ABSTRACT

Aim: To determine the prevalence and causes of blindness and visual impairment in Muchinga Province of Zambia using the RAAB methodology.

Method: Ninety (90) clusters of 40 participants aged 50 years and older were randomly selected. Consenting subjects underwent enumeration to establish a demographic profile and thereafter a clinical eye examination. Visual acuity (VA) was measured with a Tumbling ‘E’ chart. Participants having a VA worse than 6/18 were retested with a pinhole. If no improvement in VA occurred, subjects underwent clinical examination, including a dilated fundus examination where necessary, to determine the cause of visual impairment.

Results: A total number of 3,600 persons aged 50 years and above were sampled; among these 3,502 (97.3%) were examined. The age and sex-adjusted prevalence of bilateral blindness (presenting VA < 3/60) was 4.1% (95% Confidence Interval [CI], 3.4-4.9%), and age and sex-adjusted prevalence of bilateral severe VI (VA of <6/60-3/60) was 3.1% (95% CI, 2.4-3.8%). Avoidable causes of blindness such as cataract, glaucoma and non-trachoma corneal scarring were responsible for 89.8% of bilateral blindness and 86.1% of bilateral severe VI. Cataract was the major cause of blindness (53.0%); similarly, it was a major cause of severe VI (63.5%). The cataract surgical coverage in blind people adjusted for age and sex was low at 36.8% with significant gender difference of 45.8% for males and 27.6% for females. The main barrier for cataract surgery was inaccessibility of the service (49.1%); this was followed by lack of awareness of the available service (32.7%).

Conclusion: The prevalence of blindness and VI in persons aged 50 years and above was higher than estimated by WHO for Zambia. The majority of the causes were avoidable, with cataract accounting for 53% of all cases of blindness. The data suggests that expansion of eye care programmes to address avoidable causes of blindness is necessary in this area of Zambia.

Key words: Rapid Assessment of Avoidable Blindness, Cataract, Blindness, Visual Impairment, Prevalence.

INTRODUCTION

Globally, more than 82% of all blindness occurs in people U 50 years old [1]. In Africa, the prevalence is 7.3 blind people per million population [1]. These estimates are based on the World Health Organization (WHO) definition of blindness as presenting visual acuity (VA) less than 3/60 in the better eye and visual impairment as VA less than 6/18 but at least 3/60 in the better eye [2]. The study area is in the Africa-E WHO sub-region [3]. Resnikoff et al. [4] posit an expected Africa-E sub-regional prevalence of bilateral blindness in individuals U 50 years old of 9%. The implementation of the ‘VISION 2020: Right to Sight’ campaign has created global awareness of the causes of avoidable blindness and the need to provide evidence for eye health needs and the impact of interventions to guide future eye health strategies. This awareness has led to an expansion of epidemiological investigations as baseline data became more important. However, according to the International Centre for Eye Health, ‘Blindness surveys are usually lengthy, costly and complicated exercises, requiring expert assistance from epidemiologists or statisticians to produce reports [5]. It is for this reason that surveys have been undertaken in only a few countries and with only a few repeat surveys to determine the effect of the intervention programmes implemented. Comprehensive blindness surveys are therefore often not feasible for planning and monitoring VISION 2020 programmes. Affordable and faster methodologies are required.

The rapid assessment of avoidable blindness (RAAB) methodology has addressed this need. The RAAB study methodology elicits information on the magnitude and causes of blindness and vision impairment via reduced vision screening and ocular health screening of adults U 50 years old. In addition, this methodology provides information on the output and quality of eye care services, barriers to service, cataract surgical coverage and other indicators of eye care services in the study area. Numerous RAAB studies have been conducted in many countries around the world [6,7,8,9,10,11,12,13]. The RAAB survey provides a needs assessment in the region under investigation so that a focused district plan can be developed or adjusted accordingly.

Muchinga Province

Muchinga Province is located in the north-east of the country and borders with Tanzania in the north, Malawi in the east, and Eastern and Central Provinces in the south. The province is located on both sides of the Muchinga mountains (Muchinga Escarpment), which serve as
a divide between the drainage basins of the Zambezi River (Indian Ocean) and the Congo River (Atlantic Ocean), making it geographically a hard-to-reach area. It is one of the most sparsely populated provinces in the country, with a population density of 81 persons per square kilometre and a population of 1,052,996 [14]. The main rivers of the province are the Luangwa River, a major left tributary of the Zambezi, the Chambeshi River, and a tributary of Lake Bangweulu in the drainage basin of the Congo. The northern part of the country receives the highest rainfall, with an annual average ranging from 1,100 mm to over 1,400 mm. The main economic activity for the province is agriculture, with livestock farming and the growing of cereals, cassava and beans at subsistence level [14].

METHODS
A 16-year-old female from Western Province

Sample selection

The RAAB study area Muchinga Province. The total population in the area was 1,052,996, with a mixture of urban, peri-urban and semi-rural areas [14]. The estimated total population of the region surveyed was 322,601, with the population for each district as follows: Chama 103,894, Chinsali 86,723, Isoka 72,189 and Shiwang’andu 59,795 [15]. As in the rest of Zambia, the delivery of eye care follows the district health model. Current eye health care infrastructure in the study area is found in a district hospital. Human resources for eye health in the area are ophthalmic nurses and clinical officers. Primary community health workers in the area refer to community health centres which also refer to the district hospitals. Sightsavers, a non-government organisation (NGO), supports eye health services in the province through the seeing is believing programme.

A sample size adequate to demonstrate a prevalence of blindness of 4.0% 40.8% with 95% confidence was calculated. This was increased for non-participation (10%) and design effect (1.5) resulting in a size of 3,563 or 90 clusters of 40 participants each (3,600 in total). The team decided on clusters of size 40 rather than 50 due to the long distances between homes in the villages and the difficulties envisaged in moving between the homes and enrolling enough participants each day. Enumeration and recruitment of study participants

A list of all the villages and their populations in the respective wards was collected from the various districts and sent to the trainers who then used this to select the clusters. The sampling procedure embedded in the RAAB software uses probability proportional to the size of the population methodology to randomly select villages automatically. The households within clusters were selected through compact segment sampling which involved choosing a start point within the village and moving from house to house, enumerating all eligible residents (whether at home at the time of visit or absent) until 40 eligible participants are enrolled. If any eligible participants were away from home at the time of the visit, the survey team would return to the house at the end of the day to meet with them. If they were still absent, a neighbour or friend would be asked for details on the individual’s visual status.

In order to facilitate the survey team’s work, the selected village was visited a day or two beforehand by the cluster informer. They worked with village leaders to produce a sketch map of the ward showing major landmarks and the approximate distribution of households in the village. The cluster informer requested that local leaders inform the residents of the visit of the survey team and requested that residents of 50 years and above stay around their homes on the day of the survey. The village leader also appointed a guide to work with the survey team on the day of their visit to introduce them to residents.

Large villages were split into segments where each segment would include approximately 40 people aged 50 years and above. One of the segments was chosen at random in collaboration with the village leaders by drawing lots and all households within the segment were included in the sample sequentially, until 40 people aged 50 years and above were identified, examined, and their data entered on the data collection programme on the smartphone. If the segment had fewer than 40 people aged 50 years and above, then another segment was chosen at random and sampling continued. The sampling started at the edge of the village and all the households were sampled sequentially until 40 people aged 50 years and above had been examined.

If the village had fewer than 40 people aged 50 years and above, there was no need for segmentation and all the people of that age group were examined. In such cases, the cluster informer would inform the next village leader of the possibility of the RAAB team including his area in the survey.

Ethical approval

Ethical approval for this study was granted by the University of Zambia Research and Ethics Committee and cleared by the Ministry of Health. Permission to conduct the study was obtained from the Provincial Medical Office and the respective district medical offices.

When the team reached the area informed, (verbal) consent was obtained from the participants after providing information on the purpose, procedure and the possible benefits of the study. Participants were informed that participation was voluntary, and that all discussions and data collected from the study would be kept confidential, and that findings will be anonymously reported. Appropriate counselling, treatment or referral for eye problems was provided to study participants. All subjects in the study were examined after informed consent and information documents were signed. All individuals requiring further investigation for refractive correction, treatment of ocular disease or further investigatory procedures were referred to the most appropriate and accessible eye care facilities. Findings from the research were disseminated to the community in a feedback session to the community and its leaders at the end of the study.

Training

The study was preceded by a training session and pilot study involving the enumerators and clinical team to ensure the ability of all individuals in the study to carry out their respective roles. Kappa values were used as a measure of inter-observer agreement between the clinical research team and a ‘gold standard’ team, with 0.6 being an acceptable standard. All clinicians satisfied this criterion. There were five survey teams, each consisting of an ophthalmologist and an ophthalmic nurse or ophthalmic clinical officer, as well as a driver and a cluster informer who would work independently of the survey teams to prepare the clusters for their visit.

Clinical examination

The standardised RAAB protocol was used in the clinical examination and involved the assessment of visual acuity
using a tumbling E optotype of 6/60 and 6/18 sizes. Subjects who failed testing on the 6/60 optotype target were retested with a pinhole occluder. Blindness was classified as VA < 3/60 in the better eye with available correction; severe visual impairment as VA between 3/60 and 6/60 in the better eye with available correction; and moderate visual impairment as VA between 6/60 and 6/18 in the better eye with available correction. The VA examination was followed by an examination of the crystalline lens and the posterior segment with a direct ophthalmoscope. Subjects presenting with VA < 6/18 and with no improvement with pinhole were dilated using 0.5% tropicamide solution, and a dilated ophthalmoscopy was performed to determine any posterior segment cause for vision impairment. All measurements were taken in full daylight with available correction. If the VA was <6/18 in either eye, then pinhole vision was also measured. If the vision improved to >6/18, then the condition was entered into the data as refractive error.

The participant was then moved to a dark location - this was usually in their homes, where the lens was assessed for cataract formation. If there was no cataract and the vision was still <6/18, the participants’ pupils were dilated with a short-acting mydriatic for direct fundoscopy. The fundus was then examined and the cause for vision loss recorded on the RAAB application.

A questionnaire on the barriers to cataract surgery and surgical success was administered to subjects presenting with cataracts or who had undergone cataract surgery respectively.

Statistical analysis

The specific RAAB software package developed for the survey (Version 4.02) was used for data entry and standardised data analysis. Data were captured by double entry (to ensure reliability of data entry) and reports were generated daily to ensure consistency within the data capture process. Automated analyses produced reports on the unadjusted prevalence of visual impairment, causes of visual impairment, age- and gender-adjusted prevalence, and cataract surgical coverage. Multiple logistic regression analysis was conducted to determine associations between gender, age and education levels and various degrees of vision loss.

The survey was carried out over 6 weeks from October to November 2009.

RESULTS

Demographics of the sample

The total number of people examined was 3,600 giving a response rate of 97.3%, of which 80 individuals (2.2%) were unavailable, 11 (0.3%) refused and 7 (0.2%) were not capable of taking part in the survey. Almost half of the people surveyed belonged to the 50-59 years age group. The age and gender composition of examined participants in relation to the population in the survey area is summarised in Table 1.

Females constituted 54.9% (1,921) of selected participants compared to 51.9% in the population.

Bilateral vision loss in the sample

Of 166 people in the sample, 4.7% (95%CI4.0-5.5%), were found to be bilaterally blind (defined as VA worse than 3/60 in the better eye with available correction - see Table 2). The prevalence was similar between males and females, 4.6% and 4.8% respectively. The prevalence of bilateral blindness, SVI and VI is summarised in Table 2.

Adjusting for differences in age and sex between the sample and survey area produced a prevalence of blindness of 4.1% (95%CI3.3-4.9% - see Table 3). Extrapolating this to the total population of the survey areas means that an estimated 2,315 people were blind, of whom 1,179 were females (50.1% female).
Sample prevalence of severe VI (presenting VA < 6/60-3/60 in better eye) was 3.3% (95% CI 2.6-4.0%), and 31% (95% CI 2.4-3.8%) after adjustment for age and sex. Adjusted prevalence of VI was 3.3% among males and 2.9% among females, which means an estimated 895 males and 837 females with bilateral severe VI in the survey area. Sample prevalence of moderate VI (presenting VA < 6/18-6/60 in better eye) was 10.2% (95% CI 8.8-11.5%) and 9.6% (95% CI 8.3-11.0%) after adjustment for age and sex. Adjusted prevalence of MVI was 9.9% among males and 9.4% among females which means an estimated 2,678 males and 2,733 females in the survey area (50.5% female).

Causes of vision loss in the sample
Cataract was the primary cause of bilateral blindness (53.0%), and bilateral severe VI (63.5%), and a major contributor to moderate VI (36.4%). Of the remainder of blindness, glaucoma accounted for 14.5%, non-trachomatous cornea opacity was 10.2%, other posterior segment disease 7.2%, trachoma corneal opacity 6.0%, phthisis 3.0%, other globe/CNS abnormalities 3.0% and cataract surgical complications 3.0% (Table 4).

Cataract blindness, surgical outcomes and cataract surgical coverage
After adjustment for age and sex, it was estimated that 3.6% (95% CI 2.9-4.3%) of people with VA < 6/18 required cataract surgery. Table 5. Of eyes approx. 4,059 were blind with cataract (cataract may not be the major cause of blindness), table 5. Nine hundred eighty-three (983) people (1.7%, 95% CI 1.2-2.3) in the survey area were estimated to be bilaterally blind with cataract and 2,092 (3.7%, 95% CI 3.0-4.4) were estimated to have one cataract blind eye, table 5. No major differences were observed between males and females.

Table 5: Age and sex-adjusted results for cataract and blindness, severe (SVI), and moderate (MVI) visual impairment - bilateral best corrected VA

<table>
<thead>
<tr>
<th>Feature</th>
<th>Males N</th>
<th>% (95%CI)</th>
<th>Females N</th>
<th>% (95%CI)</th>
<th>Total N</th>
<th>% (95%CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bilateral cataract</td>
<td>415</td>
<td>1.6 (0.8-2.3)</td>
<td>358</td>
<td>1.9 (1.2-2.6)</td>
<td>773</td>
<td>1.7 (1.2-2.3)</td>
</tr>
<tr>
<td>Unilateral cataract</td>
<td>1,060</td>
<td>3.6 (3.0-4.3)</td>
<td>1,003</td>
<td>3.5 (3.0-4.4)</td>
<td>2,063</td>
<td>3.7 (3.0-4.4)</td>
</tr>
<tr>
<td>Cataract eyes</td>
<td>1,919</td>
<td>3.5 (2.7-4.4)</td>
<td>2,200</td>
<td>3.7 (3.0-4.6)</td>
<td>4,119</td>
<td>3.7 (3.0-4.6)</td>
</tr>
<tr>
<td>Bilateral cataract and Severe VI – VA&lt;6/60-3/60 with best correction</td>
<td>289</td>
<td>1.1 (0.7-1.5)</td>
<td>341</td>
<td>1.2 (0.8-1.5)</td>
<td>630</td>
<td>1.1 (0.9-1.4)</td>
</tr>
<tr>
<td>Unilateral cataract</td>
<td>472</td>
<td>1.7 (1.0-2.5)</td>
<td>359</td>
<td>1.8 (1.0-3.0)</td>
<td>831</td>
<td>1.5 (0.9-2.0)</td>
</tr>
<tr>
<td>Cataract eyes</td>
<td>881</td>
<td>1.6 (1.2-2.1)</td>
<td>881</td>
<td>1.5 (1.0-2.1)</td>
<td>1,762</td>
<td>1.5 (1.1-2.0)</td>
</tr>
<tr>
<td>Bilateral cataract and Moderate VI – VA&lt;6/18-6/60 with best correction</td>
<td>612</td>
<td>2.3 (1.6-3.2)</td>
<td>865</td>
<td>3.1 (2.6-4.0)</td>
<td>1,477</td>
<td>3.0 (2.5-3.5)</td>
</tr>
<tr>
<td>Unilateral cataract</td>
<td>722</td>
<td>2.7 (1.9-3.9)</td>
<td>505</td>
<td>1.9 (1.0-2.9)</td>
<td>1,227</td>
<td>2.8 (1.9-3.3)</td>
</tr>
<tr>
<td>Cataract eyes</td>
<td>1,679</td>
<td>5.1 (2.4-9.0)</td>
<td>2,070</td>
<td>5.3 (2.7-9.4)</td>
<td>3,749</td>
<td>5.3 (2.6-9.0)</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 4: Causes of visual loss (with available correction) in the study sample.

<table>
<thead>
<tr>
<th>Cause of visual loss</th>
<th>Bilateral blindness</th>
<th>Bilateral severe visual impairment</th>
<th>Bilateral moderate visual impairment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>VA &lt; 6/30 (%)</td>
<td>VA &lt; 6/60-2 3/60 (%)</td>
<td>VA &lt; 6/18-6 3/30 (%)</td>
</tr>
<tr>
<td>Refractive error</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Cataract</td>
<td>53</td>
<td>63</td>
<td>56</td>
</tr>
<tr>
<td>Cataract surgical complications</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Corneal scar</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Glaucoma</td>
<td>15</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Diabetic retinopathy</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Other posterior segment disease</td>
<td>7</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>Age related macula degeneration (AMMD)</td>
<td>-</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Trachoma corneal opacity</td>
<td>6</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Phthisis</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Other globe problems</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Note: Causes of visual loss (with available correction) in the study sample were determined by visual loss in the better eye. Total available vision loss was a combination of total available visual loss and total unpreventable visual loss.
VA = visual acuity.
who required surgery were found to have received it with males more likely to have received it than female (24.3% vs 12.2%). They were regions with inadequate eye health service before interventions were implemented. The response rate was 97.2% which can be considered very high. Although the cluster informers working with local leaders knew the village boundaries and residents well, the response rate could have probably been higher had the survey not been conducted during harvest time. Normally because of the mountainous terrain, villagers would camp at the farms away from the village until harvesting was complete. A proportion (0.3%) refused examination and the scope of the study did not provide an explanation for the reasons for refusal of the clinical examination.

The survey found a high prevalence of blindness (4.1%, 95%CI 3.4-4.9) compared to that obtained in Southern Zambia (2.3%) [16]. Results from other RAAB surveys done in Malawi [17], Rwanda [18] and Tanzania [19] ranged from 1.8-3.3% (unadjusted) which was lower than what was found in the study area. The prevalence of blindness in Muchinga was possibly higher than that of Southern Zambia due to a number of reasons: Southern Zambia’s demographic is an urban rural setting with the presence of active eye health services. The extrapolated number of blind people in the four districts of Muchinga was 2,315. The proportion of blind people was higher for females than males, a finding common to other RAAB studies in the region, except in a RAAB conducted in South Malawi where the prevalence of blindness was higher in males than females.

The main causes of blindness in Muchinga were cataract, glaucoma and non-traumatic cornea opacities. Similar causes have been observed in other RAAB surveys in the southern province of Zambia and Malawi. This result is consistent with the current trend that cataract is the most common cause of blindness worldwide. Our study found that unoperated cataract is also the major cause of severe VI and that uncorrected refractive error is the primary cause of moderate VI. The finding of refractive error as the most common cause of VI could be due to the myopic shift induced by age-related nuclear sclerosis as reported by researchers for RAAB in KwaZulu Natal [20]. In this study, avoidable causes were responsible for 89.8% of blindness. The finding that most causes of blindness are avoidable justifies the initiative to address blindness in this area. The prevention of blindness initiative in this area should include the correction of refractive errors, which contributed to 48% of moderate VI.

The age and sex-adjusted cataract surgical coverage was low (37%) compared to studies from Malawi (44.6% unadjusted) [17], Kenya (78%) [21], Tanzania (68.9%) [19] and Rwanda (47%) [18]. Muchinga province has always depended on sporadic eye camps conducted by ophthalmologists from outside the province, with the support of cooperating partners. The low CSC could be due to the absence of a dedicated ophthalmic unit headed by an ophthalmologist. The finding of a low cataract surgical coverage for females (25.5%) has also been noted in other areas of Sub Saharan Africa [22].

WHO recommended that the grades of outcome for cataract surgery with an IOL are: good outcome VA >6/18 at 90%, borderline VA >6/60 at less than 5% and poor outcome of VA<6/60 at less than 5%. The high proportion of poor outcomes after cataract surgery in this survey could be due to a combination of factors, for instance there is no ophthalmologist to follow up patients and therefore manage any complications. In this study, the majority were attributed to poor patient selection and surgical complications. Most surger-

**DISCUSSION**

This study was conducted to create baseline information on the prevalence and causes of blindness in Muchinga region. These districts were selected because they were regions with inadequate eye health services. The extrapolated number of blind people in the four districts of Muchinga was 2,315. The proportion of blind people was higher for females than males, a finding common to other RAAB studies in the region, except in a RAAB conducted in South Malawi where the prevalence of blindness was higher in males than females.

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ies, although conducted in a hospital environment, have a setting like that of an eye camp where the screening of patients preoperatively is inadequate; for instance, conditions like glaucoma may be missed as most patients present with dense cataract that obscures fundus view, and may not have had any examination before the development of cataract. Secondly, biometry is not conducted pre-operatively and patients are offered a standard lens which may not be appropriate for the patient.

In our study, half of those that had not accessed surgery for cataract reported that they were not able to access the service. Studies have reported that major reasons for low cataract surgical rates include the following: low demand because of fear of surgery, low demand from poor people because of high cost of surgery, low demand because of poor visual results, lack of eye surgeons (particularly in Africa), old age, no available services close to the community, and lack of awareness of available surgical services [23].

In our study, subjects with blindness owing to bilateral cataracts (32.5%) did not seek intervention because they were ‘unaware of treatment’.

CONCLUSION

The prevalence of blindness in Muchinga province of 4.1%. Although lower than the WHO projected for Africa, it remains higher than that obtained in the region. Cataract is the commonest cause of blindness in Muchinga with refractive errors being the main cause of VI. Eye health services are severely inadequate and inaccessible.

Cataract surgical coverage is low and there is an obvious gender imbalance in the accessibility of cataract service. Information/sensitisation on the availability of services is also low. The quality of cataract surgeries performed in the area is below the WHO recommendation.

It is therefore evident that eye health services are not available in Muchinga province and the result of this survey justifies Sightsavers extending the services to Muchinga province.

Competing interests

The authors declare that they have no financial or personal relationships which may have inappropriately influenced them in writing this article.

The study was funded by Sightsavers Zambia and Ministry of Health, Zambia.
LIST OF REFERENCES


