

# Demographic and Socioeconomic Factors, Including Workers' Compensation, as Predictors of Monocular Blindness After Open Globe Injuries

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**Objective:** To investigate the effect of demographic factors in predicting monocular blindness in patients after open globe injury (OGI) in a large tertiary ophthalmology center.

**Methods:** A retrospective chart review of patients with OGI. Clinical data collected were visual acuity, presence of globe rupture, perforating injury, and rapid afferent pupillary defect. Demographic factors included race, sex, time to follow-up, and insurance status. Primary outcome is monocular blindness with visual acuity worse than 20/200 at the last follow-up visit. Logistic regression models and univariable and multivariable analysis were performed to examine the effect of demographic characteristics.

**Results:** Four hundred and forty-three patients (mean age:  $48 \pm 22.5$  years) were included and the majority (348, 78%) were male. Patients of Black race and females were approximately twice as likely to have monocular blindness (OR: 1.9 [1.2–3.0];  $p = 0.005$  and OR: 2.0 [1.3–3.2];  $p = 0.003$ , respectively). Older individuals were more likely (OR: 1.3 [1.2–1.4];  $p < 0.001$ ) to have worse visual outcomes per each decade of life. Patients with workers' compensation were almost half as likely to have monocular blindness (OR: 0.41 [0.21–0.79];  $p = 0.008$ ), and also had significantly greater number of clinic visits (mean: 15.7 visits) than those without (mean: 11.7 visits,  $p = 0.02$ ).

**Conclusion:** Black race, older patients, and females were more likely to experience monocular blindness. Patients with workers' compensation and being Hispanic or Latino race were associated with decreased risk of monocular blindness. Combined racial and ethnic analyses showed persistent effects of non-Hispanic Blacks experiencing poor outcomes. These findings emphasize the need for a multifactorial approach in evaluating ocular trauma.

**Keywords:** open globe injury, visual outcome, demographic, insurance, workers' compensation, ocular trauma score

## Introduction

Open globe injury (OGI) is a full-thickness injury to the eyeball due to perforation, foreign body, globe rupture, or trauma.<sup>1</sup> OGIs have an incidence of 4.49 per 100,000 population, with expenditures totaling to \$793 million in an 8-year span.<sup>2</sup> For younger individuals, OGIs are commonly caused by assault, recreational or occupational injuries, while the etiology in older individuals is more commonly falls.<sup>2–4</sup>

Several demographic features such as race, sex, and age have been shown to influence visual outcome.<sup>4</sup> Patients of Black race or Hispanic ethnicity have the highest OGI incidence<sup>4,5</sup> with Black race more likely to experience monocular blindness as a result.<sup>6</sup> In terms of sex, females are more likely than males to exhibit worse outcomes.<sup>4,5</sup> Lastly, older patients were found to have poorer visual outcomes after OGI.<sup>6</sup> For these patients already in a more vulnerable position, visual impairment can extend beyond physical disability, impacting psychological, social, and economic well-being.<sup>7</sup> Deeper understanding of these demographic influences can improve care for patients with ocular injuries.

The Ocular Trauma Score (OTS) is a widely used prognostic model for estimate visual outcomes in patients with open globe injuries.<sup>3,8</sup> The presenting visual acuity (VA) is assigned a raw score, which is then adjusted for ocular comorbidities

such as the presence of an afferent pupillary defect, a ruptured globe, perforating injury, endophthalmitis, or retinal detachment.<sup>9</sup> Finally, raw scores are stratified from a range of 1 to 5, with a score of 1 representing the worst visual prognosis.<sup>9</sup> This risk stratification model effectively incorporates various presenting factors and can guide decision-making for vision preservation strategies.

There is a high prevalence of work-related OGI.<sup>7,10,11</sup> Thousands of people are blinded yearly because of work-related injuries,<sup>11</sup> yet one factor that remains unexplored in OGI outcomes is the effect of workers' compensation. The Workers' Compensation Act, commonly known as workers' compensation (WC), is an employer-provided insurance that offers financial support for job-related injuries or illnesses. This insurance is distinct from general health insurance, and patients can have one or both types of coverage.<sup>12</sup> Previous research has shown that patients with workers' compensation have more frequent clinical visits compared to those with other insurance types.<sup>13</sup> This suggests that financial incentives may lead to increased engagement with health-care providers, enabling closer monitoring of medical conditions and facilitating more timely interventions. In the context of OGI, workers' compensation coverage may encourage more consistent follow-up, potentially leading to better visual outcomes. However, no prior study has established whether workers' compensation is independently associated with the risk of monocular blindness after OGI.

This study aims to fill that gap by evaluating the role of workers' compensation alongside demographic, socio-economic and clinical risk factors in predicting long term monocular blindness after OGI. By evaluating how these diverse factors contribute to the prediction of monocular blindness in patients who sustain OGI, we can identify high risk populations and guide interventions in follow-up care.

## Methods

This was a retrospective study of patients with OGI treated at a single tertiary ophthalmology center from 2018 to 2021. The study was approved under the Institutional Review Board (IRB) at the University of Miami, # 20200719. Patients were identified based on International Classification of Diseases (ICD) or Current Procedural Terminology (CPT) codes ([Appendix A](#)). Patients included in the study had at least 3 visits: one initial presentation and two follow-up visits to ensure the observed effects were not transient, with a minimum of 3 months of follow-up. The best corrected visual acuity (BCVA) at each clinical visit was collected and was selected from the following visual acuity measurements: with correction, pinhole, or without correction, in that order. In cases of bilateral OGI, the right eye was selected for analysis due to a high prevalence of right eye dominance.<sup>14</sup> BCVA was then transformed to corresponding Logarithm of the Minimum Angle of Resolution (LogMAR) values. Additional data collected included the presence of globe rupture, perforating injury, and relative afferent pupillary defect at presentation. The demographic characteristics recorded were age, sex, race, ethnicity, time to follow-up, and insurance type.

A modified OTS was calculated by assigning a raw score of up to 100 points based on presenting VA. In accordance to the original OTS calculation, points were deducted if globe rupture, perforating injury, or relative afferent pupillary defect were present.<sup>9</sup> However, due to incomplete clinical documentation, the modified calculation did not deduct points for presence of concurrent endophthalmitis or retinal detachment, and these factors were excluded to reduce bias. Raw scores were then standardized using z-score distributions and classified into a modified OTS ranging from 1–5. Despite the omissions, the modified OTS has previously been shown to be a strong predictor of poor visual outcome, reinforcing its reliability for analysis.<sup>6</sup>

The primary outcome measure was the presence of monocular blindness at the last follow-up. It was classified as a binary variable where a VA worse than 20/200 (1.00 LogMAR) was indicative of poor outcome. The 20/200 threshold was chosen because it is considered as the criteria for legal blindness by the Social Security Administration due to the functional limitations,<sup>15</sup> and it serves as an internationally accepted benchmark for severe vision impairment.

Univariable logistic regressions were performed to examine the effect of demographic characteristics on the presence of monocular blindness. It was followed by multivariable logistic regression models to analyze statistically significant associations identified in univariable analysis. We conducted an additional sensitivity analysis by grouping race and ethnicity into a single mutually exclusive variable to capture intersectionality and its effect on monocular blindness. Statistical software used was Stata software (version 18, StataCorp LP, College Station, TX). The significance level was established at 0.05 for all statistical calculations.

## Results

The patient demographic data are included in Table 1. Of the 443 patients (mean age:  $48 \pm 22.5$  years), the majority (348 patients, 78%) were male. Although females comprised less than a quarter of the patients (98 patients, 22%), they were twice as likely (OR: 2.0 [1.3–3.2];  $p = 0.003$ ) than males to have worse visual outcomes at follow-up (Table 2). Patients of Black race represented 27% of this cohort and were almost two times (OR: 1.9 [1.2–3.0];  $p = 0.005$ ) more likely to have monocular blindness than White patients. On the contrary, Hispanic patients were half as likely (OR: 0.47 [0.32–0.69];  $p < 0.001$ ) to have adverse visual outcomes. When race and ethnicity were grouped together, non-Hispanics Whites were almost twice as likely (OR: 1.8 [1.1–2.8];  $p = 0.017$ ) than Hispanic Whites to have worse visual outcomes (Table 3). Furthermore, non-Hispanic Blacks were nearly three times more likely (OR: 2.7 [1.6–4.5];  $p < 0.001$ ) than White Hispanics to experience monocular blindness.

Older individuals were more likely (OR: 1.3 [1.2–1.4];  $p < 0.001$ ) to have worse visual outcomes than younger individuals per each decade of life. The most common cause is due to falls, which was almost three times more likely than other causes (OR: 2.7 [1.04–7.1];  $p = 0.041$ ). Workers' compensation acted as a protective factor, as these patients were almost half as likely to have a poor visual outcome (OR: 0.41 [0.21–0.79];  $p = 0.008$ ). Patients with workers' compensation also had significantly more frequent clinic visits (mean: 15.7 visits) than those without workers' compensation (11.7,  $p = 0.02$ ). When

**Table 1** Patient Demographics

	N	Percentage (%)	Mean	Standard Deviation
<b>Age (years)</b>	443		48	22.5
<b>Sex</b>				
Male	348	78.0		
Female	98	22.0		
<b>Race</b>				
White	306	72.9		
Black	114	27.1		
<b>Ethnicity</b>				
Not Hispanic or Latino	226	51.6		
Hispanic or Latino	212	48.4		
<b>Workers' Compensation</b>				
Yes	42	9.4		
No	404	90.6		
<b>Insurance Status</b>				
Not Insured	145	32.6		
Public	167	37.5		
Private	133	29.9		

**Table 2** Logistic Regressions

Predictor	Odds Ratio	Confidence Interval (95%)	p value
Age per decade	1.31	1.19–1.44	<b>&lt;0.001</b>
Female	2.02	1.26–3.22	<b>0.003</b>
Black	1.90	1.21–2.97	<b>0.005</b>
Hispanic or Latino	0.47	0.32–0.69	<b>&lt;0.001</b>
Workers' Compensation	0.41	0.21–0.79	<b>0.008</b>

**Note:** Significant effects are in bold.

**Table 3** Race and Ethnicity Groupings

Predictor	Odds Ratio	Confidence Interval (95%)	p value
White, Hispanic	Reference	—	—
White, Not Hispanic	1.76	1.11–2.81	<b>0.017</b>
Black, Not Hispanic	2.70	1.61–4.53	<b>&lt;0.001</b>
Black, Hispanic	1.09	0.38–3.15	0.868

**Note:** Significant effects are in bold.

**Table 4** Insurance Comparison

Predictor	Odds Ratio	Confidence Interval (95%)	p value
Workers' Compensation	Reference	—	—
Public	3.75	1.83–7.70	<b>&lt;0.001</b>
Private	2.13	1.83–7.70	<b>&lt;0.001</b>
Not Insured	1.62	0.77–3.40	0.203

**Note:** Significant effects are in bold.

comparing other insurance types to workers' compensation, patients with public insurance (OR: 3.8 [1.8–7.8];  $p < 0.001$ ) and private insurance (OR: 2.1 [1.8–7.7];  $p < 0.001$ ) had greater risk of experiencing monocular blindness. There was no difference between having no insurance and having workers' compensation ( $p > 0.05$ ) (Table 4).

Multivariable regression analysis demonstrated a significant association between lower OTS classification and the presence of monocular blindness at last follow-up (OTS class 1 OR: 21 [7.3–63.1];  $p < 0.001$ ), indicating that the modified OTS is a reliable prognostic tool for poorer visual outcomes (Table 5). Older age was associated with worse

**Table 5** Multivariable Regressions with Racial and Ethnic Grouping

Predictor	Odds Ratio	Confidence Interval (95%)	p value
<b>Age per decade</b>	1.24	1.10–1.41	<b>0.001</b>
<b>Sex</b>			
Male	1 (base)		
Female	0.87	0.46–1.65	0.679
<b>Race &amp; Ethnicity</b>			
White, Not Hispanic	1 (base)		
White, Hispanic	0.89	0.49–1.63	0.710
Black, Not Hispanic	2.06	1.00–4.24	<b>0.049</b>
Black, Hispanic	0.818	0.18–3.70	0.793
<b>Insurance</b>			
Workers' Compensation	1 (base)		
Not Insured	1.66	0.63–4.38	0.306
Public	0.91	0.48–1.70	0.763
Private	1.22	0.45–3.33	0.692
<b>Ocular Trauma Score</b>			
1	21.46	7.30–63.11	<b>&lt;0.001</b>
2	28.24	9.49–86.10	<b>&lt;0.001</b>
3	5.53	1.88–16.27	<b>0.002</b>
4	2.88	0.84–9.95	0.094
5	1 (base)		

**Note:** Significant effects are in bold.

visual outcomes (OR: 1.2 per decade older [1.1–1.4];  $p < 0.001$ ), and Black non-Hispanic patients were found to be twice as likely to experience monocular blindness (OR: 2.1 [1.0–4.2];  $p = 0.049$ ) as compared to White non-Hispanic patients. No significant effect was observed when sex and age were combined ( $p = 0.957$ ).

## Discussion

In this study, we investigated the demographic, clinical, and socioeconomic factors associated with monocular blindness following open-globe injury in patients presenting to a large tertiary ophthalmology center. These findings highlight the multidimensional challenges in predicting visual prognosis at presentation and emphasize the need for a holistic approach to care and risk assessment. Our research has the potential to enhance prognostic models and provide more personalized care for high-risk populations.

Sociodemographic status has been shown to play a significant role in shaping visual outcomes after OGI and may reflect broader social and systemic factors.<sup>5</sup> Consistent with previous studies, we found that Black patients faced nearly twice the risk of monocular blindness compared to White patients.<sup>4,6</sup> This disparity may be attributed to systemic barriers to care, socioeconomic inequalities, or differences in injury severity.<sup>16</sup> Interestingly, we found that the Hispanic patients were half as likely to experience monocular blindness and that the Hispanic race may act as a protective factor. The positive outcomes indicate an extension of the Hispanic paradox in OGI, which is often attributed to strong support from the cultural community.<sup>17</sup> Emerging data suggests that acculturation can moderate disease risk by buffering economic and environmental stressors commonly faced by this population.<sup>18</sup> This group has also been found to have lower rates of anxiety and better mental health overall.<sup>19</sup> Given that OGIs are generally traumatic experiences, the social support and resilient mindset associated with this community may be critical in the recovery process.

We further compared visual outcomes across groups by analyzing race and ethnicity together. As expected, White Hispanic patients exhibited the best visual outcomes, which may reflect a combined protective effect of both White racial and Hispanic ethnic backgrounds. In contrast, non-Hispanic White and non-Hispanics Black patients demonstrated significantly higher risk of poor visual outcomes. This is notable because White race is generally considered protective when analyzed alone, yet it exhibited similar outcomes to patients Black race when ethnicity was incorporated. These results suggest that the Hispanic ethnicity may offer an even stronger influence than previously recognized. Interestingly, Hispanic Black patients, who often have a sociodemographic profiles similar to non-Hispanic Blacks,<sup>20</sup> did not experience the same level of adverse outcome in our study. This finding may further support the idea that Hispanic ethnicity provides some protection in the setting of ocular trauma. Recommendation for future studies would be to investigate race and ethnicity as a combined group to better understand these effects.

Age and sex were also strongly associated with visual outcomes.<sup>5</sup> We found that older individuals and female sex were associated with worse visual outcomes, which have been previously demonstrated in literature.<sup>4–6</sup> In patients over 65 years of age, the most common cause of injury was due to falls, consistent with prior studies.<sup>2–4,21</sup> The result is further corroborated by the data presented in Table 4 comparing the various insurance types, as individuals with Medicare (for those aged 65 and older) exhibited a significantly higher risk of monocular blindness. For females, falls were also the most common cause of injury, with the majority occurring in the home. Research indicates that females are 1.5 times more likely to experience falls as compared to males,<sup>21</sup> and this risk increases with age.<sup>22</sup> We also hypothesize that intimate partner violence (IPV) among women, which predominantly takes place in domestic settings, could be another potential contributing factor. Approximately 30.6% of females experience IPV<sup>23</sup> and nearly 45% of these encounters involve ocular trauma, including OGI.<sup>24</sup> Based on these findings, female patients presenting with OGI should be screened for IPV during their treatment, as IPV may indirectly contribute to the poor visual outcomes observed in this group.

Patients with workers' compensation had significantly better visual outcomes following OGI.<sup>4</sup> This result contrasts with findings from patients with orthopedic or spinal conditions who have reported worse health outcomes and greater dissatisfaction with care.<sup>13,25</sup> The negative outcomes have been attributed to difficulty navigating the compensation system, which can lead to mental stress and physical harm.<sup>26</sup> In our patient sample, one possible explanation for the positive findings is that patients with workers' compensation had significantly more frequent clinical visits as compared to other insurance types. Increased clinical visits have been previously associated with decreased rates of mortality following an Emergency Department discharge.<sup>27</sup> While physicians dictate the level of follow-up care, financial barriers

may limit patient adherence. Workers' compensation may reduce this burden by providing more comprehensive financial support, including wage replacement, which may encourage patients to comply with follow-up care without financial strain.<sup>28</sup> In addition, given the nature of vision-threatening injuries, patients may also receive greater social work support in claiming compensation, as societal support is more robust in promoting independence for those with visual disability as compared to physical.<sup>29</sup> The protective effects of WC is especially notable when compared to the other health insurance statuses, as both public and private insurance were associated with higher odds of monocular blindness. However, no difference was observed for the uninsured group. While seemingly counterintuitive, it could reflect our sampling criteria requiring at least 3 visits for inclusion. Patients without insurance who completed at least 3 visits likely represented a healthier and more motivated subgroup, which would explain the observed relationship.

When sociodemographic variables and ocular trauma severity were analyzed together, age, non-Hispanic Blacks and OTS remained predictive of visual outcomes. The age-related outcomes can be attributed to an increased risk of falls and subsequent injury in older individuals. The OTS reflects that recovery prognosis is largely dependent on the severity of the initial presenting symptoms. However, the borderline significance of race and ethnicity presented an interpretation challenge because these results suggest a possible interaction between demographic and socioeconomic risk factors, which may confound each other. This finding underscores the importance of considering intersectionality, rather than analyzing them as entirely independent variables. Our results emphasize the importance of considering latent interactions and highlight the need for a multifactorial approach in evaluating ocular trauma. Such an approach would allow a more accurate understanding of how sociodemographic and clinical variables influence visual prognosis.

Several limitations should be noted. This was a retrospective study conducted at a single site, which may introduce biases and limit the generalizability of the results. In addition, patients were required to have a minimum number of follow-up visits and a specified follow-up duration, which may have introduced selection bias by excluding those with rapidly deteriorating or markedly improving injuries. Given the lack of pre-injury ophthalmic records for most patients, we assumed that visual function prior to trauma was normal and that the unaffected eye reflects the patient's baseline visual potential. Our study also used a modified OTS that excluded endophthalmitis and retinal detachment, which were part of the original criteria and can affect the predictive power of the scoring system. Finally, the data in this study were recorded from electronic health records and patient-reported information, which may introduce potential biases. Variations in treatment of care were not systematically documented, which could influence the visual outcomes.

## Conclusion

In this study from Miami, Florida, we explored the effect of various sociodemographic factors on monocular blindness after OGI. We found that Black race, advanced age, and females were more likely to experience monocular blindness. Workers' compensation and Hispanic ethnicity, however, appeared to serve as protective factors. Combined analyses highlighted the complex interplay between demographic, socioeconomic, and clinical risk factors in predicting visual outcomes. These interactions may not be immediately apparent and could contribute to disparities in recovery and prognosis following OGI. These findings emphasize the importance of a holistic evaluations at the time of OGI presentation, including detailed stratification of insurance status with specific attention to workers' compensation coverage. Additionally, future studies should incorporate interpersonal violence assessments to better understand its potential impact on visual outcomes. Additional research is needed to understand the underlying mechanisms driving disparities in recovery with the goal of identifying and mitigating the factors contributing to worse outcomes among high-risk populations.

## Institutional Review Board Statement

This study received Institutional Review Board approval from the University of Miami, #20200719. Patient consent was not required due to the retrospective nature of the review, and the data was maintained with confidentiality. The study adhered to the tenets of the Declaration of Helsinki.

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## Disclosure

All authors report no conflicts of interest concerning the materials or methods used in this study or the findings specified in this paper.

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