It would be valuable to study this association further; identifying underlying genetic or lifestyle factors that are protective can uncover new interventions for people with diabetes. In our study population, it appears that adults in the cohorts above 70 years of age have a lower likelihood of developing DR and STDR. It may be the case that healthcare providers can shift their focus more toward screening middle-aged adults than older populations. Multimodal imaging and cohort studies are necessary to further evaluate and confirm the association.

Gender

Our results provide reasonable evidence that the female sex is protective against DR in older adults, which aligns with other epidemiological studies performed in India, but is not consistent with other studies evaluating specifically geriatric

Table 4: Factors protective against poor presenting VA among subjects with DR

	Odds Ratio*	99% Confidence Interval	P
Payer Status (Reference: Nonpaying)			
Paying	0.65	0.59-0.72	<0.001
District Status (Reference: Rural)			
Metropolitan	0.65	0.58-0.73	<0.001
Urban	0.83	0.77-0.89	<0.001
Occupation (Reference: Agriculture)			
Government Employed/Private Sector	0.74	0.64-0.86	<0.001
Home Maker	0.87	0.73-1.04	0.048
Manual Labor	1.01	0.81-1.25	0.935
Retired	0.73	0.64-0.84	<0.001
High Myopia	10.32	4.54-23.47	<0.001
Cataract Surgery	0.70	0.64-0.77	<0.001
No Insulin Use	0.86	0.78-0.93	<0.001
High Cholesterol	0.70	0.49-0.99	0.008

*Poor VA: >20/200

populations. These differences might be explained by the different ethnicities and cultures that impact DR.[23,24] Existing literature supports the notion that females have lower rates of DR in general populations.[4,7,8] For older adults, the data has not been as clear. Thapa *et al.*[9] evaluated sex as a risk factor for DR in a geriatric population in Nepal. Their results did not show an association between sex and DR, suggesting that the increased risk of DR in males diminished with age. However, their sample size was conservative (n = 168 subjects with DM, 40 subjects with DR). Similarly, Li *et al.*[10] performed a population-based study in Mainland China; their data suggested that females over the age of 60 have slightly increased odds of DR than their male counterparts.

Occupation
Our data suggested that individuals working in manual labor have lower odds of having DR than government or private employees, homemakers, agronomists, or retirees. One possible theory is that manual labor is more physically demanding, leading to more activity and better diabetes control in these subjects than among their more sedentary counterparts. The weakened association we observed when controlling for DM duration was interesting. For this observation to be true, manual laborers in our study must have disproportionately filled the lower strata of DM duration. That is to say, there is a link between manual labor, later-onset diabetes, and lower rates of DR. A sedentary lifestyle has been associated with increased risk of DR.[25] Remaining active into older age may confer protection against development of DR, although more research on the topic is required.

Glycemic control
Results of the t-tests suggest that subjects with DR have poorer blood sugar control than those without DR. This fits the pathophysiology of DM; poor sugar control leads to more micro- and macrovascular complications including DR.[8] Although some diabetic therapeutic agents have been associated with slowed DR progression,[26] our finding that insulin use was not associated with lower risk of DR aligns with existing literature.[4,7] Insulin is a step-up therapeutic for diabetes management and thus a marker of increased diabetes morbidity. Similarly, a longer duration of DM increases the amount of time during which microvascular complications can arise.[8] This explains our finding that subjects with shorter DM duration have lower odds of developing DR.

The average renal profile (SCr, BUN) of our subjects with DR was elevated, probably from comorbid diabetic kidney disease (DKD). The association between these microvascular complications of DM has been well evaluated.[27,28] Our subjects with DR have fewer red blood cells, on average, with no change in the quality of the cells (normochromic, normocytic). Though these values fall within normal limits, this pattern trends toward a hypoproliferative anemia that has been associated with DR in other cross-sectional studies.[29-31] Decreased erythropoietin production in DKD, even in the absence of frank anemia, can explain this.[32] To understand whether anemia is an independent risk factor rather than a marker of microvascular damage, longitudinal studies would need to be performed.

Ocular comorbidities
High myopia is a well-studied protective factor against DR with a growing body of literature to support it.[8,12,13] Myopia as a marker of axial length is a popular hypothesis that is used to explain the mitigating effect of high myopia against DR.[13] Prolonged axial length is thought to decrease blood flow in the retina, slowing the mechanisms of retinal destruction in DR, and cause posterior vitreous detachments, which reduce the risk of neovascularization.[13,33,34] The value of this finding is limited by the fact that high myopia is not a modifiable variable and comes with increased risk of several other ocular pathologies, as well as severe vision loss, which is supported by the association between poor presenting VA and high myopia in our study. Nevertheless, counseling patients that their high myopia is protective in this specific context can certainly be reassuring to hear.

The relationship between cataract surgery and DR is complex. Improved visualization of the retina upon removal of an opacified lens can expose pre-existing DR, confounding an increased incidence of DR after cataract surgery. There is also evidence that untreated, severe PDR has a higher probability of progression after cataract surgery.[35] These contextualize our finding that cataracts are associated with lower rates of STDR, while cataract surgery is associated with worse visual outcomes and increased prevalence of STDR. It has been postulated that surgery also increases the risk of developing DR. Tham *et al.* performed a cohort study on Indian immigrants in Singapore and found that surgery approximately doubled the incidence of DR in this population.[36] Our study showed a milder association between surgery and DR. Although their study better assesses temporality of the relationship, their sample size is much smaller (1044 eyes). Our study was also performed in an older population of nonimmigrants. Further research is certainly required to understand the relationship between cataract surgery and its role in inciting DR.

Limitations
This study has a few limitations. Our cross-sectional study cannot establish the direction of causality between variables. With such a large dataset, there is also a greater likelihood of a type I error, which may explain unexpected associations. For these reasons, we prioritized contextualizing our results with similar studies. Our data were extracted from tertiary eye care facilities, which introduces a sampling bias and limits generalizability on a population level. However, we included subjects from all states in India and have a large sample size, which improves our generalizability.

In addition, we had incomplete datasets for certain variables. Diabetes duration was available for 62% of our sample population; thus, we only included regression models with this variable in the supplementary analysis. To accommodate for this, we highlighted predictors that were consistent between the two regression models (with and without diabetes duration) in our discussion. Similarly, our sample size for HbA1c was very small, with information on only 645 patients.

Conclusion
This study contributes to a developing body of literature on geriatric ophthalmology. Adults living past the age of 70 and those who received a diagnosis of DM later in life had lower rates of DR and STDR. High myopia, the female sex, and increased physical activity associated with occupations such as manual labor may be protective against the sight-threatening condition in adults over the age of 60. Establishing protective factors against DR in a geriatric population can help clinical ophthalmologists counsel and triage their patients with DM. Specifically, this can benefit older patients who carry the majority of the burden of diabetic eye disease.

Conflicts of interest

There are no conflicts of interest.

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Supplemental Table 1: Biochemical parameters - study population

	n	DR present (SD)	DR absent (SD)	P
Blood Sugar (mg/dL)				
HbA1c (%)	645	8.79 (2.24)	8.22 (2.24)	0.00168
Random Blood Sugar	14327	194 (94)	159 (79)	<0.001
Fasting Blood Sugar	952	156.85 (67.31)	135.68 (53.55)	<0.001
Post-prandial Blood Sugar	896	240.62 (93.25)	210.47 (75.81)	<0.001
Kidney Function Tests (mg/dL)				
BUN	11372	35.34 (20.98)	28.95 (13.09)	<0.001
Serum Creatinine	11941	1.34 (1.01)	1.09 (0.68)	<0.001
Blood Counts				
Hemoglobin	12372	12.31 (1.86)	12.76 (4.32)	<0.001
Hematocrit	5023	37.02 (5.6)	38.64 (5.23)	<0.001
RBC Count	8905	4.37 (0.98)	4.5 (1.25)	<0.001
Neutrophils	8900	64.93 (8.41)	64.19 (8.57)	<0.001
Lymphocytes	8900	29.05 (8.88)	29.78 (7.89)	<0.001

	n	DR present (SD)	DR absent (SD)	P

Supplemental Table 2: Logistic regression model predictors associated with presence of DR including duration of DM as a predictor[‡]

	Odds Ratio	99% Confidence Interval		P*
		Lower Bound	Upper Bound	
*Age	0.95	0.94	0.96	<0.001
*Female	0.71	0.65	0.77	<0.001
Payer Status (Reference: Paying)				
Nonpaying	0.94	0.86	1.02	0.061
*District Status (Reference: Rural)				
Metropolitan	0.87	0.79	0.96	<0.001
Urban	1.03	0.97	1.09	0.234
*Occupation (Reference: Government Employed/Private Sector)				
Agriculture	1	0.88	1.13	0.931
Home Maker	0.98	0.86	1.11	0.659
Manual Labor	0.88	0.74	1.04	0.049
Retired	0.94	0.94	0.95	<0.001
*High Myopia	0.28	0.18	0.43	<0.001
*Cataracts	0.79	0.73	0.84	<0.001
No Cataract Surgery	0.94	0.88	1.01	0.022
No Insulin Use	0.44	0.41	0.48	<0.001
*High Cholesterol	0.77	0.61	0.97	0.004
No hypertension	0.67	0.34	1.34	0.138
Coronary Artery Disease	0.92	0.84	1	0.014
*Visual Acuity (Reference: Mild or No Visual Impairment 0)[†]				
Moderate Visual Impairment 1	1.49	1.39	1.6	<0.001
Severe Visual Impairment 2	1.7	1.53	1.9	<0.001
Blindness 3	1.61	1.48	1.74	<0.001
Blindness 4	1.17	1	1.35	<0.001
Blindness 5	1.03	0.83	1.29	0.687
*DM Duration (Reference: >10 years)				
0-5 years	0.20	0.19	0.22	<0.001
6-10 years	0.49	0.46	0.52	<0.001

*Indicates variables that are at or below the alpha value (0.01). [†]Visual Acuity Classifications: Mild or no visual impairment 0: 20/20-20/70, Moderate visual impairment 1: >20/70-20/200, Severe visual impairment 2: >20/200-20/400, Blindness 3: >20/400-20/1200, Blindness 4: >20/1200 to Perception of light, Blindness 5: No perception of light. [‡]n=71515 total; 7228 with NSTDR; 4921 with STDR