Rapid Assessment of Avoidable Blindness in Plateau State, Nigeria

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Executive summary

A lack of country-specific epidemiological data is a major barrier to the development of national health plans and policies in low- and middle-income countries (LMICs), including Nigeria – the most populous country in Africa with 36 states and a federal capital territory. Despite its size, only one national study on the prevalence of blindness has been conducted in Nigeria, between the years of 2005 and 2007 (1). To address the issue of absence of evidence, the World Health Organisation (WHO) recommends the use of Rapid Assessment of Avoidable Blindness (RAAB) studies to provide data for planning blindness and visual impairment (VI) prevention programmes (2).

RAAB is a standard methodology for obtaining reliable data on the prevalence of VI in people aged 50 years and over, the highest-risk category (3). In Plateau State, a Rapid Assessment of Cataract Surgical Service (RACSS) survey was conducted in 2010, which reported a prevalence of blindness among people aged 50-plus years to be 4.2% (4). Since 2010, however, no new data has been produced to assess the improvement in eye health services and to guide Plateau State decision-makers in developing a new eye-care action plan, or in planning programmes.

Key findings of the present survey

Prevalence and causes of visual impairment

Age- and sex-adjusted prevalence of blindness was found to be 2.7%. Extrapolating to the estimated total population, this means there are an estimated 11,992 blind people aged over 50 years living in Plateau State. Severe visual impairment affects a further 1.4% of the population, i.e., 6,363 people and 16,397 eyes.

The major cause of blindness remains unoperated cataract (64.0%), followed by glaucoma (16.6%). Cataract and cataract surgical complications are the most important causes of severe visual impairment (74.2% and 8.2% respectively). Cataract is also the main cause of moderate visual impairment (71.1%) followed by refractive error (12.8%). Refractive error is the main cause of early visual impairment (43.5%).

Cataract services

Using the recently updated definitions, the cataract surgical coverage (CSC) at VA,6/12 in Plateau State is 27.5% overall (32.8% among males and 22.0% among females), which means that fewer than one in three people with cataract and VA,6/12 had been operated on.

Furthermore, among 282 operated eyes, 70 (24.8%) had good post-operative vision (6/12), 93 (33.0%) had borderline vision (6/60 to 6/12), and 119 (42.2%) had poor vision (worse than 6/60). As a result, the proportion of people who had surgery – and a good visual outcome from surgery effective CSC (eCSC) indicator – was low at 10.8% at VA<6/12, and slightly higher among males (12.0%) than females (9.7%). The major cause of borderline or poor post-operative vision was surgical complications (65.7%). Couching also remains a common practice in this state (12.8%), contributing to poor post-operative visual outcomes.

Gender and equity

Although there was little difference in the prevalence of blindness between men and women, the results suggest that cataract surgery is more common in men than women. We also found strong association between severe visual impairment and the presence of a disability and poorer socio-economic status. In order to achieve equity of access, strategies to improve access to services for women, those who are poorer and those with additional functional difficulties, will be important.

Contents

Tables and figures

List of abbreviations

BCVA	Best Corrected Visual Acuity
CSC	Cataract Surgical Coverage
DHS	Demographic And Health Surveys
eREC	Effective Refractive Error Coverage
eCSC	Effective Cataract Surgical Coverage
EVI	Early Visual Impairment
GPS	Global Positioning System
IOV	Inter Observer Variability
LGA	Local Government Areas
LMICs	Low- And Middle-Income Countries
MVI	Moderate Visual Impairment
NBS	National Bureau of Statistics
NBS	Nigeria Blindness Survey
NET	Nigeria Equity Tool
PVA	Presenting Visual Acuity
RAAB	Rapid Assessment of Avoidable Blindness
RACSS	Rapid Assessment of Cataract Surgical Service
NHREC	Research Ethics Committee of Plateau State Ministry of Health Nigeria
SVI	Severe Visual Impairment
UNCRPD	United Nations Convention on the Rights of Persons with Disabilities
VI	Visual Impairment
VA	Visual Acuity
WHA	World Health Assembly
WHO	World Health Organisation
WGSS-E	Washington Group Short Set - Enhanced

Introduction

In 2020, over 1.1 billion people globally were estimated to be visually impaired. Among them, 43 million people were blind, and 295 million were moderately to severely visually impaired (5). The prevalence of age-standardised blindness decreased globally from 0.85% in 1990 to 0.60% in 2019; however, the total number of blind people increased by 42.8% from 34.4 million in 1990 to 43 million in 2020. This will increase further over the next thirty years to 61 million people, largely due to population growth and ageing (5, 6).

About 90% of visual impairment (VI) is found in low- and middle-income countries (LMICs) and about 90% of it is preventable or treatable (6). The leading cause of blindness is cataract with about 17 million cases, followed by uncorrected refractive defects (3.7 million), glaucoma (3.6 million), age-related macular degeneration (1.8 million) and diabetic retinopathy (1.1 million) (6, 7).

In terms of regional differences, it is estimated that the prevalence of blindness exceeds 30 cases per 1000 in LMICs compared to less than five cases per 1000 people in high-income countries (8).

To reduce the burden of VI, the World Health Organisation (WHO) advocates an approach centred on improving the quality and provision of integrated patient-centred eye care embedded in the general health system (9). This approach is based on the principles of the Vision 2020 initiative – the Right to Sight – which was superseded by the World Report on Vision, and the commitment of member states to reduce the burden of avoidable VI and achieve a better quality of life for all citizens (10, 11).

The 74th World Health Assembly (WHA) agreed ambitious new targets for eye health, and countries must now seek to establish baseline figures for the two eye-health indicators and revise or develop national eye-health plans in order to achieve them by 2030 (12). The two indicators – effective cataract surgical coverage (eCSC) and effective refractive error coverage (eREC) – are designed to act as proxy indicators that would contribute to universal health coverage and encourage countries to improve coverage of services while maintaining good quality levels. Countries are expected to achieve a 30% increase in eCSC and a 40% increase in eREC by 2030 (12), although many do not currently have established baseline figures against which to measure progress.

The lack of country-specific epidemiological data is a major constraint on the development of national health plans and policies in LMICs. To address this issue, the WHO recommends

the scale-up of Rapid Assessment of Avoidable Blindness (RAAB) studies to provide data for planning blindness and VI prevention programmes (2). RAAB is a standard methodology for obtaining reliable data on the prevalence of VI in people at highest risk (aged 50 years and over) (3) and more than 300 RAABs have been conducted worldwide, including over 50 in sub-Saharan Africa (13).

Visual impairment and access to eye health services in Nigeria

Nigeria is the most populous country in Africa with an estimated population of 217 million spread across 36 states and a federal capital territory (14). The prevalence of blindness in Nigeria among people aged ≥40 years was estimated at 4.2% in a national survey conducted between 2005 and 2007. For people aged 50 years and over, the prevalence was 5.5% (1). A number of state-level studies have been conducted since, some using the RAAB methodology, and others using the Rapid Assessment of Cataract Surgical Services (RACSS) methodology. The prevalence of blindness varies from 9.9% in Delta State in 2005 to 1.7% in Oyo State in 2022 (see Table 1).

Table 1. State prevalence of blindness in Nigeria from 2005 to 2022

State	Years	Method	Prevalence of blindness
Delta State, Nigeria (15)	2005	RACSS	9.9%
Nigeria National Eye Health Survey (1)	2005-2007		Aged ≥40 years:4.2% (95% CI: 3.8–4.6) Aged ≥50 years: 5.5%o
Kebbi State, Nigeria (16)	2008	RACSS	4.5% (95% CI: 3.7-5.3)
Plateau State, Nigeria (4)	2010	RACSS	4.2% (95% CI: 4.1- 4.3)
Sokoto State, Nigeria (17)	2016	RAAB	7.7% (95% CI: 6.4-8.9)
Katsina State, Nigeria (18)	2020	RAAB	5.3% (95% CI 5.2- 5.3)
Kogi State, Nigeria (19)	2020	RAAB	3.5% (95% CI 2.7-4.1)
Oyo State, Nigeria (20)	2022	RAAB	1.7% (95% CI: 0.1–3.3)

The prevalence of blindness was considerably higher among women in all surveys, with unoperated cataract the leading cause of blindness, followed by glaucoma (4, 15, 16, 18-20). It has been 13 years since the last RACSS was conducted in Plateau State.

Access to eye-care services is not always equitable and certain groups of people have been identified as vulnerable to exclusion, for example women, people living in poverty and people with disabilities (21). In Nigeria, findings reported a strong relationship between visual impairment and age, gender, social status, geo-political zone and place of residence (22). In order to effectively plan services including human and financial resources, infrastructure, and equipment, it is important to understand how VI and access to services differ between different population groups.

Effective service planning should also be based on the most recent and accurate epidemiological data. Cataract surgical coverage (CSC) and effective cataract surgical coverage (eCSC) calculation have recently been updated by the WHO (23). Also, the threshold for good visual outcomes is now 6/12 (24). In Plateau State, in the most recent survey which used previous definitions, CSC was estimated at 29.4% at VA<6/60 with better coverage among men (33.4%) compared to women (25.7%) (25). The indicator needs to be updated based on the new definition to reflect the current eye health need and to monitor progress in the future.

In addition to visual impairment, people aged 50 and over are more likely to also experience other types of disability (26). Data from the Kogi RAAB reported a prevalence of disability of 8.1% and the findings reported a significant association between severe forms of visual impairment and disability (19). The United Nations Convention on the Rights of Persons with Disabilities (UNCRPD) states that people with disabilities include those with “long-term physical, mental, intellectual or sensory impairment, which in interaction with various barriers may hinder their full and effective participation in society on an equal basis” (27). It is widely acknowledged that those with disabilities are also further marginalised due to their low socio-economic status. Evidence suggests that people with disabilities are often less likely to access the health services they need (28, 29) and therefore it is important to understand how they experience access to eye health services compared to the rest of the population, so that appropriate services can be planned to ensure everyone benefits.

Study objectives

This RAAB sought to estimate the prevalence and causes of blindness and VI among people aged 50 years and over in Plateau State, Nigeria. The goal of this study is to provide the up-to-date data required for the planning of an eye health programme by the State Ministry of Health and its partners; this is in order to improve the eye health of the population.

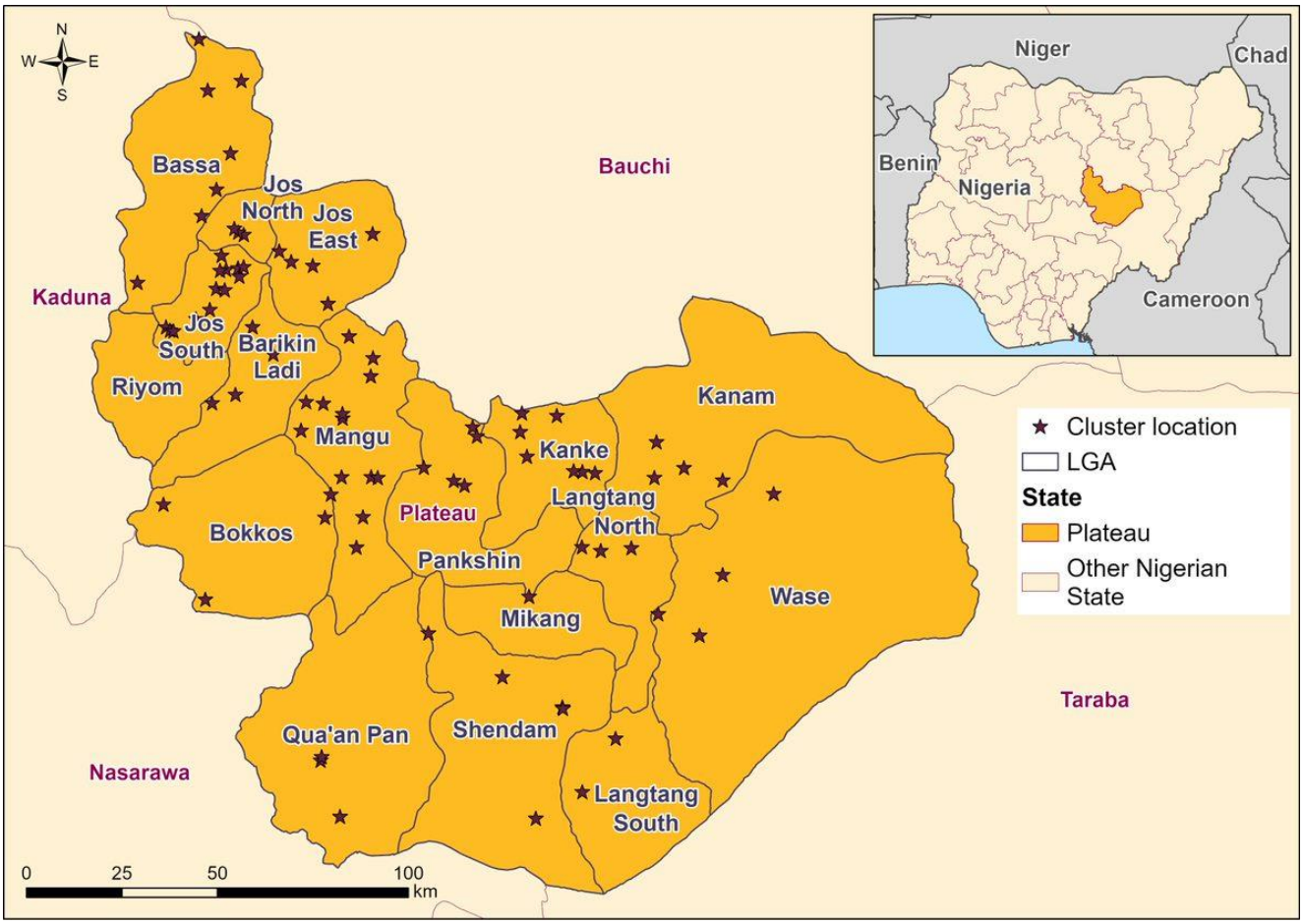
Specific objectives

1. To determine the prevalence and distribution of blindness and VI in the study population.
2. To determine the causes of blindness and VI.
3. To assess cataract surgical services by determining cataract surgical coverage and visual outcomes from cataract surgery.
4. To determine the barriers to uptake of cataract services.
5. To determine the prevalence of disability among the study population.
6. To explore the relationship between disability and socio-economic status and eye health.

Study design and location

We conducted a RAAB (a descriptive, cross-sectional population-based study) in Plateau State in Nigeria – the country's twelfth largest state, located in the central region. With an area of 26,899 square kilometres, the state had an estimated population of about 4.7 million people in 2022 (14).

Figure 1. Map showing study cluster locations within Plateau State and Local Government Area (LGA) boundaries



Study population

The study population was people aged 50 years and above who live in Plateau State. RAAB includes only the 50-plus age group, as it is where the prevalence of blindness is highest.

Inclusion criteria

- Aged 50 and over.
- Consented to participate.
- Have been ordinarily resident in the household for at least six months prior to the survey.

Exclusion criteria

- Aged less than 50 years.
- Refused to consent.
- Are visitors to the household.

Sample size and sampling strategy

The sample size was calculated using RAAB (version 6) software package. The following information was used to calculate the sample size:

- Plateau State population: 4,717,305 (from Nigeria population projections 2022).
- Expected prevalence (based on the Nigeria national blindness and visual impairment survey conducted between 2005-2007): 3.7% in north-central region.
- Worst acceptable prevalence: 2.96 (±20%).
- Confidence interval: 95%
- Non-response rate: 10%
- Design effect: 1.5 (clusters of size 50 for RAAB).

A minimum sample size of 4,164 persons aged 50 years was required for this study. These people were selected from 84 clusters of 50 persons aged 50 years and above, giving a total sample size of 4,200.

Two-stage sampling was used. For the first stage, 84 primary sampling units (villages) were selected at random from a complete list using probability proportionate to size methodology. A list of all villages in Plateau State with their populations was obtained and verified by the Nigerian National Bureau of Statistics (NBS) official website (2006 census and 2022 projections) (14). The complete list of villages was uploaded to the RAAB software, which

has an in-built probability proportionate to size selection tool. At the second stage, within each village, 50 eligible participants were enrolled in the study.

Once the 84 villages were identified, a cluster informer visited each one a few days before the team arrived, working with village leaders in order to identify the village border. If the village population was large – exceeding 500 inhabitants – a map was developed with the village leader to segment it into smaller areas. In these cases, a segment was chosen at random by first numbering them, then choosing a number at random.

Once the village/segment boundaries were clear, the cluster informer informed the study team and provided them with a copy of the map via WhatsApp. On the day of the study team visit, the team met with the village leader and nominated guide. The study team started at the house in the segment closest to the main road.

After arriving at the house, the team introduced themselves to the head of the household, facilitated through the village guide who was chosen by the leader due to their knowledge of the community. They then ascertained how many people were eligible to participate in the study. As well as providing comprehensive information about the study and purpose of the visit, the team informed the eligible participants of their rights to refuse or withdraw permission to participate, as well as the potential benefits of participation. Written consent was obtained, and in the case where a participant was illiterate, their thumbprint was obtained and witnessed by an independent person who was not part of the study team.

Within each household, all residents were enumerated, including those temporarily absent. All present and consenting participants underwent visual acuity screening, and the team attempted to revisit the house at the end of the day to capture anyone missing at the time of the initial visit. Basic data about participants unavailable for the visual acuity screening was collected from their family members or neighbours, if possible.

Data collection

Each RAAB participant completed the following steps: visual examination (Appendix A), questions about disability (Appendix B) and questions on economic status (Appendix C). All data was collected using an app on a touchscreen smartphone. The precise location of each village (not individual households) was recorded using Global Positioning System (GPS) coordinates so that only cluster-level data (not individual level) could be mapped visually and analysed geo-spatially.

Visual examination

All participants underwent an ophthalmic examination by an ophthalmologist (see list in Appendix A). Following the standard RAAB protocol, the following steps were implemented:

1. The presenting visual acuity (PVA) measurement of each eye (all participants) was measured, using available correction if any.
2. A pinhole was used to measure the best corrected visual acuity (BCVA) of each eye presenting < (6/12).
3. The lens of each eye was examined with a torch in a darkened room (all participants).
4. The posterior segment of each eye presenting < (6/12) was examined with a direct ophthalmoscope where the principal cause could not be attributed to refractive error, cataract, or corneal scarring.
5. The major cause of VI of each eye presenting < (6/12) – and in persons where both eyes presented < (6/12) and the causes were not the same – was assessed.
6. Asked questions regarding cataract surgery and where it has taken place.
7. Asked questions regarding why cataract surgery has not taken place, where it is indicated.

Minor ocular conditions identified were treated by the team, while other conditions were referred to the nearest appropriate health centre or hospital.

The International Classification of Diseases 11 (2018) classifies distance vision impairment as follows:

- Early visual impairment in RAAB (EVI) – visual acuity worse than 6/12 to 6/18.
- Moderate visual impairment (MVI) – visual acuity worse than 6/18 to 6/60.
- Severe visual impairment (SVI) – visual acuity worse than 6/60 to 3/60.
- Blindness – visual acuity worse than 3/60.

Disability tool

Disability is a complex concept and there are many ways to define and measure it. In this RAAB, we used the Washington Group Short Set - Enhanced (WGSS-E) tool which comprises 12 questions related to an individual's self-perceived difficulties in functioning in certain areas or 'domains', and which has been used successfully in other RAABs (30). Response options include four categories, allowing respondents to position themselves along a scale of functioning, and thus allowing for nuanced analysis of severity of impairment as well as type. Although several approaches to analysis are possible, in this report a binary

measure of disability was determined if an individual reported at least a lot of difficulty in at least one functional domain. The tool is included in Appendix B.

Nigeria Equity Tool

The Nigeria Equity Tool (NET) is an internationally recognised tool designed to evaluate systemic differences between social groups. Socio-economic status of participants is determined by categorising them into one of five quintiles: those who are the poorest and often most marginalised fall into the bottom quintile; those who are the wealthiest are in the top quintile. The NET (version 2015), made up of 11 questions (see Appendix C), is a simple and easy-to-use tool to measure relative wealth, based on data collected in the 2013 Demographic and Health Surveys (DHS) (31). In a short survey, it allowed us to compare the wealth of our respondents to the national population or that of other countries' populations.

Data collection

Data was stored in smartphones and synchronised at the end of each day with the Cloud server, which was accessible only to members of the research team responsible for data management and analysis. The application itself has built-in controls to minimise errors and ensure data quality. In addition, the quality of the submitted data was checked regularly by the data manager, and errors or inconsistencies were reported to the field teams in order to ensure and guarantee its quality.

Training of data collectors and interobserver variation measurement

The training of the field team, which took place over five days, was carried out by a RAAB-certified trainer, and comprised four days of theoretical training and one day of practice in the field. The fourth day of training was reserved for the interobserver variability (IOV) test in order to obtain a uniform measurement of IOV within the different teams. IOV was assessed for vision, lens assessment and causes of visual impairment to ensure that examiners had at least 60% agreement.

Study team

Five teams were formed to collect the data, with each including an ophthalmologist to act as team leader, an ophthalmic nurse, a cluster informant, a driver, and a guide (one for each village).

Data management and analysis

Study tools were programmed into CommCare software and deployed as an app on Android-based smartphones (32). Data was downloaded in .csv format and uploaded in Stata v15 software for analysis (33).

Results were tabulated, calculating sample prevalence estimates for each outcome of interest, and 95% confidence intervals surrounding them were estimated. Standard errors were adjusted for clustering using the observed design effect.

The age and sex distributions of the sample were taken into account by using the total estimated 2022 population of Plateau State (14) to estimate the 2022 ten-year age/sex groups for analysis. A weighting file was developed and for each ten-year age/sex groups adjusted estimates and confidence intervals were calculated for each key indicator. For the cataract surgical coverage (CSC), effective cataract surgical coverage (eCSC) indicator calculations have been updated to reflect a recent change in definitions by the WHO (23). Also, the threshold for good visual outcomes is now 6/12 (24).

Following in-depth statistical analyses, key indicators were exported into ArcGIS software (34) for mapping and spatial analyses to understand geographic patterns around the prevalence of visual impairment.

Ethical consideration

The protocol was submitted to the Research & Ethics Committee of Jos University Teaching Hospital. Ethical clearance with the following reference was issued: JUTH/DCS/IREC/127/XXXI/419.

Before the administration of the questionnaire, written study information was shared and explained verbally in easily understandable language, and the consent of the participant was collected. Participants were encouraged to ask questions about the survey and investigators were trained to address such questions in an open and transparent manner. When consent was given, participants were asked to sign or apply their thumbprint on the consent form attached to the information note. It was made clear to each participant that their participation was voluntary, that they could – at any time – stop participating in the study or not answer a particular question.

Copies of raw data were stripped of all identifiers (including geographical location of individuals) and remain strictly confidential. The data collection team underwent one week of training, which included the importance of confidential data collection and management.

Study sample and demographic characteristics

Overall, 4,200 participants aged 50 years and above were surveyed. 3,957 participants aged 50 years and above were examined, representing a response rate of 94.2% (see Table 2).

Table 2. Participant examination status by sex

	Examined	Not available	Refused	Unable to consent	Total
Male	1,741	73	26	7	1,847
	94.3%	4.0%	1.4%	0.4%	44.0%
Female	2,216	68	29	40	2,353
	94.2%	2.9%	1.2%	1.7%	56.0%
Total	3,957	141	55	47	4,200
	94.2%	**3.4%**	**1.3%**	**1.1%**	**100.0%**

2,216 (56.0%) of the respondents were females and the majority of participants examined were aged between 50 and 59 years (n=1,837; 46.4%) (see Table 3). Compared to the projected population of the region, our sample was older – participants aged 80+ were overrepresented in our sample (12.7% compared to an expected 3.1% share of the population). As visual impairment and disability are associated with sex and increasing age, over-representation of females and older age groups may overestimate the prevalence of visual impairment and disability. Age- and sex-adjusted results are important to estimate the 'true' burden of disease.

Table 3. Participants examined by sex and ten-year age group, compared with the total population in the study area (Nigeria National Population Commission projection for 2022 (14))

	Survey participants			State population (2022 projection)		
	Male	**Female**	**Total**	**Male**	**Female**	**Total**
50-59	811	1,026	1,837	128,578	125,818	254,396
	46.6%	46.3%	46.4%	56.0%	56.9%	56.4%
60-69	438	489	927	69,264	62,993	132,257
	25.2%	22.1%	23.4%	30.2%	28.5%	29.3%
70-79	314	376	690	25,429	24,876	50,305
	18.0%	17.0%	17.4%	11.1%	11.2%	11.2%
80+	178	325	503	6,383	7,545	13,928

	10.2%	14.7%	12.7%	2.8%	3.4%	3.1%
Total	1,741	2,216	3,957	229,654	221.232	450,886
	44.0%	**56.0%**	**100.0%**	**50.9%**	**49.1%**	**100.0%**

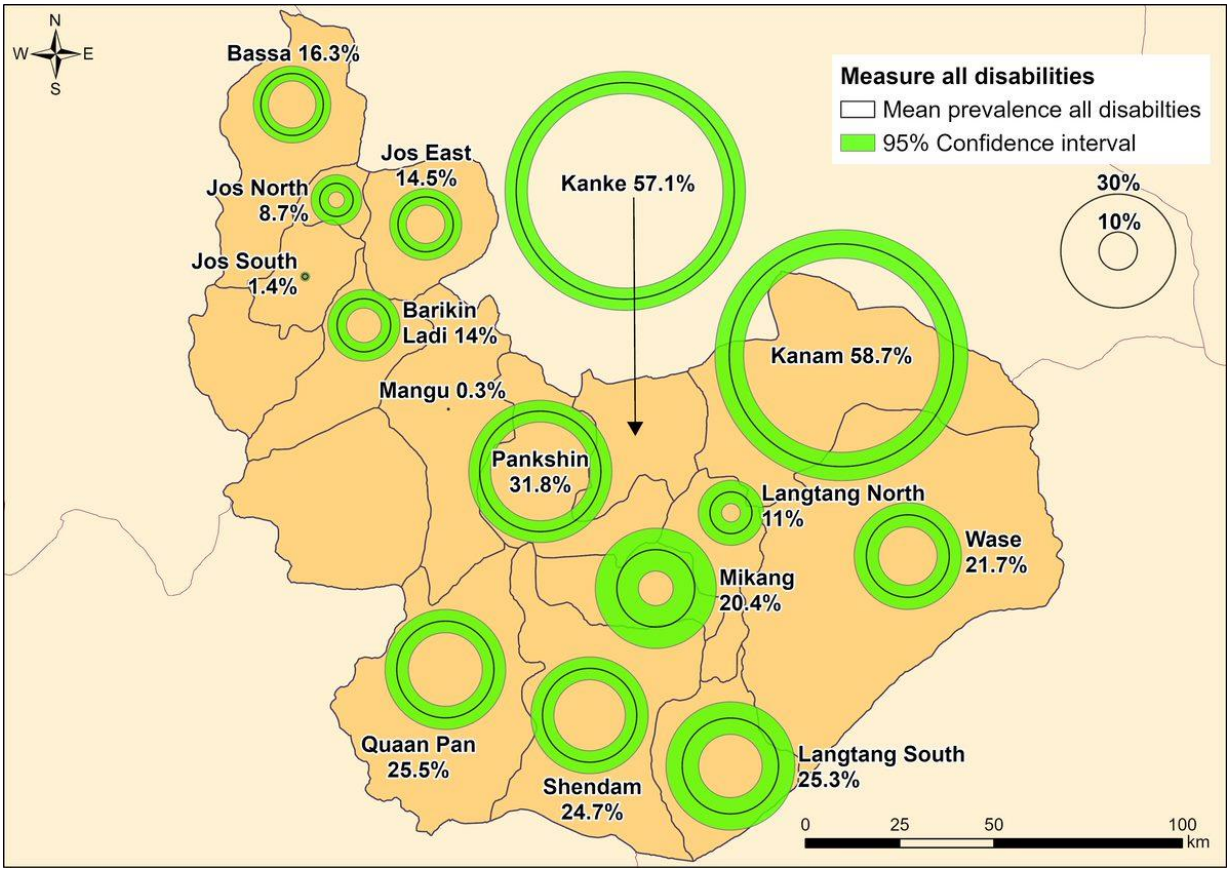
The prevalence of disability in the sample was 19.0% and was slightly higher among females (20.5%) than males (17.0%). The prevalence of disability excluding visual difficulties was 16.7% (see Table 4).

Table 4. Disability among examined male and female participants

	Male	Female	Total
Disability: all domains	295	455	750
	17.0%	20.5%	19.0%
Disability: excluding seeing difficulties	239	421	660
	13.7%	19.0%	16.7%

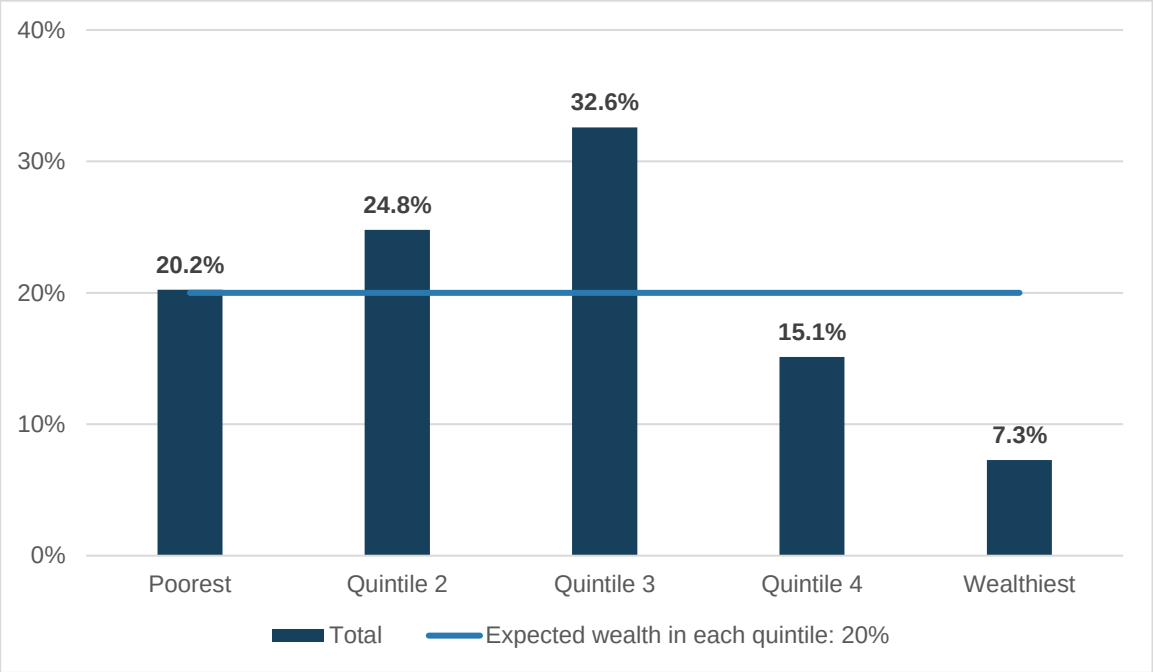
Figure 2 presents the distribution of the average prevalence of disability (all domains) by district in Plateau State. The prevalence of disability ranged from 0.3% in Mangu LGA to 58.7% in Kanam LGA.

Figure 2. Average prevalence of disability (all domains) by LGA in Plateau State



Compared to the national population (31), the study population appears to be poorer than the national average, with 45% of participants belonging to the two poorest quintiles and 22.4% belonging to the two richest quintiles (see Figure 3). If the study population is similar to the national population, the expected share would be 40%.

Figure 3. Household wealth of participants examined in study area



Prevalence of visual impairment

Of the 3,957 participants examined, 175 (4.4%) had presenting visual acuity (PVA) <3/60 in the better eye, meaning they were bilaterally blind. Using the pinhole device to obtain best-corrected VA (BCVA), this reduced to 156 participants (3.9%). SVI was observed in 97 participants (2.5%), MVI in 180 participants (4.6%) and EVI in 395 participants (10.0%) (see Table 5).

Table 5. Sample prevalence of visual impairment among males and females examined

	Male	Female	Total
Blind: best corrected vision <3/60 in better eye			
Bilateral cases	73	83	156
	4.2% (3.3-5.2%)	3.8% (3.0-4.6%)	3.9% (3.4-4.6%)
All eyes	335	365	700
	9.6% (8.7-10.6%)	8.2% (7.5-9.1%)	8.8% (8.2-9.5%)
Blind: presenting vision <3/60 in better eye			
Bilateral cases	79	96	175

	4.5% (3.7-5.6%)	4.3% (3.6-5.3%)	4.4% (3.8-5.1%)
All eyes	366	398	764
	10.5% (9.5-11.6%)	9.0% (8.2-9.9%)	9.7% (9.0-10.3%)
Severe visual impairment: better eye can see 3/60 but not 6/60			
Bilateral cases	34	63	97
	2.0% (1.4-2.7%)	2.8% (2.2-3.6%)	2.5% (2.0-3.0%)
All eyes	88	140	228
	2.5% (2.1-3.1%)	3.2% (2.7-3.7%)	2.9% (2.5-3.3%)
Moderate visual impairment: better eye can see 6/60 but not 6/18			
Bilateral cases	78	102	180
	4.5% (3.6-5.65)	4.6% (3.8-5.6%)	4.6% (3.9-5.2%)
All eyes	161	230	391
	4.6% (4.0-5.4%)	5.2% (4.6-5.9%)	4.9% (4.5-5.4%)
Early visual impairment: better eye can see 6/18 but not 6/12			
Bilateral cases	166	229	395
	9.5% (8.2-11.0%)	10.3% (9.1-11.7%)	10.0% (9.1-11.0%)
All eyes	329	497	826
	9.4% (7.1-7.4%)	11.2% (10.3-12.2%)	10.4% (9.8-11.15)

Adjusting for the 2022 age and sex structure of the population, the prevalence of blindness among people aged 50-plus years is estimated to be 2.7% (95%CI 2.1% - 3.3%). Extrapolating this to the 2022 population estimates, it is estimated that there are 11,992 blind people aged 50 and above in Plateau State. Taking into account both bilateral and unilateral blindness, a total of 61,510 eyes are blind in Plateau State (see Table 5).

Still by extrapolating to the 2022 population estimates, SVI affects around 6,363 people (1.4%) and 16,397 eyes. Similarly, MVI affects 13,340 people (3.0%) and 31,591 eyes. Age- and sex-adjusted EVI affects 34,977 people (7.8%) and 76,994 eyes (see Table 5).

The adjusted prevalence of blindness was slightly higher among males 3.1% (2.3-4.1%) than females 2.2% (1.6-3.0%) (see Table 6).

Table 6. Estimated burden of visual impairment among males and females in the study area, adjusted for age and sex

	Male	Female	Total
Blind: best corrected vision <3/60 in better eye			
Bilateral cases	6,653	4,096	10,749
	2.9% (2.1-3.9%)	1.9% (1.3-2.5%)	2.4% (1.9-3.0%)
All eyes	33,043	23,539	56,582
	7.2% (6.2-8.4%)	5.3% (4.5-6.3%)	6.3% (5.5-7.1%)
Blind: presenting vision <3/60 in better eye			
Bilateral cases	7,126	4,866	11,992
	3.1% (2.3-4.1%)	2.2% (1.6-3.0%)	2.7% (2.1-3.3%)
All eyes	35,954	25,557	61,510
	7.8% (6.7-9.1%)	5.8% (4.8-6.9%)	6.8% (6.0-7.7%)
Severe visual impairment: better eye can see 3/60 but not 6/60			
Bilateral cases	2,631	3,732	6,363
	1.1% (0.7-1.8%)	1.7% (1.2-2.3%)	1.4% (1.1-1.9%)
All eyes	7,906	8,492	16,397
	1.7% (1.3-2.3%)	1.9% (1.5-2.5%)	1.8% (1.4-2.3%)
Moderate visual impairment: better eye can see 6/60 but not 6/18			
Bilateral cases	7,396	5,945	13,340
	3.2% (2.4-4.3%)	2.7% (2.1-3.5%)	3.0% (2.4-3.6%)
All eyes	16,042	15,549	31,591
	3.5% (2.8-4.3%)	3.5% (2.9-4.3%)	3.5% (3.0-4.1%)
Early visual impairment: better eye can see 6/18 but not 6/12			
Bilateral cases	16,657	18,320	34,977
	7.3% (5.7-9.2%)	8.3% (7.0-9.7%)	7.8% (6.7-9.0%)
All eyes	35,077	41,917	76,994
	7.6% (6.2-9.3%)	9.5% (8.4-10.7%)	8.5% (7.5-9.6%)

Figure 4 shows the average prevalence of blindness from all causes by local government area (LGA) in Plateau State. The average prevalence of blindness from all causes ranged from 1.6% in Barikin Ladi LGA to 16.3% in Bokkos LGA.

Figure 4. Average prevalence in the sample of all-cause blindness in Plateau State by health district

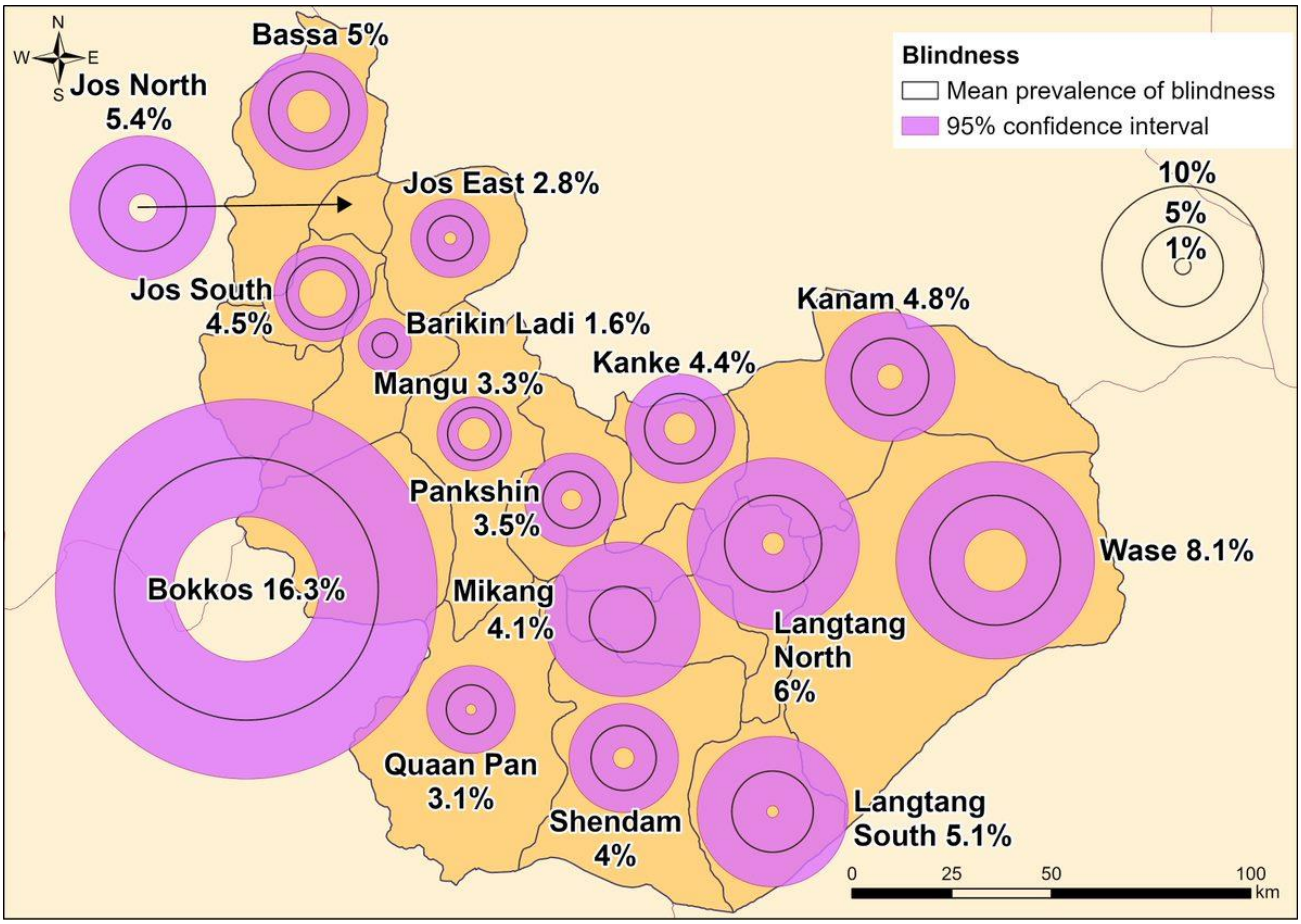
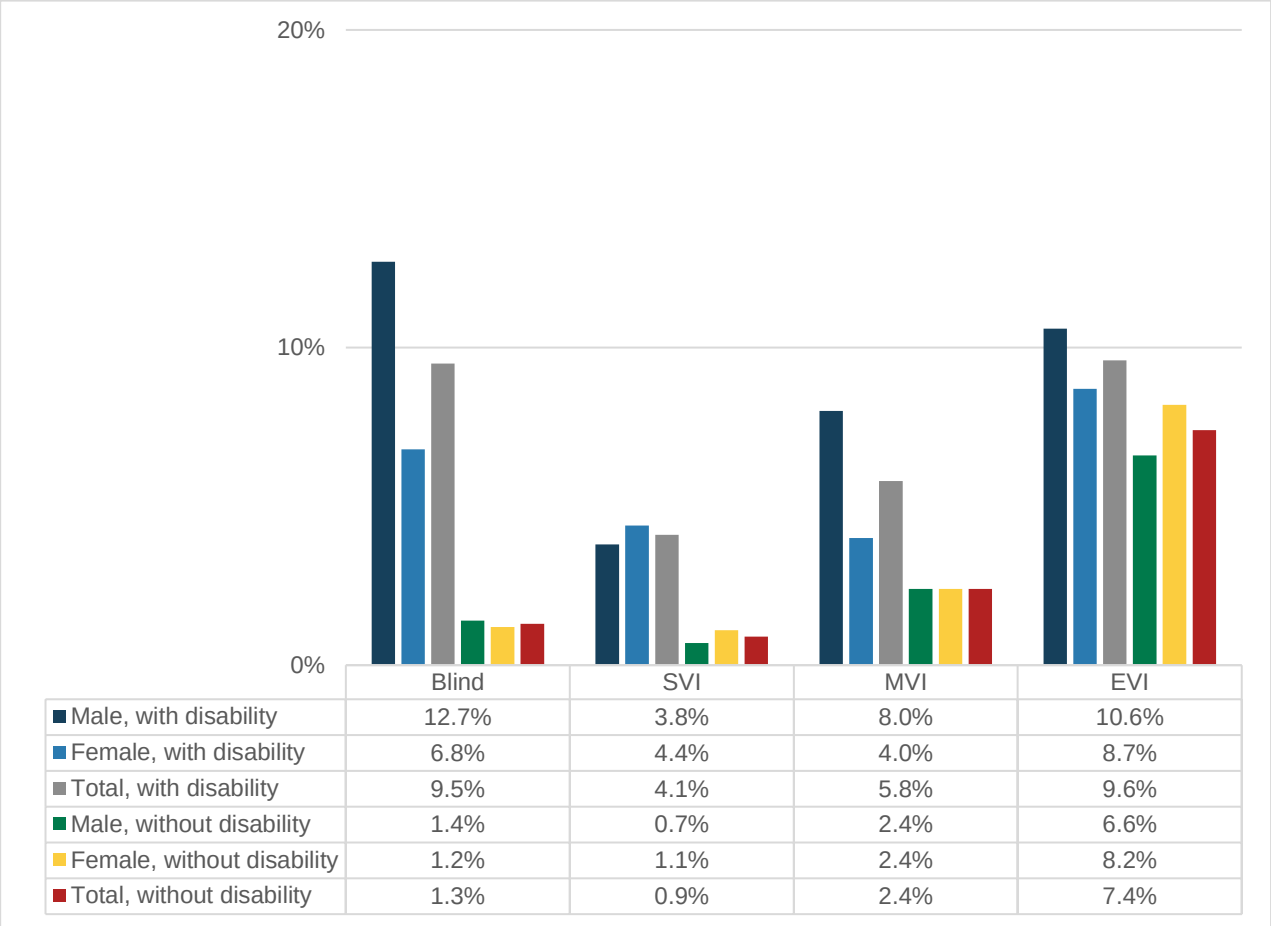


Figure 5 shows how the age- and sex-adjusted prevalence of VI differs by disability and sex. Men and women who reported a disability were more likely to be visually impaired than those without a disability. These differences were more striking for more severe levels of visual impairment, particularly blindness. For example, 12.7% of men and 6.8% of women who reported a disability were blind compared to 1.4% of men and 1.3% of women, who reported no disability.

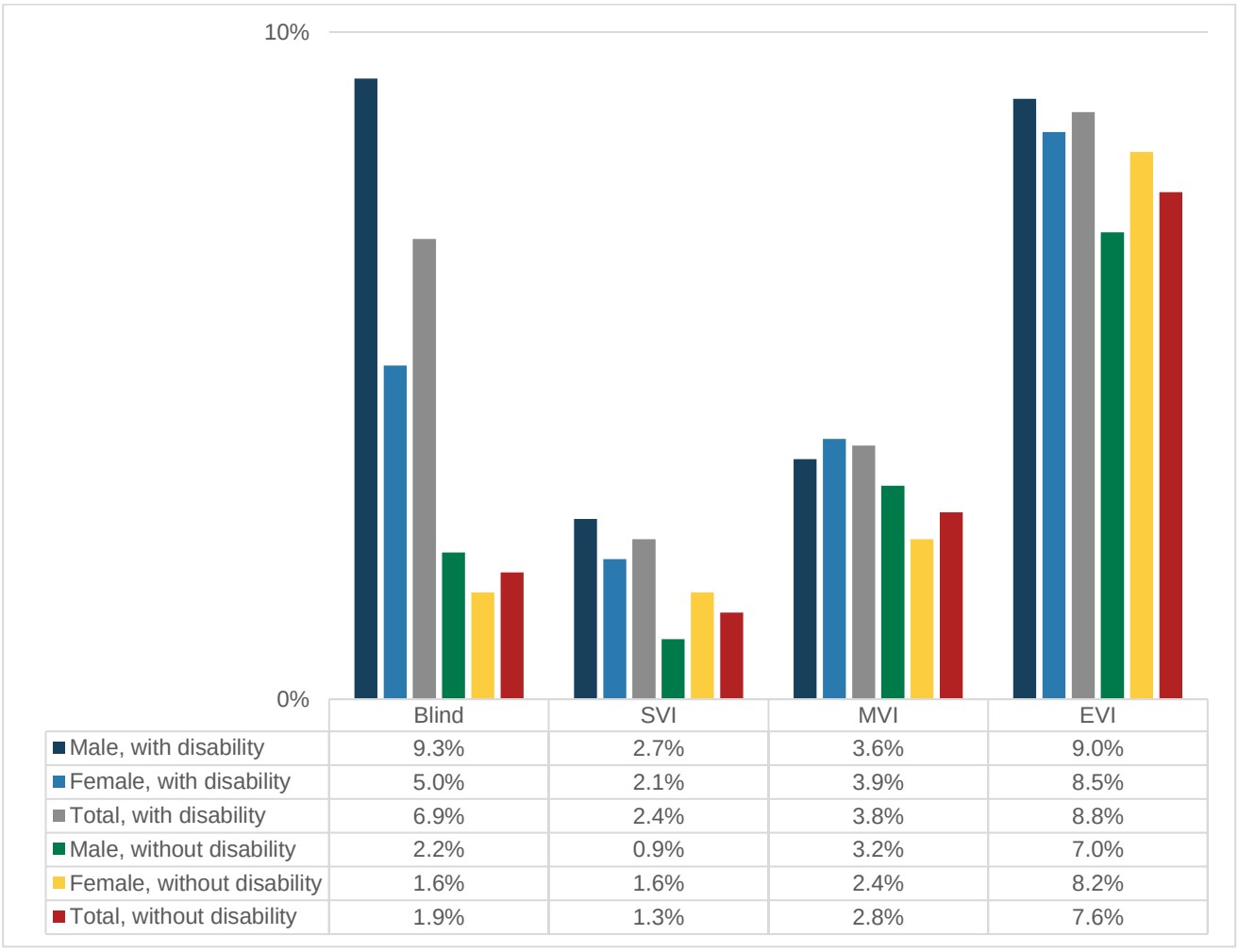
Figure 5. Age- and sex-adjusted prevalence of visual impairment, by disability, all domains



	Blind	SVI	MVI	EVI
Male, with disability	12.7%	3.8%	8.0%	10.6%
Female, with disability	6.8%	4.4%	4.0%	8.7%
Total, with disability	9.5%	4.1%	5.8%	9.6%
Male, without disability	1.4%	0.7%	2.4%	6.6%
Female, without disability	1.2%	1.1%	2.4%	8.2%
Total, without disability	1.3%	0.9%	2.4%	7.4%

Since visual impairment is likely to be strongly correlated with “difficulty in seeing” it is important to explore how VI is related to the other domains of disability. Figure 6 shows how the prevalence of VI by disability and adjusted for age and sex differs when the “difficulty in seeing” domain is excluded. We observe that the relationship between disability and visual impairment remains very high: respectively, 9.3% and 5.0% of men and women with a functional difficulty (excluding “difficulty in seeing”) were blind, as opposed to 2.2% and 1.6% of men and women without disabilities.

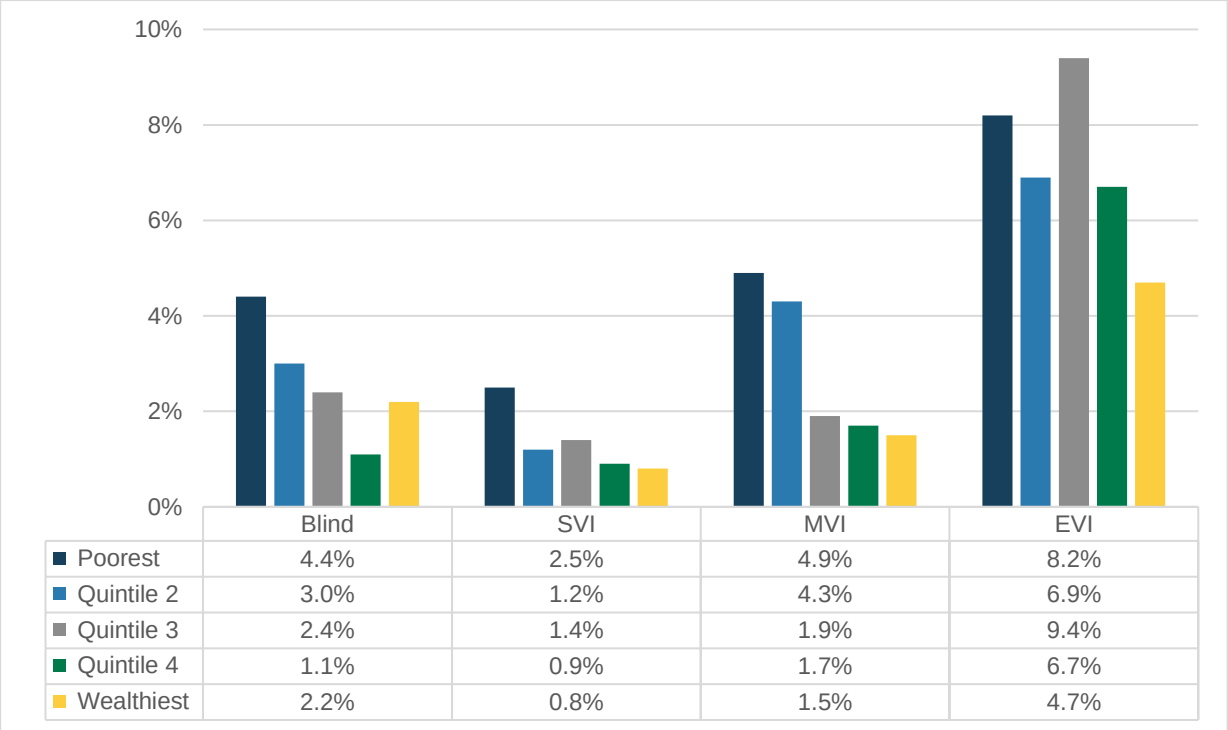
Figure 6. Age- and sex-adjusted prevalence of VI, by disability, excluding seeing domain



	Blind	SVI	MVI	EVI
Male, with disability	9.3%	2.7%	3.6%	9.0%
Female, with disability	5.0%	2.1%	3.9%	8.5%
Total, with disability	6.9%	2.4%	3.8%	8.8%
Male, without disability	2.2%	0.9%	3.2%	7.0%
Female, without disability	1.6%	1.6%	2.4%	8.2%
Total, without disability	1.9%	1.3%	2.8%	7.6%

The results of the relationship between VI and relative wealth show that the distribution of blindness was high among participants in the poorest economic quintiles: 4.4% compared to 2.2% among people from wealthier quintiles. The distribution of EVI was high among participants from the poorest and third (middle) quintile (see Figure 7).

Figure 7. Age- and sex-adjusted prevalence of visual impairment, by wealth



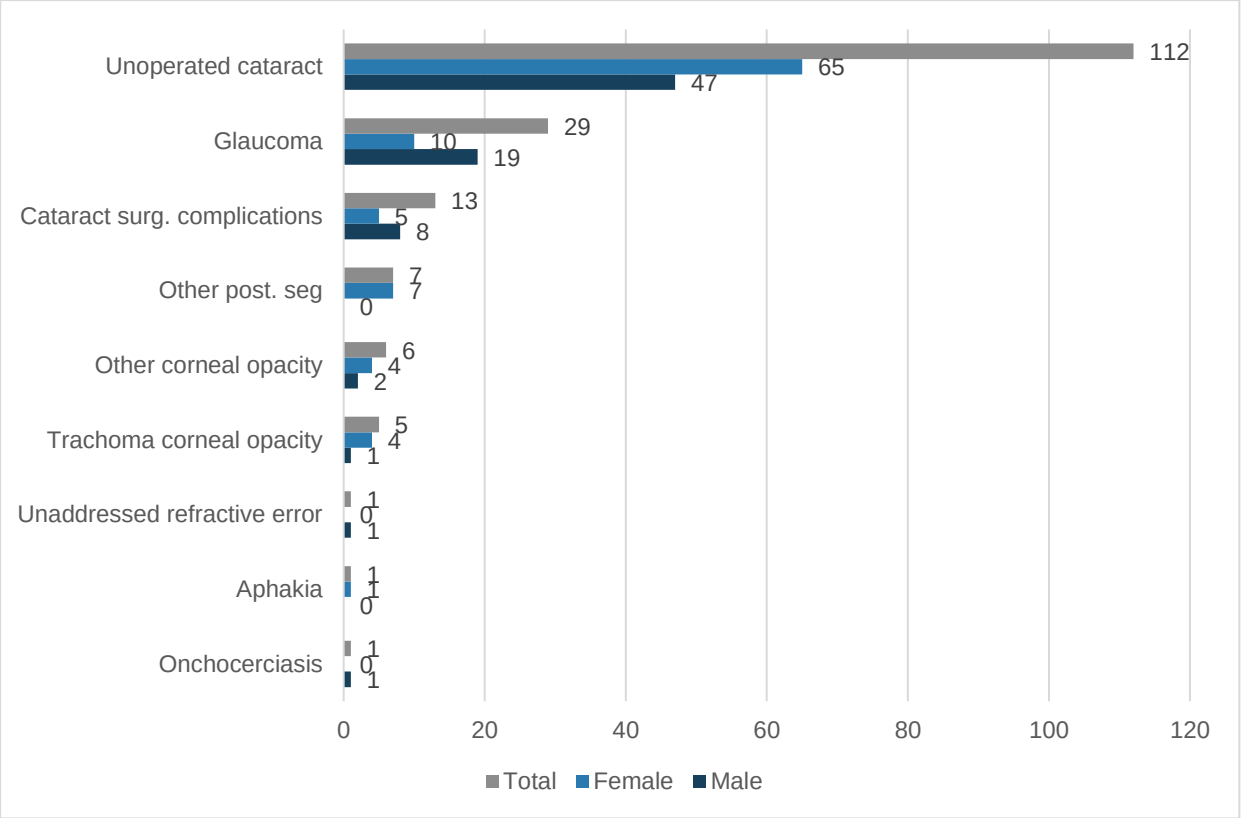
	Blind	SVI	MVI	EVI
Poorest	4.4%	2.5%	4.9%	8.2%
Quintile 2	3.0%	1.2%	4.3%	6.9%
Quintile 3	2.4%	1.4%	1.9%	9.4%
Quintile 4	1.1%	0.9%	1.7%	6.7%
Wealthiest	2.2%	0.8%	1.5%	4.7%

Causes of visual impairment

It is crucial to bear in mind that the RAAB methodology permits only one cause, which is the most easily treatable, to be attributed to each eye or individual. Therefore, comparisons between groups should be approached carefully since the outcomes do not reflect the complete range of causes of visual impairment in the study population. When a significant proportion of the population has unoperated cataract or unaddressed refractive error, these causes are most likely to be listed as leading causes of VI independent of other co-morbidities.

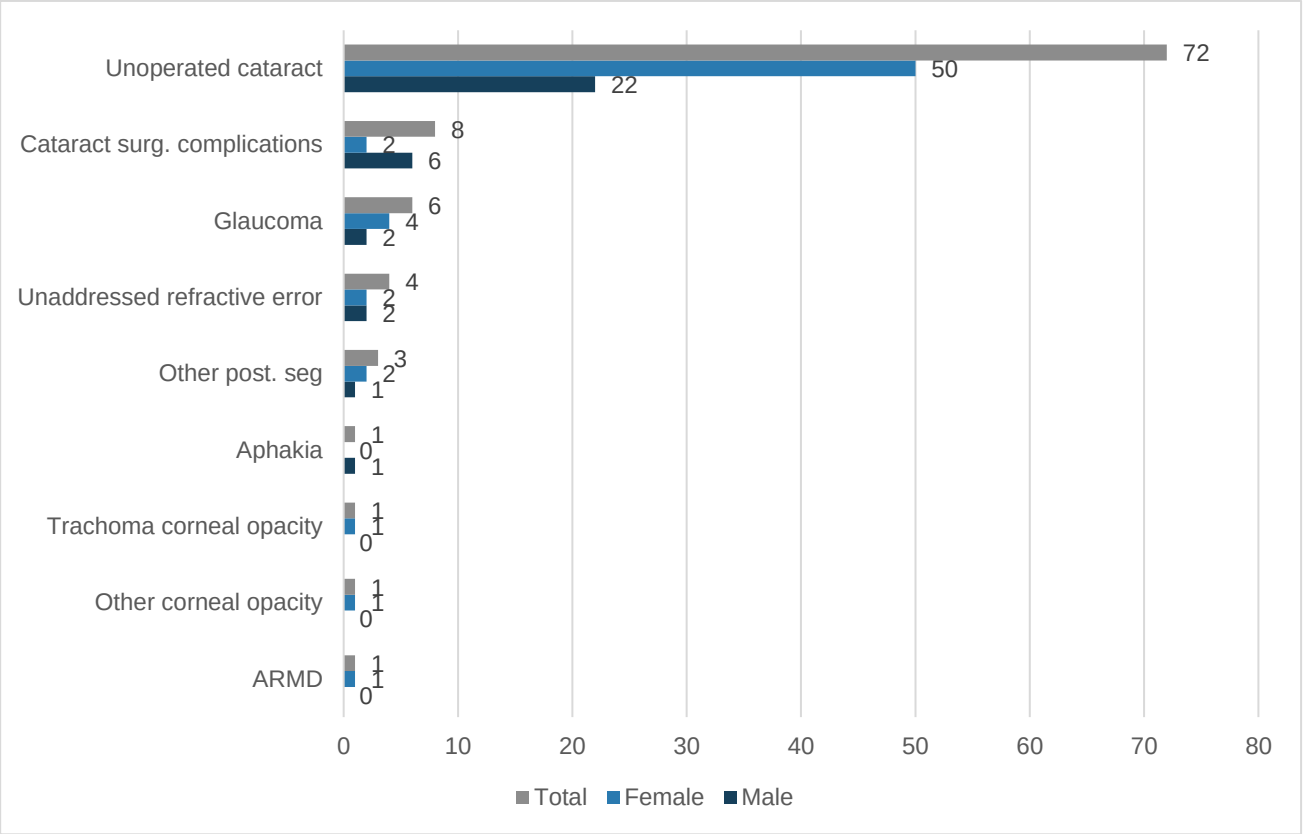
The main cause of blindness was unoperated cataract (N=112 cases; 64.0%), followed by glaucoma (N=29 cases; 16.6%), cataract surgical complications (N=13 cases; 7.4%) and other pathology of the posterior segment (N=7 cases; 4%) (see Figure 8).

Figure 8. Principal causes of blindness among examined males and females



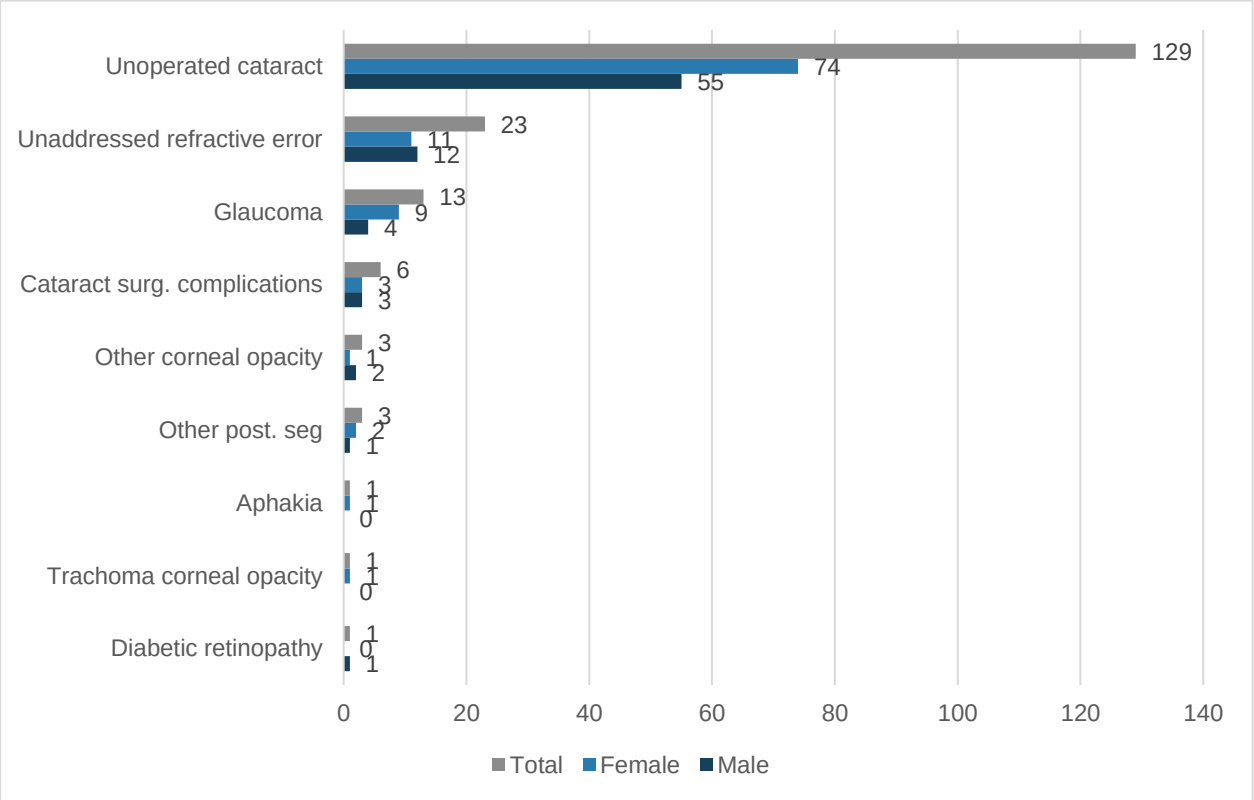
Unoperated cataract was also the main cause of severe VI (72 cases; 74.2%), followed by cataract surgical complication (8 cases; 8.2%), and glaucoma with (6 cases; 6.2%) (see Figure 9).

Figure 9. Principal causes of severe visual impairment (SVI) among examined males and females



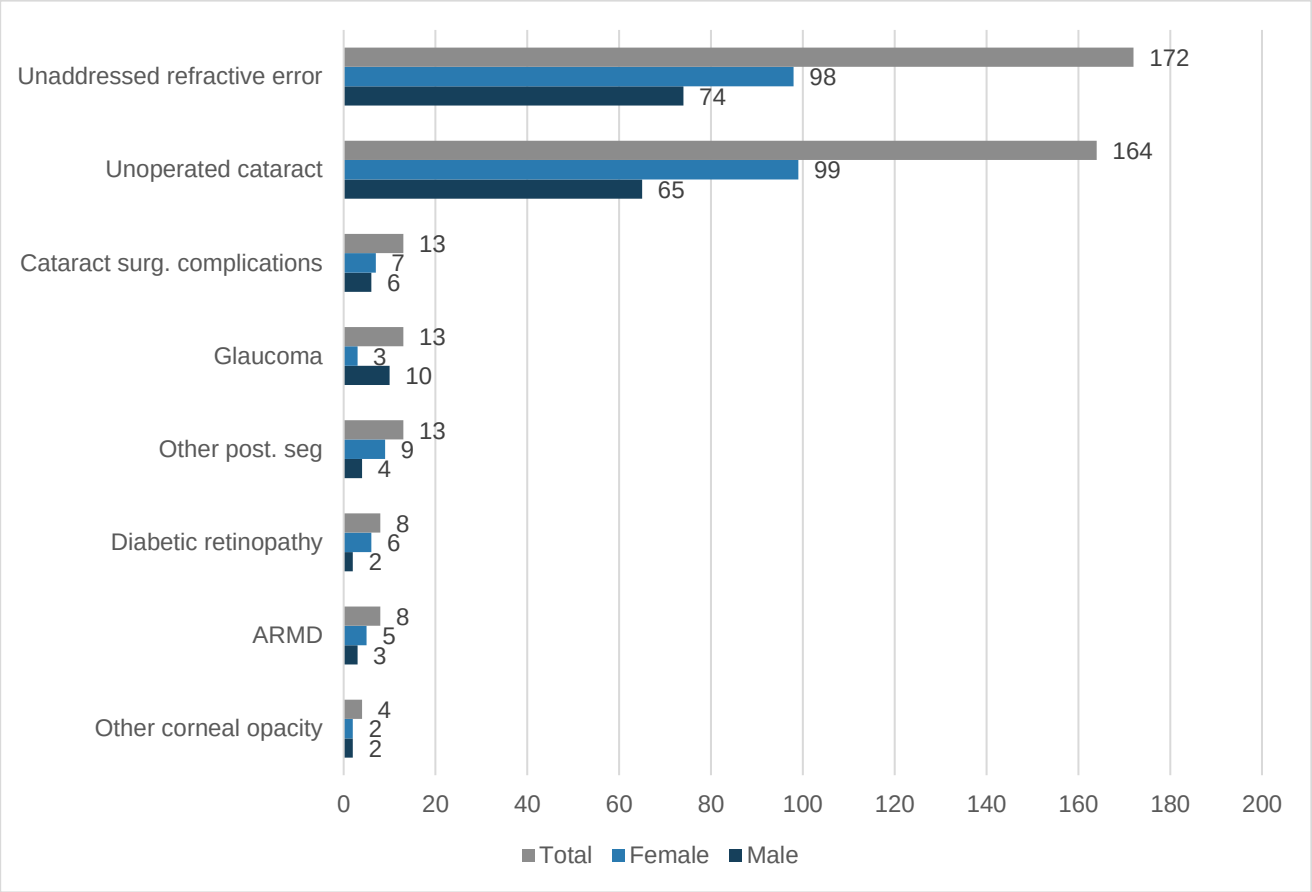
Unoperated cataract was the leading cause of moderate VI (129 cases; 71.7%), followed by refractive error (23 cases; 12.8%) and glaucoma (13 cases; 7.2%) (see Figure 10).

Figure 10. Principal causes of moderate visual impairment (MVI) among examined males and females



Refractive error was the leading cause of early VI (172 cases; 43.5%) (see Figure 11), followed by unoperated cataracts (164 cases; 41.5%) and cataract surgical complications, glaucoma, and other posterior segment pathology with 13 cases each (3.3%).

Figure 11. Principal causes of early visual impairment (EVI) among examined males and females



Cataract: prevalence, coverage of services and visual outcomes

Table 7 shows that 1.1% (95%CI 0.8-1.4%) of people aged 50 years and over in Plateau State are bilaterally blind with cataract and 0.5% (95%CI 0.3-0.8%) have severe visual impairment due to cataract. This translates to approximately 4,757 blind people, and 26,901 blind eyes and 2,330 people with SVI, and 6,292 SVI eyes and cataract across Plateau State.

We did not observe statistically significant gender differences in cataract-related blindness, SVI, MVI and EVI.

Table 7. Estimated prevalence of best corrected visual acuity and cataract among males and females, adjusted for age and sex

	Males	Females	Total
Blind: best corrected vision <3/60 in better eye			
Bilateral cataract	2,860	1,897	4,757
	1.2% (0.9-1.8%)	0.9% (0.6-1.3%)	1.1% (0.8-1.4%)
Unilateral cataract	8,917	8,469	17,386
	3.9% (2.9-4.9%)	3.8% (3.0-4.6%)	3.9% (3.2-4.5%)
Cataract eyes	14,637	12,264	26,901
	3.2% (2.3-4.1%)	2.8% (1.8-3.7%)	3.0% (2.2-3.7%)
Severe visual impairment: better eye can see 3/60 but not 6/60			
Bilateral cataract	622	1,707	2,330
	0.3% (0.1-0.6%)	0.8% (0.5-1.2%)	0.5% (0.3-0.8%)
Unilateral cataract	815	817	1,632
	0.4% (0.-0.7%)	0.4% (0.1-0.7%)	0.4% (0.1-0.6%)
Cataract eyes	2,060	4,232	6,292
	0.4% (0.1-0.8%)	1.0% (0.3-1.6%)	0.7% (0.3-1.1%)
Moderate visual impairment: better eye can see 6/60 but not 6/18			
Bilateral cataract	2,090	3,177	5,267
	0.9% (0.6-1.4%)	1.4% (1.0-2.0%)	1.2% (0.9-1.5%)
Unilateral cataract	3,400	1,434	4,834
	1.5% (0.9-2.0%)	0.6% (0.2-1.0%)	1.1% (0.7-1.4%)
Cataract eyes	7,580	7,788	15,368
	1.7% (1.0-2.3%)	1.8% (1.1-2.4%)	1.7% (1.2-2.2%)
Early visual impairment: better eye can see 6/18 but not 6/12			
Bilateral cataract	6,693	7,995	14,688
	2.9% (2.0-4.2%)	3.6% (2.9-4.6%)	3.3% (2.5-4.2%)
Unilateral cataract	2,399	3,790	6,189
	0.5% (0.0-1.4%)	0.9% (0.1-1.7%)	0.7% (0.0-1.4%)
Cataract eyes	15,783	19,780	35,563
	3.4% (2.2-4.7%)	4.5% (3.4-5.6%)	3.9% (3.0-4.9%)

Cataract surgical coverage (CSC) was estimated at 27.5% for persons at VA<6/12, the WHO-recommended reporting level (see Table 8). CSC was higher among males than females, 32.8% versus 22.0% at VA<6/12.

Table 8. Cataract surgical coverage (persons, percentage) adjusted for sex and age

	Males	Females	Total
VA <3/60	62.5%	60.7%	61.8%
VA <6/60	58.9%	45.4%	53.0%
VA <6/18	48.9%	34.5%	42.1%
VA <6/12	32.8%	22.0%	27.5%

Among 282 operated eyes, 70 (24.8%) had good post-operative vision (6/12), 93 (33.0%) had borderline vision (6/60 to 6/12) and 119 (42.2%) had poor vision (worse than 6/60). 229 (83.6%) of operated eyes had an intraocular lens (IOL) implanted, of which 69 (30.1%) had good vision, 82 (35.8%) had borderline vision and 78 (34.1%) had poor vision. 35 (12.8%) eyes had been couched, of which 80.0% had poor vision. Among the 117 (42.7%) eyes operated on in the past three years, only 28.2% had good vision, and 43.6% had poor vision. The majority of surgeries – 75 (27.4%) – took place in a government hospital, of which 30.7% of eyes had poor vision and 37.3% had good vision. The major cause of borderline or poor post-operative vision was surgical complications (65.7%) (see Table 9).

Table 9. Presenting visual acuity in operated eyes

	Good: can see 6/12	Borderline: can see 6/60	Poor: cannot see 6/60	Total
All operated eyes	70 (24.8%)	93 (33.0%)	119 (42.2%)	282 (100.0%)
By sex				
Males	36 (22.9%)	53 (33.8%)	68 (43.3%)	157 (55.7%)
Females	34 (27.2%)	40 (32.0%)	51 (40.8%)	125 (44.3%)
By type of surgery				
IOL	69 (30.1%)	82 (35.8%)	78 (34.1%)	229 (83.6%)
Non-IOL	1 (10.0%)	3 (30.0%)	6 (60.0%)	10 (3.6%)
Couching	0 (-)	7 (20.0%)	28 (80.0%)	35 (12.8%)
By years since surgery				
<4 years	33 (28.2%)	33 (28.2%)	51 (43.6%)	117 (42.7%)
5-7 years	23 (27.1%)	30 (35.3%)	32 (37.6%)	85 (31.0%)
8+ years	14 (19.4%)	29 (40.3%)	29 (40.35)	72 (26.3%)
By place of surgery				
Government hospital	23 (30.7%)	26 (34.7%)	28 (37.3%)	75 (27.4%)
Charity hospital	21 (31.3%)	24 (35.8%)	22 (32.8%)	67 (24.5%)
Private hospital	19 (27.9%)	25 (36.8%)	24 (35.3%)	68 (24.8%)

Eye camp	7 (23.3%)	10 (33.3%)	13 (43.3%)	30 (10.9%)
Traditional setting	0 (-)	7 (20.6%)	27 (79.4%)	34 (12.4%)
Surgery location				
In district	42 (23.1%)	61 (33.5%)	79 (43.4%)	182 (66.4%)
In state, outside district	28 (30.4%)	31 (33.7%)	33 (35.9%)	92 (33.6%)
Causes of VA<6/12				
Co-morbidity	-	4 (28.6%)	10 (71.4%)	14 (6.9%)
Surgical complications	-	51 (38.1%)	83 (61.9%)	134 (65.7%)
Refractive error	-	30 (88.2%)	4 (11.8%)	34 (16.7%)
Long-term complications	-	7 (31.8%)	15 (68.2%)	22 (10.8%)

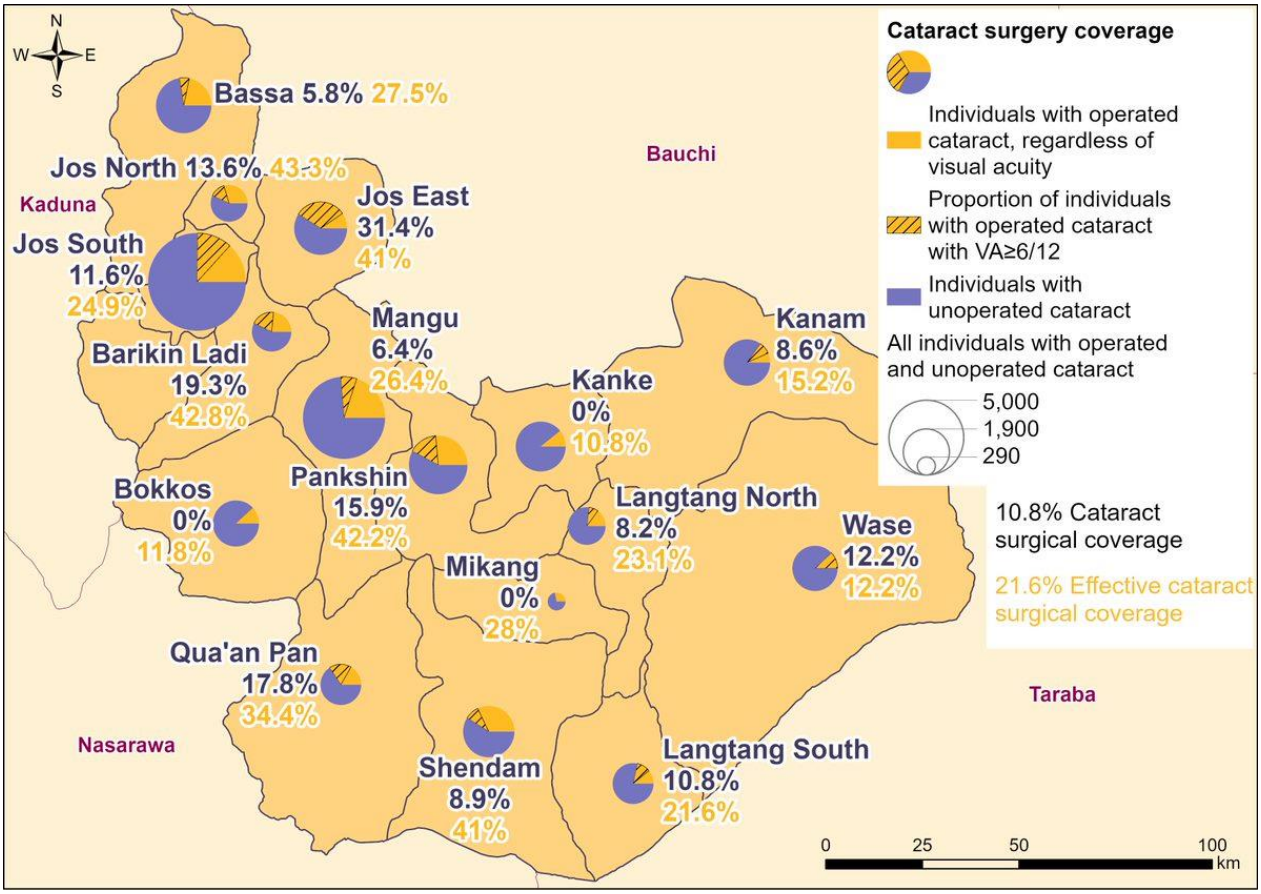
The proportion of people who had surgery and a good visual outcome from surgery eCSC was low at 10.8% at VA<6/12, the WHO-recommended reporting level (see Table 10). The eCSC was slightly higher among males (12.0%) than females (9.7%).

Table 10. Effective cataract surgical coverage (persons, percentage) adjusted for age and sex

	Males	Females	Total
VA <3/60	24.6%	31.4%	27.2%
VA <6/60	23.5%	22.3%	22.9%
VA <6/18	19.4%	16.0%	17.8%
VA <6/12	12.0%	9.7%	10.8%

Figure 12 shows the distribution of operated and unoperated cataracts by LGA. The orange section shows the estimated number of individuals with operated cataracts in the LGA, while the hatched section overlying the orange shows the proportion of those individuals with operated cataracts which have good visual outcomes, i.e., they could see 6/12 or better. The purple section shows the number of individuals with unoperated cataracts. The size of the circle shows the relative total number of operated and unoperated cataracts in that district. The proportion of individuals with operated cataracts with good visual outcome varied from 0% in Bokkos, Kanke and Mikang LGAs to 31.4% in Jos East LGA.

Figure 12. The distribution of operated and unoperated cataracts by LGA in Plateau State.



The main reason given by people with bilateral unoperated cataracts for not having cataract surgery was being unable to afford the operation (56.3%), followed by the lack of awareness about the treatment (11.5%) and fear of surgery or poor result (11.5%) (see Table 11).

Table 11. Barriers to cataract surgery among people with bilateral cataract and BCVA<6/60 (some participants gave more than one reason)

	Male	Female	Total
Cannot afford operation	46 (51.1%)	96 (59.3%)	142 (56.3%)
Unaware that treatment is possible	12 (13.3%)	17 (10.5%)	29 (11.5%)
Fear of surgery or poor result	10 (11.1%)	19 (11.7%)	29 (11.5%)
Need not felt	13 (14.4%)	13 (8.0%)	26 (10.3%)
No access to treatment	3 (3.3%)	15 (9.3%)	18 (7.1%)
Treatment denied by provider	4 (4.4%)	0 (-)	4 (1.6%)
Local reason	2 (2.2%)	2 (1.2%)	4 (1.6%)
Total	**90 (100.0%)**	**162 (100.0%)**	**252 (100.0%)**

Refractive error

Table 12 shows that 0.1% (95% CI [0.0-0.3%]) of people aged 50 years and over in Plateau State are blind with refractive error and 7.8% (95% CI [7.0-8.7%]) have early visual impairment due to refractive error.

Table 12. Sample prevalence of presenting visual acuity due to refractive error among males and females

	Males	Females	Total
Blind	4	1	5
	0.2% (0.1-0.6%)	0.05% (0.0-0.3%)	0.1% (0.0-0.3%)
Severe visual impairment	4	3	7
	0.2% (0.1-0.6%)	0.1% (0.0-0.4%)	0.2% (0.1-0.4%)
Moderate visual impairment	17	22	39
	1.0% (0.6-1.6%)	1.0% (0.7-1.5%)	1.0% (0.7-1.3%)
Early visual impairment	131	179	310
	7.5% (6.4-8.9%)	8.1% (7.0-9.3%)	7.8% (7.0-8.7%)

Extrapolating this to the 2022 population estimation, it is estimated that there are 422 blind people, 731 people with SVI, 3,424 people with MVI and 32,040 people with EVI due to refractive error in Plateau State (see Table 13).

We did not find statistically significant gender differences in refractive error related blindness, SVI, MVI and EVI.

Table 13. Age- and sex-adjusted prevalence and extrapolated magnitude of presenting visual acuity due to refractive error among males and females

	Males	Females	Total
Blind	356	66	422
	0.2% (0.0-0.6%)	0.0% (0.0-0.2%)	0.1% (0.0-0.4%)
Severe visual impairment	555	175	731
	0.2% (0.1-0.7%)	0.1% (0.0-0.4%)	0.2% (0.1-0.4%)
Moderate visual impairment	1,660	1,764	3,424
	0.7% (0.4-1.4%)	0.8% (0.5-1.3%)	0.8% (0.5-1.2%)
Early visual impairment	15,537	16,503	32,040
	6.8% (5.3-8.6%)	7.5% (6.3-8.8%)	7.1% (6.1-8.3%)

Table 13 shows that 11.7% of people aged 50 years and over in Plateau State use near-vision spectacles (see Table 14).

Table 14. Distance and near-vision spectacle use among males and females

	Males	Females	Total
Distance vision spectacles	15	11	26
	0.9%	0.5%	0.7%
Near-vision spectacles	233	229	462
	13.4%	10.3%	11.7%

Discussion

The objective of this study was to estimate the prevalence and causes of visual impairment and to understand the associations between eye health, relative wealth and disability in people aged 50 years and over in Plateau State, Nigeria.

The age- and sex-adjusted prevalence of blindness among people aged 50 years and above was 2.7% [95%CI 2.1-3.3%]. The age- and sex-adjusted prevalence of severe visual impairment (SVI) and moderate visual impairment (MVI) was respectively 1.4% [95%CI 1.1-1.9%] and 3.0% [2.4-3.6%]. The age- and sex-adjusted prevalence of early visual impairment (EVI) was 7.8% [6.7-9.0%].

Compared to the recent RACSS conducted in Plateau State in 2010 (4), the prevalence of blindness from this new RAAB was lower. The RACSS reported a prevalence of 4.2% among people aged 50 and above (4). Similarly, the prevalence of blindness observed in this study is lower than the prevalence reported in the 2005-2007 national blindness survey in the north-central geo-political zone where Plateau State is located. The 2005-2007 national blindness survey reported a prevalence of 5.5% among people aged 50 years and above (1, 22). (19)Compared to the RAAB study conducted in 2020 in Kogi State located in the same geographical zone, there were no significant differences between the prevalence of blindness in Plateau State (2.7%; 95%CI 2.1-3.3%) and Kogi State (3.5%; 95%CI 2.9-4.2%) as the confidence intervals were overlapping (19). This means that the prevalence of blindness in these two states is comparable. The prevalence of blindness among men was not statistically different from women. Similar findings were observed in Kogi (19).

Cataract was the principal cause of 64.0% of blindness and was also responsible for 74.2% and 71.7% of SVI and MVI, respectively. Glaucoma was the second main cause of blindness in Plateau State (16.6%). As the RAABs assign only one cause per eye or visually impaired person and this must be the most easily treatable, data may not be a true representation of all causes of VI in this population.

Refractive error appears to be the second main cause of MVI (12.8%) and the primary cause of EVI (43.5%). Similar findings were reported from other recent RAABs in Nigeria. In Sokoto, the RAAB conducted in 2016 reported that refractive error was responsible for 30.2% of all VI (17). Similarly, in Kogi, refractive error was responsible for 51.1% of VI (19). This further emphasises the need to develop comprehensive and affordable services that take care of spectacle needs for patients with refractive error.

Using the recently updated definitions of cataract surgical coverage (24), less than one-third of people with cataract and VA at 6/12 level in Plateau State had been operated on. CSC was 27.5% overall: 32.8% among males and 22.0% among females.

The WHO has also recently updated the definition of a 'good' visual outcome after cataract surgery from 6/18 or better to 6/12 or better (24). The definition of a 'poor' outcome remains unchanged at visual acuity worse than 6/60. In Plateau State, poor outcomes after cataract surgery remained very high (using the current definition), when compared with the previous RACSS conducted in Plateau State (25). Overall, of 282 operated eyes, 119 (42.2%) had poor outcomes compared to only 70 (24.8%) eyes having good outcomes.

The practice of couching continues to be common in Plateau State with 32 (12.8%) eyes operated on using this practice. Similar proportions was reported from the earlier RACSS in Plateau State at VA<3/60 (25). Not surprisingly, most of the couched eyes had poor visual outcomes (28 cases; 80.0%). The proportion of operated eyes with good outcomes rises to 28.0% after couched eyes are excluded.

The main reason for poor and borderline outcomes after surgery was surgical complications (including couching) (65.7%), followed by refractive error (16.7%), long-term complications (10.8%) and co-morbidities (6.9%). Previous RAABs reported similar findings (19, 35, 36). These poor visual outcomes after surgery indicate the need for improved surgical skill of cataract surgeons. Capacity strengthening should also include how to best perform biometry and how to manage intra-operative complications. In addition, provision of spectacles, management of uncorrected aphakia and better-quality control systems should also be implemented.

Surgical monitoring and outcome assessment are needed for quality improvement, and access to postoperative refractive services could improve a significant number of poor and borderline outcomes. Better outcomes will also be achieved by working with communities to raise awareness, reduce harmful practices such as couching, and provide access to quality, affordable eye care services closer to home. The establishment of outreach centres, with the necessary quality and monitoring system, can contribute to increased access to eye health services and reduce couching. Finally, the development of standard operating procedures (SOPs) for different levels of eye care facilities will ensure compliance with quality monitoring systems.

The effective cataract surgical coverage (eCSC) indicator recently defined by WHO and endorsed as a universal coverage indicator at the 2021 World Health Assembly (WHA) (24)

was very low in Plateau State at 10.8% (12.0% among males and 9.7% among females). To meet the WHA target of a 30 percentage-point increase by 2030, services in Plateau State have to identify strategies to improve both the access to services and the quality of outcomes as a priority.

Both the CSC and eCSC was higher among men than women, although the gender differences were not as pronounced as in other sub-Saharan Africa settings. This finding is consistent with findings reported in other RAABs (19, 35-37). To ensure that men and women have equal access to services, more gender-sensitive policies and activities are needed.

The prevalence of disability among people aged 50 and above was 19.0% in Plateau State. This prevalence was high compared to the prevalence reported from other RAABs in Sierra Leone, Senegal, Kogi and Mali. This can be attributed to the over-representation of very old people (80+) in our sample, as disability increases with age. As noted in the Study Limitations section below, linguistic variations in the state may have led to differences in responses from certain areas, although this is not possible to verify.

Study limitations

The findings indicate that the study population was relatively poor compared to the national population. However, it is important to note that the national wealth cut-off used by this version of the NET is relatively old and based on data collected in 2013. The reference cut-offs are therefore unlikely to represent 2023 asset ownership correctly, and as ownership generally increases with time, are likely to overestimate the wealth of our participants, making the sample look richer than they are in comparison to the national population.

The English version of the WGSS-E was used along with the Hausa language translation to assess disability, although Plateau State has many other local languages. Researchers are often confronted with the challenge of translating survey questions into multiple languages and adapting to multiple dialects. However, this means that respondents from different cultural and socio-economic backgrounds may interpret questions and responses inconsistently. This could have led to differences in responses to those questions.

Finally, it is important to highlight the common limitation of all RAABs, that it is difficult to diagnose posterior segment diseases under RAAB field conditions with just a direct ophthalmoscope. Further, only a single cause (the most easily treatable) can be allocated to

each eye or person, thus underestimating the prevalence of posterior segment and other diseases, which are important in this population.

Recommendations for eye health programmes and research in Plateau State

1. **Capacity of surgical facilities and scale of surgeries:** The number of surgeries performed in the state at present may not be sufficient to address the current burden of blindness and SVI. It is therefore important to fully understand whether the current challenges with the scale of surgeries are driven primarily by supply (capacity of facilities and human resources) or demand (patients cannot afford and are unwilling to take up surgery) or both. The number of surgeries performed in the state should be significantly increased.
2. **Improvement in surgical outcomes:** Given the huge proportion of poor cataract surgical outcomes, more attention should be paid to patient selection and surgical methods. Surgical facilities should be trained to monitor outcomes with validated tools such as the WHO tool and learnings made to improve quality of surgery.
3. **Universal coverage indicators:** It will be important for the State Ministry of Health and their partners to develop a road map and explicit plans of how to improve effective cataract surgical coverage and effective refractive error coverage in line with Nigeria's international commitments by 2030.
4. **Gender equity:** Although the current RAAB did not provide strong evidence of gender inequalities in eye care in the state, the vulnerability of women to eye care exclusion is well known and needs to be monitored. The eye health programme in Plateau State should consider developing specific strategies to address cataract burden among women through more gender sensitive approaches to service delivery and collaboration with women community groups. Messages that create awareness should be engaging for women at local level.
5. **Disability and wealth:** The study provides some evidence that people with additional functional difficulties and those in the poorest households may be at highest risk of exclusion from eye care services. The programme should develop specific strategies of how to engage the poorest households and people with disabilities, and also how to make eye care services more accessible and affordable to meet their needs.
6. **Affordability of services:** With the large proportion of unoperated cataracts attributed to high user fees, it is imperative that the programme considers how to effectively make services more affordable, to protect the poor and other vulnerable

population groups. Initiatives to drive subsidies and other financing mechanisms for eye health, particularly among women and people with disabilities, should be sought.

7. **Geography:** The study showed some evidence of geographical inequalities within the state. It is important to fully understand what drives these inequalities and how to improve CSC and reduce the burden of blindness in the most vulnerable LGAs.
8. **Addressing posterior segment disorders:** Develop research and survey plans to assess the burden of posterior segment disorders and glaucoma which are not adequately detected using the RAAB methodology.
9. **Research and dissemination:** Data from this survey contributes to the pool of data in eye health and should be used to revise the current ongoing eye care programme.

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Appendix A: RAAB Tool

RAPID ASSESSMENT FOR AVOIDABLE BLINDNESS

A. GENERAL INFORMATION — **Year - month:** 2 0 1 4 - ☐☐

Survey area: NORTHERN **Cluster:** **Individual no.:** ☐☐

Name: **Sex:** Male: O (1) Female: O (2) **Age (years):** ☐☐

Examination status:

Examined: O (1) (go to B) Refused: O (3) (go to E)

Not available: O (2) (go to E) Not able to communicate: O (4) (go to E)

Always ask: "Did you ever have any problems with your eyes?" Yes: O (1) No: O (2)

If not available - details (availability / tel number / address)

B. VISION

Uses distance glasses: No: O (1) Yes: O (2)

Uses reading glasses: No: O (1) Yes: O (2)

Presenting vision	Right eye	Left eye
Can see 6/12	O (1)	O (1)
Cannot see 6/12 but can see 6/18	O (2)	O (2)
Cannot see 6/18 but can see 6/60	O (3)	O (3)
Cannot see 6/60 but can see 3/60	O (4)	O (4)
Cannot see 3/60 but can see 1/60	O (5)	O (5)
Light perception (PL+)	O (6)	O (6)
No light perception (PL-)	O (7)	O (7)

Pinhole vision	Right eye	Left eye
Can see 6/12	O (1)	O (1)
Cannot see 6/12 but can see 6/18	O (2)	O (2)
Cannot see 6/18 but can see 6/60	O (3)	O (3)
Cannot see 6/60 but can see 3/60	O (4)	O (4)
Cannot see 3/60 but can see 1/60	O (5)	O (5)
Light perception (PL+)	O (6)	O (6)
No light perception (PL-)	O (7)	O (7)

E. HISTORY, IF NOT EXAMINED

(From relative or neighbour)

Believed	Right eye	Left eye
Not blind	O (1)	O (1)
Blind due to cataract	O (2)	O (2)
Blind due to other causes	O (3)	O (3)
Operated for cataract	O (4)	O (4)

F. WHY CATARACT SURGERY WAS NOT DONE

(Mark up to 2 responses, if VA<6/18, not improving with pinhole, with visually impairing lens opacity in one or both eyes)

Need not felt	O (1)
Fear of surgery or poor result	O (2)
Cannot afford operation	O (3)
Treatment denied by provider	O (4)
Unaware that treatment is possible	O (5)
No access to treatment	O (6)
Local reason (optional)	O (7)

C. LENS EXAMINATION

	Right eye	Left eye
Normal lens / minimal lens opacity:	O (1)	O (1)
Obvious lens opacity:	O (2)	O (2)
Lens absent (aphakia):	O (3)	O (3)
Pseudophakia without PCO:	O (4)	O (4)
Pseudophakia with PCO:	O (5)	O (5)
No view of lens:	O (6)	O (6)

D. MAIN CAUSE OF PRESENTING VA<6/12

(Mark only one cause for each eye)

	Right eye	Left eye	Principal cause in person
Refractive error:	O (1)	O (1)	O (1)
Aphakia, uncorrected:	O (2)	O (2)	O (2)
Cataract, untreated:	O (3)	O (3)	O (3)
Cataract surg. complications:	O (4)	O (4)	O (4)
Pterygium:	O (5)	O (5)	O (5)
Corneal opacity:	O (6)	O (6)	O (6)
Phthisis:	O (7)	O (7)	O (7)
Myopic Degeneration:	O (8)	O (8)	O (8)
Glaucoma:	O (9)	O (9)	O (9)
Diabetic retinopathy:	O (10)	O (10)	O (10)
ARMD:	O (11)	O (11)	O (11)
Other posterior segment:	O (12)	O (12) All	O (12)
globe/CNS abnormalities:	O (13)	O (13) Not	O (13)
examined: can see 6/12	O (14)	O (14)	O (14)

G. DETAILS ABOUT CATARACT OPERATION

	Right eye	Left eye
Age at operation (years)		
Place of operation		
Government hospital	O (1)	O (1)
Voluntary / charitable hospital	O (2)	O (2)
Private hospital	O (3)	O (3)
Eye camp / improvised setting	O (4)	O (4)
Traditional setting	O (5)	O (5)
Type of surgery		
Non IOL	O (1)	O (1)
IOL implant	O (2)	O (2)
Couching	O (3)	O (3)
Cost of surgery		
Totally free	O (1)	O (1)
Partially free	O (2)	O (2)
Fully paid	O (3)	O (3)
Cause of VA<6/12 after cataract surgery		
Ocular comorbidity (Selection)	O (1)	O (1)
Operative complications (Surgery)	O (2)	O (2)
Refractive error (Spectacles)	O (3)	O (3)
Longterm complications (Sequelae)	O (4)	O (4)
Does not apply - can see 6/12	O (5)	O (5)

Appendix B: Washington Group Short Set – Enhanced.

Preamble to the WGSS Enhanced

Interviewer read: "The next questions ask about difficulties you may have doing certain activities because of a HEALTH PROBLEM."

VISION		
VIS_1	[Do/Does] [you/he/she] have difficulty seeing, even when wearing [your/his/her] glasses]?	1. No difficulty 2. Some difficulty 3. A lot of difficulty 4. Cannot do at all
HEARING		
HEAR_1	[Do/Does] [you/he/she] have difficulty hearing, even when using a hearing aid(s)]?	1. No difficulty 2. Some difficulty 3. A lot of difficulty 4. Cannot do at all
MOBILITY		
MOB_1	[Do/Does] [you/he/she] have difficulty walking or climbing steps?	1. No difficulty 2. Some difficulty 3. A lot of difficulty 4. Cannot do at all
COMMUNICATION		
COM_1	Using [your/his/her] usual language, [do/does] [you/he/she] have difficulty communicating, for example understanding or being understood?	1. No difficulty 2. Some difficulty 3. A lot of difficulty 4. Cannot do at all
COGNITION (REMEMBERING)		
COG_1	[Do/does] [you/he/she] have difficulty remembering or concentrating?	1. No difficulty 2. Some difficulty 3. A lot of difficulty 4. Cannot do at all
SELF-CARE		
SC_SS	[Do/does] [you/he/she] have difficulty with self-care, such as washing all over or dressing?	1. No difficulty 2. Some difficulty 3. A lot of difficulty 4. Cannot do at all
UPPER BODY		
UB_1	[Do/Does] [you/he/she] have difficulty raising a two-litre bottle of water or soda from waist to eye level?	1. No difficulty 2. Some difficulty 3. A lot of difficulty 4. Cannot do at all
UB_2	[Do/Does] [you/he/she] have difficulty using [your/his/her] hands and fingers, such as picking up small objects, for example, a button or pencil, or opening or closing containers or bottles?	1. No difficulty 2. Some difficulty 3. A lot of difficulty 4. Cannot do at all
AFFECT (ANXIETY AND DEPRESSION)	*Interviewer: If respondent asks whether they are to answer about their emotional states after taking mood-regulating medications, say: "*Please answer according to whatever medication [you were/he was/she was] taking."	

ANX_1	How often [do/does] [you/he/she] feel worried, nervous, or anxious?	1. Daily 2. Weekly 3. Monthly 4. A few times a year 5. Never
ANX_2	Thinking about the last time [you/he/she] felt worried, nervous, or anxious, how would [you/he/she] describe the level of these feelings?	1. A little 2. A lot 3. Somewhere in between a little and a lot
DEP_1	How often [do/does] [you/he/she] feel depressed?	1. Daily 2. Weekly 3. Monthly 4. A few times a year 5. Never
DEP_2	Thinking about the last time [you/he/she] felt depressed, how depressed did [you/he/she] feel?	1. A little 2. A lot 3. Somewhere in between a little and a lot

Appendix C: Nigeria Equity Tool

	Question	Response categories
Q1	Does your household have … an electric iron?	 Yes No
Q2	…a fan?	Yes No
Q3	…a television?	Yes No
Q4	…a refrigerator?	Yes No
Q5	… a generating set?	Yes No
Q6	…a cable TV?	Yes No
Q7	…electricity?	Yes No
Q8	What is the main material of the walls in your household?	Cane, palm, trunks, dirt (mud) Other
Q9	What is the main material of the floor in your household?	Earth, sand, dung Other
Q10	What type of fuel does your household mainly use for cooking?	Wood Kerosene Other
Q11	Does any member of this household have a bank account?	Yes No

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