Rapid assessment of avoidable blindness in Karamoja, Uganda (2023)

Mulago National Referral Hospital
Republic of Uganda

Sightsavers

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Executive summary

A lack of country-specific epidemiological data is a major constraint on the development of national health plans and policies in low to middle income countries (LMICs). To address this issue, the World Health Organization (WHO) recommends the use of rapid assessment of avoidable blindness (RAAB) studies to provide data for planning blindness and visual impairment (VI) prevention programmes.

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). A RAAB conducted in Karamoja in 2015 found the prevalence of blindness among people in this age group to be 6.0%. In February 2023, we conducted a second RAAB in four districts of the sub-region to assess changes in the prevalence and causes of blindness and visual impairment. Additional, internationally comparable measures of self-reported functional impairments and relative household wealth were also used to better understand associations between eye health outcomes, poverty and disability.

Key findings

Prevalence and causes of visual impairment

We recruited 3,450 individuals aged 50 years and over, of whom 3,159 were examined (91.6% response rate).

Prevalence of visual impairment was found to have decreased from 6.0% (95%CI 5.2-6.9%) in 2015 to 4.9% (95%CI 4.0-5.9%]) in 2023, although the difference was not statistically significant. Extrapolating to the estimated total population, this means there are an estimated 2,575 blind people aged over 50 years, and 10,647 eyes in the study area. Severe visual impairment affects a further 1,618 people (3.1%, 95%CI 2.5-3.8%), and 4,575 eyes.

The major cause of blindness was unoperated cataract (39.3%), with corneal opacities (trachoma and other causes) responsible for a further 32.6%. Cataract and age-related macular degeneration (ARMD) were also the most important causes of severe visual impairment: 59.2% and 9.6%, respectively.

Cataract services

Using the recently updated definitions of cataract surgical coverage, only 34.5% of people with cataract and VA at 6/12 level had been operated on. This was much higher, 71.6% at the CA<3/60 level. Coverage remains higher among males than females at all levels, for example, 83.8% at VA<3/60 for males and 58.0% among females.

Post-operative visual outcomes are less than optimal, with 78.2% achieving presenting vision of less than 6/12. A major reason for this is the high co-prevalence of corneal scarring which requires strengthened primary eye care services in order to improve timely care seeking and reduce reliance on traditional remedies.

Gender and equity

Although little difference was observed between males and females in terms of prevalence of blindness, the results indicate that cataract surgical coverage is higher among males than females. Stark differences between districts, and also between people with and without disabilities, were also observed. Strategies to improve access to services for women, particularly those who are poorer or who have additional functional difficulties, will be important to achieve equity of coverage.

Contents

Abbreviations

ARMD:	age-related macular degeneration
BOOST:	Best Operative Outcomes Software Tool
CI:	confidence interval
CSC:	cataract surgical coverage
eCSC:	effective cataract surgical coverage
EVI:	early visual impairment
IOV:	inter-observer variability
LMICs:	low to middle income countries
MHREC:	Mulago Hospital Research & Ethics Committee
MVI:	moderate visual impairment
NIRA:	National Identification & Registration Authority
RAAB:	rapid assessment of avoidable blindness
SAGE:	Social Assistance Grants for Empowerment
SVI:	severe visual impairment
UNCST:	Uganda National Council for Science and Technology
VI:	visual impairment
WHO:	World Health Organization

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Introduction

Visual impairment globally and in Uganda

In 2020, an estimated 43.3 million people globally were blind (1). A further 553 million people had mild, moderate or severe visual impairment (VI). Among older adults, all-age-standardised prevalence of blindness decreased by 28.5% between 1990 and 2020, and yet the estimated number of blind people increased by 50.6%, mainly due to population growth and aging (1, 2). Older people, women and people in low and middle income countries (LMICs) are disproportionately affected: 77.7% of blind people are aged over 50 years; 91.8% live in LMICs; and 55% are women (3). There is limited data around visual impairment in people with other (non-visual) disabilities, but what exists suggests that they are at higher risk of blindness and severe vision loss than people without other disabilities (4). More than 75% of visual impairment globally is either preventable or treatable, which requires equitable access to quality comprehensive and accessible eye care services, including at the community level.

To reduce the burden of VI, the World Health Organization (WHO) recommends focusing on strengthening eye care services through their integration into the broader health system. To achieve this, a global eye health resolution (Resolution WHA73.4 *'Integrated people-centred eye care, including preventable vision impairment and blindness'*) sets feasible global eye care targets for 2030, focusing on effective refractive error coverage and effective cataract surgery coverage (5). The resolution builds on the principles of the global initiative, Vision 2020: the Right to Sight, and expresses the commitment of Member States to reducing avoidable VI and achieving quality of life for all citizens. As part of the VISION 2020 initiative, and supported by the 2019 World Report on Vision, many countries developed national plans for elimination of avoidable blindness (6). In Uganda, the Fifth National Eye Health Plan was launched in October 2022, and focuses on moving towards universal health coverage (7). A major constraint in the implementation of national plans and policies in many LMICs has been the absence of country-specific epidemiological data. In order to resolve this issue, the WHO recommended conducting periodic population-based studies, such as rapid assessment of avoidable blindness (RAAB), to provide data for decision-making and programme planning. RAAB is a standard methodology for obtaining reliable results for people in the age group with the highest prevalence of visual impairment, that is, those over 50 years of age (8).

Over 300 RAABs have been conducted globally and over 50 in sub-Saharan Africa (9). Uganda has never conducted a national eye health survey, but four sub-national population-based surveys – RAABs – conducted since 2011 indicate that VI affects around one in 11 people aged over 50 years. The prevalence of moderate VI or worse (defined as visual acuity worse than 6/18) was found to range between 6.9% and 8.9% (10). The major cause of blindness in those surveys was found to be unoperated cataract, with other significant causes including trachoma corneal opacities (Karamoja, 2015), and 'other posterior segment' diseases (Western - Ntungamo, 2011; Central - Mubende, 2012; and Western - Hoima, 2013). There is a strong gradient in the association between VI and age, for example, in the 2015 Karamoja study, blindness among people aged 80 years and above was found to be 24.6% (95%CI 19.5-29.8%) compared with 1.1% (95%CI 0.5 - 1.7%) among those aged 50-59 years.

In Uganda, as elsewhere on the continent, access to eye care services is limited, especially for women, people living in rural areas, among the poor, and among people with disabilities (2, 4, 11). Population growth and rapid demographic changes throughout Uganda mean that it is imperative that existing resources (human, financial, infrastructure and equipment) be reviewed and revised in order to effectively target the major avoidable causes of blindness. The Fifth National Eye Health Plan recognises the importance of up-to-date population-based data for *"evidence-based eye care planning, resource mobilisations, and advocacy for improved quality of eye health services"* in the country (7). Moreover, non-governmental organisations (NGOs) have planned to increase support to eye care activities for successful implementation of eye health programmes in Uganda, but can only do so if there is scientifically valid evidence on which to advocate, prioritise and plan.

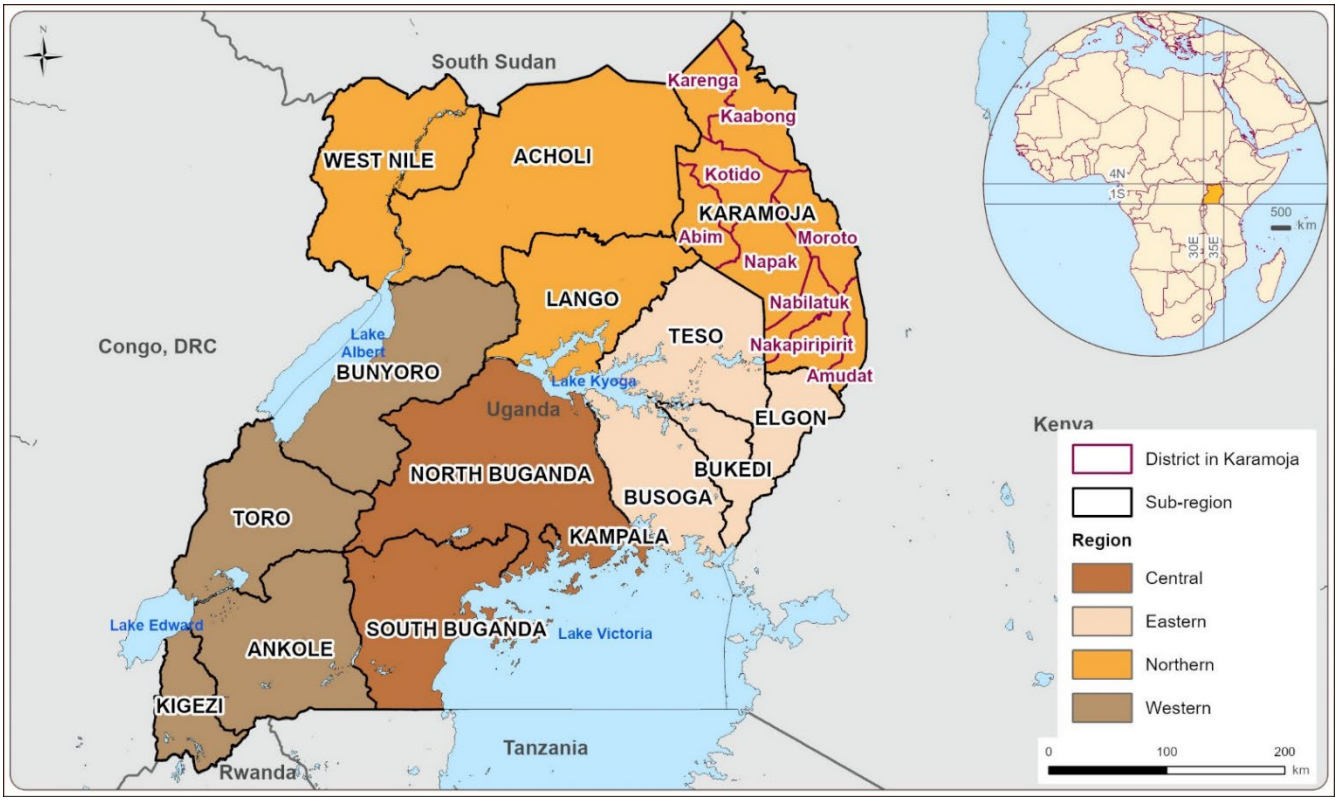
In addition to VI, a large number of people over the age of 50 years also experience other types of disabilities (12). The United Nations Convention on the Rights of Persons with Disabilities (UNCRPD) states that people with disabilities include those with *"long-term physical, mental, intellectual or sensory impairment, which in interaction with various barriers may hinder their full and effective participation in society on an equal basis*" (13). It is widely acknowledged that those with disabilities are also further marginalised due to low socio-economic status (14, 15). Evidence suggests that people with disabilities are often less likely to access the health services they need 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 they benefit.

Study location

Karamoja is a sub-region of Uganda in the north-eastern part of the country (Figure 1). The projected population in 2022 was 1,245,600 spread over nine districts: Moroto in the centre, where the main town of the region, Moroto town, is located, and Abim, Kaabong, Karenga, and Kotido to the north, and Amudat, Nakapiripirit, Nabiliatuk and Napak in the south (16). The majority ethnic group is Karamojong, and the main livelihood is livestock herding, which has historic social and cultural importance. Karamoja has a history of conflict, linked to cattle raiding across the borders with Kenya and South Sudan, which has contributed to the underdevelopment of the area and a reputation as the poorest part of Uganda. Karamoja is an extremely arid region that experiences frequent droughts, causing problems for cattle herding and crops, which means the population frequently experiences famine.

Because of ongoing security issues linked to cattle raiding in parts of the sub-region, this RAAB was done in four districts deemed to be safe for data collection: Moroto, Napak, Nabilatuk and Nakapiripirit. Security assessments were conducted throughout the duration of the fieldwork, and the study team worked closely with district authorities to ensure the safety of all involved.

Figure 1: Map showing location of Karamoja sub-region within Uganda



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Objectives of this study

The first RAAB in Karamoja was conducted in 2015, providing baseline information about the eye health needs, status and coverage of services in the area. The 2015 RAAB was conducted in Moroto, Kaabong (which at the time also included Karenga district), Abim and Kotido districts, but was considered representative of the sub-region as a whole, due to similar population groups and service provision throughout.

Since 2015, service provision has changed drastically throughout Karamoja, with the development of a new eye health unit at Moroto Regional Referral hospital, and the deployment of a regional ophthalmologist based at the hospital. Ophthalmic clinical officers based in each district work with staff at the hospital to create awareness in communities, identify people in need of services, and provide services as appropriate.

Although the districts of the reported RAAB were not exactly the same as those included in 2015, we consider that the areas are sufficiently socio-demographically comparable, and that service provision has been similar enough, to consider that the data reported here will allow for a measurement of change in Karamoja between 2015 and 2023.

The aim of this study was to inform the eye health planning and provide updated data for the interventions by the Ministry of Health and its partners in Karamoja sub-region, and to understand what changes have occurred since the study conducted in 2015.

General objective

To assess the eye health status, unmet eye health needs, and eye health service coverage among people aged ≥50 years in Karamoja sub-region in Uganda, identify factors associated with low coverage of services, and compare this with the situation in 2015.

Specific objectives

1. To determine the prevalence and distribution of blindness and visual impairment in the study population
2. To determine the major causes of blindness and visual impairment
3. To assess the coverage of cataract surgical services and visual outcomes from cataract surgery
4. To determine the barriers to uptake of cataract services
5. To assess the coverage of refractive error and trachoma surgical services
6. To assess how the results of questions 1-5 differ by disability status

7. To explore the relationship between eye health status and access to cataract services, by other personal and health characteristics, and to identify those most at risk of poor eye health status and low coverage of services
8. To analyse changes in the prevalence and causes of blindness and visual impairment, and the coverage of cataract surgical services, since 2015 and investigate the associated factors

Methods

Study design

This study had a quantitative cross-sectional population-based survey design.

Study population

The study population were people aged 50 years and above who live in four districts of Karamoja: Moroto, Napak, Nabilatuk and Nakapiripirit. RAAB includes only people aged 50 years and above, as this is where the prevalence of blindness is highest (17).

Inclusion criteria

The inclusion criteria were:

- Be aged 50 or over
- Have been ordinarily resident for at least six months prior to the survey
- Have consented to participate

Exclusion criteria

The exclusion criteria were:

- Be aged less than 50 years
- Visitors
- Refused, or unable to consent

Sample size

The sample size was calculated to be large enough to measure the difference between two proportions, such as the prevalence of severe VI between people with and without disabilities (18). We assumed that the prevalence of disability was 10% based on results from surveys conducted among the over 50s in other countries (4). No study in Uganda had described the expected prevalence of VI by disability status, however, other recent RAABs conducted by Sightsavers found the prevalence of severe VI among people with disabilities to be around double that among people without disabilities (19). For the purposes of this calculation, we assumed a prevalence of severe VI among those with disabilities to be 16% and 8% among those without disabilities. The sample size was inflated by 10% to account

for non-response, and 50% to account for design effect associated with clustering that had been observed in other RAABs.

$$n = \frac{\{u\sqrt{[\pi_1(1-\pi_1)+\pi_0(1-\pi_0)]}+v\sqrt{[2\bar{\pi}(1-\bar{\pi})]}\}^2}{(\pi_0-\pi_1)^2}$$

where:

n	the required size of each group
π_1	the expected prevalence of severe VI among people with disabilities, 16%
π_0	the expected prevalence of severe VI among people without disabilities, 8%
$\bar{\pi}$	the average of the two proportions, 12%
u	the value of the normal distribution, corresponding to 95%, 1.96
v	the value of the normal distribution corresponding to 90%, 1.28

Using this formula, n is 343, and adjusting to account for the disproportionate size of the groups of people with and without disabilities, as well as non-response and design effect, the total required sample size was 3,427 people (18). These persons were selected from 69 clusters of 50 persons aged 50 years and above which gave a total sample size of 3,450.

Sampling method

A two-stage sampling was used; 50 primary sampling units, villages, were selected at random from a complete list using probability proportionate to size methodology. A list of all villages in the four districts with their populations was obtained from the district population officers. The complete list of the villages was uploaded to the RAAB software, which has an inbuilt probability proportionate to size selection tool.

Within each village, 50 eligible participants were enrolled in the study. A cluster informer visited the village a few days before the team arrived and worked with the village leaders in order to identify the borders of the village. If the village population was large, exceeding 500 inhabitants, a map was drawn with the village leader to segment it into smaller segments. In this case, a segment was chosen at random through numbering them and choosing a number at random.

Once the village/segment boundaries were clear, the cluster informer notified the study team and provided them with a copy of the map. On the day of the study, the team would meet with the village leader and a nominated guide. The study team would start at the house in the segment closest to the main road and ascertain from the head of household the number

of eligible respondents living in the household. All would be enumerated, including those temporarily absent. All participants present underwent visual acuity screening during the visit, and the team would attempt to revisit the house at the end of the day to capture anyone who was missed at the time of the visit. Basic data about participants unavailable for the visual acuity screening was collected from their family members or neighbours where possible. The team would then proceed to the next nearest house until 50 people were enumerated.

Data collection

All sampled individuals were visited at home from 13 to 27 February 2023. Each participant enrolled onto the RAAB underwent the following steps: information provision and consent procedures; visual examination; personal and health questions. Details of these three steps are described below. All data was collected using an app on a touch-screen smartphone. Precise location of villages (not households) was recorded using global positioning system (GPS) coordinates so that cluster level (not individual level) data could be visually mapped and geospatially analysed.

Information provision and consent

As the team arrived at a house, they introduced themselves to the head of the household, facilitated through the village guide who was chosen by the village chief due to their knowledge of the community. They would ascertain 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 would inform 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 cases where a participant was illiterate, their thumb print was obtained, and witnessed by an independent person, not part of the study team.

Data was stored in the smartphones and synced at the end of each day with the cloud server which was accessible only to study team members responsible for data management and analysis. The app itself has inbuilt checks to minimise errors and ensure data quality. Additionally, submitted data was checked regularly for quality by study team members and errors or inconsistencies fed back to the study teams to ensure data quality.

Study instruments

Visual examination

All participants underwent ophthalmic examination by the ophthalmic members of the study team. They followed the standard RAAB protocol, which is well described elsewhere, and they followed the following steps (20):

1. Asking whether the individual uses spectacles, and whether they have experienced any issues with their eye health
2. Presenting (with available correction) visual acuity measurement of each eye (all participants)
3. Uncorrected visual acuity measurement of each eye for those participants with spectacles
4. Pinhole visual acuity assessment of each eye presenting <6/12
5. Lens examination of each eye with a torch in a darkened room (all participants)
6. Posterior-segment examination with a torch of each eye presenting <6/12 where the principal cause cannot be attributed to refractive error, cataract or corneal scarring
7. Assessment of the major cause of VI of each eye presenting <6/12 and in persons where both eyes present <6/12 and the causes are not the same
8. Questions regarding cataract surgery where it took place
9. Questions regarding why cataract surgery had not taken place, where it was indicated
10. Because trachoma remains a significant public health problem in Karamoja, questions regarding the presence of trichiasis, and whether or not surgery had taken place were also added to the standard RAAB tool

Minor ocular conditions identified were treated by the team. 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:

- Mild, termed 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

The study tool is included in Appendix A.

Personal, health and resource questions

In addition to the visual examination, information about a number of personal and health, characteristics were collected in order to explore the relationships with visual status, and access to eye health services. These characteristics were chosen because existing evidence suggests that they may be associated with health seeking behaviour and decision-making, and it was important to explore their influence in the Karamoja setting. These characteristics include: disability; wealth; social support; and attitudes and beliefs about health services.

Attempts were made to keep these questions to a minimum so as not to significantly increase the time required of participants. These tools were piloted/tested prior to data collection training to ensure they were easily understandable, and to condense the questions to a 30-minute interview while optimising the internal consistency of the measures, given the time and logistical constraints.

The initial pilot test instrument was administered to volunteers from health care staff at the Moroto Regional Referral Hospital that role-played participants to quickly identify any obvious problems with the ordering or wording of questions. The health care staff provided comments that were incorporated into the pilot test questionnaire. The revised instrument was then administered to approximately 40 pilot test participants from a nearby village who met the study eligibility criteria. Consent was obtained from pilot test participants. After piloting, we analysed the pilot test data to evaluate administration time for each question/section of the instrument. The study team discussed the data and made decisions regarding necessary revisions/reductions of the instruments.

The study tool that includes all the personal and health questions is included in Appendix D.

Disability

Disability is a complex concept and there are many ways to define and measure it. The UN Statistics Division commissioned a City Group to develop a methodology that could easily and simply measure disability in mainstream surveys in a way that conceptualises disability as a dynamic interaction between an individual's health conditions, environmental factors and personal factors (12). Thus, the Washington Group of Disability Statistics have developed several questions sets that can be used to measure disability within mainstream surveys, such

as the RAAB (21). The tools are well tested and validated and have been used internationally, including in censuses and surveys such as the Demographic and Health Surveys.

In this RAAB, we used the '*Short Set - Enhanced'* disability tool which comprises 12 questions related to an individual's self-perceived difficulties in functioning in eight areas or 'domains', including seeing, hearing, upper-body, lower-body, communication, cognition, anxiety and depression. Response categories are non-binary, allowing respondents to position themselves along a scale of functioning, thus allowing for nuanced analysis of severity of impairment as well as type. Although several approaches to analysis are possible, a binary measure of disability was determined if an individual reported at least a lot of difficulty in at least one functional domain.

Wealth

Wealth is an important determinant of seeking care and is a concept that can be measured in many ways. We chose to include two approaches that we believed were appropriate to the Karamoja setting. The first approach was to determine whether the individual had access to the Social Assistance Grants for Empowerment (SAGE) that is currently available to all individuals aged 80 years and above in the area. The beneficiaries are entitled to a monthly stipend of UGX 25,000 [approximately GBP 5.00]. Beneficiaries must be registered in the (National Identification & Registration Authority) NIRA database to enable the programme to assess their eligibility. The second is how the individual self-reported their household's relative wealth in comparison to other households in the community using a visual prompt (22). Participants were shown a ladder with 10 rungs, where the poorest in the community stand on the bottom and the wealthiest on the top. They were asked to choose the rung where they think their household falls. This tool has been used in several settings and found to be effective.

Social support

Social support, including support from a spouse and children, has been identified as an important determinant in accessing health care services, with socially isolated individuals including widows often experiencing low access to services (23). We included a number of questions, similar to those used in other surveys in Uganda (for example the Wellbeing of Older Persons Study), to determine an individual's marital status, and the extent to which they are supported by their children (24, 25).

Attitudes and beliefs about health services

Attitudes and beliefs about health services, including actual experiences and perceptions, have been shown to influence how individuals access health services (26). While we captured village level GPS coordinates and were able to measure actual distance to health facilities, we also asked participants to estimate the distance to health facilities in order to understand whether actual and perceived distance are similar, or whether misconceptions about distance exist, as they have shown to elsewhere. We also asked about interactions with formal health services in the previous 12 months.

Training of the data collectors and inter-observer variation testing

A certified RAAB trainer conducted a five-day training session. Days 1 and 2 focused on an overview of the study and ethics, using the app and the visual examination procedures. Day 3 focused on personal and health characteristics questions and practice, particularly of the visual examination procedures. Day 4 was an inter-observer variability test, and day 5 took place in a nearby field location to allow teams to practise procedures in a real-world setting, and ended with a logistics and safety briefing.

All field staff were trained so that they uniformly followed the same procedure to identify eligible participants, assess visual acuity, and carry out lens examination. Standardised instructions on definitions, method of selection of participants, examination protocol, and methods to obtain and record the data for their reference were given to each team. On day 4 of the training, teams underwent an inter-observer variability (IOV) test to assess whether they conduct the visual assessment in a standardised manner. Each team examined the same 50 participants, and their assessments of visual acuity, lens assessment, and causes of visual impairment were compared to measure levels of agreement. The IOV test results were satisfactory, and the teams proceeded to the field.

Study logistics

Five trained and standardised teams collected data; each team comprised of:

- An ophthalmologist to act as team leader
- An ophthalmic clinical officer
- A cluster informer
- A driver

- A village guide (one in each village)

Data management and analysis

The study tools were designed in one app using CommCare software (27). Data was downloaded in .csv format and uploaded in Stata v15 software for analysis (28).

Results were tabulated, calculating sample prevalence point estimates for each indicator of interest, and 95 per cent confidence intervals surrounding them was estimated. Standard errors were adjusted for clustering using the design effect observed. The age and sex distribution of the sample was reviewed against available census data and a weighting file was developed and used to create age- and sex-adjusted estimates and confidence intervals of each key indicator (29). Relationships between visual status and access to services with health and personal characteristics were examined using logistic regression techniques.

Cataract surgical coverage (CSC) and effective cataract surgical coverage (eCSC) were calculated using the most up to date definitions available (30, 31). To compare 2015 results, they were reanalysed using the new definitions.

Following in-depth statistical analyses, key indicators were exported into ArcGIS software for mapping and spatial analyses to understand geographic patterns around prevalence of visual impairment and health seeking behaviour (32).

Comparison with 2015 data

In the results, we attempt to compare the results of this study with a similar RAAB conducted in 2015. These comparisons have been made by looking at point estimates of age- and sex-adjusted results, and their confidence intervals. A number of changes since 2015 need to be accounted for in the comparison:

1. The 2015 RAAB did not collect data on early visual impairment, nor data on disability or wealth status
2. Definitions of several indicators have changed, including CSC, eCSC, and what constitutes a ‘good’ visual outcome (33). To compare like-with like, we have adopted the new definition and applied it to the 2015 dataset, where possible
3. The population data used in 2015 to generate age- and sex-adjusted results was based on the 2002 census (34). More recent estimates for 2015, based on the 2014 census, are now available, and show that the true 2015 population structure was

considerably different from the projection originally used (34). The 2015 age- and sex-adjusted results have been reanalysed using the more up-to-date population data, and those results presented here are the newly updated results

Ethical considerations

The protocol was submitted to the Mulago Hospital Research & Ethics Committee (MHREC), and to the Uganda National Council for Science and Technology (UNCST). The study followed all the policies, guidelines and regulations pertaining to the legal and regulatory framework of research in Uganda.

Informed consent

Information materials were prepared in Karamojong (Appendix A). Approximately Seventy-five per cent of the adult population in Karamoja is illiterate and the majority of the study population, particularly women, were unable to read or write (35). Emphasis was therefore placed on sharing information about the study verbally, in easy-to-understand language, initially through meetings with the community leaders and subsequently with individual participants.

Data collectors were trained to check individuals' understanding of the study and what participation entailed, by asking simple probing questions. Data collectors could decide not to enrol an individual into the study if they had reasonable evidence to doubt the individual's ability to make a decision. This included the individual failing to demonstrate that they could 1) understand the information relevant to their decision; 2) retain the information in their mind; 3) use or weigh that information as part of their decision-making process; or 4) communicate their decision by any means.

Written informed consent was obtained directly from all participants. Participants unable to sign consent forms themselves were asked to make a thumb print, and a literate member of the household or community asked to witness and sign the form as well.

Eligible participants were completely free to choose to participate in this study or not. Non-participation in this study would not affect any services received from the project. Participants were also free to stop the interviews or withdrawal from the study at any time without giving an explanation.

Risks and mitigation strategies

Whilst RAAB is not invasive, there can be a certain level of discomfort due to the dilation of pupils for eye screening.

Dilating people's eyes with short acting mydriatics can cause a stinging sensation and/or cause a reduced visual acuity for 1-2 hours with a residual effect for the rest of the day, such that the participant will not be able to drive. Visual acuity should return to normal within 24 hours, except for very rare cases where the effect can last for three days.

Dilated cases were counselled accordingly and asked to contact the investigators if dilatation persisted. Some subjects who were allergic to dilating drops causing red and itchy eyes were counselled accordingly and given appropriate treatment.

Benefits

Participants were given a small fee, UGX 5,000 [approximately GBP 1.00] in cash per individual, to compensate them for their time participating in the study. There will be long-term benefits that will accrue to the entire community as more information is generated to inform the development of eye health.

Individuals identified as having eye health problems through the survey were either treated in the case of a minor issue such as conjunctivitis or provided with information and a referral in the case of more significant issues. Data collectors asked for additional permission to record and share the participant's contact details with the district OCO who coordinates referrals with the regional hospital.

Confidentiality

Copies of raw data was stripped of all identifiers (including geographical location of individuals) and remains strictly confidential. Data collection teams underwent a one-week training period which included importance of confidential data collection and management.

No names or photos of participants were used in documentation and publications without express consent having been received, and all data is stored in secured filing cabinets (originals) and password-protected drivers (electronic). All people requiring services were referred as appropriate for possible free or subsidised services.

Prevention and protection against COVID-19

While COVID-19 infections were currently at an extremely low level in Uganda, procedures were put in place during fieldwork to ensure awareness and reduction of risk as far as

possible. We followed all guidance from the Ugandan government and the WHO standard COVID-19 prevention measures for community-based interventions were adapted for this study.

Results

Study sample and demographic characteristics

Sixty-nine clusters were visited and 3,159 people were examined out of the 3,450 enrolled – a response rate of 91.6% (Table 1). Of those not examined, the majority (7.0%) were unavailable, or unable to consent (1.2%), with only a minority refusing to participate (0.3%).

Table 1: Participant examination status by sex

	Examined	Not available	Refused	Unable to consent	Total
Male	1,107	133	1	9	1,250
	88.6%	10.6%	0.1%	0.7%	36.2%
Female	2,052	107	10	31	2,200
	93.3%	4.9%	0.5%	1.4%	63.8%
Total	3,159	240	11	40	3,450
	91.6%	**7.0%**	**0.3%**	**1.2%**	**100.0%**

More females than males (65.0%) were examined in the study, and females were proportionately overrepresented compared to the estimated population in the four districts (58.1%) (Table 2). Compared to the estimated total population, people aged 50-69 years – particularly males – were underrepresented and people aged 70 years and above were overrepresented. This means the sample results may overstate the magnitude of age-related visual impairment, and age- and sex-adjusted results are important for understanding the true extent of visual impairment in this population.

Table 2: Participants examined by sex and 10-year age group, compared with the total population in the study area (2023 projection (29))

	Survey participants			Study area population (2023 projection)		
	Male	Female	Total	Male	Female	Total
50-59	404	579	983	8,470	11,520	19,990
	36.5%	28.2%	31.1%	38.3%	37.5%	37.8%
60-69	296	618	914	7,640	12,990	20,630
	26.7%	30.1%	28.9%	34.5%	42.3%	39.0%
70-79	263	488	1,014	2,410	3,490	5,900

	23.8%	23.8%	23.8%	10.9%	11.4%	11.2%
80+	144	367	655	3,620	2,720	6,340
	13.0%	17.9%	16.2%	16.4%	8.9%	12.0%
Total	1,107	2,052	3,159	22,140	30,720	52,860
	35.0%	65.0%	100.0%	41.9%	58.1%	100.0%

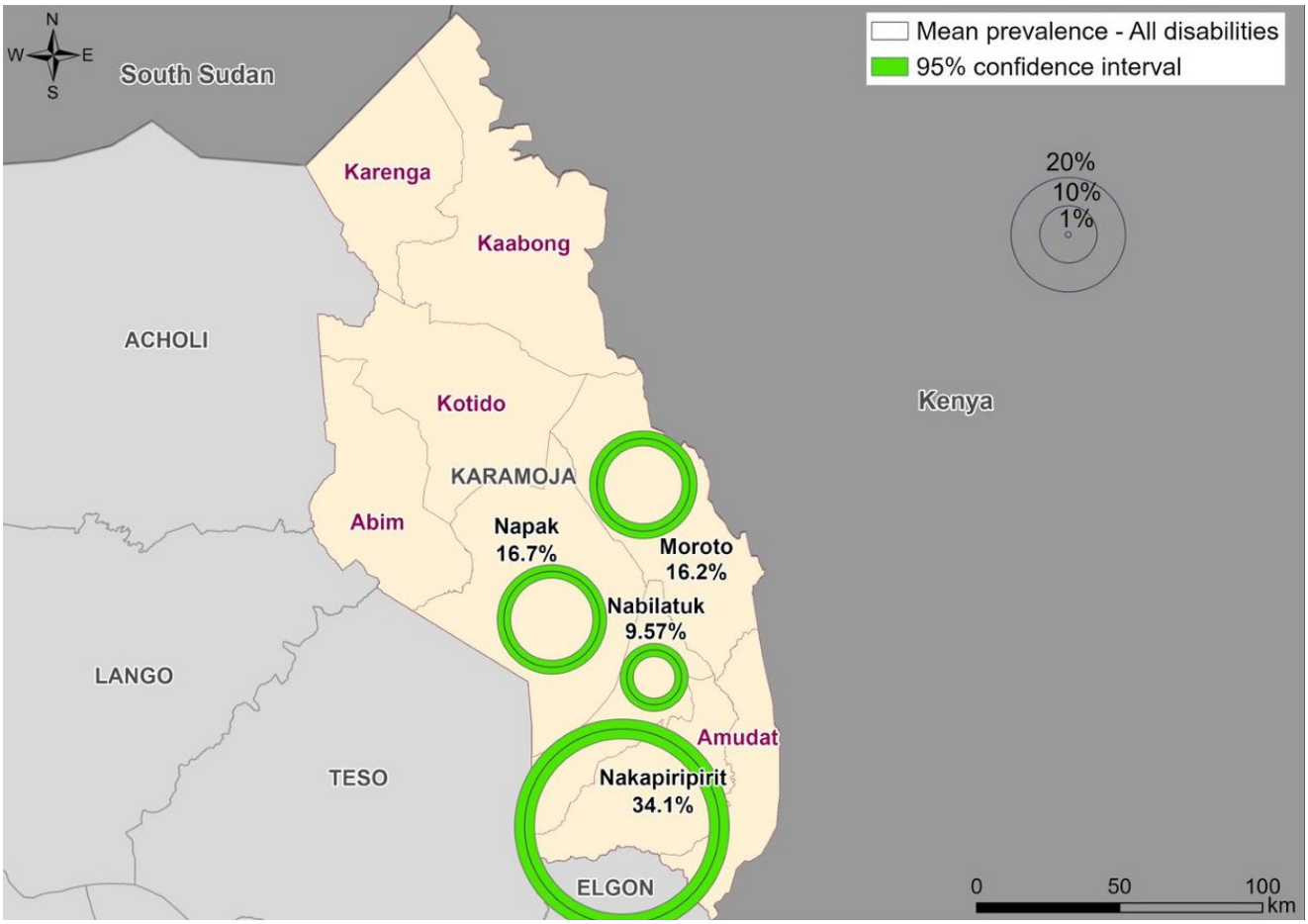
Among those examined, 21.7% were disabled, i.e., had a lot of functional difficulties or worse in one of the domains examined (Table 3). Prevalence was higher among females (23.8%) than males (17.9%). Excluding those people who only reported difficulties in the seeing domain, prevalence of disability in other domains was 19.2%, 14.5% among males and 21.7% among females.

Table 3: Disability among examined male and female participants

	Male	Female	Total
Disability: all domains	198	488	686
	17.9%	23.8%	21.7%
Disability: excluding seeing difficulties	160	445	605
	14.5%	21.7%	19.2%

Figure 2 shows the sample prevalence of disability (excluding seeing difficulties), in each district. The prevalence appears to vary widely, from 9.6% in Nabilatuk, to 34.1% in Nakapiripirit.

Figure 2: Map of sample prevalence of disability (excluding seeing difficulties), by district



Study participants consistently ranked themselves as among the poorest in their communities. When asked to place their household position compared to others in the community on a scale of 1-10, 2,507 (79.4%) put themselves on the bottom rung (rung 1), and a further 349 (11.1%) on rung 2. The average score appeared slightly higher among male participants (1.7) than females (1.3). Only 874 (27.7%) of participants said that their household had a regular source of income. The top source cited was the age-related social protection grant, 'SAGE', which 405 people received, of whom 370 (91.4%) had received in the preceding year. Selling or trading agricultural products (27.5%), and wages (11.7%) were also important sources of household income.

Table 4: Wealth among male and female participants

	Male	Female	Total
Average score on poverty ladder (IQR)	1.7 (1-2)	1.3 (1-1)	1.4 (1-1)
Household has a regular source of income?			

No	757 (68.4%)	1,528 (74.5%)	2,285 (72.3%)
Yes	350 (31.6%)	524 (25.5%)	874 (27.7%)
If yes, specify regular source of income: (n=787)			
SAGE	125 (40.5%)	280 (58.6%)	405 (58.6%)
…If yes, those who received SAGE in the past 12 months (n=405)	113 (90.4%)	257 (91.85)	370 (91.4%)
Selling or trading agricultural products	93 (30.1%)	123 (25.7%)	216 (27.5%)
Wages	61 (19.7%)	31 (6.5%)	92 (11.7%)
Selling or trading non-agricultural products	18 (5.8%)	29 (6.1%)	47 (6.0%)
Remittances from family	9 (2.9%)	10 (2.1%)	19 (2.4%)
Other	3 (1.0%)	5 (1.15)	8 (1.0%)

Prevalence of visual impairment

196 participants, 6.2% of the total examined, were bilaterally blind with available correction (Table 5). When a pinhole was used to understand how access to corrective devices might affect VA, 176 people, or 5.6% of people were bilaterally blind. SVI was observed in 125 people (4.0%), MVI in 321 people (10.2%) and EVI in 285 people (9.0%).

Among males and females examined in the sample, the prevalence of visual impairment is observed to be greater among females, particularly for blindness and severe VI, where the confidence intervals do not overlap.

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	37	139	176
	3.3% [2.4-4.6%]	6.8% [5.8-7.9%]	5.6% [4.8-6.4%]
All eyes	199	503	702

	9.0% [7.9-10.3%]	12.3% [11.3-13.3%]	11.% [10.4-11.9%]
Blind: presenting vision <3/60 in better eye			
Bilateral cases	46	15	196
	4.2% [2.9-5.5%]	7.3% [5.9-8.7%]	6.2% [5.1-7.3%]
All eyes	220	548	768
	9.9% [8.8-11.3%]	13.4% [12.3-14.4%]	1.2% [1.1-1.3%]
Severe visual impairment: better eye can see 3/60 but not 6/60			
Bilateral cases	39	86	125
	3.5% [2.5-4.5%]	4.2% [3.1-5.3%]	4.0% [3.1-4.8%]
All eyes	117	216	333
	5.3% [4.4-6.3%]	5.3% [4.6-6.0%]	5.3% [4.7-5.8%]
Moderate visual impairment: better eye can see 6/60 but not 6/18			
Bilateral cases	102	219	321
	9.2% [7.4-11.1%]	10.7% [8.9-12.4%]	10.2% [8.8-11.5%]
All eyes	233	465	698
	10.5% [9.3-11.9%]	11.3% [10.4-12.3%]	11.0% [10.3-11.8%]
Early visual impairment: better eye can see 6/18 but not 6/12			
Bilateral cases	109	176	285
	9.9% [7.9-11.8%]	8.6% [7.2-9.9%]	9.0% [7.9-10.1%]
All eyes	228	360	588
	10.3% [9.1-11.6%]	8.8% [7.9-9.7%]	9.3% [11.4-13.0%]

Adjusting for age and sex, the prevalence of blindness is estimated to be 4.9%, although based on the 95% confidence interval (CI), this could be as low as 4.0% or as high as 5.9% (Table 6). Extrapolating this to the population, it is estimated that there are 2,575 bilaterally blind people aged 50 years and above in the study area. In total, it is estimated that 10.1% of eyes of people aged 50 years and above are blind (that includes people who have one or both eyes blind), which translates to 10,647 blind eyes in people 50+ years in the study area.

Age- and sex-adjusted bilateral SVI affects approximately 1,618 people (3.1%), and 4,575 eyes in total. Age- and sex-adjusted MVI affects 4,255 people (8.0%), and 9,698 eyes. Age- and sex-adjusted EVI affects 4,144 people (7.8%), and 8,995 eyes.

After adjusting for age and sex, the differences between males and females appear much smaller, and are unlikely to be statistically significant as the confidence intervals presented at each level of visual impairment overlap.

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	773	1,535	2,308
	3.5% [2.5-4.8%]	5.0% [3.9-6.4%]	4.4% [3.5-5.4%]
All eyes	3,841	5,923	9,764
	8.7% [7.2-10.4%]	9.6% [8.3-11.1%]	9.2% [8.1-10.5%]
Blind: presenting vision <3/60 in better eye			
Bilateral cases	920	1,655	2,575
	4.2% [3.1-5.6%]	5.4% [4.2-6.8%]	4.9% [4.0-5.9%]
All eyes	4,223	6,424	10,647
	9.5% [8.0-11.3%]	10.5% [9.1-12.0%]	10.1% [9.0-11.3%]
Severe visual impairment: better eye can see 3/60 but not 6/60			
Bilateral cases	709	910	1,618
	3.2% [2.4-4.3%]	3.0% [2.2-3.9%]	3.1% [2.5-3.8%]
All eyes	2,233	2,343	4,575
	5.0% [4.1-6.2%]	3.8% [9.1-4.6%]	4.3% [3.7-5.1%]
Moderate visual impairment: better eye can see 6/60 but not 6/18			
Bilateral cases	2,009	2,245	4,255
	9.1% [7.4-11.1%]	7.3% [6.1-8.7%]	8.0% [7.0-9.3%]
All eyes	4,588	5,110	9,698
	10.4% [8.8-12.2%]	8.3% [7.3-9.5%]	9.2% [8.1-10.3%]
Early visual impairment: better eye can see 6/18 but not 6/12			
Bilateral cases	2,018	2,127	4,144
	9.1% [7.5-11.1%]	6.9% [5.8-8.3%]	7.8% [6.8-9.0%]
All eyes	4,357	4,637	8,995
	9.8% [8.3-11.6%]	7.5% [6.5-8.8%]	8.5% [7.5-9.6%]

Figure 3 shows a map of the mean sample prevalence of all-cause bilateral blindness by each district. Prevalence of blindness appears to vary significantly, with the lowest prevalence in the south, Nakapiripirit (2.8%), and Nabilatuk (5.6%), compared with Moroto (7.9%) and Napak (7.7%).

Figure 3: Map of mean prevalence of all-cause bilateral blindness among sample, by district

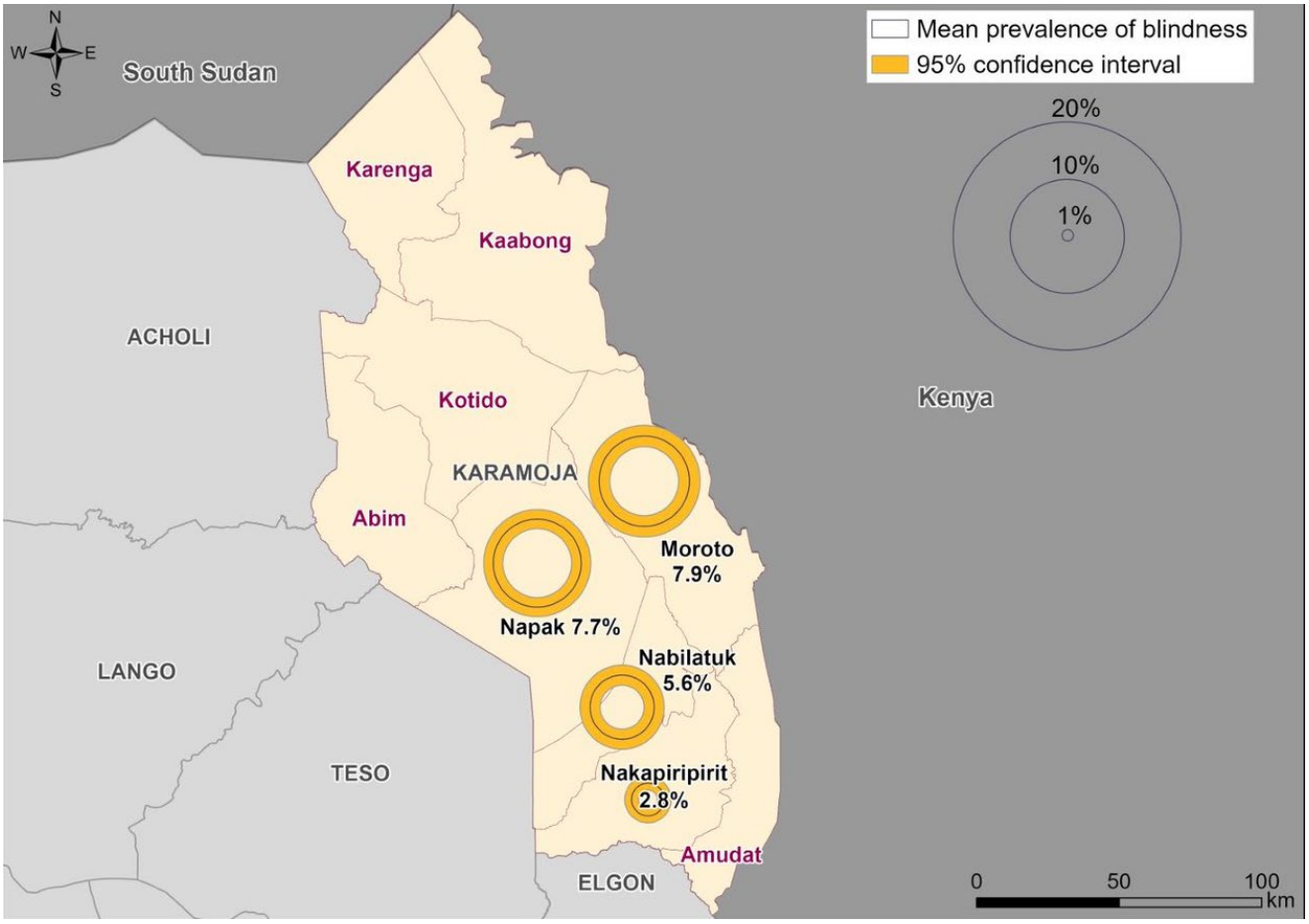
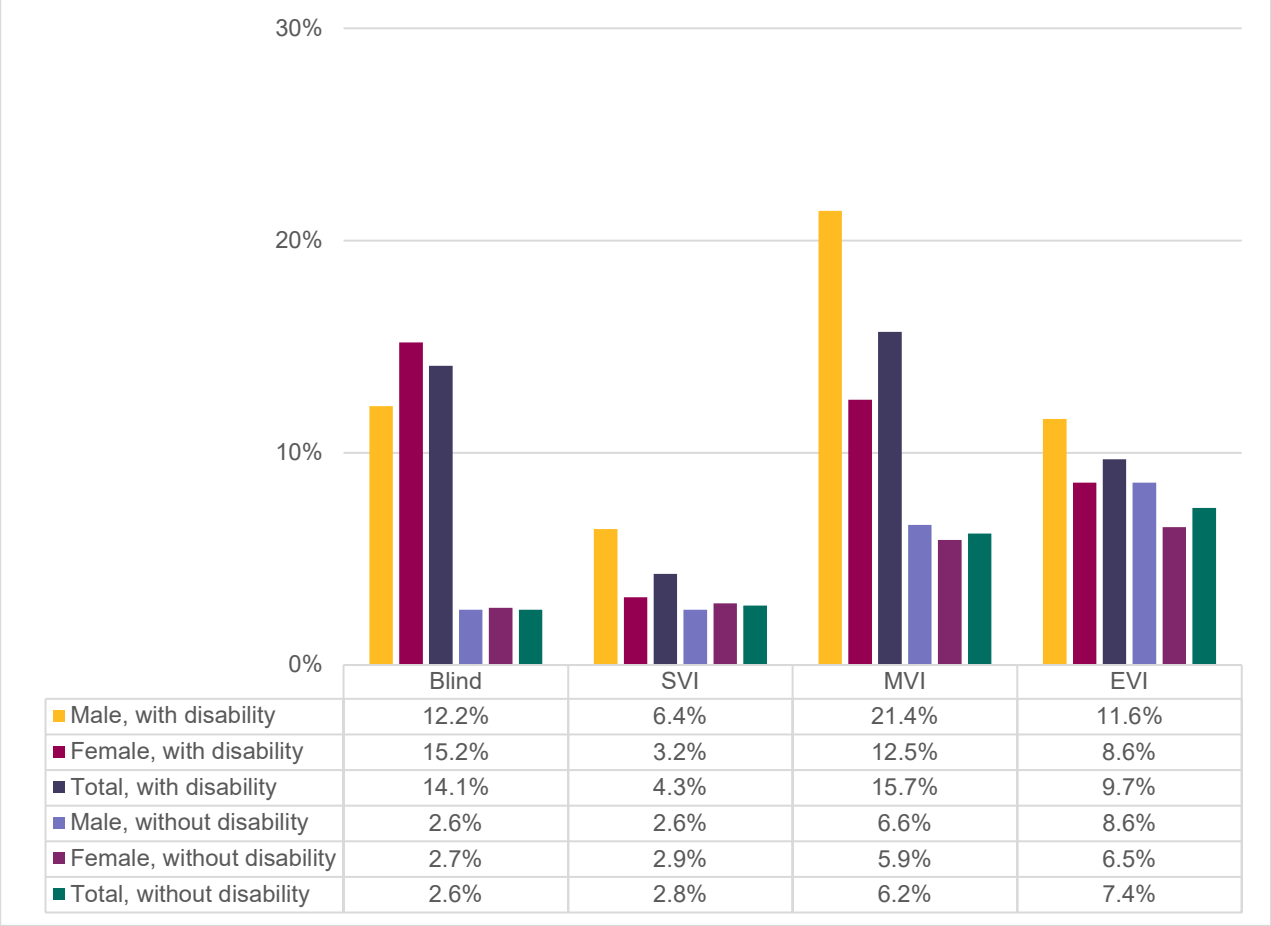


Figure 4 shows how the age- and sex-adjusted prevalence of visual impairment differs by disability and sex. Males and females with disabilities were more likely to have visual impairment than individuals without disabilities, and the differences were more striking for more severe degrees of visual impairment, particularly blindness. For example, 12.2% of men and 15.2% of women with any type of disability were blind, compared to 2.6% of men and 2.7% of women without disabilities.

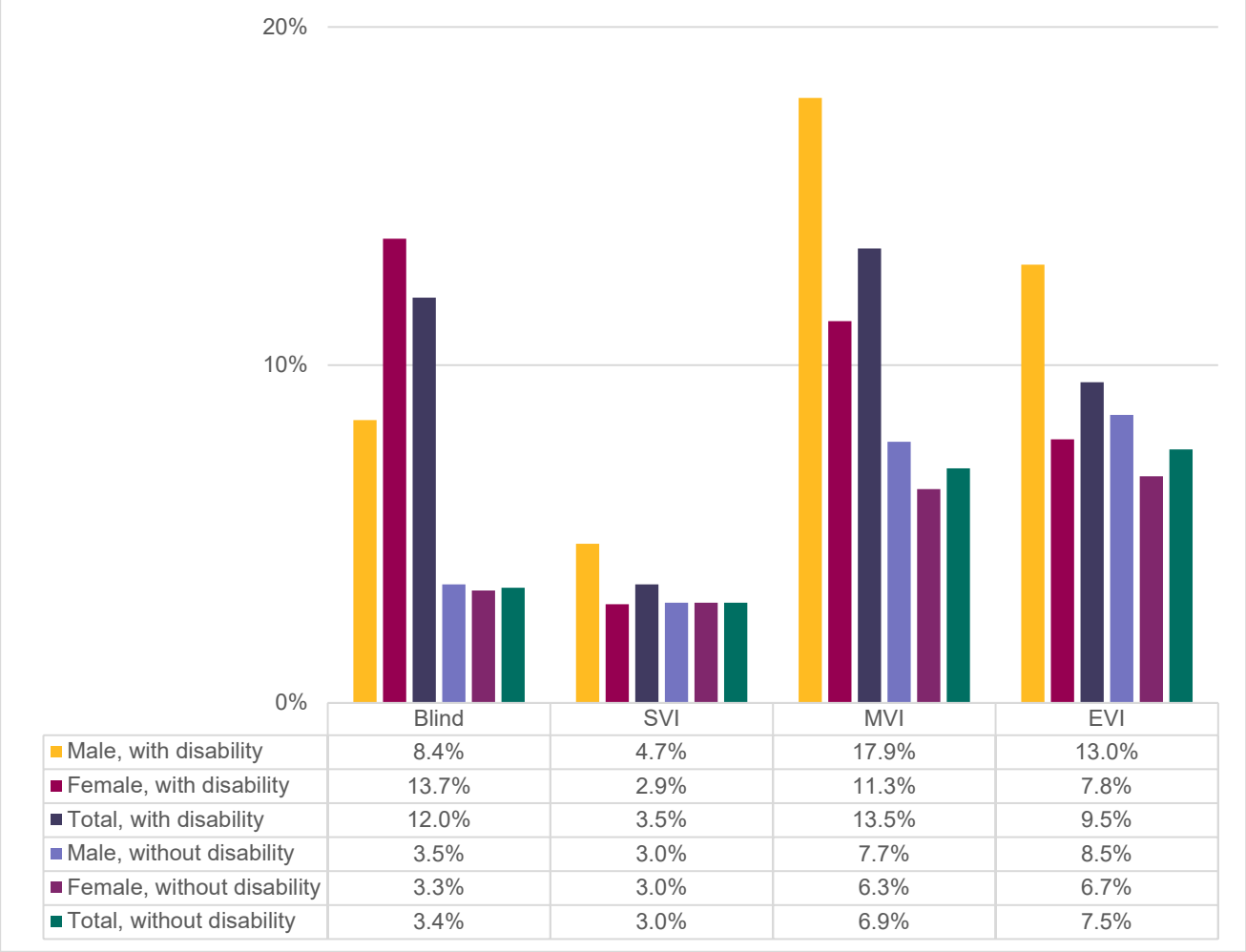
Figure 4: Age- and sex-adjusted prevalence of visual impairment, by disability, all domains



	Blind	SVI	MVI	EVI
Male, with disability	12.2%	6.4%	21.4%	11.6%
Female, with disability	15.2%	3.2%	12.5%	8.6%
Total, with disability	14.1%	4.3%	15.7%	9.7%
Male, without disability	2.6%	2.6%	6.6%	8.6%
Female, without disability	2.7%	2.9%	5.9%	6.5%
Total, without disability	2.6%	2.8%	6.2%	7.4%

Since visual impairment is very likely to be strongly correlated with difficulties in the seeing domain, it is important to explore how visual impairment relates to the other disability domains measured. Figure 5 shows how the age- and sex-adjusted prevalence of visual impairment differs by disability, excluding the seeing domain. Even when excluding the seeing domain from the measure of disability, the relationship between disability (non-visual functional difficulties) and visual impairment is strong, with 8.4% of men and 13.7% of women with non-visual disabilities being blind, compared with 3.5% of men and 3.3% of women without disabilities.

Figure 5: Age- and sex-adjusted prevalence of visual impairment, by disability, excluding seeing domain



	Blind	SVI	MVI	EVI
Male, with disability	8.4%	4.7%	17.9%	13.0%
Female, with disability	13.7%	2.9%	11.3%	7.8%
Total, with disability	12.0%	3.5%	13.5%	9.5%
Male, without disability	3.5%	3.0%	7.7%	8.5%
Female, without disability	3.3%	3.0%	6.3%	6.7%
Total, without disability	3.4%	3.0%	6.9%	7.5%

Figure 6 shows how adjusted visual impairment is related to relative wealth. Although most participants ranked their household wealth as extremely low – the majority scoring it as 1 on the ladder – there is a slight observable relationship between an individual's presenting vision, and how they position themselves on the wealth ladder. Male participants with lower levels of visual acuity have lower mean position on the ladder than those with higher levels of visual acuity. For example, among male participants, the mean position among blind participants was 1.08, compared with 1.71 among those with normal vision. The relationship is similar among females, and overall, however, the participants with 'normal vision' have a lower mean score than EVI, indicating that women with normal vision may consider themselves poorer than those with EVI or MVI, although not those who are SVI or blind.

Figure 6: Age- and sex-adjusted prevalence of visual impairment, by wealth

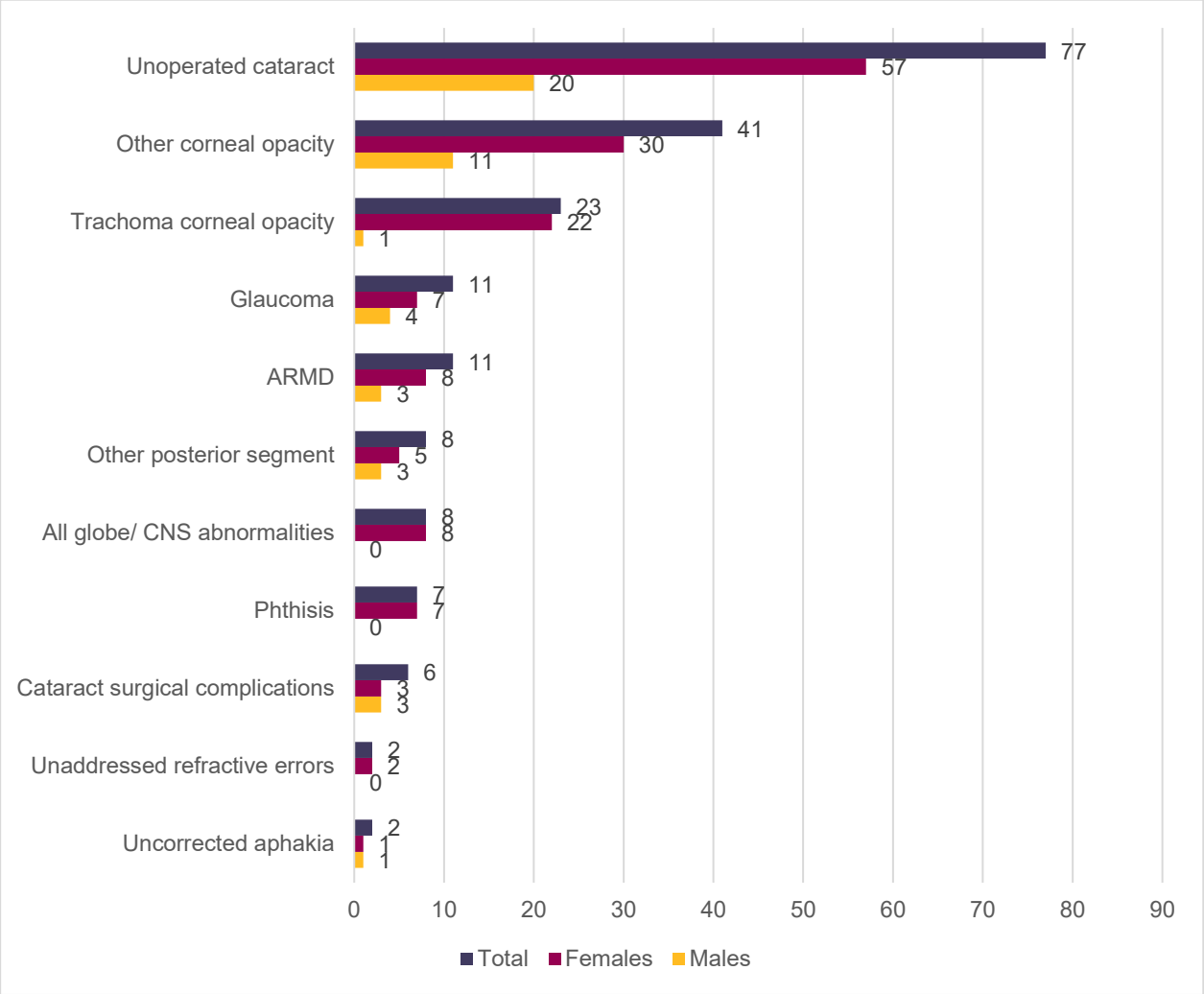
	Blind	SVI	MVI	EVI	Normal vision
Mean wealth: all	1.12	1.16	1.44	1.60	1.47
Mean wealth: males	1.08	1.24	1.50	1.62	1.71
Mean wealth: females	1.15	1.10	1.41	1.59	1.30

Causes of visual impairment

The most common principal cause of blindness among bilaterally blind individuals was unoperated cataract (77; 39.3%), followed by 'other' (i.e., non-trachoma) corneal opacity (41; 20.9%); and trachomatous corneal opacity (23; 11.7%) (Figure 7). Other causes responsible for smaller proportions of the overall burden included glaucoma (11; 5.6%), ARMD (11 (5.6%), 'other' posterior segment diseases (8; 4.1%), globe or CNS abnormalities (8; 4.1%), phthisis (7; 3.6%), cataract surgical complications (6; 3.1%), unaddressed refractive error (2; 1.0%), and uncorrected aphakia (1; 1.0%).

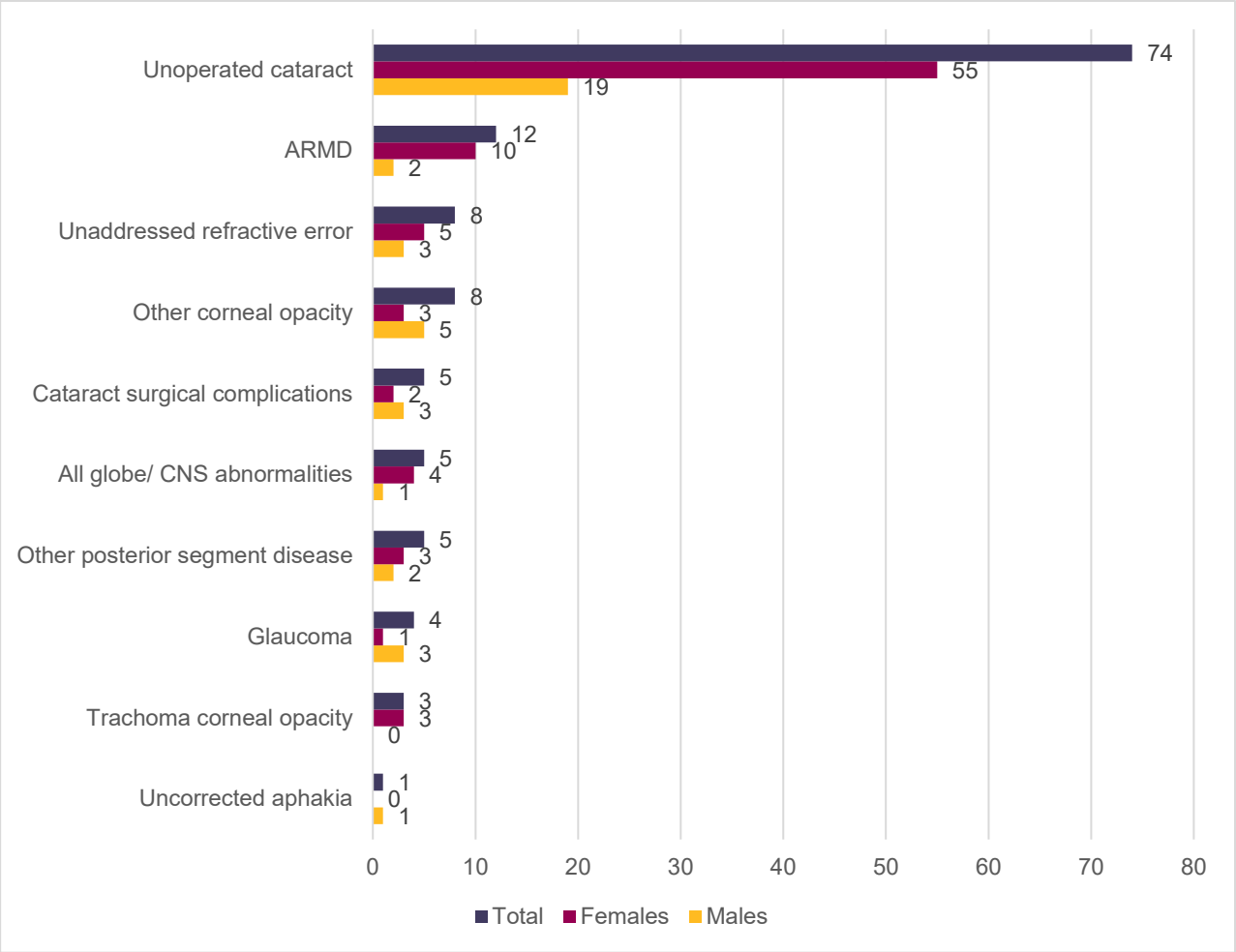
It is important to remember that the RAAB methodology allows only one cause – the most easily treatable – to be allocated per person. Comparisons between groups (such as males and females) must be made cautiously, as the findings do not show the complete distribution of causes of visual impairment in the studied population, particularly where a significant proportion of the population have untreated cataract or unaddressed refractive error, as these causes will most likely be listed as the principal causes of visual impairment, irrespective of co-morbidities. The RAAB ocular examination is also not comprehensive enough for a certain glaucoma diagnosis, and thus these cases are only suspected and require full clinical examination.

Figure 7: Principal causes of blindness among examined males and females



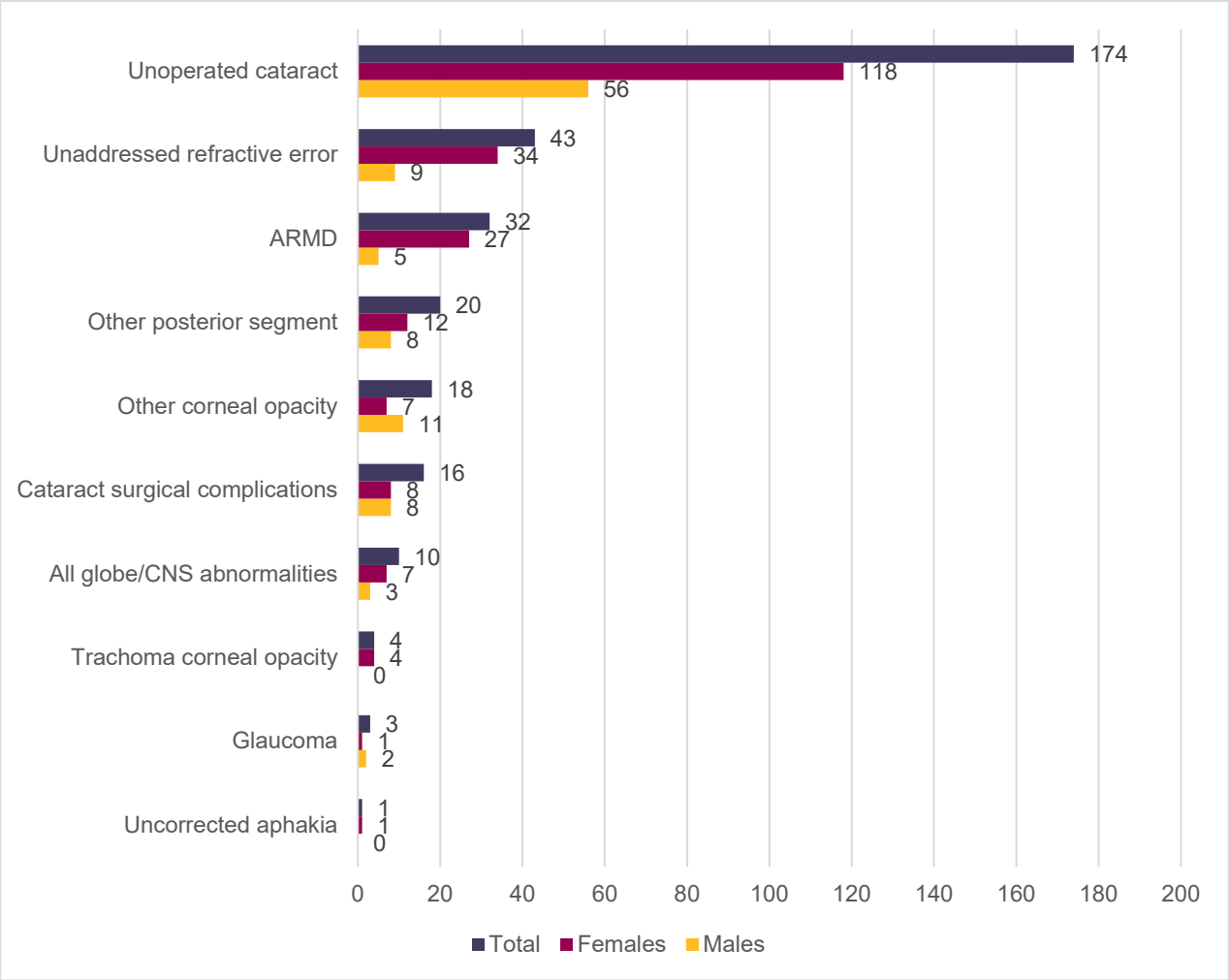
Unoperated cataract was also the most common principal cause of bilateral SVI (74; 59.2%), followed by ARMD (12; 9.6%) (Figure 8). All other causes were each responsible for a relatively small proportion of SVI, and included unaddressed refractive error (8; 6.4%), 'other' corneal opacity (8; 6.4%), cataract surgical complications (5; 4.0%), globe or CNS abnormalities (5; 4.0%), 'other' posterior segment diseases (5; 4.0%), glaucoma (4; 3.2%), trachoma corneal opacities (3; 2.4%), and uncorrected aphakia (1; 0.8%).

Figure 8: Principal causes of severe visual impairment among examined males and females



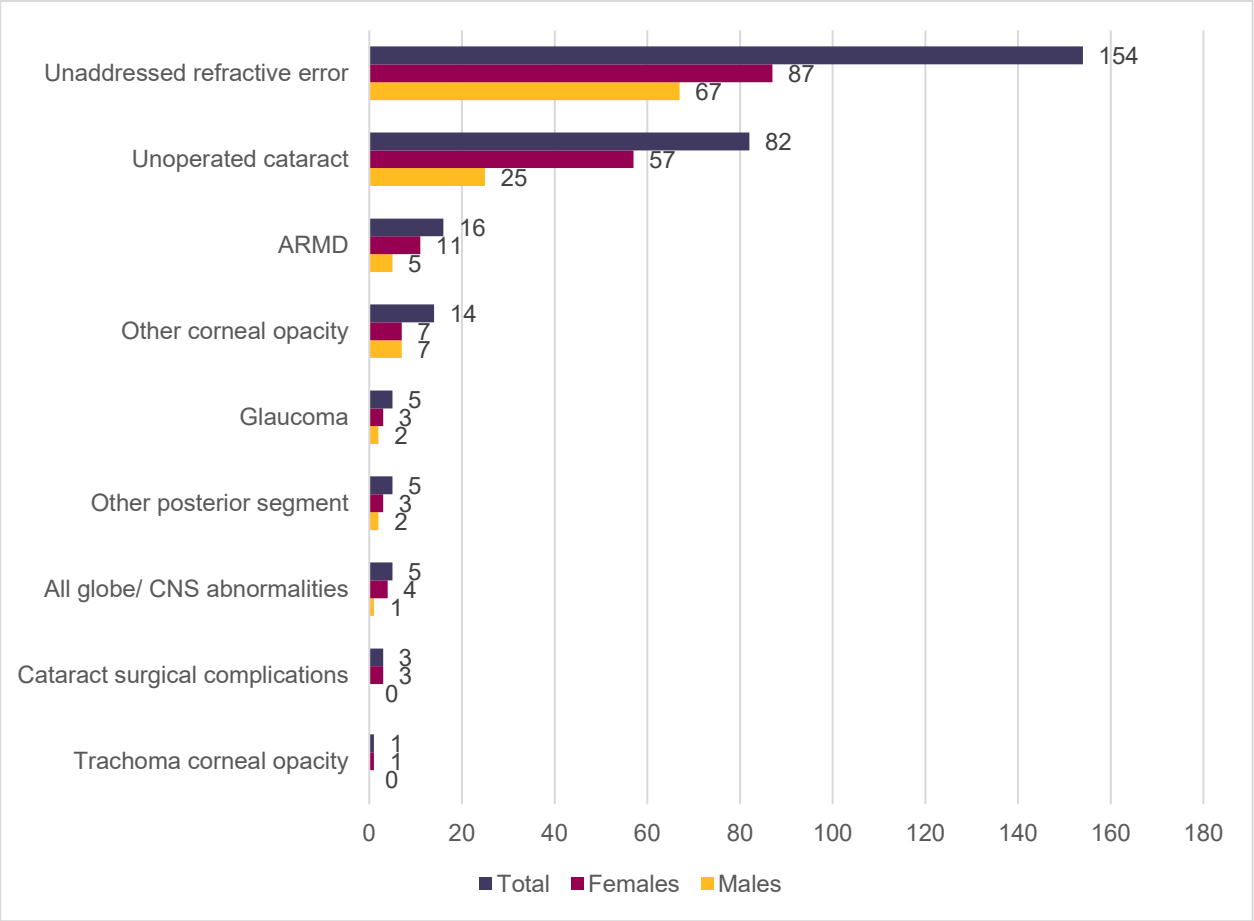
Unoperated cataract was the main principal cause of bilateral MVI (174; 54.2%), followed by unaddressed refractive error (43; 13.4%), and ARMD (32; 10.0%) (Figure 9). Other causes responsible for MVI included 'other' posterior segment diseases (20; 6.2%), 'other' corneal opacity (18; 5.6%), cataract surgical complications (16; 5.0%), globe or CNS abnormalities (10; 3.1%), trachoma corneal opacities (4; 1.3%), glaucoma (3; 0.9%), and uncorrected aphakia (1; 0.3%).

Figure 9: Principal causes of moderate visual impairment among examined males and females



Unaddressed refractive error was the main principal cause of bilateral EVI (154; 54.0%) (Figure 10), followed by unoperated cataract (82; 28.8%). Other, less significant, principal causes included ARMD (16, 5.6%), other corneal opacities (14, 4.9%), glaucoma (5, 1.8%), 'other' posterior segment diseases (5; 1.8%), globe or CNS abnormalities (5; 1.8%), cataract surgical complications (3; 1.1%), and trachoma corneal opacity (1 (0.4%).

Figure 10: Principal causes of early visual impairment among examined males and females



Cataract: prevalence, coverage of services and visual outcomes

Table 7 shows that around 1.0% (95% CI 0.5-1.5%) of people aged 50+ years in the study area are bilaterally blind due to cataract, and another 3.8% (95% CI 3.3-4.4%) are unilaterally visually impaired due to the disease. This translated to 3,104 blind eyes with cataract in the study area. A further 1.2% of people aged over 50 years are severely visually impaired with a cataract, 3.1% are moderately visually impaired with a cataract, and 1.2% have early visual impairment with a cataract.

Although there appears to be a slight, non-statistically significant, difference between men and women who are blind with a cataract (0.7% compared with 1.2%), there doesn't appear to be any significant gender differences at lower levels of visual impairment.

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	157	381	538
	0.7% (0.3-1.2%)	1.2% (0.6-1.9%)	1.0% (0.5-1.5%)
Unilateral cataract	831	1,201	2,032
	3.8% (2.9-4.6%)	3.9% (3.2-4.6%)	3.8% (3.3-4.4%)
Cataract eyes	1,143	1,961	3,104
	2.6% (1.8 - 3.3%)	3.2% (2.4 - 4.0%)	2.9% (2.3 - 3.6%)
Severe visual impairment: better eye can see 3/60 but not 6/60			
Bilateral cataract	305	347	652
	1.4% (0.6-2.1%)	1.1% (0.6-1.7%)	1.2% (0.8-1.7%)
Unilateral cataract	295	329	624
	1.3% (0.7-1.9%)	1.1% (0.6-1.5%)	1.2% (0.8-1.6%)
Cataract eyes	904	1,023	1,927
	2.0% (1.3-2.8%)	1.7% (1.0-2.3%)	1.8% (1.3-2.4%)
Moderate visual impairment: better eye can see 6/60 but not 6/18			
Bilateral cataract	758	871	1,629
	3.4% (2.4-4.5%)	2.8% (1.7-4.0%)	3.1% (2.2-3.9%)
Unilateral cataract	452	776	1,228
	2.0% (1.1-3.0%)	2.5% (1.7-3.3%)	2.3% (1.7-2.9%)
Cataract eyes	1,968	2,518	4,486
	4.4% (3.2-5.7%)	4.1% (2.9-5.3%)	4.2% (3.3-5.2%)
Early visual impairment: better eye can see 6/18 but not 6/12			
Bilateral cataract	536	781	1,317
	1.2% (0.1-2.3%)	1.3% (0.0-2.6%)	1.2 (0.2-2.3%)
Unilateral cataract	78	70	147
	0.2% (0.0-1.0%)	0.1% (0.0-0.8%)	0.1% (0.0-0.8%)
Cataract eyes	1,149	1,624	2,783
	2.6% (1.6-3.6%)	2.7% (1.5-3.8%)	2.6% (1.7-3.6%)

Cataract surgical coverage (CSC) was estimated at 34.5% for persons at VA <6/12, the reporting threshold recommended by the WHO (Table 8). Looking at the 3/60 level, it was

much higher at 71.6%. CSC was much higher among men compared to women at all levels, 83.8% compared to 56.0% at VA <3/60, and 42.8% compared to 27.0% at VA <6/12.

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

	Males	Females	Total
VA <3/60	83.8	58.0	71.6
VA <6/60	66.7	45.7	56.6
VA <6/18	49.0	34.1	41.5
VA <6/12	42.8	27.0	34.5

Figure 11 shows the estimated distribution of individuals with operated and unoperated cataracts, extrapolated to the actual population size, by health district. The orange section shows the estimated number of individuals with operated cataracts in the district. The hatched section overlying the orange shows the proportion of those individuals with operated cataracts which have good visual outcomes, that is, 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 highest estimated total number of individuals with operated and unoperated cataracts appear to be in Napak, and the smallest appears to be in Nabilatuk. The greatest proportion of unoperated cataracts appear to be in Napak and Moroto. The smallest proportion of operated eyes with good outcomes appear to be in Moroto and Nabilatuk.

Figure 11: Map of cataract and effective cataract surgical coverage among persons, by district

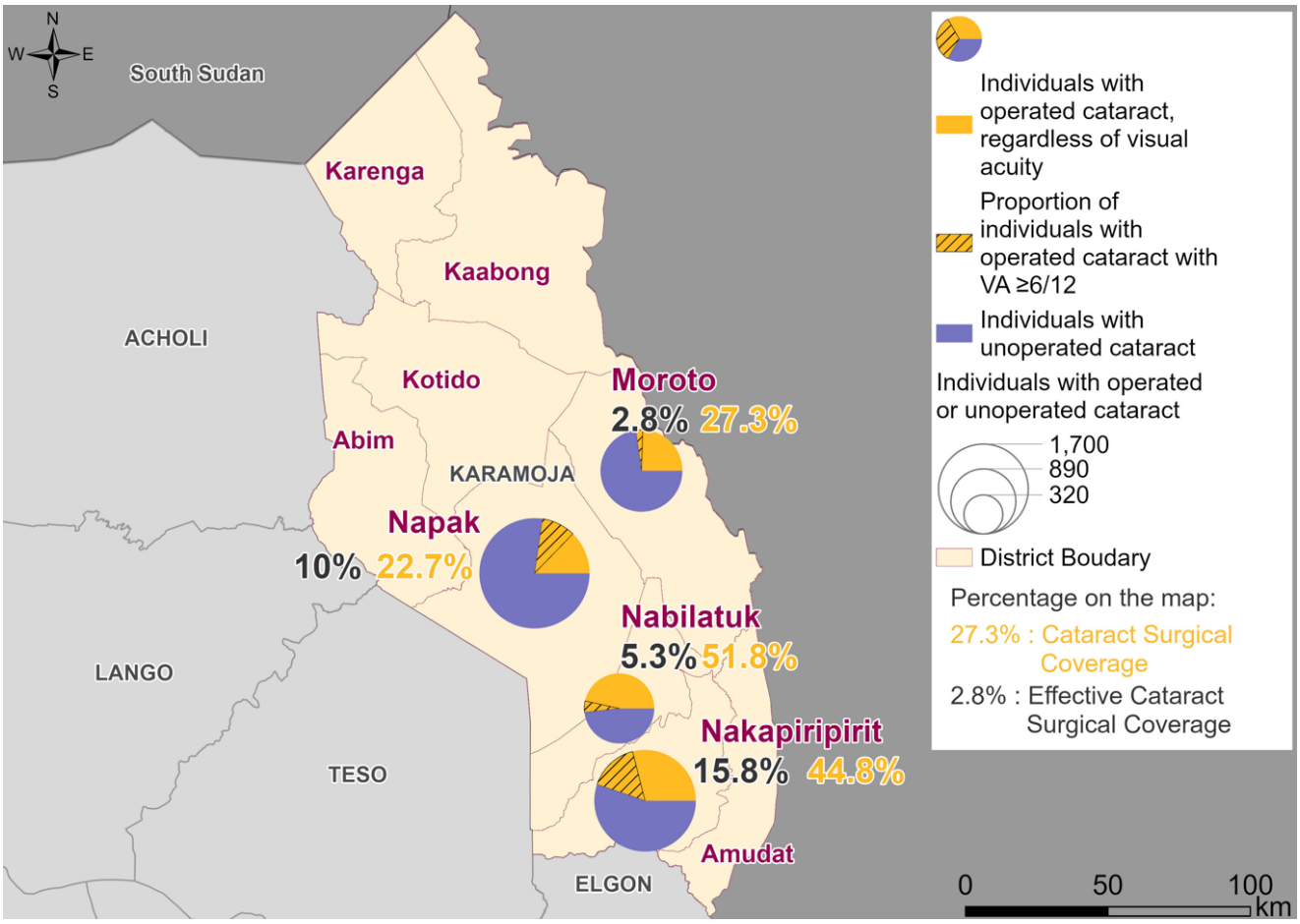


Table 9 shows the presenting vision of eyes operated for cataract. Most eyes have outcomes recently defined by the WHO as borderline (can see 6/60, but not 6/12) (43.4%), followed by those that cannot see 6/60 (34.8%), and the those that can see 6/12 or better (21.8%). The major reasons for borderline and poor outcomes are selection, that is, co-morbidities in operated eyes (35.6%), and surgical complications (34.0%). A further 23.1% are due to refractive errors, and 7.3% due to long-term complications developed since surgery. Two-thirds of eyes in the study were operated in the past four years, and 18.6% in the three years prior to that.

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	**71 (21.8%)**	**141 (43.4%)**	**113 (34.8%)**	**325 (100.0%)**
By sex				

Males	31 (22.8%)	50 (36.8%)	55 (40.4%)	136 (41.8%)
Females	40 (21.2%)	91 (48.1%)	58 (30.7%)	189 (58.2%)
By type of surgery				
IOL	71 (22.9%)	135 (43.5%)	104 (33.5%)	310 (97.5%)
Non-IOL	-	3 (37.5%)	5 (62.5%)	8 (2.5%)
By years since surgery				
<4 years	49 (23.1%)	95 (44.8%)	68 (32.1%)	212 (66.7%)
5-7 years	14 (23.7%)	22 (37.3%)	23 (39.0%)	59 (18.6%)
8+ years	8 (17.0%)	21 (44.7%)	18 (38.3%)	47 (14.8%)
By place of surgery				
Government hospital	64 (22.5%)	120 (42.1%)	101 (35.4%)	285 (89.6%)
Charity hospital	1 (11.1%)	7 (77.8%)	1 (11.1%)	9 (2.8%)
Private hospital	6 (25.0%)	11 (45.8%)	7 (29.2%)	24 (7.5%)
Causes of borderline and poor post-op VA				
Co-morbidity	-	35 (39.8%)	53 (60.2%)	88 (35.6%)
Surgical complications	-	39 (45.2%)	45 (54.8%)	84 (34.0%)
Refractive error	-	56 (98.2%)	1 (1.8%)	57 (23.1%)
Long-term complications	-	8 (44.4%)	10 (55.6%)	18 (7.3%)

Effective cataract surgical coverage, the proportion of people requiring cataract surgery who have had it and who have achieved a good visual outcome (i.e., VA ≥6/12), was 9.8% at VA< 6/12, the level recommended for reporting by the WHO (Table 10). It was higher among males (13.2%) than females (3.8%).

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

	Males	Females	Total
VA <3/60	30.2	16.3	23.6

VA <6/60	22.6	12.4	17.6
VA <6/18	16.2	9.2	12.7
VA <6/12	13.2	3.8	9.8

The most common reason given by study participants with bilateral cataract and BCVA<6/60 was being unaware that treatment is possible (38.4%), followed by not feeling a need for treatment (32.7%), and not having access to treatment (16.4%) (Table 11). Men and women appeared to provide the same reasons for not accessing surgery.

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
Unaware that treatment is possible	17 (39.5%)	44 (37.9%)	61 (38.4%)
Need not felt	14 (32.6%)	38 (32.8%)	52 (32.7%)
No access to treatment	9 (20.9%)	17 (14.7%)	26 (16.4%)
Cannot afford operation	1 (2.3%)	7 (6.0%)	8 (5.0%)
Fear for surgery or poor result	1 (2.3%)	5 (4.3%)	6 (3.8%)
Fear of eye removal	1 (2.3%)	2 (1.7%)	3 (1.9%)
Treatment denied by provider	0 -	2 (1.7%)	2 (1.3%)
Cultural beliefs	0 -	1 (0.9%)	1 (0.6%)
Total	**43 (100.0%)**	**116 (100.0%)**	**159 (100.0%)**

Refractive error

Table 12 shows the sample prevalence of presenting visual acuity due to refractive error among participants. In the RAAB, refractive error as a cause of visual impairment is defined as the better eyes having VA<6/12 but improving to 6/2 with pinhole. Blindness due to refractive error is extremely rare, but not impossible, and in Karamoja, three people (0.09%), all women, were identified in the sample as being blind due to refractive error. Refractive error was the cause of SVI among 19 participants (0.6%), the cause of MVI among 91 participants (2.9%), and the cause of EVI among 306 participants (9.7%). A difference between males and females only appeared at the EVI level, where males appeared significantly more likely than females to experience EVI (12.3% compared with 8.3%).

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

	Males	Females	Total
Blind	0	3	3
	-	0.1% [0.1-0.5%]	0.1% [0.0-0.3%]
Severe visual impairment	5	14	19
	0.5% [0.2-1.1%]	0.7% [0.4-1.1%]	0.6% [0.4-0.9%]
Moderate visual impairment	31	60	91
	2.8% [2.0-4.0%]	2.9% [2.3-3.7%]	2.9% [2.4-3.5%]
Early visual impairment	136	170	306
	12.3% [10.5-14.4%]	8.3% [7.2-9.6%]	9.7% [8.7-10.8%]

Extrapolating to the population, Table 13 shows the expected numbers of people in the study area with refractive error as a cause of visual impairment. In total, it may be that there are 35 people blind with refractive error, 227 with SVI, 1,368 with MVI, and 4,893 with EVI, in the area.

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	0	35	35
	-	0.1% [0.0-0.4%]	0.1% [0.0-0.2%]
Severe visual impairment	98	129	227
	0.4% [0.2-1.1%]	0.4% [0.2-0.8%]	0.4% [0.3-0.7%]
Moderate visual impairment	638	730	1,368
	2.9% [2.0-4.2%]	2.4% [1.8-3.2%]	2.6% [2.0-3.3%]
Early visual impairment	2,645	2,249	4,893
	11.9% [9.9-14.3%]	7.3% [5.9-9.0%]	9.3% [7.9-10.8%]

Table 14 shows spectacle use among study participants. Spectacle use is extremely low in the study area, with only eight individuals (0.2%) having distance specs, and five (0.2%) having near vision specs.

Table 14: Distance and near vision spectacle use among males and females

	Males		Females		Total	
	n	%	n	%	n	%
Distance vision specs	3	0.3%	5	0.2%	8	0.2%
Near vision specs	3	0.3%	2	0.1%	5	0.2%

Trachoma

Table 15 shows the number of participants observed to have signs of trichiasis, 102 (3.2%) in total, although more females (84; 4.1%), than males (18; 1.6%). Among those with signs, 60 (58.8%) had been operated and a further six (5.9%) had been offered management, although had either declined or not yet taken it up.

Table 15: Trichiasis status among males and females

	Males		Females		Total	
	n	%	n	%	n	%
Trichiasis present in at least one eye	18	1.6%	84	4.1%	102	3.2%
Operated for trichiasis (n=102)	10	55.6%	50	59.2%	60	58.8%
Not operated but offered management for trichiasis	2	11.1%	4	4.8%	6	5.9%

Changes in eye health between 2011 and 2021

The RAAB undertaken in Karamoja in 2015 was conducted in four districts: Moroto (same as 2023), and Kotido, Kaabong and Abim. The study aimed to enrol 3,850 people and achieved an enrolment rate of 96.8% (3,727 people). Compared with the 2014 census data, men and

younger people were underrepresented in the study sample – similar to the 2023 RAAB (29). It is important therefore to compare the age- and sex-standardised results of the two studies to ensure differences due to sampling are accounted for. The 2015 RAAB did not collect data on early visual impairment, nor data on disability or wealth status.

The population data used to standardise results in 2015 was a poor estimation, as the 2014 census data was unavailable at the time of analysis (34, 35). Therefore, the 2015 data has now been reanalysed using data based on the 2014 census, which is considered a much more accurate representation of the Karamojong population, than that used at the time. Therefore, the 2015 adjusted results here differ from what was originally reported in 2015 but are considered the most accurate estimates of the situation at the time.

Change in prevalence of visual impairment

The sample prevalence of blindness was 5.9% although as described above, it is important to use the age- and sex-adjusted prevalence to account for sampling bias. Table 16 shows the age- and sex-adjusted prevalence of visual impairment in Karamoja in 2015 and the estimated numbers of people affected. Figure 12 shows the change in age- and sex-adjusted prevalence between 2015 and 2023. The estimated prevalence of age- and sex-adjusted bilateral blindness has decreased slightly, from 6.0% in 2015 to 4.9% in 2023. The prevalence of SVI has remained similar: 2.6% in 2015 and 3.1% in 2023. The prevalence of MVI has also decreased from 9.5% in 2015 to 8.0% in 2023. All the confidence intervals around the estimates overlap, indicating the differences are not significant. The differences between male and female specific estimates, and for eyes, follow a similar trend.

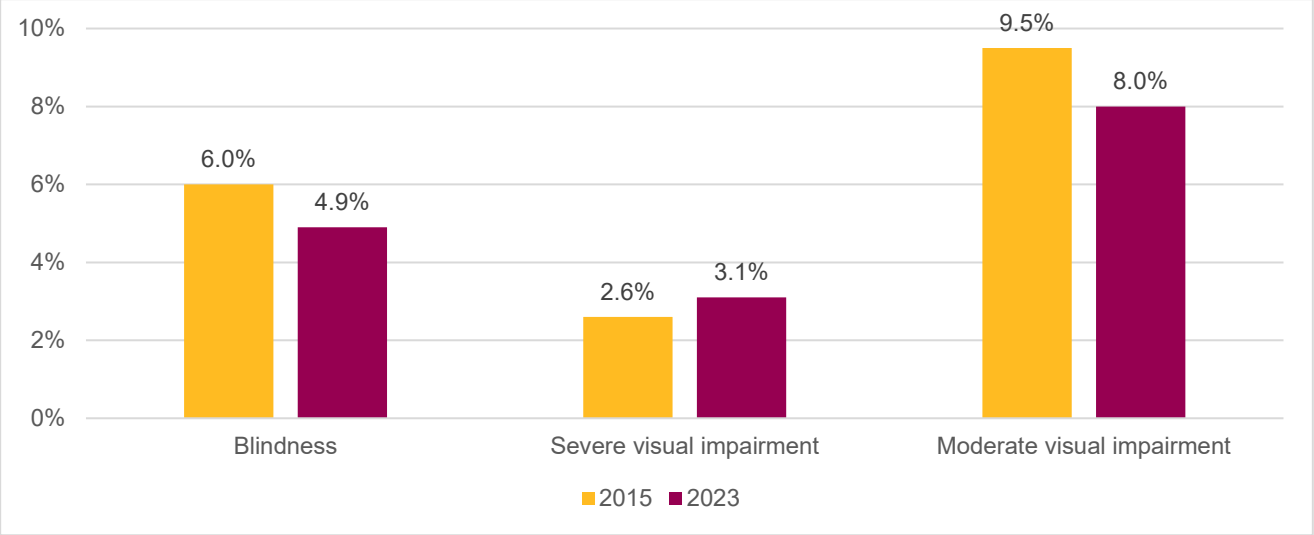
Despite the decrease in the prevalence of blindness, the number of people aged over 50 estimated to be bilaterally blind remains relatively stable: 2,281 in 2015 and 2,575 in 2023. This reflects the increasing number of people aged over 50 years in the Karamoja region, and Uganda generally.

Table 16: Estimated burden of visual impairment among males and females in Karamoja, adjusted for age and sex in 2015

	Male	Female	Total
Blind: presenting vision <3/60 in better eye			
Bilateral cases	829	1,452	2,281
	5.0% (3.8-6.4%)	6.9% (5.8-8.1%)	6.0% (5.2-6.9%)
All eyes	3,505	5,392	8,897

	10.5% (9.1-12.0%)	12.8% (11.5-14.15)	11.8% (10.8-12.7%)
Severe visual impairment: better eye can see 3/60 but not 6/60			
Bilateral cases	393	577	970
	2.4% (1.6-3.4%)	2.7% (2.0-3.8%)	2.6% (2.0-3.3%)
All eyes	1,088	1,551	2,640
	3.3% (2.6-4.0%)	3.7% (2.9-4.7%)	3.5% (2.9-4.2%)
Moderate visual impairment: better eye can see 6/60 but not 6/18			
Bilateral cases	1,487	2,111	3,598
	8.9% (7.1-11.1%)	10.0% (8.6-11.6%)	9.5% (8.3-10.9%)
All eyes	3,538	4,599	8,137
	10.6% (8.9-12.5%)	10.9% (9.7-12.2%)	10.8% (9.6-12.0%)

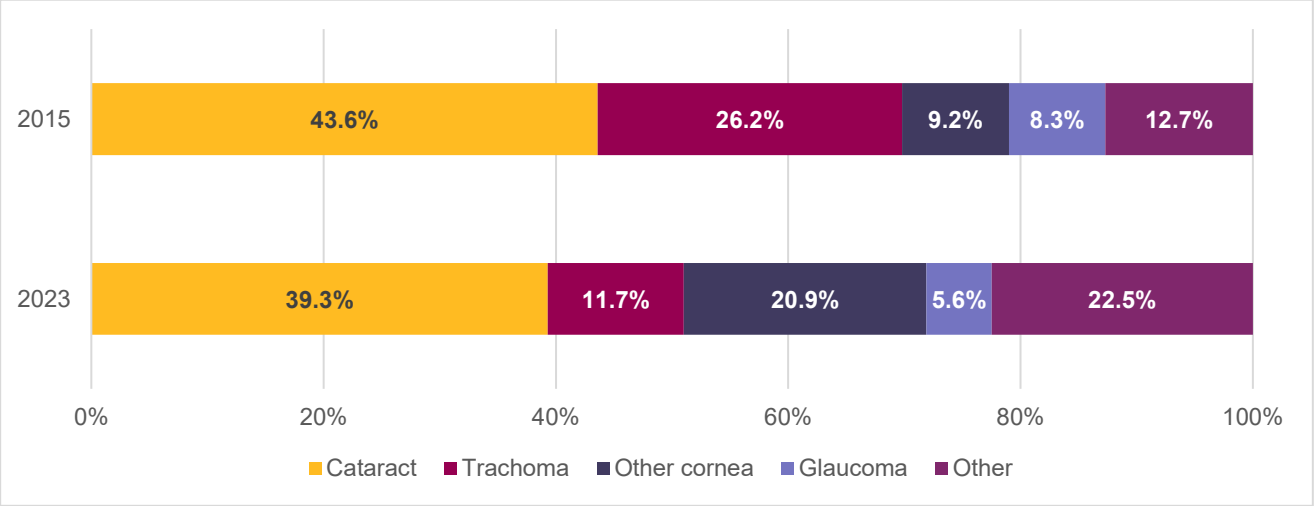
Figure 12: Prevalence of age- and sex-adjusted visual impairment in 2015 and 2023



Change in causes of visual impairment

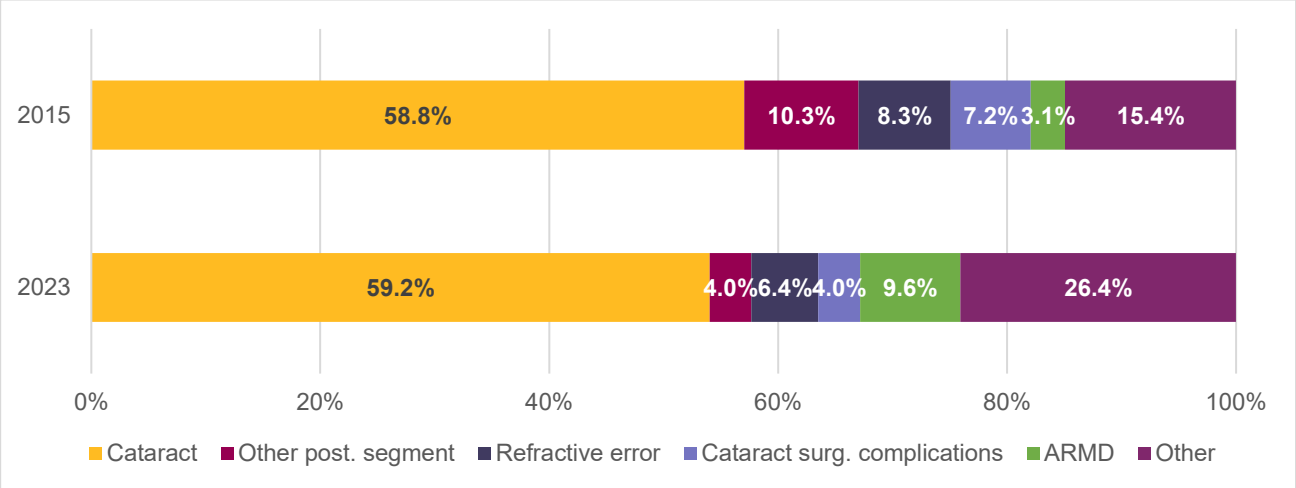
Figure 13 shows that cataract is the most common principal cause of blindness in both 2015 (43.6%) and 2023 (39.3%), and corneal opacities the second and third most common causes. Trachoma related corneal opacities were more common in 2015 (26.2% compared with 11.7% in 2023), and 'other' corneal opacities more common in 2023 (20.9% compared with 9.2% in 2015).

Figure 13: Principal causes of blindness in 2015 and 2023



The proportion of SVI due to unoperated cataract is almost exactly the same in 2023 (59.25) as it was in 2015 (58.8%) (Figure 14). Posterior segment diseases were important causes in both years: ARMD in 2023 (9.6%) and 'other' posterior segment diseases in 2015 (10.3%).

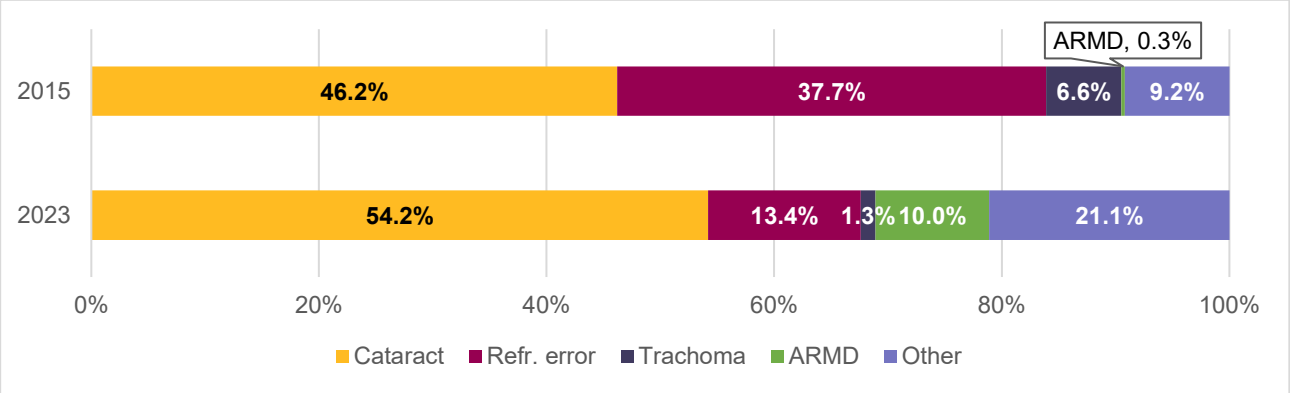
Figure 14: Principal causes of severe visual impairment in 2015 and 2023



The main cause of MVI was unoperated cataract in 2015 (46.2%) and 2023 (54.2%) (Figure 15). Unaddressed refractive error was a major secondary cause in 2015 (37.7%), and a less important cause of MVI in 2023 (13.4%). The reduction of unaddressed refractive error in importance in the MVI category in 2023 may be partly due to the introduction of the new, EVI category that measures visual acuity to 6/12, which wasn't assessed in 2015, and into which many individuals with unaddressed refractive error may fall. If we were to combine the EVI and MVI categories in 2023, the proportions would be more similar to those in 2015, but still

with a greater proportion attributable to cataract: cataract, 42.2%; unaddressed refractive error, 32.5%; ARMD 7.9%; and all other causes, 17.4%.

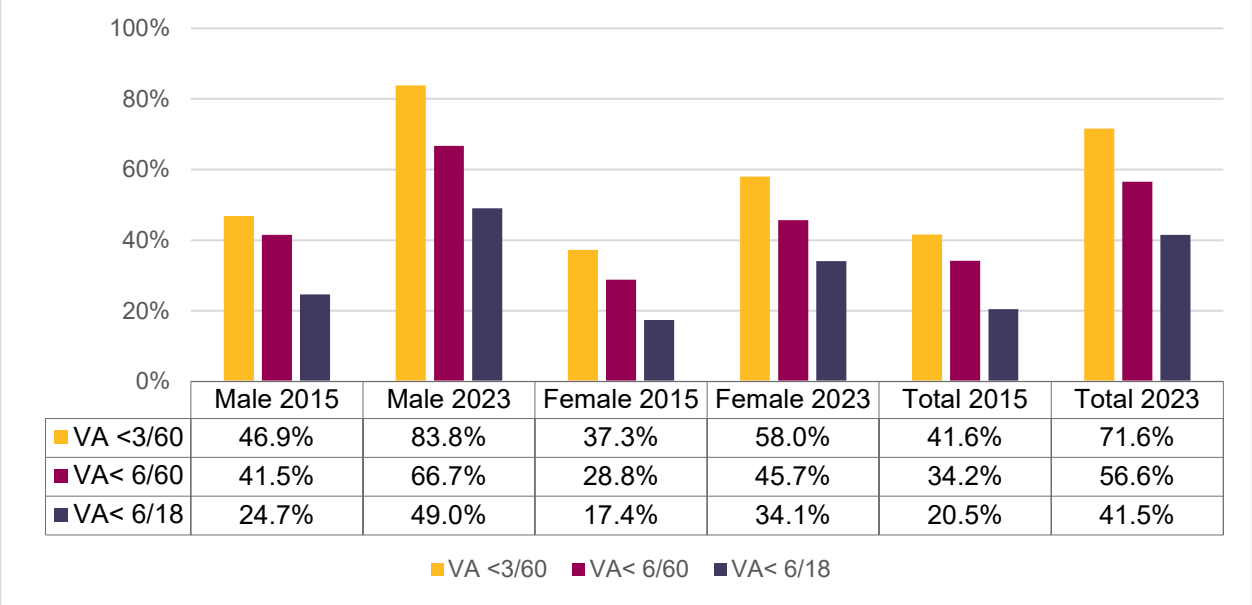
Figure 15: Principal causes of moderate visual impairment in 2015 and 2023



Change in cataract services

The definition for cataract surgical coverage (CSC) changed recently, and so the 2015 RAAB results have been re-analysed using the new definition in order to compare accurately with the 2023 results. Figure 16 shows the age- and sex-adjusted CSC for males and females in 2015 and 2023. CSC improved overall, and among males and females at all levels of VA between 2015 and 2023. At the VA< 6/18 levels (the closest to the WHO recommended reporting level of VA<6/12), the increase appears equitable among males and females, with coverage among males and females increasing 1.9-fold (males from 24.7% to 49.0%; and females from 17.4% to 34.1%).

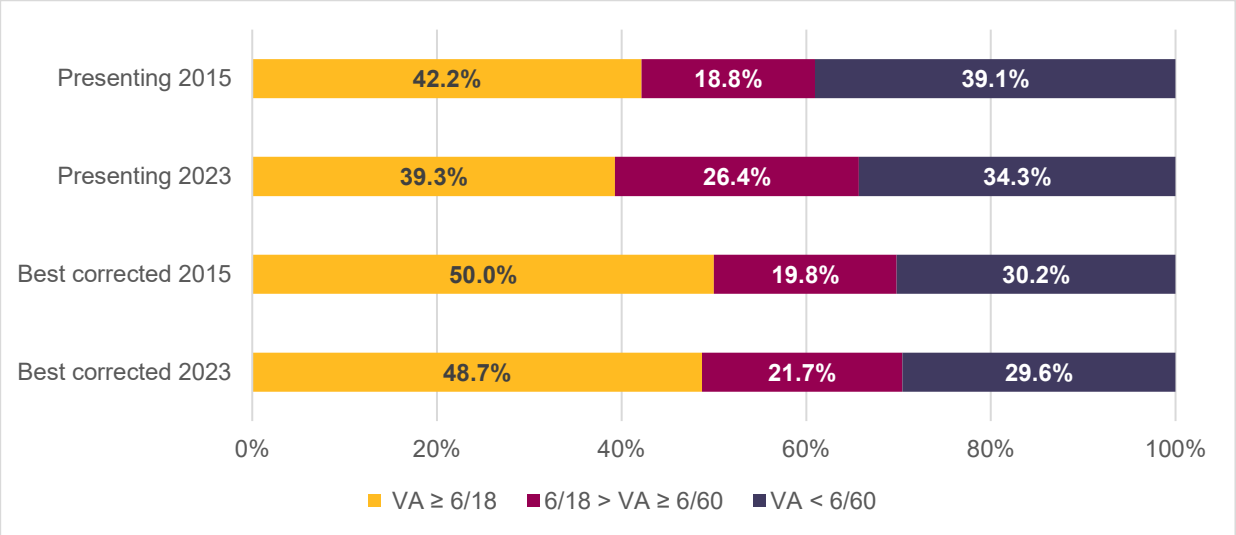
Figure 16: Adjusted cataract surgical coverage among males and females, and at different levels of visual impairment, in 2015 and 2023



	Male 2015	Male 2023	Female 2015	Female 2023	Total 2015	Total 2023
VA <3/60	46.9%	83.8%	37.3%	58.0%	41.6%	71.6%
VA< 6/60	41.5%	66.7%	28.8%	45.7%	34.2%	56.6%
VA< 6/18	24.7%	49.0%	17.4%	34.1%	20.5%	41.5%

The definition of a 'good' visual outcome changed recently to be VA ≥ 6/12. This data was not collected in 2015, so Figure 17 compares visual outcomes in 2015 and 2023 by VA level, rather than using the WHO definitions. Proportionately, the post-operative VA among operated eyes is similar in 2015 and 2023, with little change. The proportion of eyes with visual acuity of 6/18 or better is around 50% in both years.

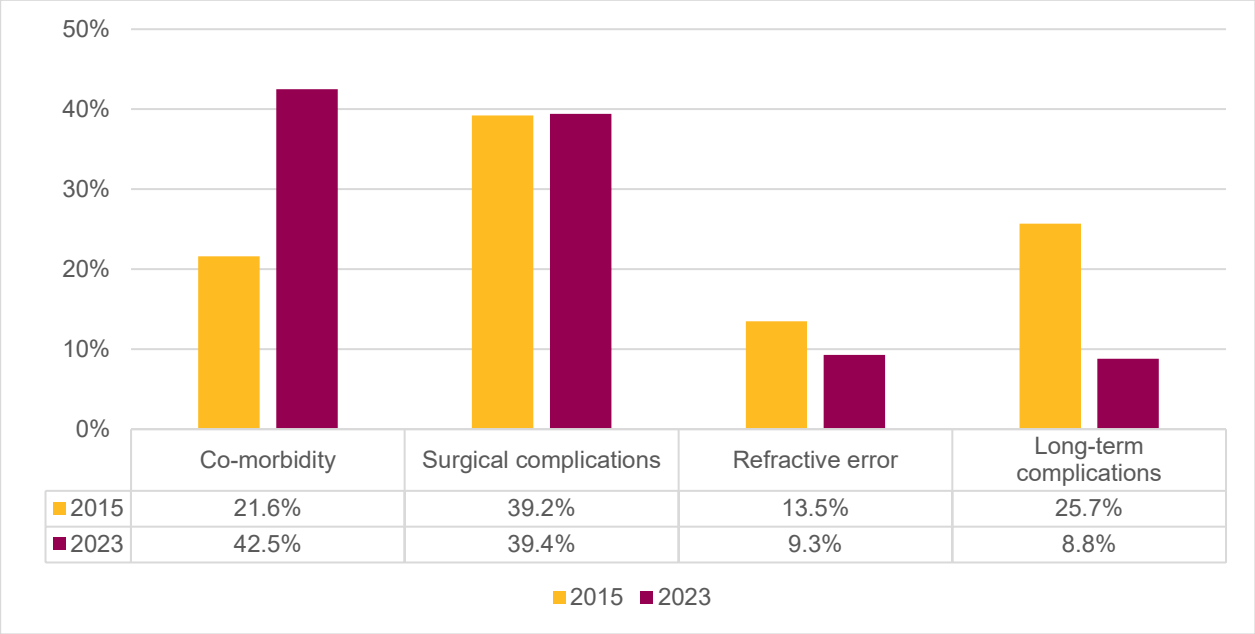
Figure 17: Quality of visual outcomes of operated eyes in 2015 and 2023



In both surveys, eyes with vision worse than 6/18 were allocated one of four possible reasons for that poor vision. Between 2015 and 2023, the share due to selection, or pre-exiting conditions, increased from 21.6% to 42.5% (Figure 17). The proportion due to surgical complications remained stable (39.2% in 2015 and 39.4% in 2023), and the

proportions to due to refractive error and long-term complications reduced from 13.5% to 9.3%, and from 25.7% to 8.8%, respectively.

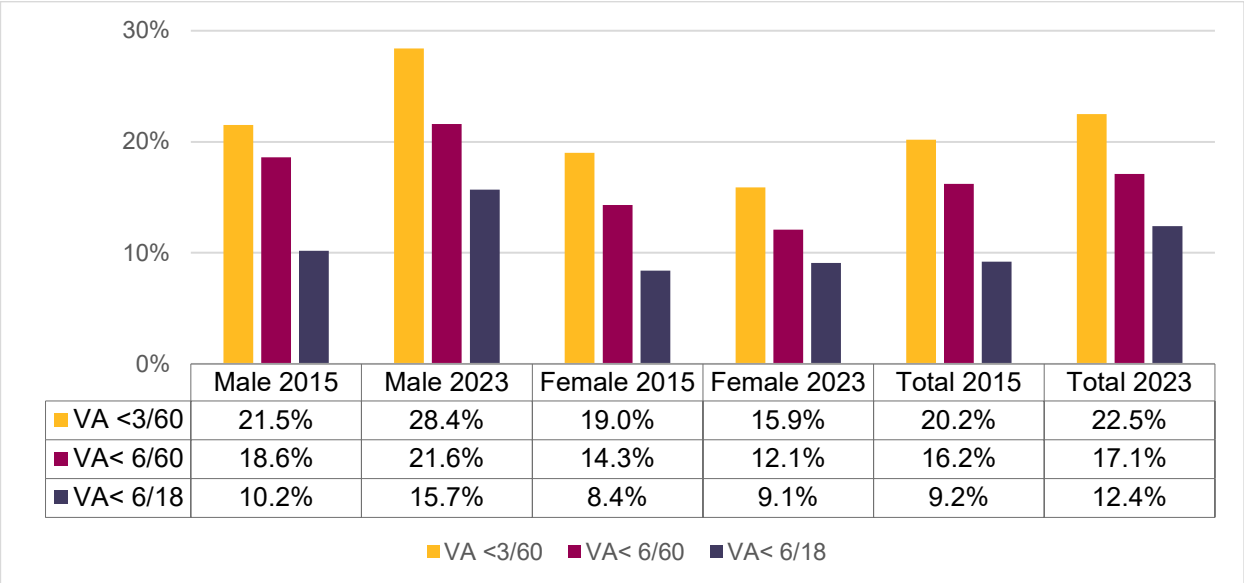
Figure 18: Reasons for post-operative visual outcomes VA<6/18 in 2015 and 2023



	Co-morbidity	Surgical complications	Refractive error	Long-term complications
2015	21.6%	39.2%	13.5%	25.7%
2023	42.5%	39.4%	9.3%	8.8%

Effective cataract surgical coverage (eCSC) was not calculated in 2015, but here we use the new definition to compare with that of 2015 (Figure 19). Overall, eCSC has increased from 9.2% in 2015 to 12.4% in 2023, however, that increase is mostly among males who experienced an increase from 10.2% to 15.7%, while females experienced an increase from 8.4% to 9.1%.

Figure 19: Adjusted effective cataract surgical coverage among males and females, and at different levels of visual impairment, in 2015 and 2023



	Male 2015	Male 2023	Female 2015	Female 2023	Total 2015	Total 2023
VA <3/60	21.5%	28.4%	19.0%	15.9%	20.2%	22.5%
VA< 6/60	18.6%	21.6%	14.3%	12.1%	16.2%	17.1%
VA< 6/18	10.2%	15.7%	8.4%	9.1%	9.2%	12.4%

Discussion

Key study findings

This study found the prevalence of age- and sex-adjusted presenting blindness to be 4.9% overall (95%CI 4.0-5.9%), and slightly higher among females (5.0%, 95%CI 3.9-6.4%), than males (3.5%, 95%CI 2.5-4.8%). This represents a clear, although not statistically significant, reduction in the prevalence of blindness since 2015 when it was 6.0% (95% CI 5.2-6.9%). That study reported a similar pattern between males (5.0%, 95%CI 3.8-6.4%) and females (6.9%, 95%CI 5.8-8.1). Despite this achievement, an aging population and increasing number of older people in the region, mean that the absolute numbers of people aged over 50 years with blindness and visual impairment remain similar in 2023, as in 2015. This is consistent with the findings of other RAABs conducted in the sub-Saharan region in recent years (19, 36).

The major cause of blindness at all levels of visual impairment is unoperated cataract. Despite a huge increase in the number of surgeries performed since 2019, when Karamoja received its first resident ophthalmologist, the burden of age-related cataract remains high. However, the adjusted cataract surgical coverage is far better in 2023 than in 2015, nearly doubling among both males and females, a major contributor to the reduction of blindness observed. Cataract services were paused for eight months in 2020 during the COVID-19 pandemic and the cataract surgical rate that year reduced to 216.7, down from 547.5 in 2019. 3,609 cataract surgeries were undertaken between 2019 and 2022, mainly on patients from the southern part of the region. Services have been affected by insecurity in Karamoja, particularly the northern districts, restricting access to a large proportion of the population, making the reduction in blindness in a relatively short time even more remarkable. It is now likely that the eye health status among people living in the northern districts is worse than those living in the southern districts, due to the additional challenges they face accessing health services.

The other important causes of blindness and VI in the region remain corneal opacities. While trachoma-related corneal opacities appear to have decreased since 2015, ‘other’ causes have increased, meaning that the combined proportional share remains relatively stable. Not only is corneal scarring a more complex condition to manage in a low resource location such as Karamoja, but its presence also impacts how other conditions, such as cataract, can be effectively treated and reduces the likelihood of an individual having their vision restored to a

higher level, such as 6/18 or 6/12. The impact of the high prevalence of corneal scarring in the area is observed in the post-operative visual outcomes results, where the WHO defined 'good' (i.e., VA ≥6/12) outcomes are low (21.8%) even among those operated in the past four years (23.7%). A RAAB survey may therefore not be the best way to determine the quality of visual outcomes in a high corneal scarring setting such as Karamoja, and other methods, such as a facility-based monitoring tool that can account for pre-existing conditions that may limit post-operative VA, can be effectively accounted for. The Best Operative Outcomes (BOOST) Software Tool is ideal since it monitors immediate post-operative outcomes and allows surgeons to identify and exclude anticipated causes of poor visual acuity outcomes such as corneal opacity (37). Recent unpublished data collected at the Moroto Regional Referral Hospital indicates that from 121 surgeries, 44.6% (54) have good outcomes, and 6.6% (8) have poor outcomes; significantly better than the results found in the RAAB. This highlights the importance of reviewing multiple data sources to understand issues around surgical quality and illustrates an important limitation of RAAB data.

Posterior segment diseases remain a significant cause of visual impairment in 2023, similar to 2015. Age-related macular degeneration (ARMD) is expected in this age group, however, the notably high prevalence in this RAAB might point more towards the diagnostic criteria used given the limitations of direct ophthalmoscopy. RAAB does not provide options for categorisation of ARMD into wet and dry categories which is pertinent when considering programme interventions. There is therefore need for a facility-based survey to determine the magnitude of the problem and also to clearly designate those categorised as 'other' posterior segment diseases.

This study sought to determine dimensions of inequity in the burden of eye disease, and access to eye health services in the Karamoja subregion. The initial results indicate that people with functional difficulties additional to their visual impairment may be more likely to have higher levels of visual impairment, than people without additional functional difficulties. Further analysis of the data may be useful to elucidate further understanding of how these factors interplay. The pathways through which this inequality has come about requires further investigation so that strategies can be identified and put in place to improve equity. Community norms and values around health seeking, particularly for elderly people who may require support from their families, are likely to play an important role in low coverage among certain groups. Strategies, such as linking eye health screening with the camps that disburse the Social Assistance Grants for Empowerment (SAGE) funds, have proved successful in

mobilising elderly community members and their support networks, and links to other similar initiatives could be considered.

Despite challenges in capturing relative wealth among participants in the study area, some data does appear to indicate that lower self-reported relative household wealth may be associated with higher levels of visual impairment. This may be due to poorer people being more likely to acquire visual impairment or less likely to seek services, or because having a household member with a visual impairment can place financial strain on a household and increase the likelihood that they live in relative poverty. As services – including transport to and from facilities – are already provided for free, further consideration into the pathways by which poorer people are excluded from services are required. Further research would be helpful to clarify the nature and extent of the relationship, and thus how strategies may be implemented to improve eye health among poorer people.

Study limitations

The study response rate was good at 91.6%. However, when comparing the population (10-year age group distribution) with the study sample, younger people (aged 50-59), particularly men, were underrepresented, and hence statistical adjustments were made to weight the results to the 'true' population. The population data used, was itself based on projections from the 2014 census, and thus may contain some errors. In any case, given the semi-nomadic lifestyle practised by some members of the communities, estimating the population size and structure in Karamoja is a difficult task.

Data on the relationships between wealth and VI in this study should be treated with caution, as the ladder tool used here to measure relative wealth is relatively new and our population based on this tool appeared to be homogenous, and very poor. It is possible that despite the field testing and enumerator training, the homogeneity in the responses could be due to poor implementation of the tool or misunderstanding by the participants. It is also possible that measuring relative wealth among extremely poor populations such as those in Karamoja is extremely difficult, and a different conceptualisation of poverty needs to be considered. Further consideration of appropriate tools for using in surveys among similar populations is required.

The security issues affecting the northern districts included in the 2015 RAAB hinders to some extent the comparability of the two studies, although it is felt that the status in 2015 was similar enough for those results to be generalised to the districts included in 2023. However, since there has been limited access for health workers in northern districts since

2019, and difficulties in travelling for community members, it is likely that the situation in northern districts is now worse than that in the southern districts, which experience a better security situation.

Finally, it is important to highlight the common limitation of all RAABs: 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 Karamoja

In order to improve coverage of eye health services, the following are recommended:

1. Increase the number of ophthalmologists resident in the region. The WHO recommendation is 4 per million, and with a population of 1,245,600, the current ratio in Karamoja is 0.8 per million
2. Ensure district-level eye health staff, such ophthalmic clinical officers, are sufficient in number and have available resources
3. Increase budgeting and spend with regards to eye health for equipment and outreach activities, at both district and regional levels
4. Investment in primary eye care services close to communities to help increase the timely identification and treatment of corneal scarring, and reduce reliance on traditional remedies to help to reduce the burden of disease in the area
5. Update the standard list of Essential Medicines and Health Supplies to ensure consumables for cataract surgery (for example, IOLs) and other routine eye health conditions are available at regional referral hospitals and districts, where appropriate
6. Engage behaviour change strategies to improve awareness around eye health and the services available at the district and regional levels to increase the number of walk-in patients
7. A reduction in security incidents and a reestablishment of peace in the northern districts will allow services to resume as normal in that area

In order to improve post-operative visual outcomes among cataract patients, the following are recommended:

1. Frequent monitoring of visual outcomes using the BOOST tool to identify challenges and monitor progress in all centres offering cataract surgery
2. Improving the identification of patients with existing co-morbidities by regular training of the screening team
3. Improving the surgeon's skills by identifying courses, mentoring opportunities, and ensuring they have access to good quality, well-functioning equipment
4. Improving Biometry skills by regular training of staff
5. Ensuring the availability of a wide range of intraocular lens powers
6. Correction of refractive errors by providing free distance spectacles
7. Ensuring follow-up is done for all patients in order to identify and treat minor post operation challenges, where possible

The following research studies have been identified to generate evidence needed to improve service development and provision in Karamoja:

1. A further study to understand the magnitude and impact of posterior segment diseases in the region would be helpful to get a full picture of the epidemiology and to guide future service provision
2. Despite the evidence of a difference in eye health status and coverage among women, people with disabilities, people living in different districts, and poorer people, it is unclear why these differences exist, how they came about, and how they can be overcome. Research is required to explore these factors to improve equity of services in the region
3. In order to develop an effective refractive error service in Karamoja, evidence is required about the acceptability of spectacles within the community, and how they can be provided in a way that is sustainable, and acceptable to the community
4. Little is known about how cataract surgery can impact the lives of individuals living in a semi-nomadic community like Karamoja, and a study to explore the changes in quality of life among operated individuals would provide valuable evidence to support the scale-up of activities in similar areas

5. The partnership between SAGE and the eye health programme has been identified as being very successful, however, little empirical evidence exists to suggest the impact of combining the activity on uptake, acceptability and satisfaction among elderly community members. A study to explore these issues would provide the evidence required to encourage uptake of similar approaches in other regions

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Appendices

Appendix A – Rapid assessment of avoidable blindness questionnaire

RAPID ASSESSMENT FOR AVOIDABLE BLINDNESS

A. GENERAL INFORMATION — Year - month: ____ - ____

Survey area: _____ **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)

B. VISION

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

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

Uncorrected 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)

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)

F. WHY CATARACT SURGERY WAS NOT DONE

(Mark up to 2 responses, if VA<6/12, not improving with pinhole with visually impairing lens opacity in one or both eyes)

- Need not felt O (1)
- Fear for 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)

E. HISTORY, IF NOT EXAMINED

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)

H. DETAILS ABOUT TRACHOMA SURGERY

	Right eye: Yes	No	Can't tell	Left eye: Yes	No	Can't tell
Trichiasis sign present? (either lid)	O (1)	O (2)	O (3)	O (1)	O (2)	O (3)
(IF YES) Trichiasis surgery? (ask and observe)	O (1)	O (2)	O (3)	O (1)	O (2)	O (3)
(IF NO) Has a health worker offered management?	O (1)	O (2)	O (3)	O (1)	O (2)	O (3)

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) (F)
Cataract surg. complications:	O (4)	O (4)	O (4)
Trachoma corneal opacity:	O (5)	O (5)	O (5)
Other corneal opacity:	O (6)	O (6)	O (6)
Phthisis:	O (7)	O (7)	O (7)
Onchocerciasis:	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)	O (12)
All globe/CNS abnormalities:	O (13)	O (13)	O (13)
Not 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: Personal, health and resource instrument

I.	PERSONAL AND HEALTH QUESTIONNAIRE	No difficulty	Some difficulty	A lot of difficulty	Cannot do at all
	Interviewer read:				
	"The next questions ask about difficulties you may have doing certain activities because of a HEALTH PROBLEM."				
1	Do you have difficulty seeing, even when wearing your glasses?	O (1)	O (2)	O (3)	O (4)
2	Do you have difficulty hearing, even when using a hearing aid(s)?	O (1)	O (2)	O (3)	O (4)
3	Do you have difficulty walking or climbing steps?	O (1)	O (2)	O (3)	O (4)
4	Using your usual language, do you have difficulty communicating, for example understanding or being understood?	O (1)	O (2)	O (3)	O (4)
5	Do you have difficulty remembering or concentrating?	O (1)	O (2)	O (3)	O (4)
6	Do you have difficulty with self care, such as washing all over or dressing?	O (1)	O (2)	O (3)	O (4)

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 taking."

9	How often do you feel worried, nervous or anxious?	Daily O (1) Weekly O (2) Monthly O (3) A few times a year O (4) Never O (5)	#	Thinking about the last time you felt worried, nervous or anxious, how would you describe the level of these feelings?	A little O (1) A lot O (2) Somewhere in-between a little and a lot O (3)
11	How often do you feel depresed?	Daily O (1) Weekly O (2) Monthly O (3) A few times a year O (4) Never O (5)	#	Thinking about the last time you felt depressed, how depressed did you feel?	A little O (1) A lot O (2) Somewhere in-between a little and a lot O (3)
13	"Imagine ten steps, where on the bottom, the first step, stand the poorest people, and on the highest step, the tenth, stand the rich (show a picture of the steps). On which step are you today?"				
14	Does your household have a regular source of income? (TICK ALL THAT APPLY)				Yes O (1) No O (2)
	(IF YES, SPECIFY)	Wages, salary from job O (1) Earnings from selling agricultural and livestock products O (2) Earnings from selling, trading, or hawking products O (3)			Remittances from children abroad or in the country O (4) Income from property rental O (5) Senior Citizens Grant (SAGE) O (6) Other O (7)
15	(IF RECEIVE SAGE) Did you receive the Senior Citizens Grants in the last 12 months?				Yes O (1) No O (2)
16	What is your current marital status?	Never married O (1) Married/ cohabiting O (2)			Divorced/ separated O (3) Widowed O (4)
17	(IF married, separated or widowed)			MAN: how many wives do/did you have? WOMAN: how many wives does/did your husband have including yourself?	
18	Did you bare any children?				Yes O (1) No O (2)
19	(IF YES) How many of these children live near to you?				
20	In addition to you, how many people live in your immediate household?				

		Not at all	Once or twice	More than twice	Daily
21	In the last 2 weeks, how often have you…				
a	…been out of the house/ dwelling to attend social meetings, activities, weddings, events?	O (1)	O (2)	O (3)	O (4)
b	…gotten out of the house/ dwelling to visit a relative, neighbour or friend?	O (1)	O (2)	O (3)	O (4)
c	…had visitors to your house, such as friends, neighbours, and relatives?	O (1)	O (2)	O (3)	O (4)
d	….attended religious services?	O (1)	O (2)	O (3)	O (4)

22	How long do you think it would take you to travel to that health centre? (nearest hour)			
23	The last time you needed health care, did you get health care?			Yes O (1) No O (2)
24	(IF NO) What reasons best explain why you did not get health care?			
		Could not afford the cost of the visit O (1) No transport available O (2) No one to go with you O (3) Previously badly treated O (4) Other commitments O (5) Weather was too bad to travel O (6)	Health care providers drugs or equipment were inadequate O (7) Healthcare providers skills were inadequate O (8) You did not know where to go O (9) You tried, but were denied health care O (10) You thought you were not sick enough O (11) Fear of being attacked while travelling to health facility O (12)

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