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Blindness And Poverty: An Outreach-Based, Case-Control Study Assessing The Relationship Between Poverty And Visual Impairment From Cataract In Greater Accra, Central, Eastern, Western, Volta, And Ashanti Regions Of Ghana

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Blindness and poverty: An outreach-based, case-control study assessing the relationship between poverty and visual impairment from cataract in Greater Accra, Central, Eastern, Western, Volta, and Ashanti regions of Ghana

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Abstract

Background

Blinding cataracts have been linked to poverty, and are the most common form of preventable blindness in the developing world. The WHO has identified cataract surgery as one of the top five potential public health interventions in developing countries; however, studies exploring the initial economic attributes before cataract surgery and subsequent outcomes following the sight-restorative surgery in the developing world have not been undertaken. This study assesses the baseline economic and sociodemographic attributes of a cohort of 267 cataract cases in rural villages throughout southern Ghana and compares them with 100 controls to test whether those with existing cataracts are more likely to be impoverished than their peers. Furthermore, this study explores the economic and sociodemographic differences of patients who elect to undergo subsidized cataract surgery compared to those who referred for cataract surgery, but do not undergo the operation.

Methods and Findings

An outreach-based case-control study recruited 100 control patients and 267 cataract patients at village eye care outreaches in the months of June, July, and August 2011. Cases and controls were both 20 years or older, with cases having been diagnosed with a dense/blinding cataract. Controls were excluded if they were diagnosed with a dense/blinding cataract or if their visual acuity was 20/200 or worse. Enrolled patients completed a questionnaire where the Ghana-specific Poverty Scorecard was used to indirectly assess likelihood of poverty (defined as $2.50/day purchasing power parity (PPP)). Chi-square and multivariate logistic regression showed that cases were more likely to be living below the poverty line than controls (OR 0.91 (CI 0.89, 0.94)) and were 7.29 (CI 2.89, 18.62) times as likely to be in the lowest quintile of poverty. Among cases, unadjusted OR showed that those who underwent surgery were more likely to live bellow the established poverty level than those who did not go for surgery (OR 0.96 (CI 0.93, 0.98), p=0.0392)), however, this was no longer significant when controlling for age, sex, household size, and chorionic disease status (OR 0.97 (CI 0.94, 1.00) p=0.0974). Those that went for surgery were more often male (OR 2.54 (CI 1.09, 5.95) and unemployed (OR 5.62 (CI 1.55, 20.44).

Conclusions

Data from this study suggests that poverty and blindness from cataracts are linked in rural villages in Ghana. Whether the downward economic trends associated with cataracts are reversed following surgery remains a valuable question that will be explored in subsequent follow-up with this cohort. Additionally, evidence suggests that future interventions and policies should target women in the uptake of the sight-restoring surgery.

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Background

Blindness is one of the most common disabilities throughout the world and represents a significant global health issue. Conservative estimates suggest that nearly 39 million people live with blindness worldwide, with an additional 285 million suffering from extremely poor vision.[1,2] The economic and social costs of unnecessary blindness throughout the world is staggering. Approximately 90% of the blind are unable to work, leading to financial insecurity, decreased productivity, social isolation, and increased morbidity.[3] It is projected that without appropriate action, the global level of blindness would double by 2020, resulting in economic losses close to US$250 billion.[4] Significant barriers to eye care within the developing world--including lack of adequate health infrastructure, high costs for services, limited transportation, and misinformation about eye health--have placed much of the global burden of blindness upon communities and individuals in the throes of poverty. [5,6]

While blindness is a devastating condition, with the proper care and treatment, more than 80% of cases can be reversed.[2,7] This represents a significant potential public health and economic opportunity. While there are many preventable/treatable causes of blindness, dense cataracts represent the largest portion with 51% of all cases of blindness—approximately 20 million people worldwide.[4,7,8] Cataracts occur when the lens of the eye becomes cloudy or opaque, limiting the amount of light entering the eye and making focusing of the light strained. Within more developed countries, where eye care services abound, cataracts are typically diagnosed early and treated before developing into a blinding, dense lens.

Cataracts are associated with a number of risk factors including old age and diabetes.[1,2,9,10] In the developing world the disease often affects younger patients due to increased exposure to harmful environmental sources (UV radiation, biofuel smoke, harsh chemicals) and potential genetic predisposition.[4,9,11] Furthermore, with the reduction of major infectious diseases throughout the world and subsequent increased quality of life, many more people are living longer, increasing their likelihood of developing blinding cataracts.

Treatment is relatively simple, though it does require a skilled ophthalmic surgeon. During the procedure, the damaged lens is removed and an artificial lens is inserted. The procedure requires only topical anesthetics and typically lasts 15 minutes from start to finish. Costs are minimal (approximately US$15), and the potential gain is very large.[10] The WHO has identified cataract surgery as one of the five most cost-effective health interventions throughout the world, with Sub-Saharan Africa estimated with a cost effectiveness of $91 to $106 for quality-adjusted life years (QALY).[2,5,9] In developing countries, significant barriers to eye care, most notably cost and poor infrastructure, have led to continued high rates of cataract-related blindness.[12,13]

The WHO notes that in the poorest nations of the world—particularly those in sub-Saharan Africa and Asia--cataracts account for at least half of all blindness, despite the established technology that can restore vision at an extremely low cost.[14] In Ghana, blindness from cataracts affects nearly 105,000 people, with 21,000 new cases annually.[8] Although cataracts can be surgically removed, in Ghana surgical services are inadequate, where there are only 16 ophthalmologists for a population of nearly 25 million people.[12] The high prevalence of cataracts among Ghanaians mixed with significant barriers to care and limited access to services has led to an extensive backlog of patients with blinding cataracts in need of the sight-restoring surgery.[15]

Previous research has suggested that there is an association between poverty and the presence of blinding cataracts.[16,17] In a case-control study in Kenya and Southeast Asia, Kuper and Pollack and colleagues point out that cataract blindness was associated with higher unemployment and lower standards of living.[11] A growing body of research has begun to examine the relationship between poverty and preventable blindness in partnership with interventions aiming to reduce preventable blindness in high needs areas. Recent studies have shown a significant relationship between poverty levels and the presence of cataracts; however, such a study has never been undertaken in Western Africa and in Ghana specifically, where cataract prevalence has been estimated to be among the highest in the world.[16,18,19]

This study examines the association between poverty level and the presence of cataracts in patients attending village outreaches in the Greater Accra, Central, Eastern, Western, Volta, and Ashanti regions of Ghana, in association with the Crystal Eye Clinic and Unite For Sight. Unite For Site is a non-profit that assists local eye clinics to screen for common eye aliments and provide free or minimal costs treatments in countries where significant barriers to eye treatment exist. Their work in association with the Crystal Eye Clinic in Accra, Ghana has established Unite For Sight as the major provider of cataract surgeries in Ghana, accounting for 46% of all surgeries in the country. [20]

The primary hypothesis of this study is that those presenting with cataracts at village outreaches in southern Ghana are more likely to live below the established level of poverty ($2.50/day PPP) as measured by the Ghana-specific Poverty Scorecard than those without cataracts. Furthermore, this study also explores whether those diagnosed with cataracts and subsequently undergo cataract surgery have a lower poverty score value than those diagnosed with cataracts, but choose not to undergo sight-restoring surgery.

Methods

Type of Study

Outreach-based, case-control study

Setting

Case and control participants were recruited through village outreaches in the Greater Accra, Central, Eastern, Western, Volta, and Ashanti regions of Ghana in association with the Crystal Eye Clinic and Unite For Sight—the leading providers of cataract surgery in Ghana. Villages were selected in coordination with the Crystal Eye Clinic and its outreach team. Outreaches took place with trained ophthalmic staff in remote villages, and consisted of a meeting with village elders/leaders; village eye care education led by local staff; visual acuity screening; examination of patients by ophthalmic nurse/optometrist; and eyeglass and medication dispensing. Participants were enrolled from 28 villages from 1 June through 10 August 2011.

Selection of Cases and Controls

All participants underwent visual acuity (VA) testing and ophthalmic examination by local eye doctors, which is standard procedure. The visual acuity, diagnosis, and principal cause of blindness or visual impairment were recorded in the eye doctor's standard records.

Patients were eligible for inclusion as cases if they were 20 years or older presenting with cataract visual impairment, were advised by the eye doctor to receive cataract surgery, and had a visual acuity worse than 20/200 in both eyes. All eligible cases identified through this process were invited to participate in the study. Inclusion criteria for controls included individuals seeking eye care at village outreaches who were 20 years or older with no evidence of cataract visual impairment and had a visual acuity of better than 20/200 in one or both eyes. All case and control participants gave informed consent in order to be enrolled into this study.

Case and control participants who had significant communication impairments (e.g. deafness, dementia, or psychiatric disease) were excluded (n=4). Also, those with missing data respect to age were excluded during the analysis portion of this study (n=2).

Data Collection

All case and control participants were interviewed in English by the researcher with a Unite For Sight local community ambassador or Crystal Eye Clinic staff member serving as translator.

Measures of Poverty

Poverty was measured through the Ghana-specific Simple Poverty Scorecard. For the purposes of analysis, poverty scorecard values were separated into quintiles. The use of the poverty scorecard is an efficient, cost-effective method of assessing poverty levels using indirect indicators of poverty.[21] The scorecard has been validated in previous studies and is recognized as an accurate and appropriate way that can quickly monitor poverty.[22–24] The measure of US $2.50/day PPP was established as the poverty level for this study, which is in line with analogous studies in Sub-Saharan Africa, and follows USAIDs standard procedure.[25]

Sociodemographic data were also collected from patients including data on education and employment using a questionnaire. Information was also collected on vision-related quality of life using World Health Organization Prevention of Blindness and Deafness 20-item Visual Functioning Questionnaire.[14]

Statistical Analysis

Quintiles of poverty scores were calculated to assess whether answers were plausible, and to identify and exclude potential outliers. McNemar's chi-square test was used to test the primary and secondary hypotheses, as well to determine significance of relevant variables. Additionally, multivariate logistic regression analyses were conducted to assess the association between case/control status and likelihood of being found in the lowest quintile of poverty scorecard values. Likelihood ratio tests were used to assess the significance of adding covariates with more than two levels (e.g. age groups). Also, tests for trend across quintiles of poverty variables using p-values was assessed. Finally, in an attempt to help better define the relationship between poverty and cataracts, the data was stratified by cases that actually underwent surgery, age, sex, and level of visual impairment among the cases.

Data was inputted using Excel 2010 and analyzed using SAS version 8.2.

Results

Analysis of the data supported the primary hypothesis that those diagnosed with cataracts were more likely to be at a lower economic level than cases. These results were significant when adjusting for age, gender, chronic diseases and household size (p<0.0001). Further analysis of the data initially suggested that those utilizing minimal-cost, sight-restoring cataract surgery were at a lower poverty level than those refusing treatment; however, after adjusting for age, gender, marital status, employment status, chronic disease, and household size, the difference was no longer significant (p=0.0974).

Overall Characteristics Of Sample

Case and control participants were taken from the same population and shared many of the same sociodemographic characteristics. Cases were oversampled at a rate nearly 5:2. In total there were 267 cases and 100 participants without cataracts (Table 1). The overall sample was predominantly women: 63% with a mean age of 65.15 (± 15.24) years. Almost half of participants were currently employed, with 27% retired and 20% unemployed. Sixty-five percent of participants reported not having a chronic condition, however 22% had been diagnosed with hypertension and nearly 11% with diabetes. The average household size was just over 7 people. The mean poverty score value for the sample was 41.92, which corresponds to an approximate 66% average likelihood of living below $2.50/day PPP.

Table 1 Description of sample (cases and controls).

Characteristic	n (%)[a]
Cataract	267 (72.75)
No Cataract	100 (27.25)
Age (years), mean ± SD	65.15 (15.24)
Sex	
Male	135 (36.78)
Female	232 (63.22)
Literacy	
Literate	178 (48.50)
Illiterate	195 (53.13)
Marital status	
Married	177 (48.23)
Widowed	120 (32.70)
Never married	68 (18.53)
Household size, mean ± SD	7.21 (3.53)
Employment Status	
Employed	186 (50.82)
Retired	100 (27.32)
Unemployed	74 (20.16)
Student	6 (1.63)
Chronic conditions	
None	240 (65.40)
Diabetes	40 (10.90)
Hypertension	82 (22.34)
Arthritis	25 (6.81)
Best vision	5.23 (2.39)
Poverty Scorecard Value, mean ± SD	41.92 (13.14)
By quintile, mean ± SD	
1	26.37 (3.94)
2	34.51 (1.85)
3	40.25 (1.36)
4	47.63 (2.86)
5	62.51 (7.53)

[a] Percentages may not add to 100 due to rounding.

Primary Hypothesis

Sociodemographic Characteristics of Cases and Controls

Comparing cases and control groups yielded some interesting differences (Table 2). Notably, cases were significantly more likely to be older than the comparison group: 69.36 (±11.93) vs. 53.93 (± 17.35). The largest age group for those diagnosed with cataracts was 70-79 years old (48% of group sample) while the largest age group among comparison was 60-69 (26%). A greater proportion of cases were also illiterate (62% vs. 29%) and widowed (43% vs. 37%). The groups had a similar breakdown in terms of gender (approximately 35% male and 65% female).

Table 2 Description of cases and controls with *p*-value assessing heterogeneity between groups.

Characteristic[a]	Cataracts[b] 267 (72.75)	Comparison[b] 100 (27.25)	*p*-value[c]
Age (years), mean ± SD	69.36 (11.93)	53.93 (17.35)	< 0.0001
Age			<0.0001
20-39	6 (2.40)	22 (22.22)	
40-49	9 (3.60)	12 (12.12)	
50-59	27 (10.80)	23 (23.23)	
60-69	59 (23.60)	26 (26.26)	
70-79	120 (48.00)	14 (14.14)	
80 +	29 (11.60)	2 (2.02)	
Sex			0.4984
Male	101 (37.83)	34 (34.00)	
Female	166 (62.17)	66 (66.00)	
Literacy			< 0.0001
Literate	101 (37.83)	71 (71.00)	
Illiterate	166 (62.17)	29 (29.00)	
Marital status			< 0.0001
Married	118 (44.19)	46 (46.00)	
Widowed	116 (43.45)	37 (37.00)	
Never married	31 (11.61)	17 (17.00)	
Household size	7.71 (3.74)	5.87 (2.45)	<0.0001
Employment Status			< 0.0001
Employed	115 (43.07)	71 (71.72)	
Retired	87 (32.58)	13 (13.13)	
Unemployed	65 (24.34)	9 (9.09)	
Student	0	6 (6.06)	
Chronic conditions			< 0.0001
None	158 (59.18)	82 (82.00)	
Diabetes	35 (13.11)	5 (5.00)	0.0265
Hypertension	70 (26.22)	12 (12.00)	0.0036
Arthritis	24 (8.99)	1 (1.00)	0.0068
Best vision, mean ± SD	6.06 (2.35)	3.01 (2.48)	<0.0001
Visited eye doctor	153 (57.30)	17 (85.00)	0.0150
Visited traditional healer	96 (36.50)	8 (20.51)	0.0499
Monthly spending on healthcare ($US), mean ± SD	40.59 (33.38)	39.25 (42.59)	0.8292
Poverty Scorecard value, mean ± SD	38.06 (10.81)	52.23 (13.31)	< 0.0001
PSC by quintile by case status, mean ± SD			<0.0001
1	24.93 (3.61)	26.37 (3.94)	
2	32.53 (1.59)	34.51 (1.85)	
3	37.62 (1.17)	40.25 (1.36)	
4	42.68 (1.83)	47.63 (2.86)	
5	54.75 (7.72)	62.51 (7.53)	
PSC by quintile			<0.0001
1	74 (27.72)	5 (5.00)	
2	66 (24.72)	13 (13.00)	
3	52 (19.48)	11 (11.00)	
4	53 (19.85)	20 (20.00)	
5	22 (8.24)	51 (51.00)	

[a] Table values are mean ± SD for continuous variables and n (column %) for categorical variables.
[b] Percentages may not sum to 100% due to rounding.
[c] P-value is for t-test (continuous variables) or χ^2 test (categorical variables).

Household And Economic Characteristics of Cases and Controls

Differences between cases and controls in household and economic measures were also noteworthy. Those with blinding cataracts were more likely to be unemployed (24% vs. 9%) with a majority of cases (82%) that were unemployed reporting that their eyesight was the major factor in them losing their job. Household size was also significantly different between cases and controls: 7.7 ± 3.7 vs. 5.9 ± 2.5, respectively.

Healthcare Characteristics of Cases and Controls

While cases and controls shared some important sociodemographic qualities, they differed in their general health, access to health services, and health spending. Forty-one percent of cases reported being diagnosed with a chronic disease (diabetes, hypertension, or arthritis), while only 18% of cases reported such. Controls had significantly better visual acuity, and a greater proportion of participants reported ever going to an eye doctor (85% vs. 57%). Interestingly, a greater proportion of cases reported having visited a traditional/local healer within the past year (37% vs. 21%). Differences in healthcare spending between the two groups were not significant; however, healthcare spending was a sizable portion of monthly income: $40.59 (± 33.38) for cases and $39.25 (± 42.59) for controls.

Table 3 Multivariate logistic regression of factors associated with being diagnosed with a blinding cataract (N=367)

Characteristic	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	*p*-value
Poverty Score Card			
Quintile 1	1.00 (reference)	1.00 (reference)	---
Quintile 2	0.34 (0.12, 1.01)	0.31 (0.09, 1.03)	0.0558
Quintile 3	0.32 (0.11, 0.97)*	0.29 (0.08, 1.02)	0.0535
Quintile 4	0.18 (0.06, 0.51)*	0.29 (0.09, 0.94)*	0.0396
Quintile 5	0.03 (0.01, 0.08)*	0.02 (0.01, 0.06)*	< 0.0001
Age			
20-39	1.00 (reference)	1.00 (reference)	---
40-49	2.75 (0.79, 9.60)	2.87 (0.70, 11.86)	0.1442
50-59	4.30 (1.49, 12.43)*	6.49 (1.86, 22.64)*	0.0033
60-69	8.32 (3.02, 22.93)*	9.57 (2.98, 30.76)*	0.0001
70-79	31.43 (10.90, 90.61)*	26.28 (7.57, 91.25)*	< 0.0001
> 79	53.17 (9.78, 289.14)*	46.31 (6.77, 317.01)*	< 0.0001
Gender			
Female	1.00 (reference)	1.00 (reference)	0.2188
Male	0.85 (0.52, 1.37)	0.66 (0.34, 1.28)	
Chronic Disease			
Yes	1.00 (reference)	1.00 (reference)	---
No	0.32 (0.18, 0.56)*	0.27 (0.12, 0.61)*	0.0016

* : Value is statistically significant at α = 0.05

Poverty Characteristics of Cases and Controls

Cases experienced poverty to a much greater degree than controls (p<0.0001). Those diagnosed with cataracts had a mean poverty scorecard value of 38.06 (± 10.81), which is equivalent with 73.5% likelihood of living below $2.50/day PPP. However, controls had a mean poverty scorecard value of 52.23 (± 13.31), which equates to a 42.0% likelihood of living below $2.50/day PPP. These differences held across quintiles of poverty, with 51% of controls in the highest quintile compared to 8% of cases in the highest quintile. Conversely, 28% of cases were in the lowest quintile of poverty, while only 5% of controls were in this stratum.

Multivariate Analysis for Cases and Controls

Multivariate analysis of the data was undertaken to control for confounders and analyze odds ratios for individual variables in the model. Stratified analysis and backwards elimination using likelihood ratios and appropriateness of convergence suggested that age, gender, and chronic diseases were potential confounders and were controlled for in the model (Table 3). Analysis indicated significant decreases in odds ratios between the top two quintiles of wealth and being diagnosed with a cataract: 0.29 (CI 0.09, 0.94) for the fourth quintile and 0.03 (CI 0.01, 0.10) for the fifth quintile (Table 4). This data supports the primary hypothesis of this study that those with blinding cataracts would be at a lower poverty level than those not diagnosed with cataracts. Furthermore, multivariate analysis showed a significant dose response relationship as assessed by the p-value for trend across quintiles of poverty (p<0.0001) and age groups (p<0.0001). Significant associations were also observed for several other interesting factors even after controlling for age, gender, and chronic disease status. Cases showed an adjusted odds ratio of 9.53 (CI 2.73, 33.24) for being widowed. Cataracts were similarly associated with increased risks in unemployment (3.08 (CI 1.11, 8.59)) and chronic disease (3.86 (CI 1.68, 8.87)).

Secondary Hypothesis

Sociodemographic Characteristics of Patients Electing to Have Surgery and Those Who Did Not

Examining the sociodemographic data for those who were diagnosed with blinding cataracts and underwent sight-restoring surgery compared to those who were similarly diagnosed but chose not to undergo the procedure yielded some compelling information. Patients in both groups were of a similar age, however those undergoing the procedure were slightly younger (68.84 ± 11.72) than those not undergoing the procedure (71.55 ± 12.66), but this difference was not statistically significant (p=0.1448) (Table 5). Interestingly, a greater percentage of males underwent surgery than those who did not (41% vs. 25%, p=0.0434). Literacy levels were not significantly different; neither were marital status or household size.

Healthcare Characteristics of Patients Electing to Have Surgery and Those Who Did Not

Those undergoing surgery had a lesser degree of chronic diseases (39% vs. 49%), however this was not significant (p=0.1855). Both groups had similar vision and habits in accessing eye care and local healers. Interestingly, those undergoing the procedure tended to spend more per month on healthcare than those who did not.

Poverty Characteristics of Patients Electing to Have Surgery and Those Who Did Not

The data suggests that those who underwent the subsidized surgery had a significantly lower poverty scorecard value than those who did not: 37.39 ± 10.12 which is equivalent to a 73.5% likelihood of living below $2.50/day PPP vs. 40.86 ± 13.08 which equates to a 66.1% likelihood of living below $2.50/day PPP; p=0.0392. However, when examined by quintiles, the differences were not significant.

Table 4 Multivariate associations between study variables and having diagnosed cataract vs. none.

Characteristic	Unadjusted OR (95% CI)	OR (95%, CI), adjusted[a]	*p*-value
Age (years), mean ± SD	1.08 (1.06, 2.00)*	1.00 (0.91, 1.67)	0.9942
Age			<0.0001
20-39	1.00 (reference)	1.00 (reference)	
40-49	2.75 (0.79, 9.60)	3.00 (0.73, 12.37)	
50-59	4.30 (1.49, 12.43)*	6.86 (1.96, 24.02)*	
60-69	8.32 (3.02, 22.93)*	9.34 (2.89, 30.14)*	
70-79	31.43 (10.90, 90.61)*	27.98 (7.61, 98.34)*	
80 +	53.17 (9.78, 289.14)*	55.20 (7.61, 400.11)*	
Sex			0.4984
Male	1.00 (reference)	1.00 (reference)	
Female	1.17 (0.73, 1.92)	1.37 (0.70, 2.69)	
Literacy			0.2330
Literate	1.00 (reference)	1.00 (reference)	
Illiterate	4.02 (2.44, 6.62)*	1.54 (0.76, 3.13)	
Marital status			0.0040
Married	1.00 (reference)	1.00 (reference)	
Widowed	14.26 (5.02, 40.51)	9.53 (2.73, 33.24)*	
Never married	0.41 (0.23, 0.73)	0.78 (0.36, 1.71)	
Household size	1.19 (1.10, 1.29)*	1.10 (0.98, 1.23)	0.1195
Employment Status			0.0183
Employed	1.00 (reference)	1.00 (reference)	
Retired	4.13 (2.15, 7.94)	2.02 (0.77, 5.32)	
Unemployed	4.46 (2.09, 9.51)	3.08 (1.11, 8.59)*	
Chronic conditions			0.0016
No	1.00 (reference)	1.00 (reference)	
Yes (1 or more)	3.13 (1.79, 5.56)*	3.86 (1.68, 8.87)*	
Diabetes			0.0140
No	1.00 (reference)	1.00 (reference)	
Yes	2.87 (1.09, 7.54)	5.19 (1.40, 19.32)*	
Hypertension			0.0275
No	1.00 (reference)	1.00 (reference)	
Yes	2.61 (1.34, 5.05)*	2.90 (1.13, 7.47)*	
Arthritis			0.0512
No	1.00 (reference)	1.00 (reference)	
Yes	9.77 (1.31, 73.13)*	10.73 (0.99, 116.60)	
Best vision, mean ± SD	1.61 (1.44, 1.80)*	1.35 (1.17, 1.56)*	<0.0001
Visited eye doctor ever	0.24 (0.07, 0.83)*	0.07 (0.01, 1.15)	0.0624
Visited a traditional	2.23 (0.98, 5.04)	1.73 (0.63, 4.72)	0.2878
Monthly spending on healthcare ($US)	1.00 (0.99, 1.00)	1.00 (0.99, 1.01)	0.7736
Poverty Scorecard	0.91 (0.89, 0.93)*	0.91 (0.89, 0.94)*	< 0.0001
PSC by quintile			<0.0001
1	1.00 (reference)	1.00 (reference)	
2	0.34 (0.12, 1.01)	0.31 (0.09, 1.03)	
3	0.32 (0.11, 0.97)*	0.29 (0.08, 1.02)	
4	0.18 (0.06, 0.51)*	0.29 (0.09, 0.94)*	
5	0.03 (0.01, 0.08)*	0.02 (0.01, 0.06)*	

[a] Adjusted for age, gender, and chronic disease status

* : Value is statistically significant at $\alpha = 0.05$

Table 5: Unadjusted associations between study variables and % PSC

Characteristic (n, %)	Undergo surgery: Yes (N =216)[b]	Undergo surgery: No (N = 51)[b]	*p*-value[c]
Age (years), mean ± SD	68.84 (±11.72)	71.55 (±12.66)	0.1448
Sex			0.0434
Female	128 (59.26)	38 (74.51)	
Male	88 (40.74)	13 (25.49)	
Diagnosis			0.4612
1 eye	97 (44.91)	20 (39.22)	
Both eyes	31 (60.78)	119 (55.09)	
Literacy			0.2906
Literate	85 (39.35)	16 (31.37)	
Illiterate	131 (60.65)	35 (68.63)	
Marital status			0.5285
Married	98 (45.37)	20 (39.22)	
Widowed	91 (42.13)	25 (49.02)	
Never married	26 (12.04)	5 (9.80)	
Household size, mean ± SD	7.75 (± 3.72)	7.55 (± 3.89)	0.7309
Employment Status			< 0.0001
Employed	92 (42.59)	23 (45.10)	
Retired	62 (28.70)	25 (49.02)	
Unemployed	62 (28.70)	3 (5.88)	
Chronic conditions	84 (38.89)	25 (49.02)	0.1855
None	132 (61.11)	26 (50.98)	
Diabetes	29 (13.42)	6 (11.76)	
Hypertension	55 (25.46)	15 (29.41)	
Arthritis	17 (7.87)	7 (13.72)	
Best vision, mean ± SD	6.07 (2.39)	6.00 (2.20)	0.8500
Visited eye doctor	124 (57.41)	29 (56.86)	0.9436
Visited traditional healer	77 (36.32)	19 (37.25)	0.9010
Monthly spending on healthcare ($US)[d], mean ± SD	42.37 (34.58)	31.01 (24.42)	0.1641
Poverty Scorecard Value, mean ± SD	37.39 (± 10.12)	40.86 (± 13.08)	0.0392
Poverty Score by quintiles			0.5604
1	49 (22.69)	8 (15.69)	
2	47 (21.76)	12 (21.76)	
3	40 (18.52)	7 (13.73)	
4	42 (19.44)	11 (21.57)	
5	38 (17.59)	13 (25.49)	

[a] Table values are mean ± SD for continuous variables and n (column %) for categorical variables.
[b] Percentages may not sum to 100% due to rounding.
[c] P-value is for t-test (continuous variables) or χ^2 test (categorical variables).
[d] Exchange rate based on 1 Ghana Ceddi= 0.5612 USD

Multivariate Analysis for Patients Electing to Have Surgery and Those Who Did Not

Stratification and multivariate analysis of the data was undertaken in an attempt to control for confounders of the outcome variable and to analyze odds ratios for individual variables in the model. Backwards elimination and comparing likelihood ratios and appropriateness of convergence suggested that age, gender, marital status, employment status, chronic diseases, and household size were potential confounders (Table 6). Controlling for these variables suggested that differences in poverty as assessed by the mean poverty scorecard value for each cohort was not significant: OR 0.97 (CI 0.94, 1.00), p=0.0974 (Table 7). No trend existed across quintiles of poverty or age. Other variables yielded insightful information regarding factors contributing to the outcome variable. For example, males were 2.54 (CI 1.09, 5.95) times as likely to undergo the subsidized cataract surgery as females. Also, those who were unemployed had an odds ratio of 5.62 (CI 1.55, 20.44) of undergoing the procedure compared to those who were employed. Those who were retired were less likely to go for surgery, though the value was not significant (OR 0.69 (CI 0.37, 1.54,) p=0.3490).

Table 6 Multivariate logistic regression of factors associated with utilizing sight-restoring surgery (N=267)

Characteristic	Unadjusted OR (95% CI)	Adjusted OR[a] (95% CI)	*p*-value
Poverty Score Card			
Quintile 1	1.00 (reference)	1.00 (reference)	---
Quintile 2	0.63 (0.24, 1.70)	0.73 (0.25, 2.13)	0.5636
Quintile 3	0.93 (0.31, 2.79)	1.54 (0.44, 5.39)	0.5010
Quintile 4	0.62 (0.23, 1.69)	0.62 (0.21, 1.88)	0.3979
Quintile 5	0.48 (0.18,1.27)	0.66 (0.20, 2.16)	0.4920
Age			
20-39	1.00 (reference)	1.00 (reference)	---
40-49	1.60 (0.08, 31.77)	1.57 (0.07, 36.07)	0.7765
50-59	0,70 (0.07, 7.20)	0.76 (0.06, 8.87)	0.8239
60-69	0.87 (0.09, 8.24)	1.07 (0.10, 11.58)	0.9564
70-79	1.06 (0.12, 9.62)	1.16 (0.11, 12.77)	0.9012
>79	0.33 (0.03, 3.18)	0.51 (0.04, 6.35)	0.5994
Gender			
Female	1.00 (reference)	1.00 (reference)	---
Male	2.01 (1.01, 3.99)	2.54 (1.09, 5.95)	0.0317
Marital status			
Married	1.00 (reference)	1.00 (reference)	---
Never married	1.10 (0.38, 3.21)	1.41 (0.41, 4.83)	0.5839
Widowed	0.77 (0.41, 1.47)	1.37 (0.58, 3.21)	0.4756
Employment Status			
Employed	1.00 (reference)	1.00 (reference)	---
Retired	0.62 (0.32, 1.19)	0.69 (0.37, 1.54)	0.3490
Unemployed	5.17 (1.49, 17.95)	5.62 (1.55, 20.44)	0.0088
Chronic disease			
No	1.00 (reference)	1.00 (reference)	---
Yes	0.66 (0.36, 1.22)	1.33 (0.65, 2.72)	0.4319
Household size	1.02 (0.93, 1.10)	0.97 (0.88, 1.07)	0.5324

[a] Likelihood ratio p<0.0256
* Value is statistically significant at $\alpha = 0.05$

Table 7 Multivariate associations between study variables and undergoing subsidized sight-restoring surgery vs. not

Characteristic (n, %)	Unadjusted OR (95% CI)	Adjusted OR (95%, CI)[a]	*p*-value
Age (years), mean ± SD	0.98 (0.95, 1.01)	0.99 (0.95, 1.02)	0.4047
Age			0.5918
20-39	1.00 (reference)	1.00 (reference)	
40-49	1.60 (0.08, 31.77)	1.57 (0.07, 36.07)	
50-59	0.70 (0.07, 7.20)	0.76 (0.06, 8.87)	
60-69	0.87 (0.09, 8.24)	1.07 (0.10, 11.58)	
70-79	1.06 (0.12, 9.62)	1.16 (0.11, 12.77)	
80 +	0.33 (0.03, 3.18)	0.51 (0.04, 6.35)	
Sex			0.0317
Female	1.00 (reference)	1.00 (reference)	
Male	2.01 (1.01, 3.99)*	2.54 (1.09, 5.95)*	
Diagnosis			0.5724
1 eye	1.00 (reference)	1.00 (reference)	
Both eyes	0.79 (0.43, 1.48)	0.82 (0.40, 1.66)	
Literacy			0.5526
Literate	1.00 (reference)	1.00 (reference)	
Illiterate	1.42 (0.74, 2.72)	1.29 (0.56, 2.96)	
Marital status			0.9367
Married	1.00 (reference)	1.00 (reference)	
Widowed	1.10 (0.38, 3.21)	1.41 (0.41, 4.83)	
Never married	0.77 (0.41, 1.47)	1.37 (0.58, 3.21)	
Household size, mean ± SD	1.02 (0.93, 1.10)	0.97 (0.88, 1.07)	0.5324
Employment Status			0.0228
Employed	1.00 (reference)	1.00 (reference)	
Retired	0.62 (0.32, 1.19)	0.69 (0.37, 1.54)	
Unemployed	5.17 (1.49, 17.95)*	5.62 (1.55, 20.44)*	
Chronic conditions			0.4319
None	1.00 (reference)	1.00 (reference)	
Yes (at least one)	0.66 (0.36, 1.22)	1.33 (0.65, 2.72)	
Diabetes			0.9932
No	1.00 (reference)	1.00 (reference)	
Yes	1.16 (0.56, 2.97)	1.00 (0.35, 2.86)	
Hypertension			0.8521
No	1.00 (reference)	1.00 (reference)	
Yes	0.82 (0.42, 1.61)	0.93 (0.42, 2.03)	
Arthritis			0.3630
No	1.00 (reference)	1.00 (reference)	
Yes	0.54 (0.21, 1.37)	0.60 (0.19, 1.82)	
Best vision, mean ± SD	1.01 (0.89, 1.15)	1.02 (0.87, 1.20)	0.7928
Visited eye doctor (ever)			0.6224
No	1.00 (reference)	1.00 (reference)	
Yes	1.02 (0.55, 1.89)	1.20 (0.59, 2.44)	
Visited traditional healer			0.4459
No	1.00 (reference)	1.00 (reference)	
Yes	0.96 (0.51, 1.81)	0.75 (0.36, 1.57)	
Monthly spending healthcare ($US)[d]	1.01 (1.00, 1.02)	1.01 (1.00, 1.02)	0.1544
Poverty Scorecard Value	0.97 (0.95, 1.00)*	0.97 (0.94, 1.00)	0.0974
Poverty Score by quintiles			0.3761
1	1.00 (reference)	1.00 (reference)	
2	0.63 (0.24, 1.70)	0.73 (0.25, 2.13)	
3	0.93 (0.31, 2.79)	1.54 (0.44, 5.39)	
4	0.62 (0.23, 1.69)	0.62 (0.21, 1.88)	
5	0.48 (0.18,1.27)	0.66 (0.20, 2.16)	

* Value is statistically significant at $\alpha = 0.05$

As the lowest quintile of poverty was used as a reference in much of the analysis, an additional stratified, multivariate logistic regression was undertaken to test the hypothesis among those at the highest likelihood of living under $2.50/day PPP. To explore the primary hypothesis in this group, quintiles were created using poverty data from all 367 participants. Of the 267 cases, 28% were in the lowest poverty quintile while 5% of the 100 controls were in this same quintile. An adjusted odds ratio of 7.29 (CI 2.85, 18.62) further supports the primary hypothesis (Table 8).

Exploring the secondary hypothesis's solvency in a similar manner, quintiles were created among all diagnosed cases (n=267). Among those electing to undergo the sight-restoring surgery (n=216), 28% were among the lowest quintile. This was not significantly different than those choosing not to undergo surgery (n=51) in which 25% of participants in this group were found among the lowest poverty quintile. This data does not support the secondary hypothesis for this quintile of poverty. Further analysis using study variables was undertaken to explore differences among theses to groups and generate additional research hypothesis.

Discussion

The goal of this study was to produce an accurate, evidence-based description of the relationship between poverty and cataract blindness in the Greater Accra, Central, Eastern, Western, Volta, and Ashanti regions of Ghana. Using an outreach-based, case–control model provided evidence that people with visual impairment from cataract are more likely to be poor than control participants also seeking eye care during village outreaches in southern Ghana during June, July, and August of 2011. Indeed, evidence from this study supports the hypothesis that patients with visual loss due to cataracts are at a higher risk of significant poverty than those without blinding cataracts. Furthermore the evidence suggests a significant trend across age groups and poverty score quintiles; that is, the likelihood of being diagnosed with a blinding cataract increases significantly with age and decreases as wealth increases. This demonstrates the impact of poor vision on poverty and supports previous findings of a relationship between cataract and poverty in emerging developing countries.[16,18,19,26]

This study provides novel evidence supporting an existing relationship between poverty and poor eyesight due to cataracts within Ghana, an emerging developing country with a high proportion of preventable blindness. Teasing apart the factors leading to this difference remains a challenge, though evidence from this study offers some guidance. The data suggests that compared to others seeking care at eye health outreaches, those diagnosed with cataracts tend to be older, more likely to be unemployed, more likely to suffer from chronic diseases, have overall worse sight, and more likely to live on less than $2.50/day PPP. Adjustment for age, gender, and chronic disease did not entirely explain the association between poverty and cataract visual impairment, suggesting that it operated through other pathways.

Blindness is both a cause and consequence of poverty, but there are few empirical data to support this claim. Globally, the prevalence of blindness is five-fold higher in poor than rich countries.[27] Furthermore establishing temporality within the relationship is challenging.[28] Visual impairment could cause poverty through reduced employment opportunities, which data from this study would seem to support. Of the 62 cases reporting unemployment, 58 reported that loss of employment came about from an inability to perform tasks due to poor eye sight. Although

Table 8 Bivariate and multivariate logistic regression of associations between being in the lowest quintile of poverty and study variables.

Characteristic	N[a]	% in lowest quintile of PSC	Adjusted OR[b] (95% CI)
Cataract			
No	100	5.00	1.00
Yes	267	27.72	7.29 (2.85, 18.62)*
Undergo cataract surgery			
No	51	25.49	1.00
Yes	216	28.24	1.15 (0.57, 2.31)
Age			
20-39	6	33.33	1.00
40-49	9	22.22	0.57 (0.06, 5.77)
50-59	27	22.22	0.57 (0.08, 3.92)
60-69	59	30.51	0.88 (0.15, 5.24)
70-79	120	26.67	0.73 (0.13, 4.16)
80 +	29	20.69	0.52 (0.08, 3.56)
Sex			
Male	101	25.74	1.00
Female	166	28.92	1.17 (0.67, 2.05)
Literacy			
Literate	101	19.80	1.00
Illiterate	166	32.53	1.95 (1.09, 5.26)*
Marital status			
Married	118	23.73	1.00
Widowed	116	32.76	1.57 (0.88, 2.78)
Never married	31	25.81	1.12 (0.45, 2.78)
Chronic disease			
No	158	30.38	1.00
Yes	109	23.85	0.72 (0.41, 1.25)
Diabetes			
No	232	18.45	1.00
Yes	35	22.86	1.34 (0.58, 3.11)
Arthritis			
No	243	28.81	1.00
Yes	24	16.67	0.49 (0.16, 1.50)
Blood Pressure			
No	197	28.93	1.00
Yes	17	24.29	0.79 (0.42, 1.48)
Diagnosis			
1 eye	117	27.35	1.00
Both eyes	151	28.00	1.03 (0.60, 1.77)
Previous cataract surgery			
No	241	21.58	1.00
Yes	25	20.00	1.02 (0.41, 2.54)
Ever been to eye doctor			
No	114	37.72	1.00
Yes	153	20.26	0.42 (0.24, 0.73)*
Unemployed because of eyes			
No	209	25.36	1.00
Yes	58	36.21	1.67 (0.90, 3.10)

[a] With the exception of data for "Cataracts" which includes data from both cases and controls, all other study variables refer to diagnosed cases only.

[b] Adjusted for age, gender, marital status, employment status, chronic diseases, and household size.

* Value is statistically significant at $\alpha = 0.05$

this study did not assess it, a stronger relationship between cataract and poverty might be observed among the blind case participants who may have fewer employment opportunities than among those less impaired (i.e., moderate visual impairment). Indeed, being visually impaired and out of work is a double jeopardy for many who live on the brink of poverty.

Poverty may cause visual impairment through restricted access to cataract surgery. Evidence from this study suggests that those with cataracts seek eye care less readily than their peers, although they probably need it more. When asked why they had not sought care, 64% of those diagnosed with cataracts indicated cost to be the biggest barrier. Others mentioned that they did not think that their condition was treatable, and that transportation prevented them from seeking care earlier.

Blinding cataracts are particularly debilitating in developing nations like Ghana. Within Ghana there are only a handful of trained ophthalmic surgeons, all of whom live in urban centers. The majority of cases are found scattered throughout the rural villages. Financial, logistic, and cultural limitations prevent many from receiving the proper eye care they need. Out of frustration, many turn to local healers who perform "couching with a needle" or prescribe harmful tonics to rinse the eye. Evidence from this study suggests that those suffering from blinding cataracts are more likely than their peers to utilize local healers, often exacerbating the problem, and depleting limited financial resources. Thus, the most significant barrier for the majority of Ghanaians suffering from blinding cataracts is being properly diagnosed, finding transportation to a major health center, and receiving the sight restoring surgery—and behind all this is the staggering cost. It is of no surprise, then, that the poor are less likely to undergo cataract surgery.[2,29]

Secondary Hypothesis and Future Areas of Research

The secondary hypothesis of this study explored what barriers would remain if the financial costs associated with undergoing cataract surgery were subsidized by local and international eye care groups and NGOs. It was presumed that those electing to undergo the subsidized surgery would be of a higher likelihood of living under the established poverty line, as those who could least afford it would tend to benefit the most from the services. While the evidence suggested that such a relationship might exist, there appears to be little difference between those who underwent the surgery and those who did not with respect to poverty status when adjusting for age, gender, marital status, employment, chronic disease, and household size. Remarkably, men were more than twice as likely (OR 2.54 (CI 1.09, 5.95)) to undergo surgery than women, and those who were unemployed were five times as likely to undergo surgery than those who were employed, and even greater still than those who were retired. Such a finding may suggest that men are more independent within the culture and have greater mobility and access to care, even in the face of highly subsidized interventions.

Examining the data from the secondary hypothesis also sheds light on potential motivating factors for taking up subsidized surgery among cataract referrals. As there was a significant difference with respect to employment between those undergoing surgery and those electing not to, it is possible that one motivating factor for undergoing the surgery is the potential to improve one's occupational opportunities and to seek out employment following the sight-restorative surgery. Future research exploring this hypothesis, as well as monitoring the poverty score values of participants is currently underway.

This study highlights the need to explore the association between blindness and access to care by gender within developing countries. Ghana is still largely a patriarchal society where men enjoy greater economic and social mobility. The fact that men were more than 2.5 likely to take advantage of the subsidized surgery may reflect these cultural norms. Future research could help tease out this relationship and offer suggestions on how to improve interventions to increase female surgery participation.

Study Strengths

This study had several strengths that serve to further validate the results. This was the first study to compare those blinded by dense cataracts with their peers using the Poverty Scorecard. Furthermore, it is the first study to examine economic and sociodemographic differences among referred cataract patients who uptake subsidized, sight-restoring surgery compared to those who do not. Finally, it is the first study to establish a cohort of cataract surgery recipients and track their economic status following surgery.

Another strength was the utility of the Poverty Scorecard. The scorecard is inexpensive to implement and can be understood by non-specialists, and utilizes data that is easily reportable by subjects, limiting recall error and bias. It is designed to be practical for local pro-poor organizations and struggling ministries of health who want to improve how they monitor and manage their social performance and shifts in indirect economic measures. Additionally, this study was developed in partnership with local eye care specialists and with the assistance of local eye care ambassadors familiar with the needs of the villages under their stewardship. Potential cases were actively recruited and encouraged to attend village eye care outreaches.

Study Limitations

While there are many strengths in this study, there are also several limitations. Measurement of poverty is always a tricky issue and this study's use of the indirect method using the Ghana-specific Poverty Scorecard may not have captured the full extent of individual's economic status. However, the measure has been previously validated and is widely used by research organizations and NGOs in the developing world.[21–24]

Another limitation of the study was that the results may not be entirely generalizable since the source population was those seeking eye services at a traveling eye care outreach. As such it is difficult to assess whether the attendees were reflective of the true population. It is likely that the observed results were attenuated, as those more likely to be unable to come may have lacked the financial resources or transportation means to travel to the outreach center. Patient recruitment was handled by local healthcare ambassadors, in cooperation with village government/elders, faith-based organizations, and satellite health clinics (if present in the village). As measures of poverty were given by self-report, there is potential for social desirability bias, however it is difficult to determine the direction of the potential bias.

Sensitivity analysis in one village, Kyepi, suggested that 78% of adults 40 or older attended the outreach, which was typical for most villages. Although the sample size was relatively small (267 cases), given the limitations of personnel and funding, the cohort is robust for baseline evaluation and future research.

Policy Implications

The data gathered through this study present a more complete picture of poverty and cataracts in a nation that is dealing with age related disabilities among a population that is living longer than ever before. Such findings are important to local caregivers and national policy makers in Ghana and other emerging nations. Indeed, there are broad applications for these findings among other developing countries with significant backlogs of blind adults in need of cataract surgery. As populations continue to live longer, treating blindness will increasingly become a significant issue of concern. Studies like this are needed to help convince policy-makers of the importance of good eyesight in maintaining a strong economy, strengthening communities, and decreasing morbidity and risk of premature death from blindness-associated accidents.

Specifically, data from this study and its future follow-up assessments of individual economic reversal, should help guide policies and healthcare interventions to efficiently allocate resources and deliver care that will yield the highest rate of return and promote economic productivity.[5,16,19] Several previous studies point to the significant economic reversal that decreasing preventable blindness can have on a community.[2,3,26]

Conclusions

Evidence from this study suggests that people with visual impairment due to cataract were poorer than controls in the Greater Accra, Central, Eastern, Western, Volta, and Ashanti regions of Ghana. Analysis of this study's data indicates that the relationship between poverty is tenuous, yet real. As the Millennium Development Goals are committed to the eradication of extreme poverty and provision of health care to the poor, targeting diseases like cataracts that are disproportionately born by those who are most impoverished is not only a humanitarian obligation, but one that is also extremely cost-effective and has potential to improve domestic economic productivity. Finally, this study highlights the need for increased provision of cataract surgery among the poor, and improved interventions to attract women for sight-restorative procedures. Further study of patients following cataract surgery, assessing their economic and employment changes and opportunities will provide additional data that may solidify cataract surgery is a highly cost-effective intervention with significant economic and public health gains within emerging economic countries like Ghana and other west African nations.

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