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Prevalence and causes of blindness and visual impairment; and cataract surgical services in Katsina state of Nigeria

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ABSTRACT

Aim To generate data on blindness and visual impairment for planning and monitoring a comprehensive eye care programme in Katsina state of Nigeria.

Method A rapid assessment of avoidable blindness (RAAB) survey methodology was used to select 3120 persons aged 50 years and over. The sample was selected using a multistage cluster randomised sampling. Each participant had visual acuity and lens assessment. Persons with vision less than 6/12 in any eye were assessed for the cause of visual impairment. Persons with cataract were asked why they had not had surgery. Data were captured electronically with the mRAAB Android-based software and analysed with STATA V.14 software.

Results A response rate of 90.1% was achieved. The age-sex adjusted blindness prevalence was 5.3% (95% CI 5.2% to 5.3%). Women were 30% more likely to be blind (OR 1.3, 95% CI 1.2 to 1.3). The principal causes of blindness were cataract (70%), other posterior segment (12%) and glaucoma (7%); 86.7% of blindness was avoidable. The prevalence of cataract blindness is 2.6% (95% CI 2.5% to 2.6%) with higher odds in women (OR 1.2, 95% CI 1.2 to 1.3, $p < 0.005$). The cataract surgical coverage $< 6/60$ for persons was 28.2% and women were 45% less likely to have had cataract surgery (OR 0.55, 95% CI 0.34 to 0.78, $p < 0.005$). The major barriers to cataract surgery are lack of felt need and the cost of services.

Conclusion Katsina state of Nigeria has high burden of avoidable blindness affecting more women. The state eye care programme should have cataract services that are more accessible, affordable and gender sensitive.

INTRODUCTION

Since the launch of the WHO VISION 2020: The Right to Sight programme in 1999,¹ stakeholders have collaborated globally to establish or support eye care services. In Nigeria, several non-governmental organisations have collaborated with many state governments (like Cross River, Kaduna, Kwara and Sokoto states) to establish eye care programmes aiming for an eye care service that is accountable, affordable, equitable, integrated and sustainable.^{2,3}

The World Health Assembly resolution WHA66.4⁴ of 2013 urged Member States of the WHO to generate evidence on the magnitude and causes of blindness and visual impairment (VI) for planning and monitoring of eye care services. Evidence-based eye planning is expected to achieve

universal eye health in Member States as contained in the resolution.

The Katsina State Government of Nigeria in collaboration with Noor Dubai Foundation, a United Arab Emirates-based charity, is planning to establish an eye care programme in the state. However, Katsina state of Nigeria has no recent data on magnitude and causes of blindness and VI. The last reported prevalence of blindness and visual impairment from a subdistrict of the state was two decades ago, which reported blindness prevalence of 8.2% (95% CI 5.8% to 10.5%) and low vision of 6.9% (95% CI 4.7% to 9.2%) among 40 years and older.⁵ Thus, a study was commissioned to generate these data for evidence-based planning and monitoring of the proposed eye care programme towards the attainment of Universal Eye Health in the state. The study was also to determine the extent to which cataract services have met the needs in the society and the barriers to uptake of cataract surgery in the state.

METHODS AND MATERIALS

This was a cross-sectional study of persons aged 50 years and over residing in Katsina state of Nigeria. The WHO-recommended rapid assessment of avoidable blindness (RAAB)^{4,6,7} methodology was used to conduct the study as it provides a more cost-effective approach to generating data on blindness and VI compared with a full epidemiological survey. Data collection took place in November and December 2018. Study participants were informed of the purpose of the study in the local Hausa language, and a signature or thumb print was obtained from them for acceptance to participate. The provisions of the Declaration of Helsinki were also applied regarding the right to participate or to withdraw at any stage of the study.

A minimum sample size of 3030 was obtained based on the following variables: target population of 466 578 aged 50 years and older representing 6.9% of estimated total population of 6 740 481 in the state as of 2011.⁸ Estimated prevalence of blindness in persons 50 years and over of 5.6% as reported in recent survey in neighbouring districts of Sokoto state.³ Maximum tolerable error of $5.6\% \pm 1$. A design effect of 1.4 and non-response rate of 5% were applied.

The study sample was selected using multi-stage cluster randomised sampling. Using probability proportional to cluster size sampling, 78



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communities were randomly selected in the first sampling stage as clusters. In the second sampling stage, each cluster was divided into segments comprising 40 persons aged 50 years and over. Where there was more than one segment, a segment was selected by simple random sampling. All eligible persons in the selected segment were then enumerated until the desired cluster sample size is attained (40). In a segment with less than 40 eligible persons, a nearby segment was selected to complete the cluster sample. Only persons aged 50 years and over who are residents in the selected segment for at least 6 months were invited to participate in the study. Ages of most people had to be approximated by important local calendar events due to non-documentation of births in the area.

The presenting vision (visual acuity, VA) of each participant was tested using a single optotype E-chart. The chart has a single 60 size optotype on one side and a 12 size optotype on the other side. Each eye was tested separately. The direction of the E was randomly changed five times for the reading of the study participants. An eye was considered to pass an acuity line after correctly identifying four of five directions of the optotypes shown. Any eye that failed to identify the 6/12 optotype had pinhole acuity assessment. An ophthalmic nurse conducted the VA assessment. Lens examination was then performed by the ophthalmologist using a penlight to determine if an eye has the natural crystalline lens, intraocular lens or is aphakic/pseudophakic. Those with a VA of less than 6/12 with pinhole were further evaluated to determine the cause of VI for each eye and for the person using the WHO algorithm.⁹ The evaluation included direct and indirect ophthalmoscopy with pupil dilation (with Tropicamide 1% eye-drops) if required, after confirming the anterior angle is not shallow. Where there is more than one possible cause of VI in any eye, the disease most curable was considered, otherwise the most easily preventable was selected. For each person the cause of VI was determined by considering the causes in the two eyes and selecting the cause that is most curable, otherwise the easily preventable cause. Those diagnosed with cataract in any eye as the cause of VA <6/12 were asked why they had not had surgery. Up to two barriers to accessing cataract surgery were selected. Persons who had cataract surgery were asked when and where they had surgery and the cost of the surgery. The operational definitions were based on RAAB operational definitions.¹⁰ Participant(s) identified with eye diseases were referred to nearby eye clinics for further care.

Three teams collected the data and each team comprised an ophthalmologist, an ophthalmic nurse, a driver and a local guide. A certified RAAB trainer trained the teams on RAAB survey procedures and operational definitions in 6 days. This was conducted in a general hospital and in a nearby non-survey community for field training. A minimum intergrader agreement

of 0.7 on VA, lens assessment and cause of VI with the RAAB trainer was achieved before the survey started.

All collected data were electronically captured with the aid of the mRAAB software on an Android phone by all three teams and sent to the survey's principal investigator, who cleaned the data by using the consistency check of the RAAB software. The data were analysed using STATA V.14. Age and sex-adjusted prevalence was calculated in Microsoft Excel using the 2011 Katsina state population estimates.⁸ Tests of statistical significance were conducted to determine level of statistical significance between groups at $p < 0.05$. Blindness was defined as presenting VA of <3/60 in the better eye; severe visual impairment (SVI) as a VA of <6/60-3/60 in the better eye; and early to moderate VI (EMVI) as a VA of <6/12-6/60 in the better eye. 'All VI' as VA less than 6/12 to no perception of light. The cataract surgical coverage (CSC) for persons and eyes was calculated using the following formula:¹¹

$$\text{Cataract Surgical Coverage (persons) (VA)} = (x + y/x + y + z) \times 100,$$

where: x=persons with unilateral (pseudo)aphakia and operable cataract in the other eye; y=persons with bilateral (pseudo)aphakia; z=persons with bilateral operable cataract.

$$\text{Cataract Surgical Coverage (eyes) (VA)} = (a/a + b) \times 100,$$

where: a=(pseudo)aphakic eyes; b=eyes with operable cataract.

RESULTS

Of the 3120 enumerated, 2812 persons were examined (response rate of 90.1%) as in table 1. Males constituted 51.2% of the examined (1441 of 2812). Because the ages of participants were estimates, a tendency towards rounding up age and underestimation was observed.

Prevalence of blindness and VI

The unadjusted prevalence of blindness with available correction was 5.4% (95% CI 4.6% to 6.3%); SVI was 2.3% (95% CI 1.8% to 2.9%); EMVI was 23.5% (95% CI 21.9% to 25.1%).

The age-sex adjusted blindness prevalence for the population was 5.3% (95% CI 5.2% to 5.3%), SVI was 1.8% (95% CI 1.8% to 1.8%) and EMVI was 19.1% (95% CI 19.0% to 19.2%) (table 2). The odds of blindness in women was 1.3 (95% CI 1.2 to 1.3) compared with men. There was a strong association at $p < 0.05$ between being female and blindness ($p < 0.005$). However, the difference in prevalence of EMVI and SVI among the sexes is not statistically significant.

Causes of blindness and VI

The principal causes of bilateral blindness were cataract, other posterior segment and glaucoma accounting for 88.8% of

Table 1 Examination status of eligible persons

Age group (years)	Examined			Not available		Refused		Not capable	
	Males (n)	Females (n)	Total (%)	Males (n)	Females (n)	Males (n)	Females (n)	Males (n)	Females (n)
50–54	263	312	575 (20.4)	18	35	3	8	0	0
55–59	269	309	578 (20.5)	20	22	5	6	0	3
60–64	257	297	554 (19.7)	38	22	6	9	0	3
65–69	200	158	358 (12.7)	23	8	2	6	0	0
70–74	209	120	329 (11.7)	28	8	3	2	1	0
75–79	112	49	161 (5.7)	2	1	3	1	0	1
80+	131	126	257 (9.1)	5	4	1	4	1	6
Total	1441 (51.2%)	1371 (48.8%)	2812 (100)	134	100	23	36	2	13

Table 2 Sex-adjusted prevalence and magnitude of blindness and visual impairment

	EMVI		SVI		Blindness	
	n	% (95% CI)	n	% (95% CI)	n	% (95% CI)
Male	52 206	19.2 (19.0 to 19.3)	5166	1.9 (1.8 to 2.0)	13 867	5.1 (5.0 to 5.2)
Female	36 988	19.0 (18.8 to 19.2)	3309	1.8 (1.6 to 1.8)	10 707	5.5 (5.4 to 5.6)
Total	89 194	19.1 (19.0 to 19.2)	8476	1.8 (1.8 to 1.8)	24 574	5.3 (5.2 to 5.3)

EMVI, early to moderate visual impairment; SVI, severe visual impairment.

blindness as in [table 3](#). About 86.7% of the causes of blindness are avoidable. The principal causes of EMVI were cataract and refractive errors accounting for 87% of the causes.

The leading causes of unilateral blindness were cataract (56.7%), glaucoma (9.1%) and non-trachomatous corneal opacity (8.9%) while the leading causes of unilateral 'All VI' were cataract (63.1%) and refractive errors (21.6%).

Cataract blindness

The sex-adjusted bilateral cataract prevalence was 2.6% (95% CI 2.5% to 2.6%). There is a very strong evidence of a statistically significant difference at $p < 0.05$ between the sexes with females having a 20% higher odds of prevalence of cataract blindness (OR 1.2, 95% CI 1.2 to 1.3, $p < 0.005$). An estimated 224 454 eyes of 143 944 persons in the target population are in need of cataract surgery to treat blindness or VI in one or both eyes ([table 4](#)).

Cataract surgical coverage

The CSC for persons and eyes for VA $< 6/60$ is 28.2% and 23.4%, respectively, as in [table 5](#). Women were 45% less likely to have had cataract surgery compared with men with a statistically significant difference at $p < 0.05$ (OR 0.55, 95% CI 0.34 to 0.78, $p < 0.005$). Among all the eyes that had cataract interventions in the last 5 years, 86.6% of the eyes had cataract surgery while the remaining 13.4% had couching. However, for eyes that had

cataract interventions more than 5 years ago, only 52.1% had cataract surgery while 47.9% had couching. Couching is a traditional form of treating cataract involving blunt dislocation of the crystalline lens into the vitreous cavity of the eye.

Majority of those operated for cataract had free surgery (63%, 104 of 165), with only 27% (44 of 165) paying for the surgery. Most cataract surgeries were conducted in a charitable hospital (38%), government hospital (31%) and eye camps (22%). Only 8% (15 of 178) were performed in private hospitals.

Outcome of cataract surgery

With available correction, 38% of pseudophakic eyes had a post-operative VA of $\geq 6/12$ (normal vision) that increased to 53% with pinhole correction. For 'couching' eyes, however, only 3.5% of the eyes had a VA of $\geq 6/12$ with available correction that increased to 8.8% with pinhole correction. Visual outcome after cataract surgery was poor (VA $< 6/60$) in 19.2% of the pseudophakic eyes with available correction that reduced to 7.9% with pinhole correction, whereas 84.2% of the couching eyes had poor outcome with available correction which reduced to 65% with pinhole correction.

Causes of poor visual outcome in pseudophakic eyes

The causes of 'Poor' and 'Borderline' visual outcome in pseudophakic eyes are mainly due to ocular comorbidity (43%) and surgery-related complications (40%). Out of the 78 eyes with 'Borderline outcome' (VA $< 6/12-6/60$) the main causes were 'Ocular co-morbidity' (42.3%) and 'Uncorrected refractive error' (33.3%). The main causes of poor visual outcome (VA $< 6/60$) were ocular comorbidity (42%) and operative complications (40%).

Barriers to cataract surgery

The major barriers to cataract surgery are a lack of felt need for improvement in vision by the participants because of ageing (38%) and the cost of services (35%). There was no significant difference between the sexes. However, among those with vision worse than 6/60 'Cost' was the major barrier (33%), while for those with vision better than 6/60 the major barrier was 'Need not felt' (52.5%). There is no difference across the sexes for the different VA levels.

DISCUSSION

The response rate of 90.1% in the study is good although we had projected to achieve 95% coverage of the selected population. The underachievement was due to the absence of 7% of the sample population who were out harvesting their farm produce. The good response obtained in this study is attributable to good mobilisation and cooperation received from local authorities and the study participants. The population distribution suggests an under-representation of persons in the age group of 50–54 years. The lack of birth certificate resulted in age estimation that showed a tendency to push the age to mid-60s or late 60s.

Table 3 Principal causes of blindness and visual impairment with available correction

Cause	EMVI	SVI	Blind	All VI
	$< 6/12-6/60$ n (%)	$< 6/60-3/60$ n (%)	$< 3/60$ n (%)	$< 6/12-NPL$ n (%)
Cataract	447 (66.5)	39 (76.5)	100 (69.9)	586 (67.7)
Refractive error	137 (20.4)	0 (0)	1 (0.7)	138 (15.9)
Glaucoma	10 (1.5)	4 (7.8)	10 (7.0)	24 (2.8)
Non-trachoma CO	14 (2.1)	2 (3.9)	5 (3.5)	21 (2.4)
Cataract surgical complications	15 (2.2)	0 (0)	2 (1.4)	17 (2.0)
Trachoma CO	2 (0.3)	1 (2.0)	5 (3.5)	8 (0.9)
Uncorrected aphakia	1 (0.1)	0 (0)	1 (0.7)	2 (0.2)
Diabetic retinopathy	1 (0.1)	1 (2.0)	0 (0)	2 (0.2)
AR macular degeneration	2 (0.3)	0 (0)	0 (0.0)	2 (0.2)
All globe/CNS abnormalities	1 (0.1)	0 (0)	1 (0.7)	2 (0.2)
Phthisis	0 (0)	0 (0)	1 (0.7)	1 (0.1)
Other posterior segment	42 (6.3)	4 (7.8)	17 (11.9)	63 (7.3)
Total	672 (100)	51 (100)	143 (100)	866 (100)

AR, age related; CNS, central nervous system; CO, corneal opacity; EMVI, early to moderate visual impairment; NPL, no perception of light; SVI, severe visual impairment; VI, visual impairment.

Table 4 Extrapolation of number of people and eyes with cataract blindness and visual impairment in the state

	EMVI		SVI		Blindness	
	n	% (95% CI)	n	% (95% CI)	n	% (95% CI)
Bilateral cataract						
Male	36229	13.3 (13.2 to 13.4)	3208	1.2 (1.1 to 1.2)	6416	2.3 (2.3 to 2.4)
Female	26553	13.6 (13.4 to 13.8)	2424	1.2 (1.2 to 1.3)	5680	2.9 (2.8 to 3.0)
Total	62782	13.4 (13.3 to 13.5)	5632	1.2 (1.1 to 1.2)	12096	2.6 (2.5 to 2.6)
Cataract eyes						
Male	106989	39.3 (39.1 to 39.5)	7737	2.8 (2.8 to 2.8)	16417	6.0 (5.9 to 6.1)
Female	71991	37.0 (36.8 to 37.2)	6268	4.0 (3.9 to 4.1)	15052	7.7 (7.6 to 7.8)
Total	178980	38.4 (38.2 to 38.5)	14005	3.0 (2.9 to 3.0)	31469	6.7 (6.7 to 6.8)

% denotes prevalence; n refers to number of people in the state.

EMVI, early to moderate visual impairment; SVI, severe visual impairment.

The prevalence of blindness in this study is lower than was reported two decades ago from a district of the state (8.2% for persons 40 years and older).⁵ However, the prevalence is similar to the finding of the more recent Nigerian national survey (5.5%).¹² Some improvements in eye health services and resources in the state over the last two decades might have resulted in decrease burden of blindness. Currently there are six ophthalmologists working in two optimally equipped eye clinics in the state compared with two decades ago when there was only one ophthalmologist with one poorly equipped eye clinic. The major causes of blindness and SVI in the study compare to the finding in a nearby population where cataract-related causes constituted 72.5% of causes of blindness.¹³ Cataract and refractive error alone are responsible for over 86% of all forms of VI in the study area. This suggests that even though there may have been improvement in eye services in the state over the last two decades, these services are still suboptimal as basic uncorrected refractive error is not being adequately addressed. Fortunately, there are proven cost-effective interventions for these two conditions. This should be prioritised in the proposed eye care programme for the state.

The prevalence of cataract blindness in this study area is higher than that reported in neighbouring Sokoto state (1.9%).¹³ The CSC for persons (VA <6/60) for the study area (28%) is much lower than the findings in neighbouring Sokoto state of Nigeria (62%),¹³ and also in Tanzania (65%)¹⁴ and Nakuru, Kenya (71%).¹⁵ Even though this coverage rate was a remarkable improvement from surgical coverage of 4% reported about two decades ago in a subdistrict of the state,⁵ it is still very low. This is more relevant considering the fact that the study area has had free mass cataract surgery services at the state capital for more than 5 years until recently when partial payment of N6000 (US\$16.5 equivalent) was introduced to sustain the services. However, as these surgeries were carried out only in the state capital, transport costs to reach the service may have been an

obstacle in a state with a large land mass of over 24 000 km² and poor transportation network. Indeed, cost of accessing cataract services featured as a major barrier to having cataract surgery among the study population. In contrast, the cataract services in the neighbouring Sokoto state, which reported a higher surgical coverage,¹³ were based on outreach services whereby cataract surgeries are taken to the remote rural areas and were offered for a longer period of time. This indicates the need for an eye care programme with strengthened cataract surgical services by decentralising the services to be more accessible and affordable to remote areas.

Similar to findings in this study several reports in the literature had reported women with higher prevalence of blindness^{14,16} and cataract blindness but lower odds of cataract surgery uptake.¹² Male dominance, lack of financial resources, illiteracy and lack of information have been identified as potential factors resulting in this gender imbalance.¹⁷ In this study, due to a unique demographic structure of the area characterised by higher percentage of male population than females, the absolute number of cataract blind men was more than females. All the same, proactive approach to women blindness and cataract may be more beneficial for advocacy and for resource mobilisation and because women in such rural communities are already disadvantaged by discrimination rooted in sociocultural factors.¹⁸ The higher burden of blindness and cataract prevalence among women in the state may be addressed by using women case finders and provision of cataract surgery fee subsidy for them.

The visual outcome with available correction in pseudophakic eyes is comparable to the finding in nearby districts of Sokoto state (18% poor outcome).¹⁹ But the major causes of poor outcome in this study including couched eyes were ocular comorbidity, surgery-related complications and uncorrected refractive error. There is a need for the proposed eye care programme to support surgeons on appropriate patient selection, institute cataract services self-auditing and refresher courses to reduce

Table 5 Cataract surgical coverage (CSC) by persons and eyes

Visual acuity	CSC persons			CSC eyes		
	<6/12	<6/60	<3/60	<6/12	<6/60	<3/60
Males						
Cataract surgical coverage (%)	14.1	33.7	36.3	15.1	28.9	31.9
Females						
Cataract surgical coverage (%)	8.2	21.7	23.4	6.3	17.3	19.0
Total						
Cataract surgical coverage (%)	11.3	28.2	30.4	10.1	23.4	25.8

surgery-related complications especially in the government hospitals where majority of the complications occurred. Routine use of biometry, availability of intraocular lenses of all powers and promoting use of spectacles can improve the proportion of eyes/persons with good surgical outcome in the study area.

Other posterior segment disorders apart from glaucoma, diabetic retinopathy and age-related macular degeneration that constituted 11.9% of blindness could not be determined in the study. As such, another study is needed to be able to determine what these posterior segment diseases are.

The findings of this study buttress the necessity for implementation of a comprehensive eye care programme in Katsina state with emphasis on provision and decentralisation of cataract and refractive error services. The programme should include patient education and subsidy especially for females towards achieving universal health coverage. This study was limited by imprecise age estimation resulting in over-representation or under-representation of certain age groups and use of basic eye examination such that other posterior segment disorders could not be ascertained. The high response, however, support the generalisability of the results to reflect the VI and cataract surgical services situation in Katsina state.

CONCLUSION

The prevalence of blindness and cataract blindness in the population is high and the causes of blindness are mostly avoidable with a gender inequality in the prevalence of blindness and uptake of cataract services. More efforts are necessary to increase awareness and accessibility and improve gender equity in cataract and other eye health services.

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Data availability statement Data are available upon request.

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