

# Changes in prevalence and causes of visual impairment and cataract surgical coverage in Nampula, Mozambique between 2011 and 2018: findings from two cross-sectional surveys

Emma Jolley (✉ [ejolley@sightsavers.org](mailto:ejolley@sightsavers.org))

Sightsavers <https://orcid.org/0000-0002-2388-3454>

Mércia Cumaio

Sightsavers

Anselmo Vilanculos

Nampula Central Hospital

Izidine Hassan

Sightsavers

Kahaki Kimani

University of Nairobi

Kolawole Ogundimu

Sightsavers

Elena Schmidt

Sightsavers

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# Abstract

## Background

Globally, there are few examples of repeated eye health surveys to assess changes in prevalence and causes of visual impairment, and service coverage over time. Two separate, unlinked rapid assessments of avoidable blindness (RAAB) were conducted in Nampula province, Mozambique in 2011 and 2018. This paper reports the observed changes and examines how the trends differ for males and females.

## Methods

Standard RAAB methodology was used in both studies. Two-stage cluster sampling was used to generate random samples of adults aged over 50 years. Participants underwent a simplified visual acuity exam focusing on presenting and pinhole visual acuity (VA), a lens exam and posterior segment exam using a direct ophthalmoscope for all subjects with presenting VA < 6/18. Data were analysed using Stata and logistic regression models were developed to assess changes.

## Results

The 2011 study enrolled 3,050 people and examined 96.9% (2,954 people). The 2018 survey enrolled 4,191 people and examined 95.8% (4,015 people). Age and sex adjusted estimates of blindness decreased from 6.2% in 2011 to 4.5% in 2018 ( $z=-2.21$ ,  $p = 0.028$ ), severe visual impairment remained the same (2.6% in 2011 and 2.7% in 2018,  $z = 0.1$ ,  $p = 0.9$ ) and moderate visual impairment increased (5.9% in 2011 to 11.0% in 2018,  $z = 5.78$ ,  $p < 0.001$ ). Cataract surgical coverage was higher among males in both surveys (13.4% among males vs 7.7% among females in 2011, and 40.0% among males vs 19.4% among females in 2018) and the gender disparity grew between surveys.

## Conclusions

Significant changes were observed in the eye health and service coverage between 2011 and 2018. An increase in the proportion of good visual acuity among operated eyes between the surveys is of note and may correspond with improvements made to the services provided in the province. Further improvements to services are required to improve access for women and people with moderate visual impairment.

## Background

The World Report on Vision, 2019, highlights the lack of robust survey data as a key challenge to addressing eye conditions and visual impairment (VI), particularly in sub-Saharan Africa(1). Changing demographics and lifestyles mean that the number of people affected by eye conditions is rapidly increasing, but not necessarily in line with the capacity of the health system or health seeking

behaviour(2). Up-to-date population-based survey data is key for planning eye care services and monitoring changes in the epidemiology of eye diseases. Repeated surveys that use the same methodology and measures are also important to track and measure progress of eye care response over time and ensure services remain geared towards the needs of the populations they serve(3, 4).

Key indicators of success for national blindness prevention programmes have been long understood to include prevalence and causes of visual impairment, as well as measures of coverage of services among the population, for example cataract surgical coverage (CSC) which describes the proportion of people who have received cataract surgery, divided by the population in need(1, 4–6). However, more recently, there is a move to examine service coverage beyond a crude measure such as CSC, and to account for the impact of health interventions on health outcomes. These discussions have led to the introduction of a concept of *effective coverage* of services, defined as the proportion of the population who have accessed the intervention AND have received the maximum possible health gain given the ideal quality, divided by the population in need of the intervention.(7) Of course, debate remains as to how to define quality, however, the general premise of moving beyond crude coverage ratios to a more nuanced representation of service provision is well accepted. Within eye health therefore, suggestions have been made to create the indicators of *effective cataract surgical coverage*, and *effective refractive error coverage*, to be used alongside the crude service coverage indicators.(8, 9)

In addition to measuring these indicators in the population as a whole, it is important to understand how such measures differ between different sub-groups, men and women, rich and poor, urban and rural and those with and without disabilities(8, 10, 11). Evidence exists to suggest that health needs and access to health services varies between different population sub-groups but often to different extents in different locations(10, 12, 13).

The Sustainable Development Goal mantra of *leaving no one behind*, as well as renewed focus from WHO on achieving universal health coverage, mean that political pressure is greater than ever for governments to demonstrate that they are including all members of society in all they do, including health service provision. Population based surveys, including those focused on visual impairment, need to incorporate measures of equity, to ensure that results can be examined by different population sub-groups (1, 8, 10, 14).

## Visual Impairment In Mozambique

No national blindness study has ever been conducted in Mozambique although several sub-national level studies have been undertaken that focus on specific population groups or ocular conditions. Between 2012 and 2015, 96 surveys were conducted to map trachoma in 137 districts across the country including both trichiasis among people aged 15 years and above, and trachomatous inflammation–follicular among children aged 1–9 years(15). A Rapid Assessment of Refractive Error, Presbyopia, and Visual Impairment and Associated Quality of Life among people aged 15–50 years was conducted in Nampula province in 2015(16). Rapid assessments of avoidable blindness (RAAB) have been conducted among

people aged over 50 years in Nampula province in 2011, Sofala province in 2012 and Inhambane province in 2016(17–19).

The 2011 RAAB in Nampula identified high prevalence of presenting bilateral blindness (6.2%), with cataract as the major cause (73.0%). Coverage of cataract services were low (10.3%), with women particularly disadvantaged as compared with men (7.7% vs 12.8%). Importantly, visual acuity among operated people was poor, which, although not directly linked with surgical provision, can be considered a crude indicator that surgery was not providing the 'maximum possible health gain' for patients.

## **Nampula Eye Care Programme, 2011-2018**

Following the dissemination of findings, The Nampula Eye Care Programme, delivered in partnership between The Ministry of Health and international non-governmental organisation (NGO) Sightsavers, prioritised activities to increase coverage with cataract services and improve visual outcomes of surgery by: introducing optical biometry and a keratometer in the main tertiary hospital and through outreaches in the district hospitals; training and deploying ophthalmic technicians to primary and secondary health facilities throughout the province; strengthening the community outreach programme to improve community education and increase screening services; introducing one week follow-up to deal with immediate complications; and introducing patient transport for surgical services. More recently, since 2016, the partnership has sought to improve the gender focus of the programme and has: increased the proportion of community health workers trained who are female; prioritised women for screening and treatment; sensitised staff to the additional and specific needs for both females and people living with disabilities; and introduced a standardised cataract monitoring tool to identify any poor results and implement improvements(20, 21).

In 2018, the Nampula eye care programme conducted a second RAAB in Nampula province to measure changes since the 2011 study and realign programme activities according to the updated data. The objective of this paper is to report how the prevalence and causes of VI, and crude and effective coverage of cataract services has changed between RAABs conducted in Nampula province in 2011 and 2018. We also sought to understand how the situation differed for men and women between 2011 and 2018.

## **Methods**

Two separate, unlinked cross-sectional surveys were undertaken in Nampula province, Mozambique. The first survey was undertaken in August 2011, and the second survey was undertaken in August and September 2018. Both used the standardised RAAB methodology which has been well described elsewhere(22).

The major objectives of both studies were to determine the prevalence of visual impairment among people aged 50 years or above; determine the causes of visual impairment; and to determine the coverage with cataract surgical services of people living in Nampula province.

# Sampling

Sampling methodology was similar in both surveys and followed standard RAAB methodology. The primary sampling unit was people aged 50 years and above who lived in sampled clusters and households. Two-stage sampling was conducted that entailed probability proportional-to-size (PPS) to select enumeration units followed by compact segment sampling (CSS) within enumeration units to select households. PPS sampling was conducted for both surveys by constructing a list of all enumeration units in the province using 2007 census data obtained from the National Institute of Statistics (Instituto Nacional De Estadística). Population size was listed alongside the name of the unit and was uploaded with the RAAB software to select the required number of clusters. CSS was conducted within the selected enumeration units if they were particularly large, i.e. if it could be expected that at least twice as many people as we hoped to enumerate aged over 50 years would live there (i.e. at least 100 in 2011 and at least 80 in 2018). The CSS was conducted prior to the visit by the enumeration team and was done collaboratively between the cluster informer and local leader to ensure the rationale for selecting only part of the area to participate in the survey was well understood.

Sample size calculations were made for both surveys using the calculator built in to the RAAB software. In 2011 the sample size was calculated to be 3,050 people, or 61 clusters of 50 people. This was based on an expected prevalence of blindness in adults aged over 50 years of 5.0%, a precision of 20% (i.e. worst acceptable result of 4.0%), 95% confidence intervals, with a design effect of 1.5 for clusters of 50 people, and 10% non-response.

In 2018 the sample size was calculated to be 4,200 people, or 105 clusters of 40 people. This was based on an expected prevalence of blindness in adults aged over 50 years of 5.0%, 95% confidence, a precision of 16% (i.e. worst acceptable result of 4.2%), with a design effect of 1.4 for clusters of 40 people, and 5% non-response. The 5% non-response rate and clusters of size 40 were chosen for this survey due to recent experiences of conducting trachoma surveys in the area which yielded high response rates but long travel times between and within clusters.

## Inclusion and exclusion criteria

People eligible to participate in the survey were people aged 50 years or above who had been resident in the household for the past six months. People aged under 50 years or who were newly resident or only visiting were ineligible. People normally eligible but absent on the day the study team visited were enrolled but not examined and basic details on their visual status were gathered from their families or neighbours.

## Enrolment and examination procedures

RAAB study teams in both surveys consisted of either an ophthalmologist and ophthalmic technician or two ophthalmic technicians. In both cases, all team members underwent a one-week standardised training course by a RAAB certified trainer and successfully passed an intra-observer variation test, for

which the minimum acceptable kappa scores was 0.6 over nine indicators. In 2011 there were four teams and 2018 there were five teams collecting data.

Study procedures were the same in both surveys. A cluster informer travelled a day or two ahead of the RAAB study team to each enumeration unit to meet the community leader and inform them about the study. If the community was large they would conduct a CSS exercise to select a smaller portion of the community for the RAAB study team to visit.

Once at a house, the study team introduced themselves to the head of the household and ascertained whether any residents were eligible for participation in the study. Eligible participants were given information about the study and consent was sought. A presenting visual acuity (VA) examination was undertaken, with spectacles if available, outside the house using a simplified 'E' optotype according to standard RAAB procedure. Participants with VA < 6/18 in either eye were re-examined using a pinhole occlude to ascertain their best corrected visual acuity. All participants underwent a lens examination in a darkened location (normally inside their house) to determine whether the lens was normal, occluded, aphakic, pseudoaphakic with or without posterior capsule opacification, or not visible at all. All eyes with presenting VA < 6/18 were then assigned a primary cause of visual impairment, with the study team undertaking an examination of the posterior segment if necessary. Participants with unoperated cataract were asked reasons for not having sought care. Participants who had been previously operated for cataract were asked for details of their operation(s).

## **Population data**

Population data used for the 2011 survey was taken from the 2007 census, and for the 2018 survey was from the 2017 census.

Table 1  
Distributions of Nampula population by age and sex from 2007 and 2017 censuses

	Males		Females		Total	
	n	%	n	%	n	%
<b>2017 census</b>						
50–59 years	88,291	49.7%	87,587	54.3%	<b>175,878</b>	<b>51.9%</b>
60–69 years	53,307	30.0%	47,032	29.2%	<b>100,339</b>	<b>29.6%</b>
70–79 years	25,315	14.3%	19,047	11.8%	<b>44,362</b>	<b>13.1%</b>
80–99 years	10,564	6.0%	7,543	4.7%	<b>18,107</b>	<b>5.3%</b>
<b>Total</b>	<b>177,477</b>	<b>100.0%</b>	<b>161,209</b>	<b>100.0%</b>	<b>338,686</b>	<b>100.0%</b>
<b>2017 census</b>						
50–59 years	112,292	48.8%	106,864	48.7%	<b>219,156</b>	<b>48.8%</b>
60–69 years	66,816	29.1%	63,828	29.1%	<b>130,644</b>	<b>29.1%</b>
70–79 years	32,083	13.9%	30,169	13.8%	<b>62,252</b>	<b>13.9%</b>
80–99 years	18,812	8.2%	18,348	8.4%	<b>37,160</b>	<b>8.3%</b>
<b>Total</b>	<b>230,003</b>	<b>100.0%</b>	<b>219,209</b>	<b>100.0%</b>	<b>449,212</b>	<b>100.0%</b>

Study definitions were as follows:

<b>Blindness</b>	<b>VA &lt; 3/60 in the better eye with available correction (presenting VA)</b>
Severe VI	VA < 6/60–3/60 in the better eye with available correction
Moderate VI	VA < 6/18–6/60 in the better eye with available correction
Good visual outcome in operated eye	VA ≥ 6/18 in operated eye
Borderline	VA ≥ 6/60 but < 6/18 in operated eye
Poor	VA < 6/60 in operated eye
Cataract surgical coverage (persons) (5)	$\frac{x + y}{x + y + z} \times 100$ <p>Where</p> <p>x = persons with unilateral (pseudo)aphakia and an operable cataract in the other eye,</p> <p>y = persons with bilateral (pseudo) aphakia, and</p> <p>z = persons with bilateral operable cataract</p>
Effective cataract surgical coverage (persons)(8)	$\frac{c + d}{x + y + z} \times 100$ <p>Where</p> <p>c = individuals with unilateral pseudo/aphakia achieving presenting visual acuity of 6/18 or better in the operated eye and operable cataract in the other eye</p> <p>d = individuals with bilateral pseudo/aphakia achieving presenting visual acuity of 6/18 or better in at least one eye</p> <p>and x, y, and z are as above</p>

## Data analysis

For both surveys, data analysis was carried out by the RAAB software which produces comprehensive standard tables addressing sample and age and sex adjusted prevalence of visual impairment, causes of visual impairment, cataract surgical coverage, quality of visual outcomes, reasons for poor visual outcomes, and barriers to cataract surgery. We assessed differences between measures in the two surveys and between males and females using logistic regression models developed using Stata v15 statistical software(23). The models examined associations, presented as odds ratios, between the binary outcome measures (blind, Severe VI, Moderate VI) and the independent variables described adjusted for clustering and age and sex differences. We used p-values to assess whether the observed differences in odds ratios reported in the model were likely to have occurred by chance, using the standard 1 in 20 (p = 0.05) as an indicator of whether the association was likely to have occurred by chance.



## Ethics

Both studies were conducted in line with the principles of ethical conduct of research and were granted ethical approval by the Mozambique National Bioethics Committee prior to collecting data.

In both 2011 and 2018, participants were given oral information about the study and provided with an opportunity to ask questions. It was stressed that participation was entirely voluntary, and written consent was taken with adaptations for those who were illiterate or had other impairments preventing them from signing their own name. Participants examined and found to have ocular morbidities were either treated on site, given referral to the nearest health facility with required services, or asked for permission to share their name with the team recorder to ensure they would be transported to Nampula Central Hospital at the next available time.

## Results

Table 2 shows the response status of participants by sex. The 2011 study enrolled 3,050 people and examined 96.9% (2,954 people). The 2018 survey enrolled 4,191 people and examined 95.8% (4,015 people). Women accounted for 45.6% of those examined in the 2011 survey and 45.3% of those examined in the 2018 survey.

In 2011, very few people who were not examined were absent from home (0.6%) compared with those who refused or were unable to participate (2.5%). In 2018, the reasons for not being examined were more evenly split between those absent from home (2.2%) and those who refused or were unable (2.0%).

Table 2  
Sex distribution of respondents, by examination status

2011 survey								
	Examined		Absent		Refused/ unable		Total	
	n	%	n	%	n	%	n	%
<b>Males</b>	1,347	97.0	13	0.9	28	2.0	1,388	100
<b>Females</b>	1,607	96.7	6	0.4	49	2.9	1,662	100
<b>Total</b>	<b>2,954</b>	<b>96.9</b>	<b>19</b>	<b>0.6</b>	<b>77</b>	<b>2.5</b>	<b>3,050</b>	<b>100</b>
2018 survey								
	Examined		Absent		Refused/ unable		Total	
	n	%	n	%	n	%	n	%
<b>Males</b>	1,819	95.4	50	2.6	37	1.9	1,906	100
<b>Females</b>	2,196	96.1	42	1.8	47	2.1	2,285	100
<b>Total</b>	<b>4,015</b>	<b>95.8</b>	<b>92</b>	<b>2.2</b>	<b>84</b>	<b>2.0</b>	<b>4,191</b>	<b>100</b>

## Prevalence Of Visual Impairment

The sample prevalence of bilateral blindness, shown in Table 3, was significantly lower in 2018 than 2011 (7.1% in 2011 vs 4.7% in 2018,  $z=-4.39$ ,  $p < 0.001$ ). Sample prevalence of severe VI remained similar between the two surveys (3.1% in 2011 vs 2.8% in 2018,  $z=-0.51$ ,  $p = 0.6$ ), and sample prevalence of moderate VI increased significantly (6.5% in 2011 vs 11.3% in 2018,  $z = 6.71$ ,  $p < 0.001$ ).

Table 3  
Sample prevalence of visual impairment in 2011 and 2018 surveys

2011 survey						
	Males		Females		Total	
	n	% 95%CI	N	% 95%CI	n	% 95%CI
<b>Bilateral blindness</b>	92	6.8% 5.2–8.4	119	7.4% 5.6–9.2	<b>211</b>	7.1% 5.8–8.5
<b>Bilateral severe VI</b>	47	3.5% 2.4–4.5	43	2.7% 1.9–3.5	<b>90</b>	3.1% 2.4–3.7
<b>Bilateral moderate VI</b>	90	6.7% 5.1–8.2	103	6.4% 5.2–7.6	<b>193</b>	6.5% 5.5–7.6
2018 survey						
<b>Bilateral blindness</b>	76	4.2% 3.2–5.1	111	5.1% 3.9–6.2	<b>187</b>	4.7% 3.8–5.5
<b>Bilateral severe VI</b>	46	2.5% 1.7–3.3	68	3.1% 2.4–3.8	<b>114</b>	2.8% 2.3–3.4
<b>Bilateral moderate VI</b>	210	11.5% 10.1–13.0	244	11.1% 9.4–12.8	<b>454</b>	11.3% 10.1–12.5

After adjusting the results for age and sex structure of the population, Table 4, the prevalence of bilateral blindness in Nampula province decreased from 6.2% in 2011 to 4.5% in 2018 ( $z=-2.21$ ,  $p = 0.028$ ). The decrease in the prevalence of blindness was predominantly observed among males (6.1% vs 3.8%,  $z=-2.61$ ,  $p = 0.01$ ), and was not significant among females (6.3% vs 5.3%,  $z=-1.04$ ,  $p = 0.3$ ).

Bilateral severe VI remained almost the same at 2.6% in 2011 and 2.7% in 2018 ( $z = 0.1$ ,  $p = 0.9$ ). A decrease was observed among males (2.9% vs 2.4%,  $z=-1.07$ ,  $p = 0.3$ ) and an increase among females (2.2% vs 3.1%,  $z = 1.4$ ,  $p = 0.2$ ), although neither change was significant.

Bilateral moderate VI increased from 5.9% in 2011 to 11.0% in 2018 ( $z = 5.78$ ,  $p < 0.001$ ). Increases were observed among both males (6.3% vs 10.8%,  $z = 3.94$ ,  $p < 0.001$ ), and females (5.5% vs 11.2%,  $z = 5.29$ ,  $p < 0.001$ ).

Table 4  
Age and sex adjusted prevalence in 2011 and 2018 surveys

<b>2011 survey</b>			
	<b>Male</b>	<b>Female</b>	<b>Total</b>
	<b>%</b>	<b>%</b>	<b>%</b>
	<b>95%CI</b>	<b>95%CI</b>	<b>95%CI</b>
<b>Bilateral blindness</b>	6.1%	6.3%	<b>6.2%</b>
	4.5–7.7	4.5-8.0	<b>4.8–7.5</b>
<b>Bilateral severe VI</b>	2.9%	2.2%	<b>2.6%</b>
	1.9-4.0	1.4-3.0	<b>1.9–3.3</b>
<b>Bilateral moderate VI</b>	6.3%	5.5%	<b>5.9%</b>
	4.7–7.8	4.3–6.6	<b>4.8–6.9</b>
<b>2018 survey</b>			
<b>Bilateral blindness</b>	3.8%	5.3%	<b>4.5%</b>
	3.0-4.7	4.2–6.6	<b>3.7–5.4</b>
<b>Bilateral severe VI</b>	2.4%	3.1%	<b>2.7%</b>
	1.7–3.3	2.4-4.0	<b>2.2–3.3</b>
<b>Bilateral moderate VI</b>	10.8%	11.2%	<b>11.0%</b>
	9.5–12.2	9.6–13.0	<b>9.9–12.2</b>

## Causes Of Visual Impairment

The proportion of bilateral blindness due to cataract decreased from 73% in 2011 to 56% in 2018, Table 5. Cataract was responsible for similar levels of severe VI in both surveys: 68.9% in 2011 and 68.4% in 2018. The proportion of bilateral moderate VI due to cataract increased from 36.3% in 2011 to 43.2% in 2018. Glaucoma increased as a major cause of bilateral blindness from 9% in 2011 to 20% in 2018, and also appeared to be responsible for more severe VI, increasing from 2–7%, and moderate VI from 1–3.1%. Refractive error was an insignificant cause of blindness in both surveys (0.9% in 2011 and 0.5% in 2018). It also remained fairly static as a cause of both severe and moderate VI between 2011 (Severe VI 15.6%; Moderate VI 43.5%) and 2018 (Severe VI 16.7%; Moderate VI 46.3%). Other causes of VI at all levels remained small and relatively similar in both surveys.

Table 5  
Causes of visual impairment in 2011 and 2018 surveys

<b>2011 survey</b>						
	<b>Blindness</b>		<b>Severe VI</b>		<b>Moderate VI</b>	
	<b>N</b>	<b>%</b>	<b>N</b>	<b>%</b>	<b>N</b>	<b>%</b>
Refractive error	2	0.9%	14	15.6%	84	43.5%
Uncorrected aphakia	0	0	0	0	2	1.0%
Unoperated cataract	154	73.0%	62	68.9%	70	36.3%
Trachomatous corneal opacity	4	1.9%	0	0	1	0.5%
Non-trachomatous corneal opacity	5	2.4%	0	0	4	2.1%
Phthisis	0	0	0	0	0	0
Glaucoma	19	9.0%	2	2.2%	2	1.0%
ARMD	2	0.9%	1	1.1%	2	1.0%
Other posterior segment/ globe diseases	25	11.8%	11	12.2%	28	14.5%
<b>2018 survey</b>						
Refractive error	1	0.5%	19	16.7%	210	46.3%
Uncorrected aphakia	0	0	0	0	0	0
Unoperated cataract	104	55.6%	78	68.4%	196	43.2%
Trachomatous corneal opacity	3	1.6%	1	0.9%	0	0
Non-trachomatous corneal opacity	9	4.8%	0	0	2	0.4%
Phthisis	6	3.2%	0	0	1	0.2%
Glaucoma	38	20.3%	8	7.0%	14	3.1%
ARMD	1	0.5%	2	1.8%	1	0.2%
Other posterior segment/ globe diseases	22	11.8%	6	5.3%	27	5.9%

## Post-surgical Visual Outcomes

Visual outcomes among eyes operated for cataract improved between the two surveys, Table 6. In 2011, 34.6% of operated eyes had good presenting vision, i.e. they could see 6/18, increasing to 57.7% with a pinhole. In 2018, 58.2% of eyes had good presenting vision, increasing to 72.4% using a pinhole. The proportion of eyes with 'poor' presenting vision, i.e. they could not see 6/60, was 26.9% in 2011 (23.1%

with pinhole) and decreased to 22.4% (16.3% with pinhole) by 2018. Very few eyes, three in each study, had an operation without an intraocular lens.

Table 6  
Visual outcomes after cataract surgery in 2011 and 2018 surveys

<b>2011 study</b>						
	Non-IOL		IOL		Total	
	Eyes	%	Eyes	%	Eyes	%
<b>VA in operated eyes in sample with available correction (presenting)</b>						
Good: can see 6/18	0	0.0	9	39.1	9	34.6
Borderline: can see 6/60	2	66.7	8	34.8	10	38.5
Poor: cannot see 6/60	1	33.3	6	26.1	7	26.9
<b>VA in operated eyes in sample with best correction (pinhole)</b>						
Good: can see 6/18	1	33.3	14	60.9	15	57.7
Borderline: can see 6/60	1	33.3	4	17.4	5	19.2
Poor: cannot see 6/60	1	33.3	5	21.7	6	23.1
<b>Total</b>	<b>3</b>	<b>100.0</b>	<b>23</b>	<b>100.0</b>	<b>26</b>	<b>100.0</b>
<b>2018 study</b>						
<b>VA in operated eyes in sample with available correction (presenting)</b>						
Good: can see 6/18	0	0.0	57	60.0	57	58.2
Borderline: can see 6/60	0	0.0	19	20.0	19	19.4
Poor: cannot see 6/60	3	100.0	19	20.0	22	22.4
<b>VA in operated eyes in sample with best correction (pinhole)</b>						
Good: can see 6/18	0	0.0	71	74.7	71	72.4
Borderline: can see 6/60	0	0.0	11	11.6	11	11.2
Poor: cannot see 6/60	3	100.0	13	13.7	16	16.3
	<b>3</b>	<b>100.0</b>	<b>95</b>	<b>100.0</b>	<b>98</b>	<b>100.0</b>

## Cataract Surgical Coverage

Cataract surgical coverage among persons increased between 2011 and 2018, with coverage among males being uniformly higher than among females in both surveys and at all VA levels, Table 7. At VA <

3/60 CSC increased from 10.1–28.4%, with CSC among males increasing three-fold from 13.4–40.0% and CSC among females increasing 2.5-fold from 7.7–19.4%. At VA < 6/60, CSC increased from 8.2% in 2011 to 21.3% in 2018 and at VA < 6/18 CSC increased from 6.4% in 2011 to 12.1% in 2018.

Effective cataract surgical coverage also increased between 2011 and 2018. In 2011, eCSC was very low at all levels of visual acuity and for males and females. It increased from 4.4% in 2011 to 18.9% in 2018 at the VA < 3/60 level with males experiencing a greater increase (4.5–29.1%) than females (4.4–11.1%). Similar patterns were observed at the other levels of visual acuity.

Table 7  
Adjusted cataract surgical coverage (persons)  
and effective cataract surgical coverage  
(persons) in 2011 and 2018 surveys

<b>2011 survey</b>			
	<b>VA &lt; 3/60</b>	<b>VA &lt; 6/60</b>	<b>VA &lt; 6/18</b>
<b>Cataract surgical coverage %</b>			
Total	10.1	8.2	6.4
Male	13.4	11.2	8.5
Female	7.7	5.9	4.8
<b>Effective cataract surgical coverage %</b>			
Total	4.4	3.4	2.5
Male	4.5	3.4	2.6
Female	4.4	3.4	2.4
<b>2018 survey</b>			
<b>Cataract surgical coverage %</b>			
Total	28.3	21.3	12.1
Male	40.0	30.7	19.5
Female	19.4	14.1	7.0
<b>Effective cataract surgical coverage %</b>			
Total	18.9	14.4	7.4
Male	29.1	22.7	12.2
Female	11.1	8.1	4.1

## Discussion

Between 2011 and 2018 the prevalence of blindness decreased, severe visual impairment remained the same and prevalence of moderate visual impairment increased. Although the proportion of blindness due to cataract has reduced, it remains a very important cause at all levels of visual impairment. Refractive error remains an important cause of VI, but posterior segment diseases appear to be increasing in importance.

Age and sex adjusted estimates of prevalence indicated relative equality between males and females in 2011 with 6.1% (95%CI 4.5–7.7%) of males bilaterally blind compared with 6.3% (95%CI 4.5-8.0%) of females. However, in 2018 we observed a non-statistically significant difference favouring males: 3.8% (95%CI 3.0-4.7) compared with 5.3% (95%CI 4.2–6.6%).

Although coverage and effective coverage of cataract services vastly improved between 2011 and 2018, they remain low. Cataract surgical coverage was significantly lower for women with no statistically demonstrable improvement observed overtime, although the relatively small number of surgeries observed may have undermined our ability to measure this change. However, the data indicates a worrying trend towards increased, rather than decreased equality of outcomes for males and females, and indicates further effort is required to identify effective strategies to improve equity of access for females. This finding is in line from other research from sub-Saharan Africa and further afield(10, 12, 24, 25).

The focus made by the Nampula eye care team after the 2011 RAAB in reducing cataract blindness and improving visual outcomes was broadly successful. However, the focus appears to have been primarily on patients who were blind, making little difference for people affected by early stage visual impairment from cataract. This focus is not surprising given that the capacity of services available remain limited compared to the relatively large size of the province with most districts receiving only intermittent surgical provision through the use of eye camps. Regular surgical services are available only at Nampula central hospital in the provincial capital. Surgical services delivered through camps rather than permanent services may reach predominantly blind patients for a number of reasons including they are more easily identified through community-based screening activities and they may be more willing to undergo the waiting time associated with visiting surgeons(26). Surgical services delivered through such camps may also exacerbate differences related to gender and poverty such as ability to leave the home and associated responsibilities in order to attend the camp(27).

Planning based on the 2018 survey should review how eye care services in Nampula province can be scaled up to address all causes and levels of VI. There is also a need to develop strategies to reach population areas and population sub-groups which are left further behind, and particularly women. Future research and population-based surveys should consider capturing standardised indicators of equity, such as those recommended on the PROGRESS checklist to support better inclusion of equity data in such studies(24, 28). The routine addition of data such as: Place of residence; Race/ethnicity/ culture/ language; Occupation; Gender/sex; Religion; Education; Socioeconomic status; Social capital/ networks,



would support better localised planning, which is vitally important in resource constrained environments such as Nampula as well as reporting against global targets such as the sustainable development goals.

This study is subject to several limitations. In particular, the RAAB methodology itself is relatively limited in terms of determining specific causes of VI, for example posterior segment diseases, and cannot tell us about magnitude or trends of visual impairment in younger age groups and children.(22) RAAB requires examiners to determine only the one most likely cause of VI and so cannot tell us anything about co-morbidity which is likely among older participants. RAABs are powered to calculate the prevalence of blindness in a study site and may not sample enough participants to reliably measure the differences between population sub-groups.

## Conclusions

This study highlights the importance of repeated surveys to understand progress and trends within district eye health programmes. The different results for males and females highlight the variation that can occur between sub-groups and underlines the needs to investigate other characteristics, for example disability, poverty and location. This study shows that improvements can be made in tackling avoidable blindness in an extremely underserved area. However, challenges around coverage and equity of services remain and the challenge for health planners and implementers must shift to address these issues.

## List Of Abbreviations

- ARMD Age related macular degeneration
- CI Confidence interval
- CSC Cataract surgical coverage
- CSR Cataract surgical rate
- CSS Compact segment sampling
- ECSC Effective cataract surgical coverage
- IOL Intra-ocular lens
- IOV Inter-observer variation
- PPS Probability proportionate to size
- RAAB Rapid assessment of avoidable blindness
- VA Visual acuity

VI Visual impairment

## **Declarations**

## **Consent for publication**

Not applicable

### **Availability of data and materials**

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

### **Competing interests**

The authors declare that they have no competing interests.

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2011 – Sightsavers.

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DFID had no role in any part of the study. Several Sightsavers staff had roles in both studies, as detailed below.

## **Authors' contributions**

EJ made significant contributions to the design of the 2018 study, acquisition of 2018 data, analysis and interpretation of 2011 and 2018 results, and drafted this manuscript.

MCumaio made significant contributions to the design of the 2011 and 2018 studies, acquisition of 2011 and 2018 data and interpretation of 2011 and 2018 results.

AV made significant contributions to the design of the 2011 and 2018 studies, acquisition of 2018 data and interpretation of 2011 and 2018 results.

IH made significant contributions to the design of the 2011 and 2018 studies, and interpretation of 2011 and 2018 results.

KK made significant contributions to the design of the 2011 study, acquisition of 2011 data, analysis and interpretation of 2011 results.

KO made significant contributions to the design of the 2018 study, acquisition of 2018 data, interpretation of 2018 results, and substantively revised this manuscript.

ES made significant contributions to the interpretation of 2011 and 2018 results, and substantively revised this manuscript.

ALL authors have approved the submitted version of this manuscript AND have agreed both to be personally accountable for the author's own contributions and to ensure that questions related to the accuracy or integrity of any part of the work, even ones in which the author was not personally involved, are appropriately investigated, resolved, and the resolution documented in the literature.

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