

Blindness Above and Below the Poverty Line: Reflections form Sofala, Mozambique.

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To the people of Mozambique who endured the impact of *Cyclone Idai* in March 2019

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ABSTRACT

Objective: Although the correlation between visual impairment and poverty has been established, economic assessment is not a standard component of blindness surveys. The purpose of this study was to determine the prevalence of avoidable blindness and its association with poverty in Sofala province of Mozambique.

Methods: As part of a Rapid Assessment of Avoidable Blindness, 94% of a random sample of 3600 people >50 years responded to questions regarding daily per capita expenditure. The WHO definition of blindness (presenting visual acuity <3/60) was used to determine the visual status of participants, and the World Bank's threshold of living on <\$1.25 International Dollar a day demarcated the poverty line.

Results: The prevalence of blindness was 3.2% [95% Confidence Interval (CI): 2.6, 3.8]. People living below the poverty line had a significantly greater odds of being blind [Odds Ratio (OR): 2.6 (CI: 1.6 to 4.5)]. Age above 60 [OR: 7.0 [CI: 4.6 to 10.80] predicted blindness but the association with illiteracy, gender or rural residence was not significant.

Conclusions: Blindness disproportionately affects people living below the poverty line. Development initiatives could augment the impact of blindness prevention programs. Measuring poverty should become a standard component of visual impairment surveys.

INTRODUCTION

Despite marked achievements in the expansion of eye care services in the past two decades, blindness remains a global public health challenge. According to a 2015 estimate, 217 million had moderate or severe distance visual impairment of whom 36 million were blind.¹ Also, 855 had near vision impairment from uncorrected presbyopia, lack of reading eyeglasses.² Cataract and uncorrected refractive error together cause 55% of the blindness and 77% of the vision impairment in people aged above 50.¹

Visual impairment has been linked to socioeconomic determinants of health in general and poverty in particular.³⁻⁶ About ninety percent of blind people live in developing countries of Asia and Africa.¹ Disability may lead to poverty due to the loss of earning power, but poverty itself may aggravate disability by limiting access to healthcare services.⁷ Earlier studies have shown such a reciprocal interrelationship between economic deprivation and blindness in Africa.⁸ Compared to the substantial societal costs of visual impairment, the economic return of prevention of blindness programs is

significant.⁹ Although the global initiative 'VISION2020: The Right to Sight' successfully entered its final phase, a lot remains to be done in realizing universal eye health in this world.¹⁰ If economic status is related to visual impairment, poverty eradication efforts, one of the seventeen targets under the initiative known as Sustainable Development Goals, are likely to hasten the elimination of avoidable blindness.¹¹

Mozambique's had a population of 20.5 million in 2012 with an average life expectancy was 42 years and a per capita income of US\$348. Sofala is one of the central provinces of Mozambique that had a population of 1.85 million in 2012.¹² The Central Hospital of Beira provides eye care services throughout the region with the support of a non-governmental organization, LIGHT FOR THE WORLD. The progress and impact of these interventions have not been evaluated. There was no national survey that determined the magnitude and causes of blindness in Mozambique. Based on data from studies in the region, however, the prevalence of blindness was estimated to be 0.75% to 1% in 2010.¹³

The need for baseline and follow-up data for planning and evaluation of the growing number of intervention programs to alleviate visual impairment led to the development of cost-effective standardized surveys such as the Rapid Assessment of

Avoidable Blindness (RAAB). The number of surveys increased since 1995 with over 330 (64 in Africa) from 79 countries registered in the RAAB Repository by 2017.¹⁴ Some of these surveys determined the prevalence of additional elements such as eyeglass wear, presbyopia or diabetic retinopathy, though few assessed the poverty levels of participants concurrently. The purposes of the study were to determine the prevalence and causes of blindness in people aged 50+ years and to evaluate the association between blindness and poverty in the Sofala province of Mozambique.

METHODS

Design: The survey was conducted using an established methodology and open software called RAAB.^{15, 16} All people aged 50 years and above, living in the boundaries of Sofala province for more than the past six months and who volunteer for examination were eligible to participate in the survey. Sample size was calculated to be 3600 using the utilities function of the RAAB software based on the following assumptions: expected prevalence of blindness in people 50+ of 5%, a precision span of 20% (4 to 6) in a 95% confidence limit, a cluster effect of 1.5 and 10% contingency for absentees and non-responders. About 8.7% of the population of Sofala (160,000) was 50 years or above in 2012.¹³ Seventy-two clusters of 50 people were selected using a multi-stage

random cluster sampling method. In the first stage, Localities within the districts were selected based on Probability Proportionate to Size technique. In the second stage, the sector that contains the cluster was identified using the 'compact segment' method.^{15,16}

Data Management and Analysis: The data collection phase happened in November and December 2012. The survey team comprised of three groups, led by ophthalmologists or a senior ophthalmic technician, who received a week of practical training by a certified RAAB trainer. The team collected data using a standardized questionnaire extracted from the RAAB software and translated into Portuguese. We added questions on poverty level and eyeglass wear to the optional section of the survey. Participants declared their total weekly household expenses, and the interviewer calculated the daily per capita expense based on their family size. Presenting visual acuity (VA) was measured with a tumbling "E" chart at six meters in the participants' courtyard. The team leaders determined the cause in those with VA below 6/18 in either eye. Primary data from the survey was recorded in two databases on the field and checked for consistency. Validating the double-entry data sets produced a clean master database. The RAAB software generated initial descriptive results. Logistic regression analysis tested the associations

between blindness, poverty, and other independent variables.

Terms: The World Health Organization (WHO) defines visual impairment as a presenting VA of $<6/18$ [$< 20/60$, 0.1] in the best eye with available correction. It includes mild visual impairment, severe visual impairment, and blindness. Blindness was defined as presenting VA less than 3/60 with the best eye. The principal causes of visual impairment were identified based on the definitions described in the RAAB methodology and software. Poverty was defined as living on less than 1.25 International Dollar (I\$) or 20 Mozambican Metical per day.^{15,16} The international poverty line has been one dollar a day until the World Bank revised this in 2008 to \$1.25 based on a purchasing-power-parity of a dollar in 2005.¹⁷ The nominal currency exchange rate of \$1.25 corresponds to about 36 Meticais in 2012, but it had the power to purchase twice as many items in Mozambique. Accordingly, the national poverty line in Mozambique was living on 18 Meticais per person per day, which is equivalent to I\$1.25.¹⁸ Considering inflation, we used 20 meticais as the threshold to demarcate the poverty line. In 2009, 58% of the population in Sofala province was below the poverty line.¹⁹

Ethics: The national bioethics committee of Mozambique approved the study while the Provincial Directorate of Health of Sofala

Province authorized and facilitated the survey. Individuals and their chief of localities provided informed consent. Data collected from individuals were de-identified and recorded anonymously.

RESULTS

Study Population: Of the enumerated people, 3,386 could be examined, resulting

in a response rate of 94%. Men constituted 50.7% of absentees, and there was no significant difference regarding mean age among participants (62.4 years) and non-respondents (61.8 years). The age-sex distribution in the sample mirrored the pattern in the population except that most of the participants were females (58.7%) and in the 60-64 age group (**Table 1**)

Table 1: Age-Sex distribution of participants in a rapid assessment of avoidable blindness Sofala province of Mozambique, 2012

Age Group	Male		Female		Total	
	Sample	Population	Sample	Population	Sample	Population
50 to 54	21.8%	28.7%	27.6%	30.1%	25.2%	29.4%
55 to 59	18.0%	24.0%	17.5%	21.2%	17.7%	22.5%
60 to 64	22.5%	15.7%	21.2%	16.8%	21.7%	16.2%
65 to 79	11.9%	11.9%	12.5%	11.9%	12.3%	11.9%
70 to 74	12.5%	7.7%	9.6%	8.1%	10.8%	7.9%
75 to 79	5.4%	5.7%	4.5%	5.6%	4.8%	5.6%
80 to 99	7.9%	6.3%	7.1%	6.4%	7.4%	6.3%
Total (50+)	n=1397	N=77935	n=1989	N=83040	n=3386	N=160975

Prevalence and causes of Blindness:

The overall prevalence of visual impairment (VA<6/18) was 17.5% [CI: 16.3, 18.9 while that of blindness (VA<3/60) was 3.2% [95% Confidence Interval (CI) 2.6, 3.8;]. When adjusted for age and sex, the prevalence of visual impairment and blindness fall to 16.2% [CI: 16.0, 16.4] and 2.7% [CI: 2.0, 3.4]. Cataract (55.1%) and glaucoma

(24.0%) were the leading causes of blindness whereas refractive errors accounted for most of the visual impairment (29%) following cataract (48%). Overall 73% of the causes of blindness in Sofala were avoidable, either preventable or treatable.

Table 2: Descriptive Summary of key findings of a Rapid Assessment of Avoidable Blindness in people aged 50+ in Sofala province of Mozambique, 2012.

Outcomes	Indicators	N/n	#	%	[95% CI]
Visual Impairment (VI): PVA <6/18	Prevalence: unadjusted	3386	593	17.5	[16.3-18.9]
	Cataract	593	285	48.0	
	Refractive Error (RE)	593	172	29.0	
	Glaucoma	593	42	7.0	
Blindness: PVA <3/60	Prevalence (unadjusted)	3386	107	3.20	[2.6-3.8]
	Cataract	107	59	55.1	
	Glaucoma	107	26	24.0	
	Corneal Scars	107	12	11.0	
	Trachoma Corneal Opacity	107	4	3.7	
Cataract Surgical Coverages	For Persons (VA <6/60)	498	165	33.1	
	Operated in the Province	98	71	72.70	
	IOL implantation Rate	98	89	91.0	
Cataract Surgical Outcomes	Good: All surgeries, PVA> 6/18	89	34	38.2	
	Good: IOL, 5yrs, PHVA> 6/18)	66	35	53.0	
	Patients Satisfied with outcome	98	65	66.0	
Barriers to Cataract Surgery	Lack of Awareness	165	88	53.3	
	False Beliefs	165	41	24.8	
	Distance to services	165	35	21.2	
Extrapolations (to Sofala Population)	VI in people 50+ (adjusted)	160,975	26050	16.2	[16 -16.4]
	Blindness in 50+ (adjusted)	160,975	4404	2.7	[2.0- 3.4]
	Blindness in general population	1.85 Mil	5550	0.3	
	Need eyeglasses for RE	1.85 Mil	8274	0.5	
	Current Cataract Surgical Rate	Per Mil	400	::	
	Target Cataract Surgical Rate	Per Mil	1366	::	

N= Population, n= Sample, PVA= Presenting Visual Acuity, PHVA= Pinhole Visual acuity, IOL= Intraocular Lens, Mil= Million, RE= Refractive Error

Cataract Services: Ninety-one percent of the 98 eyes operated for cataract had intraocular lens (IOL) implants. People received surgical services at the central hospital (54.1%), local outreach sites (27.6%), in neighboring provinces (15.3%) or abroad (3.1%). About two-thirds (66%) of patients were satisfied with the visual outcome after cataract surgery. Though 48.6% of people with cataract blindness (VA<3/60) were operated, cataract surgical coverage (CSC) for persons and eyes with operable cataract (VA<6/60) was 33.1% and 21%, respectively. Coverage was lower among women (26.7%) with operable cataract as compared to men (44.3

Among 165 people with operable cataract, lack of awareness (53.3%), false belief (24.8%) and distance (21.2%) were the most common barriers to obtaining services. Visual outcome after cataract surgery among 89 eyes operated any time was good (PVA > 6/18) in 38.2 %, borderline (6/60 to 6/18) in 23.6 % and poor (PVA < 6 / 60) in 38.2 %. The outcome of cataract surgeries performed in the past five years in 66 eyes with IOL implantation was good in 42.2% (53% with pinhole test), but the vision remained poor in 27.3 % of cases. The main causes of borderline or poor outcome among 29 eyes operated in the last three years were poor selection (55.2 %) and surgical complications (34.5 %).

Poverty and social determinants: Half (50.3%) of respondents were found to be

living below the poverty line while 2671 (74.2%) were not literate. Only one person among the sample population was wearing eyeglasses for distance vision (<0.1%). Older age was the most significant risk factor for blindness (OR= 7.0; CI: 4.6, 10.8). Poverty was strongly associated with the likelihood of being blind (OR= 2.6; CI: 1.6, 4.5). Also, people with no formal education had higher odds of being blind (OR= 1.9; CI: 1.6, 4.5). Blindness appeared to affect more women and people living in rural areas than men and urban dwellers, but this was not statistically significant. However, no significant association was found between visual impairment and other independent factors except age. **Table 3** illustrates the degree of association of risk factors with blindness.

Extrapolations: Global estimates showed that 82 % of blindness occurs among people aged and above.¹³ And about 8.7 % of the population in Sofala was 50 or older.¹¹ Based on these assumptions, the prevalence of blindness in the general population of Sofala was extrapolated to be 0.3%. Age and Sex adjusted estimates revealed that of 26,050 (16.2%) people aged 50+ in Sofala province had a visual impairment, of which 4,404 (2.7%) were blind. The number of people with operable cataract (VA<6/60) was 6,730 bilateral cases and 28,629 eyes. Over 8274 people with Refractive Errors needed eyeglasses to correct their visual impairment. The current cataract surgical rates (CSR) in Sofala would be about 400, considering

750 eyes are operated each year by the central hospital and excluding those operated elsewhere. Target CSRs were calculated for different visual acuity levels using a model that considers the incidence of cataract and mortality of cataract cases

in Africa.²⁰ Accordingly, Sofala province needs 1366 operations annually to deal with all cataract eyes that have significant visual impairment and blindness (VA <6/60).

Table 3: Analysis of Socioeconomic and demographic risk factors for blindness, Sofala, Mozambique, 2012

Risk Factor	Comparison Groups	n	# Blind	%	Univariate, Odds Ratio [95% CI]	Multivariate, Odds Ratio [95% CI]
Economy (poverty)	≥ Poverty line	1689	24	1.4%	--	--
	< Poverty line	1696	83	4.9%	3.6 [2.3 - 5.6]	2.6 [1.6 - 4.5]
Education (literacy)	Literate	869	9	1.0%	--	--
	Illiterate	2516	98	3.9%	3.9 [1.9 - 7.7]	2.2 [1.0 - 4.6]
Age	50 to 59	1456	7	0.5%	--	--
	60 to 99	1929	100	5.18%	11.3 [5.2 - 24.4]	7 [4.6 - 10.8]
Gender	Male	1397	39	2.8%	--	--
	Female	1988	68	3.4%	1.2 [0.8 - 1.8]	1.0 [0.6 - 1.5]
Residence	Urban /City	741	21	2.8%	--	--
	District/Rural	2644	86	3.3%	1.4 [0.8 - 2.2]	1.5 [0.9 - 2.6]

DISCUSSIONS

Besides producing baseline data on the prevalence of visual impairment and the coverage of eye care services in Sofala province, the study concurrently determined the association between blindness and poverty at individual levels using a practical tool. The age-sex prevalence of blindness in Sofala (3.2%, CI 2.8, 4.4) was significantly lower than local and regional estimates. A RAAB in the

nearby province of Nampula in 2011 revealed a prevalence of 7.1%.²¹ In Eastern Sub-Saharan Africa, blindness among 50+ years of age was estimated to be 5.7% (CI: 4.4 - 6.9) in 2010.²² However, the low prevalence in Sofala was similar to recent reports from neighboring countries such as Malawi (3.3% CI: 2.5, 4.1), Tanzania (2.4%, CI: 2.5, 4.1) and Zambia (2.3%, CI: 1.8 to 2.8) where rural eye care services are expanding.²³⁻²⁵ The presence of a comprehensive blindness prevention

program with outreach services might have played a crucial role in lowering the magnitude of blindness in Sofala province. Three quarters (73%) of the causes of blindness in Sofala was preventable or treatable, and cataract accounted for half of the visual impairment (48%). These findings agree with most global estimates and regional reports.^{1, 21, 23-25} Refractive error remained a significant cause of visual impairment (29%) as described elsewhere.^{2, 22} The proportion of corneal opacity was low, reflecting the global trend in the reduction of infectious cases of blindness.^{1, 22}

Coverage of cataract services inadequate as only one in 3 persons with operable cataract had surgery in Sofala. Although a CSR of 2000 per million is recommended for low-income countries, Sofala needs 1366 based on the low density and composition of its elderly population.²⁰ Lack of awareness and false beliefs were the leading barriers to cataract surgery implying a need for culturally appropriate health education. Although the recommended level of a good outcome for cataract surgery is 80%, population-based surveys rarely found this level success as hospital-based studies do. The proportion of 'good' and 'borderline' visual outcome after cataract surgery in Sofala (53%) was below some reports such as from Tanzania (69%).²⁴ However, the 'poor' outcome (27.3%) in Sofala went with the pattern in

other African countries such as Malawi (24%)²³ and Zambia (28%).²⁵ Bad selection of cases (55.2%) and surgical complications (34.5%) accounted for most of the poor outcomes. Many cases present very late with ocular comorbidity in Africa. Ophthalmic surgeons were transitioning to a small incision cataract surgical technique and biometry equipment were rarely used because of malfunctions. The level of patient dissatisfaction (23%) about the outcome of cataract surgery revealed a significant room for improvement.

Analysis of poverty and socio-demographic factors revealed that age and poverty were strongly associated with the likelihood of being blind in Sofala province. Older adults living below the poverty line in Sofala had 2.6 times the odds of being blind. Old age may lead to loss of income in developing countries moderating some of the effects of poverty on blindness. Compared to those with regular sight, people with blinding cataract are, and interventions facilitating cataract surgery improves quality of life and individual as well as household income.²⁶ In Nampula, 60.8% of households surveyed in 2018 were below the poverty line, and 3.9% of people above 50 were blind.²¹ The corresponding figures in the Sofala in 2012 were 50.3% and 2.7%. The proportional difference between the two provinces of Mozambique may indicate an association between blindness and poverty on an aggregate level. Many studies have

demonstrated the reciprocal association between economic deprivation and the risk of losing sight.^{6, 8, 27} Even the outputs and outcomes of cataract surgery are proportionally affected by the socio-economic development level of a country.²⁸ Investment in blindness prevention is a cost-effective endeavor compared to the high price paid for rehabilitation and loss of productivity from visual impairment. Likewise, poverty eradication efforts as part of Sustainable Development Goals would help the elimination of avoidable blindness.¹⁰ Although it is difficult to establish a causal link between poverty and blindness, many agree the elimination of avoidable blindness is not conceivable without economic development.³ Socioeconomic status, measured as higher income, higher educational status, or non-manual occupational social class, is inversely associated with the prevalence of blindness or visual impairment.³ However, the effect of poverty on mild and severe visual impairment was not as evident in the Sofala study and this warrants further investigation with tools that measure poverty comprehensively. Women are reportedly more likely to be blind than men, but this was not the case in the Sofala survey. However, more women (62%) had un-operated cataract intimating the existence of inequity in accessing eye care services.

The limitations of this study emanated from the RAAB methodology and the tool used to estimate poverty. First, the sample size could be too small to reduce the effect of chance. The sample size was calculated with the assumption that the prevalence of blindness would be about 5 %, but the actual prevalence was 2.7%. Second, the disease of the posterior segment of the eye might have been underreported as RAAB is designed to identify mainly the common causes of blindness that are easy to diagnose with simple instruments. Third, poverty was measured with a single attribute of daily expenditure that was liable to recall bias. Standardized techniques such as poverty scorecards and are recommended for more accurate measurement of economic status in rural communities.²⁹ Our study employed a unique approach combining three established techniques in one: assessment of economic status of individuals with average daily expenditure piggy-backed on a standardized population-based cross-sectional survey of blindness (RAAB), and classification of poverty level using subsistence on an international dollar a day. The provincial poverty level determined by daily expenditure in this study was comparable to national reports that used a more comprehensive method to assess household economic status.¹⁹ We measured individual poverty levels and visual status concurrently, but the results confer with studies that compared blindness with aggregate levels of poverty

at cluster or household level.^{6,27} Therefore, the results of this study are reasonably generalizable to similar communities in Mozambique and beyond. Further investigations should develop and evaluate novel ways of measuring poverty in blindness surveys. In this regard, the inclusion of an equity tool to measure socioeconomic status in the updated version of RAAB would be a big leap forward.¹⁴

In conclusion, this study added empirical evidence on the association between blindness and poverty and confirmed that age is the leading risk factor for visual impairment. The prevalence of blindness in Sofala province is decreasing, but nearly three-quarters of the causes of blindness were avoidable justifying the need for continued development of eye care

services. Monitoring visual outcome of cataract surgery, training in advanced surgical techniques and the use of biometry equipment should become a routine practice to improve the quality of cataract surgery in Africa.³⁰ The low level of public awareness about cataract surgery necessitates new health promotion approaches. People living below the poverty line are more likely to be affected by blindness. Making blindness prevention programs an integral part of poverty alleviation initiatives could provide a synergistic impact on the prevalence of visual impairment.¹⁰ Measurement of economic variables should become a standard component of blindness surveys. Proving the causal link between blindness and poverty may be difficult but researchers should find robust techniques for measuring economic status in blindness surveys.

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