# Identifying Risk Factors for Blindness From Glaucoma at First Presentation to a Tertiary Clinic

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• PURPOSE: **Glaucoma is the leading cause of irreversible blindness, a crippling disability resulting in higher risks of chronic health conditions. To better understand disparities in blindness risk, we identified risk factors of blindness on first presentation to a glaucoma clinic using a large clinical database.**

• DESIGN: **Retrospective cross-sectional study.**

• METHODS: **We used electronic health records of glaucoma patients from the Duke Ophthalmic Registry. *International Classification of Diseases* codes were used to identify glaucoma and exclude concurrent diseases. Blindness classification was based on the definition of legal blindness. Risk factors included gender, race, marital status, age, intraocular pressure, diabetes history, income level, and education. Odds ratios (ORs) and 95% CIs were calculated for risk factors using univariable and multivariable logistic regression.**

• RESULTS: **Our cohort consisted of 3753 patients, with 192 (5%) blind on first presentation. In univariable models, African American / Black race (OR 2.48, 95% CI 1.83-3.36), single marital status (1.74, 95% CI 1.25-2.44), prior diabetes diagnosis (2.23, 95% CI 1.52-3.27), and higher intraocular pressure (1.29 per 1 SD higher, 95% CI 1.13-1.46) were associated with increased risk of presenting blind, whereas higher annual income (0.75, 95% CI 0.65-0.86) and education (0.77, 95% CI 0.69-0.85) were associated with lower risk. These associations remained significant and in the same direction in a multivariable model apart from income, which became insignificant.**

• CONCLUSIONS: **Using a large real-world clinical database, we identified risk factors associated with presentation with blindness among glaucoma patients. Our results highlight disparities in health care outcomes and indicate the importance of targeted education to reduce disparities in blindness. (Am J Ophthalmol 2023;250: 130–137. © 2023 Elsevier Inc. All rights reserved.)**

Glaucoma is a progressive eye disease that affects the optic nerve and can result in irreversible blindness.[1] Worldwide, it is estimated that 76 million people have glaucoma between the ages of 40 and 80 years.[2] Of these, approximately 11.6 million people are bilaterally blind from glaucoma, making it the leading cause of irreversible blindness.[3]

Blindness is a crippling disability that hinders a person's ability to perform routine daily tasks and is associated with feelings of loneliness, loss of independence, social isolation, and depression.[4-9] Additionally, visual impairment is associated with a greater risk of mortality, unintentional injury, and chronic conditions.[10-12] Furthermore, according to Medical Expenditure Panel Survey data from 1996 to 2002, those who are blind or visually impaired experience higher medical care costs, greater amounts of informal health care, and decreased quality of life.[13]

Because of these negative effects, early diagnosis and treatment of glaucoma are important to track the progression of the disease and reduce the risk of blindness. However, early glaucoma diagnosis can be difficult as the condition often remains asymptomatic until late stages.[14] As a result, groups that do not have an accurate comprehension of the disease or that have less access to health care may be less likely to seek care and therefore more likely to have vision loss due to glaucoma. For example, a study of 152 glaucoma patients at a San Francisco hospital found that Black and Latino patients were more likely than White patients (odds ratios: 7.16 and 4.77, respectively) to be inconsistent with follow-up appointments, potentially because of lack of understanding about the consequences of glaucoma.[15] Additionally, studies have found that blindness due to glaucoma

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is 6 to 8 times more likely for Black Americans compared to White.[16]

Little work has been done on risk factors for presenting to a care center already blind as opposed to over the course of treatment. This is important, as studies have shown that progression to blindness is relatively uncommon in developed countries if a patient is being treated. As such, it is likely that the largest decrease in blindness from glaucoma can be achieved from public education and targeted public screening to reduce the risk of presenting for treatment already blind.[17] Therefore, risk factors for presenting blind may provide insight on populations that seek care "too late" and may require targeted public screening and education on glaucoma. A previous case-control study found no statistical difference in presentation with blindness between Black and White patients; however, the study had only 37 Black case-control pairs and 19 White case-control pairs, did not examine other demographic variables, and did not primarily focus on blindness at presentation.[18]

In this study, we investigated a large cohort of glaucoma patients to identify risk factors of blindness on first presentation. The study cohort was curated from electronic health records (EHRs) from the Duke Ophthalmic Registry (DOR), leveraging clinical and demographic data available on first presentation to highlight disparities in blindness risk before clinical care at a tertiary care center. We hypothesized that disadvantaged sociodemographic and socioeconomic groups, that historically have less access to health care, would have greater risk of presenting blind.

## METHODS

This was a retrospective cross-sectional study using patients from the Duke Ophthalmic Registry (DOR), which consisted of adults at least 18 years of age with glaucoma who were evaluated at the Duke Eye Center or its satellite clinics from 2012 to 2019. The Duke University Institutional Review Board approved this study with a waiver of informed consent because of the retrospective nature of this work. All methods adhered to the tenets of the Declaration of Helsinki for research involving human subjects and were conducted in accordance with regulations of the Health Insurance Portability and Accountability Act.

Information on comprehensive ophthalmic examinations from baseline and follow-up visits were collected including patient diagnosis codes (*International Classification of Diseases* [*ICD*]), procedures (*Current Procedural Terminology* [*CPT*]), medications, and laboratory tests. Intraocular pressure (IOP) measured using the Goldmann applanation tonometry (Haag-Streit) and the Tono-Pen (Reichert, Inc) were also extracted from the database. Standard automated perimetry tests were acquired with the Humphrey field analyzer (Carl Zeiss Meditec, Inc) during the study period. Only 24-2 and 30-2 Swedish Interactive Threshold Algorithm or full threshold tests of the Humphrey field analyzer with size III white stimulus were exported from the database. Visual fields were excluded if they had >33% fixation losses or >15% false positives.

Patients were included if they had a diagnosis of glaucoma based on *ICD* codes upon first encounter to a Duke Eye Center glaucoma clinic. Additionally, the patients were classified as having primary open-angle glaucoma (POAG) or other glaucomas based on *ICD* codes. Patients were required to have a minimum of 1 good-quality visual field or best-corrected visual acuity measure recorded within 90 days of a first glaucoma encounter (defined as the baseline visit). They were excluded if they had a concurrent disease (identified using *ICD* codes) that could be affecting their vision, including an intraocular tumor, optical neuritis or other nonglaucomatous optic nerve and visual pathway disease, retinal detachment, endophthalmitis, amblyopia, age-related macular degeneration, and if they had prior photocoagulation. Details of the codes used for classification, inclusion, and exclusion criteria have been published previously.[19,20]

• **CLASSIFICATION OF BLINDNESS:** Blindness was defined at the patient level and classified using the United States Social Security Administration's definition of legal blindness.[21] This definition specifies legal blindness as central visual acuity ≤20/200 with correction or a visual field mean deviation ≤ –22 dB in the better eye. This definition has been used before in glaucoma research studies.[22,23] Visual fields and visual acuity were collected within a 180-day window around the baseline encounter. Mean deviation values from 30-2 and 24-2 visual fields were used.

• **RISK FACTORS:** The demographic risk factors studied included gender (male vs female), race (African American / Black vs White), marital status (single vs married), age, income level, and education.

Race, gender, and marital status were self-reported. African American / Black and White were the only races included in the analysis because of the population of patients seen at the Duke Eye Center and statistical considerations related to power. Single marital status included divorced and widowed. Income level and education were obtained from United States Census Bureau's American Community Survey for 2006-2011. Income level was measured by the per capita income in the past 12 months and was race specific. Education was measured by the percentage of residents who achieved a high school education and was sex specific. Census data were assigned to patients based on the zip code they lived in. It is important to note that the income and education variables were not patient specific because they were aggregated using the patient's zip code. Although this loss in granularity is a limitation for the analysis, it has been shown to be an acceptable alternative to patient-level socioeconomic data.[24]

**TABLE 1.** Summary Statistics for Study Cohort Overall and Across Blindness Status

| Variable | All (N = 3753) | Legally Blind (n = 192; 5%) | Not Blind (n = 3561; 95%) | *P* |
|---|---|---|---|---|
| Average SAP MD (dB) | –8.85 (8.10) | –26.8 (4.34) | –8.06 (7.27) | **<.001** |
| Gender, male, n (%) | 1749 (47) | 95 (49) | 1654 (46) | .456 |
| Race (African American / Black), n (%) | 1654 (44) | 125 (65) | 1529 (43) | **<.001** |
| Marital status (single), n (%) | 1427 (43) | 93 (55) | 1334 (42) | **.001** |
| Glaucoma type (other), n (%) | 1998 (53) | 107 (56) | 1891 (53) | .525 |
| Baseline age (y) | 66.20 (13.95) | 66.16 (16.14) | 66.20 (13.83) | .971 |
| Average IOP (mm Hg) | 18.06 (6.62) | 19.89 (8.73) | 17.96 (6.47) | **.003** |
| Diabetes, n (%) | 359 (10) | 35 (18) | 324 (9) | **<.001** |
| Annual income (per $10 000) | 2.99 (1.63) | 2.4 (1.56) | 3.02 (1.63) | **<.001** |
| Education (per 10%) | 85.58 (12.71) | 80.62 (15.39) | 85.83 (12.51) | **<.001** |

IOP = intraocular pressure, MD = mean deviation, SAP = standard automated perimetry.

Summaries are mean and SD, unless otherwise noted. All summaries are presented at the initial presentation to the Duke Eye Center. *P* values represent hypothesis tests across blindness status, with categorical variables using the $\chi^2$ test, and continuous variables using the *t* test.

The clinical risk factors included baseline IOP (measured in mm Hg and averaged between the left and right eye) and history of diabetes as some studies suggest that patients with diabetes are at an increased risk for glaucoma.[25,26] History of diabetes was determined by presence of an *ICD* code for diabetes before the baseline visit date (*ICD-9*: 249, 250; *ICD-10*: E08-13). Baseline standard automated perimetry mean deviation was excluded because it was a measurement used to define the blindness outcome.

• **STATISTICAL ANALYSES:** In this analysis, we investigated the effect of the previously mentioned risk factors on presenting blind to the Duke Eye Center from a diagnosis of glaucoma. Univariable and multivariable logistic regressions were performed using the blindness indicator as the outcome variable. The associations of the risk factors with blindness were presented with ORs and 95% CIs for both the univariable and multivariable models. Models are presented overall and within glaucoma diagnosis type, POAG, and other glaucoma. Finally, the overall performance of the models was evaluated using the area under the receiver operating characteristic (ROC) curve (AUC). Any risk factors that had missing values were imputed using multiple imputation with 5 imputed datasets using the "mice" package in R.[27]

The summaries for the cohort are presented with continuous variables presented as mean and SD and categorical variables presented as counts and percentages. Patient data were anonymized, and all statistical analyses were conducted using the R programming language (version 3.5.1; R Core Team) within the Protected Analytics Computing Environment (PACE). PACE is a secure virtual network space developed by Duke University for analysis of identifiable protected health information. The type 1 error was set at 0.05 throughout.

## RESULTS

Our cohort consisted of 3753 glaucoma patients. Of these, 1755 (47%) had POAG and 1998 (53%) had other types of glaucoma, with a total of 192 (5%) patients presenting with legal blindness at their first visit. Of these 192 patients, 112 presented blind by visual acuity, 78 by visual field, and 2 by both metrics. Table 1 presents baseline demographic and clinical characteristics for this cohort. Overall, the mean (SD) age was 66.2 (13.6) years, 1749 subjects (47%) were male, 1654 (44%) self-identified as African American / Black, and 1427 (43%) were single. The average income in ten-thousand dollars was 3.0 (1.6), and the average percentage of residents receiving a high school education was 85.6% (12.7%). The mean average IOP was 18.1 (6.6) mm Hg and 359 (10%) of patients had a prior diabetes diagnosis. Only marital status (11%), income (14%), and education (13%) had missing values, with missingness in an appropriate range for multiple imputation.

Compared to the patients who did not present blind, the blind cohort had a greater proportion of African American / Black patients (65% vs 43%), single patients (55% vs 42%), and patients with a history of diabetes (18% vs 9%). Additionally, the blind cohort had a higher mean average IOP, 19.9 (8.7) mm Hg, compared with the not-blind cohort, at 18.0 (6.5) mm Hg. Finally, the blind cohort had a lower average annual income in ten-thousand dollars, 2.4 (1.6) compared to 3.0 (1.6), and a lower average percentage of residents receiving a high school education, 80.6 (15.6) compared to 86.8 (12.5).

Table 2 and Figure 1 display the results for the univariable and multivariable logistic regression models for all patients. In univariable models, all variables were significant ($P <$ .05) for predicting presentation of blindness except for gender, glaucoma type, and age. African American / Black race

**TABLE 2.** Univariable and Multivariable Logistic Regression Models for All Patients.

| Variable | Univariable | | Multivariable | |
|---|---|---|---|---|
| | OR (95% CI) | *P* | OR (95% CI) | *P* |
| Gender (male) | 1.13 (0.84, 1.51) | .412 | 1.19 (0.87, 1.63) | .266 |
| Race (African American / Black) | 2.48 (1.83, 3.36) | **<.001** | 1.81 (1.24, 2.64) | **.002** |
| Marital status (single) | 1.74 (1.25, 2.44) | **.002** | 1.45 (1.01, 2.08) | **.050** |
| Glaucoma type (other) | 0.90 (0.67, 1.20) | .478 | 0.90 (0.67, 1.22) | .507 |
| Age (per 10 y) | 1.00 (0.90, 1.11) | .967 | 1.10 (0.99, 1.23) | .087 |
| Average IOP (per 1 SD) | 1.29 (1.13, 1.46) | **<.001** | 1.22 (1.07, 1.39) | **.003** |
| Diabetes (yes) | 2.23 (1.52, 3.27) | **<.001** | 1.68 (1.13, 2.50) | **.011** |
| Annual income (per $10 000) | 0.75 (0.65, 0.86) | **<.001** | 0.95 (0.80, 1.12) | .558 |
| At least high school education (per 10%) | 0.77 (0.69, 0.85) | **<.001** | 0.86 (0.75, 0.98) | **.028** |

IOP = intraocular pressure, OR = odds ratio.

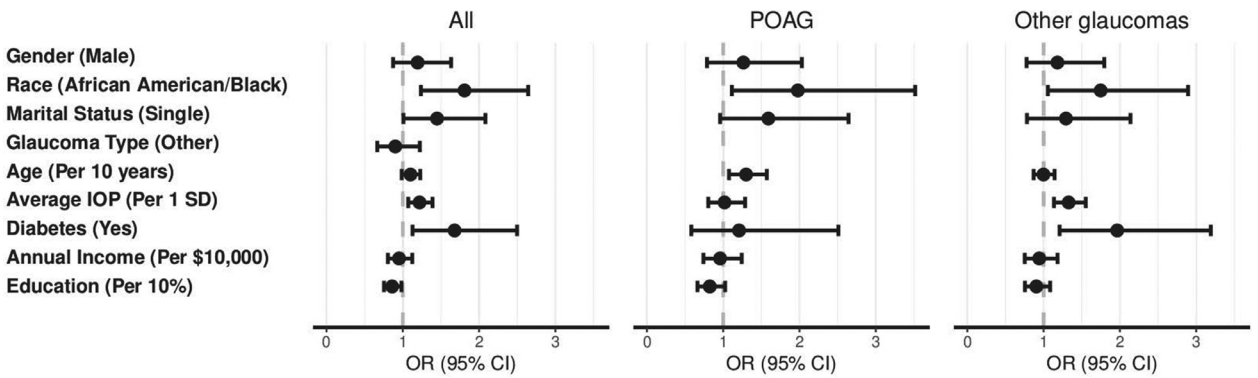


**FIGURE 1. Forest plot demonstrating the odds ratios (ORs) and 95% CIs from the multivariable logistic regression models for all patients (left), primary open angle glaucoma (POAG) patients only (middle), and patients with other glaucoma types (right). IOP = intraocular pressure.**

(OR 2.48, 95% CI 1.83-3.36), single marital status (OR 1.74, 95% CI 1.25-2.44), higher IOP (OR 1.29 per 1 SD higher, 95% CI 1.13-1.46), and prior diagnosis of diabetes (OR 2.23, 95% CI 1.52-3.27) were associated with a greater risk of presenting blind. Meanwhile, higher annual income (OR 0.75, 95% CI 0.65-0.86) and higher education (OR 0.77, 95% CI 0.69-0.85) were associated with lower risk of presenting blind. The associations found in the univariable models remained statistically significant and in the same direction in the multivariable logistic model, with an exception for annual income, which became insignificant. The AUC of the ROC curve for the overall multivariable model was 0.69 (Figure 2).

Table 3 displays the results of the univariable and multivariable logistic regression models for POAG patients. African American / Black race (OR 2.40, 95% CI 1.52-3.80), single marital status (OR 1.89, 95% CI 1.18-3.04), and a 10-year increase in age (OR 1.20, 95% CI 1.00-1.44) were associated with a greater risk of presenting blind. Meanwhile, higher annual income (OR 0.76, 95% CI 0.62-0.92) and higher education (OR 0.75, 95% CI 0.64-0.88) were associated with lower risk of presenting blind. Of these significant associations, only age and race remained significant in the multivariable model.

Table 4 displays the results of the univariable and multivariable logistic regression models for patients with other glaucoma diagnoses. In univariable models, all risk factors were significantly associated with blindness, except for gender and age, and maintained the same direction as in the models with all patients. In the multivariable model, the only variables that remained significant were African American / Black race (OR 1.75, 95% CI 1.06-2.89), higher IOP (OR 1.33 per 1 SD higher, 95% CI 1.14-1.55), and a prior diagnosis of diabetes (OR 1.96, 95% CI 1.21-3.19). The AUC of the ROC curve of the multivariable model was 0.68 for POAG and 0.70 for other glaucomas (Figure 2).

## DISCUSSION

In this study, we identified sociodemographic, socioeconomic, and clinical risk factors for presenting with blind-

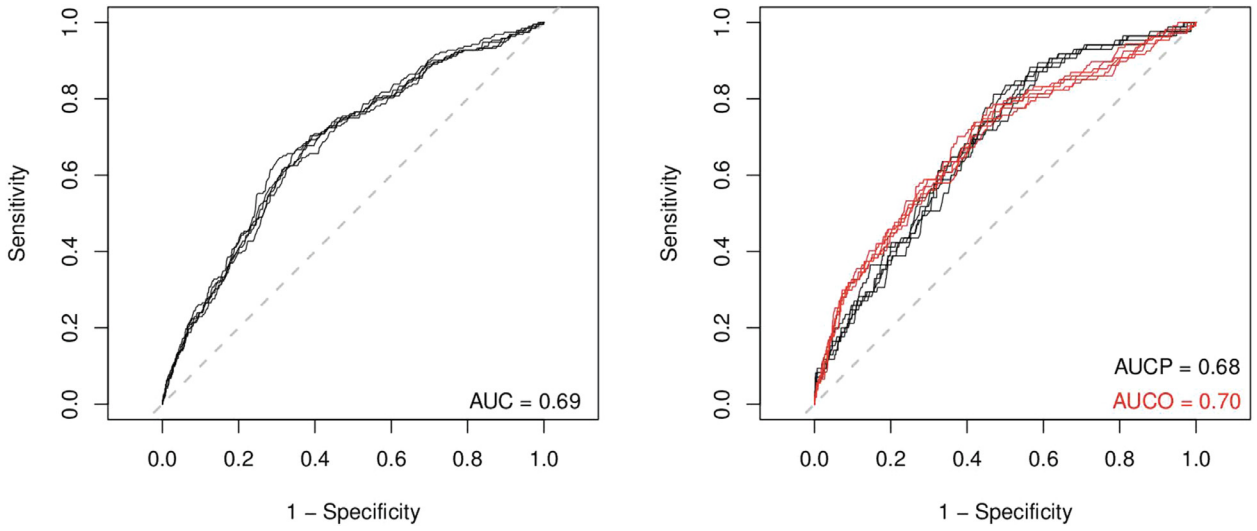


**FIGURE 2.** Receiver operating characteristic (ROC) curves showing the ability of the predicted probabilities of blindness derived from the multivariable logistic regression model to discriminate cases and controls. The panel on the left is for all patients whereas on the right there are curves for primary open angle glaucoma (POAG; black) and other glaucoma (red) patients. The area under the ROC curve (AUC) for the 3 models is 0.69, 0.68, and 0.70, respectively. Note that each curve is comprised of 5 curves from the multiple imputation. AUCP = AUC for POAG; AUCO = AUC for other glaucoma types.

**TABLE 3.** Univariable and Multivariable Logistic Regression Models for Patients With POAG

| | Univariable | | Multivariable | |
|---|---|---|---|---|
| Variable | OR (95% CI) | *P* | OR (95% CI) | *P* |
| Gender (male) | 1.18 (0.76, 1.83) | .451 | 1.26 (0.79, 2.03) | .332 |
| Race (African American / Black) | 2.40 (1.52, 3.80) | **<.001** | 1.98 (1.11, 3.52) | **.021** |
| Marital status (single) | 1.89 (1.18, 3.04) | **.009** | 1.59 (0.96, 2.64) | .074 |
| Age (per 10 y) | 1.20 (1.00, 1.44) | **.049** | 1.30 (1.08, 1.57) | **.006** |
| Average IOP (per 1 SD) | 1.02 (0.81, 1.29) | .846 | 1.02 (0.80, 1.29) | .886 |
| Diabetes (yes) | 1.50 (0.73, 3.07) | .265 | 1.21 (0.58, 2.51) | .612 |
| Annual income (per $10 000) | 0.76 (0.62, 0.92) | **.007** | 0.96 (0.74, 1.24) | .756 |
| At least high school education (per 10%) | 0.75 (0.64, 0.88) | **.001** | 0.82 (0.66, 1.03) | .096 |

IOP = intraocular pressure, OR = odds ratio, POAG = primary open-angle glaucoma.

**TABLE 4.** Univariable and Multivariable Logistic Regression Models for Patients With Other Glaucoma Types

| | Univariable | | Multivariable | |
|---|---|---|---|---|
| Variable | OR (95% CI) | *P* | OR (95% CI) | *P* |
| Gender (male) | 1.10 (0.74, 1.62) | .640 | 1.18 (0.78, 1.79) | .436 |
| Race (African American / Black) | 2.56 (1.70, 3.84) | **<.001** | 1.75 (1.06, 2.89) | **.031** |
| Marital status (single) | 1.64 (1.04, 2.59) | **.038** | 1.29 (0.78, 2.14) | .323 |
| Age (per 10 y) | 0.91 (0.80, 1.04) | .161 | 1.00 (0.87, 1.14) | .974 |
| Average IOP (per 1 SD) | 1.43 (1.23, 1.67) | **<.001** | 1.33 (1.14, 1.55) | **<.001** |
| Diabetes (yes) | 2.68 (1.69, 4.27) | **<.001** | 1.96 (1.21, 3.19) | **.006** |
| Annual income (per $10 000) | 0.75 (0.63, 0.89) | **.002** | 0.94 (0.75, 1.18) | .613 |
| At least high school education (per 10%) | 0.78 (0.68, 0.90) | **.001** | 0.90 (0.75, 1.09) | .284 |

IOP = intraocular pressure, OR = odds ratio.

ness to a tertiary glaucoma clinic. Overall, the incidence of blindness at presentation was relatively low at 5% and did not appear to differ between the patients with POAG and other glaucoma. When all patients with primary or secondary glaucoma were analyzed in a multivariable model, African American / Black race, higher IOP, history of diabetes, and sociodemographic characteristics such as single marital status and lower education level were significant risk factors for blindness on first presentation at the Duke Eye Center.

When POAG was analyzed separately from other subtypes of glaucoma, our results demonstrated potential differences in risk factors for blindness for each diagnostic group. Although race was a significant predictor of blindness in a multivariable model for both POAG and other glaucomas, higher IOP and history of diabetes were significant for other glaucomas but not POAG. Meanwhile, a 10-year increase in age was a significant predictor in presenting blind in a multivariable model for POAG but not other glaucomas. This can be expected, as there are some aggressive glaucomas associated with secondary disorders that may cause blindness in younger patients, whereas POAG has been shown to be an age-related disease.[28,29]

In our multivariable models, higher IOP at presentation was significant in predicting blindness for other glaucomas but not POAG. There is indisputable high-level evidence that higher IOP increases the risk of conversion to and deterioration of all types of glaucoma but the fact that IOP was less of a predictor in POAG than other glaucomas in our models can be explained. POAG is often diagnosed and treated by comprehensive ophthalmologists and optometrists, and some patients may be referred to a specialist only if the condition is refractory to treatment. Because the Duke Eye Center is a tertiary glaucoma service, it is likely that many patients most likely came with some degree of IOP-lowering interventions. Secondary glaucomas, however, tend to have higher IOP than POAG, and thus, in these patients it follows that a higher IOP is associated with a greater risk of presenting blind. Additionally, this might also reflect previous data indicating that some eyes with POAG can progress and potentially go blind despite lower levels of IOP.[30]

The results of our study also indicated that a history of diabetes was not a significant predictor of presenting blind for POAG but was significant for other glaucomas. This may be because other glaucomas included neovascular glaucoma, a very severe form of glaucoma where patients frequently present blind. Our study included 283 patients with neovascular glaucoma, of whom 11% were blind on presentation. Of these 283 patients, 30% had a record of having diabetes.

Importantly, our study suggests that sociodemographic characteristics also play a significant role in presenting with blindness from glaucoma. For both POAG and other glaucomas, African American / Black race was a significant predictor of presenting blind in multivariable models. However, it is important to note that this does not necessarily indicate that race itself is associated with blindness. Instead, the race variable may be measuring other socioeconomic factors that are more directly associated with presenting already blind.

In this study, annual income and education were included to explain differences in blindness risk. These variables were significant in predicting blindness in the univariable models for both POAG and other glaucomas. However, they did not remain significant in multivariable models whereas race did, indicating that they cannot explain the entire association between race and blindness. This may be because annual income and education level were crudely measured at the zip code level instead of patient-level. Thus, our adjustment for health disparity was not precise enough to explain the racial disparities in presenting blind.

Furthermore, there may be other variables that are associated with race such as access to care, medical education, and structural racism that could explain the association between race and blindness. This would be in line with what is known for most chronic diseases. In general, chronic diseases like glaucoma require access to specialized medical care, frequent ancillary testing, and expensive medical and surgical interventions. Although the effect of indirect or nonmedical costs can be more difficult to quantify, they are no less of a burden and negatively impact adherence to treatment.[31,32]

As subjects develop further into the disease course, they increasingly rely on support systems such as immediate family for office visits and use of medication. Additionally, because glaucoma is a silent, chronic disease, continued patient trust in doctors is vital for successful treatment. Yet, factors such as racial bias and the history of medical trauma in the Black community has been linked to eroded trust within Black patients, leading to lower adherence to treatment.[33,34] Finally, it has been proposed that chronic stress from racism may play a role in cardiovascular risk factors related to glaucoma.[35] Thus, structural racism may play a significant role in the disparity between Black and White patients.[36]

Higher-level education is also strongly linked to better health and determinants of health, such as health behaviors, preventative service use, and patient empowerment and advocacy.[37,38] This is especially significant for a disease like glaucoma, which is asymptomatic early on. However, because patients with low education are less likely to engage in preventative service use, they are more likely to present late for diagnosis and have a higher risk of progressing to blindness by the time they reach a tertiary center like Duke.[39] Our study highlights the influence of such socioeconomic variables in glaucoma care and the historical necessity to ensure that racial minorities and socioeconomically disadvantaged patients are properly educated about and have adequate access to eye care.

Our study did have limitations. For example, although we did have a large retrospective cohort, the data had missing values that required imputation. Nonetheless, the percentage of missingness was only in 3 risk factors, and less than 16% and the multiple imputation approach should be sufficient.[40] Additionally, there are limitations associated with the use of *ICD* codes to determine glaucoma diagnosis. This is because *ICD* codes are used for billing, not making diagnoses. As a result, there may be some coding errors in our data set, impacting the overall reliability of our data.

Furthermore, there was a lack of stratification between newly diagnosed glaucoma and previously diagnosed glaucoma within our data. Thus, we cannot be sure how long patients have had a glaucoma diagnosis before presenting to the clinic. However, because our study defines the baseline visit as the first encounter with the clinic, and not the first diagnosis of glaucoma, we are able to minimize the impact of this limitation.

Finally, because we defined our cohort as the first encounter to the glaucoma clinic, the visual fields used to define blindness may be impacted by the known learning effect associated with initial visual field testing. However, it is reasonably expected that most patients with glaucoma referred for tertiary care have had some experience with visual field testing with their primary providers, and only 182 (5%) patients were excluded because of a lack of a good quality visual field or best-corrected visual acuity measure.

There are also limitations associated with the demographic data used in the study. In particular, the demographic factors of annual income and education were crudely calculated by zip code as patient-specific data were not available. Additionally, in the clinical data, 24-2 visual field tests were used in addition to 30-2 as defined by the US SSA for the definition of blindness. The effect of this is likely small as studies have shown that 24-2 visual field tests provide comparable information to 30-2 visual field tests.[41] Finally, patients with substantial visual impairment or blindness are also often referred to specialized care for appropriate vision rehabilitation. Because Duke is a tertiary referral center, the patient population may not generalize to all glaucoma patient populations.

In conclusion, our study highlights the effect of clinical, sociodemographic, and socioeconomic variables on presentation of blindness from glaucoma at a tertiary eye center. African American / Black race, higher IOP, history of diabetes, single marital status, and lower education level were significant risks factors for blindness on first presentation for all glaucomas. However, our study also suggests potential differences in risk factors for presenting blind between POAG and other glaucomas, with older age being a more significant risk factor for presenting blind from POAG, and higher IOP and history of diabetes being more significant in other types of glaucoma. Additionally, race was a significant risk factor for both POAG and other glaucomas, though this may be due to other socioeconomic and societal factors associated with race such as access to care, income, education, and racism. These findings underscore the importance of socioeconomic variables like education and income on presenting blind from glaucoma, highlighting the need for better education and care in disadvantaged communities.

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