Sociodemographic and Economic Determinants of Penetrating Keratoplasty Outcomes

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Introduction

- Corneal transplantation is the most commonly performed solid-tissue transplant procedure in the world.

- Penetrating keratoplasty (PK) is a full-thickness transplant of the cornea and is the conventional method of transplantation, for which leading indications include pseudophakic bullous keratopathy with scarring, keratoconus, and infectious keratitis.[1]

- Multiple large studies have investigated long-term PK graft rejection and survival rates as well as pertinent risk factors.[2-4]
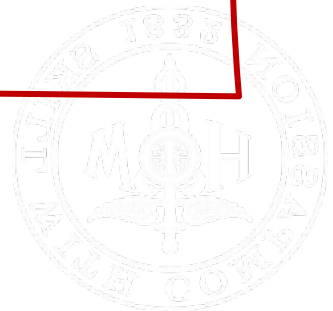
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Introduction

- Economic inequality in the United States is among the highest of developed nations, and there is a life expectancy gap of 10-15 years between the wealthiest and poorest 1% of the American population.[5,6]

- In addition to income, factors including race, sex, ethnicity, primary language, education, housing, employment and heath insurance status have been shown to have a significant association with general health outcomes.[7,8]

- The literature on associations between sociodemographic and economic factors and ophthalmic health outcomes is limited.[9,10]

Purpose

The aim of this study was:

- To determine the potential impact of sociodemographic and economic factors on graft survival after PK.

- **Design:**

  ➢ Retrospective single center case series.

- **Inclusion Criteria:**
  1. Consecutive patients who were treated at Wills Eye Hospital with PK between **December 2001** and **November 2018**.
  2. Patients who had undergone PK in both eyes or multiple PKs, only had **the first PK of the first** eye included.

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Patients and Methods

- **Study Groups**:
  - ➢ Yearly regional average adjusted gross income (AGI) was determined by cross-referencing the patient's self-reported residential zip code with the average AGI per zip code supplied by the Internal Revenue Service.

  - ➢ Two groups were created:
    1. **Lower AGI group:** those living in neighborhoods with the lowest 10% of AGI (**N = 82**) with average household income of **$32,100 ± 4,000**.
    2. **Higher AGI group:** the remaining 90% of individuals (**N = 740**) with average household income of **$86,900 ± 52,200**.

Patients and Methods

- **Study Groups**:
  - ➤ The United States government's federal **poverty line** is one of the most commonly-used markers of poverty and is calculated by finding the total cost of all the essential resources that an average human adult consumes in one year.

  - ➤ Our classification was based on the United States poverty line guidelines in 2021, which classified a family of four with a household income of **$26,500** as "poor".

  - ➤ The lower income group represented individuals who lived in neighborhoods with an average AGI near the United States poverty line, while the higher income group represented those above the United States poverty line.[11,12]

- **Main outcome measures**:
  - ➤ The primary outcome measure was **graft failure** defined as visually-significant and irreversible stromal edema, haze, or scarring.

  - ➤ Stromal edema that improved with topical steroids was not considered to be graft failure, and peripheral edema that did not affect visual acuity was also excluded from this definition.

  - ➤ The date of graft failure was the first postoperative visit with a documented clinical finding of edema, haze, or scarring that eventually led to graft failure.

Results

- A total of **822** patients **(822 eyes)** were included with a mean age of **57.1 ± 22.1 years**.

- Over **4.2 ± 3.1** years, graft failure occurred in **35.3%** of eyes.

- Age, sex, diabetes, smoking, traumatic injury or burn history were comparable between groups (**all P>0.05**).

- Black race was more common in the lower income group (**50.0% vs 11.5%, P<0.001**).

Table 1. Baseline Characteristics in the Lower and Higher AGI Groups

		Lowe AGI	Higher AGI	Total	P-value
Number of Eyes		82	740	822	
Number of Patients		82	740	822	
Average Growth Income: $		32,100±4,000	86,900±52,200	81,500± 52,200	**<0.001**
Age: Years		53.5±20.1	57.5±20.3	57.1 ± 22.1	0.116
Sex (females): N (%)		37 (45.1)	379 (51.2)	409 (50.5)	0.298
Race: N (%)	White	18 (22.0)	499 (67.4)	517 (62.9)	**<0.001**
	Black	41 (50.0)	85 (11.5)	126 (15.3)	
	Asian	2 (2.4)	17 (2.3)	19 (2.3)	
	Other	21 (25.6)	139 (18.8)	160 (19.5)	
Diabetes: N (%)		17 (20.7)	97 (13.1)	144 (13.9)	0.064
Smoking: N (%)		17 (20.7)	132 (17.8)	149 (18.1)	0.545
Traumatic Eye Injury : N (%)		7 (8.5)	53 (7.2)	60 (7.3)	0.653
Chemical Burn: N (%)		0 (0.0)	4 (0.5)	4 (0.5)	1.000

Results

- Definite graft rejection and graft failure were higher in the lower AGI group, but the difference didn't reach the significance level (**P=0.068** and **P=0.145, respectively**).

- Time to failure and the mean follow-up duration were similar in both groups (**all P>0.05**).

Table 2. Main Outcome Measures in the Lower and Higher AGI Groups

	Lower AGI	Higher AGI	Total	P-value
Number of Eyes	82	740	822	
Number of Patients	82	740	822	
Possible Rejection: N (%)	24 (29.3)	208 (28.1)	232 (28.2)	0.797
Definite Rejection: N (%)	37 (45.1)	255 (34.5)	292 (35.5)	0.068
Failure: N (%)	35 (42.7)	255 (34.5)	290 (35.3)	0.145
Time To Failure: Months	10.4±12.8	10.4±17.0	10.4±17.0	0.991
Follow-up Duration: Years	4.0±2.7	4.2±3.1	4.2±3.1	0.469

Results

- Multivariate logistic regression analysis identified ocular and sociodemographic and economic predictors of graft failure.

- The latter included:

  1. Younger age (**P=0.025**).

  2. Black race (**P=0.014**).

  3. Lower income neighborhood (**P=0.014**).

Table 3. Predictors of Graft Failure Using Multivariate Regression Analysis

	Wald	P-value	Hazard Ratio	95% Confidence Interval	
				Lower	Upper
Sociodemographic and Economic Factors					
Age	5.042	**0.025**	0.988	0.978	0.998
AGI Group	6.041	**0.014**	0.48	0.267	0.862
Race (White, Reference)	7.194	0.066			
Race (Black)	6.023	**0.014**	1.756	1.12	2.754
Race (Asian)	2.334	0.127	1.615	0.873	2.988
Race (Others)	3.165	0.075	2.713	0.903	8.148
Ocular Factors					
Glaucoma	14.304	**<0.001**	2.158	1.448	3.214
Prior Anterior Segment Surgery	11.99	**0.001**	2.541	1.499	4.307
Prior Glaucoma Surgery	11.996	**0.001**	2.338	1.446	3.782
Neovascularization	4.999	**0.025**	1.219	1.025	1.45
Active Microbial Infection	57.534	**<0.001**	8.42	4.855	14.603
Silicone Oil	10.584	**0.001**	12.521	2.731	57.402
Anterior Chamber Intraocular Lens	8.81	**0.003**	3.13	1.473	6.65
Posterior Chamber Intraocular Lens	5.416	**0.020**	1.971	1.113	3.491
Aphakia	17.357	**<0.001**	4.498	2.217	9.126

Discussion

- Higher burdens of illness, disability, and mortality have been associated with lower socioeconomic status across the medical specialties.[13]

- The ophthalmic literature on the association between sociodemographic and economic factors and clinical presentation, surgical outcomes, and adherence to treatment is limited.[9,10]

- Our study analyzed a possible relationship between income and surgical outcomes of PK and found that despite similar preoperative characteristics in the two groups, the lower income group was more vulnerable to graft failure after PK in the multivariate model.

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Discussion

- Race was the only significantly different baseline characteristic between groups as Blacks were more prevalent in the lower AGI group, whereas white race was more common in the higher AGI group.

- It is possible that the lower income group had a higher proportion of black race (P<0.001), which may have affected surgical outcomes. Previous studies have suggested that black race may be associated with higher failure rate after Descemet stripping endothelial keratoplasty.[14]

- Low socioeconomic status was shown to be a contributing factor for the poorer outcome of PK in patients with bilaterally blinding corneal disease compared to those who are unilaterally blind.[15]

Conclusion

- To our knowledge, this is the first study to investigate an association between sociodemographic and economic factors and surgical outcomes of PK on a large scale.

- PK graft prognosis demonstrated a strong association with sociodemographic and economic factors.

- Younger patients, those of black race, or lower income may be more vulnerable to graft failure after PK.

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