Prevalence of Refractive Error and Visual Impairment among Rural Dwellers in Mashonaland Central Province, Zimbabwe

Selassie Tagoh¹, Samuel Kyei¹,², Michael Agyemang Kwarteng³, Evans Aboagye¹
¹Department of Optometry, Faculty of Sciences and Engineering, Bindura University of Science Education, Bindura, Zimbabwe, ²Department of Optometry and Vision Science, School of Allied Health Sciences, College of Health and Allied Sciences, University of Cape Coast, Cape Coast, Ghana, ³Discipline of Optometry, College of Health Sciences, University of KwaZulu-Natal, Durban, South Africa

Abstract

Purpose: To determine the prevalence of refractive error and visual impairment in a rural population of Zimbabwe.

Methods: This community-based, cross-sectional study used a multi-stage sampling to select the participants from households in four communities within three rural districts in Mashonaland Central Province. Participants’ demographic data were collated, and their presenting visual acuity (VA) was measured using the logMAR E chart. Clinical refraction was preceded by an anterior segment and posterior segment eye examinations. Visual impairment was defined as presenting VA worse than 6/12 (0.3 logMAR) in the better eye. Descriptive statistics were presented as frequencies.

Results: A total of 519 participants were involved in this study. Their ages ranged from 5 to 100 years (mean age = 50.94; standard deviation ± 21.12 years). Out of the 519 participants, 233 (44.9%) were male, and 286 (55.1%) were female. The prevalence of visual impairment was 56.8% (95% confidence interval [CI]: 55.7–67.2), and blindness was 13.1% (95% CI: 11.2–17.6). The prevalence of near visual impairment based on presenting near VA (N = 408) was 78.6% (95% CI: 78.1–85.4). The two most common causes of visual impairment were uncorrected refractive errors (UREs) (54.2%) and cataract (24.8%). The most common cause of blindness was cataract (41.2%). Hypermetropia (56.9%) was the most common refractive error.

Conclusions: A high burden of visual impairment due to UREs and cataracts was observed among the rural dwellers of Zimbabwe. Public health education, access to refractive error services, and cataract surgery are necessary to mitigate this high burden of visual impairment.

Keywords: Blindness, Cataract, Refractive error, Visual impairment, Zimbabwe

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high cost of spectacles. The high cost of spectacles has been highlighted as an important barrier to spectacle use in India, East Africa, and China. An important problem in Zimbabwe is the lack of access to optimum refractive error services capable of providing accurate refractive error correction. Again, unaffordability has been identified as a significant barrier to the utilization of eye health services.

The quality of subjective refraction is dependent on the standard of care and the availability of skilled practitioners. Automated refraction requires access to expensive machines, which must be adequately maintained and calibrated. Retinoscopy is a less expensive technology potentially suitable for use in the developing world, but the need for rigorous training has limited its use.

A URE has a great impact on the quality of life of children because they have many years of poor vision as compared to the elderly. It also has a dramatic impact on their learning process and educational capacity increasing the rate of absenteeism, drop-out, and poor career prospects. Refractive error, if not corrected early, can result in amblyopia, which is a loss in vision in at least one eye in the absence of any obvious structural anomalies or ocular disease due to a delay in the normal neurophysiological development of the visual pathway and visual cortex. Due to the far-reaching consequences of visual impairment resulting from simple to remedy condition such as refractive error, VISION 2020: The Right to Sight program prioritizes the elimination of such needless blindness across the globe.

Zimbabwe has sixteen ophthalmologists with no optometrist in public health institutions, but two ophthalmic nurses trained in refraction. The national eye health strategy has reported that refractive error accounts for 5% of visual impairment in Zimbabwe, with presbyopia accounting for 70%. However, the report had a limitation as it was based on a projection from the global prevalence and not country-specific data. Furthermore, Chirunga et al. conducted a study among adult Zimbabweans aged 50 and older. The findings in this study cannot be extrapolated to represent that of the general population due to age. There is a paucity of information on the magnitude of UREs and visual impairment in rural Zimbabwe to inform public health intervention. Hence, this study aimed to determine the prevalence of refractive error and visual impairment among selected rural communities in Mashonaland Central province of Zimbabwe.

**METHODS**

The study was conducted in four communities within three districts, namely Mushumbi-Mbire, Kamutsenzere, Mukumbura, and Muzarabani in the Mashonaland Central province of Zimbabwe. These districts are among the designated rural districts of Mashonaland Central province, and they are predominantly the Shona ethnic group.

This was a community-based cross-sectional study among the natives of Mushumbi-Mbire, Kamutsenzere, Mukumbura, and Muzarabani of Mashonaland Central province, Zimbabwe. The study involved the measurement of visual acuity (VA), clinical refraction, an anterior and posterior segment eye examination, refraction, and collation of demographic data of participants.

A multi-stage sampling was used in this study. A random sampling method was first used to select three districts (Mt. Darwin district, Muzarabani district, and Mbire district) from the 8 rural districts (a total of 10) in the Mashonaland Central province using the lottery method. Out of these 3 districts, four rural communities, i.e., Kamustenzere, Mukumbura, Mushumbi, and Muzarabani, were randomly selected from a list of all rural communities. This technique resulted in the selection of two rural communities from the Mt. Darwin district and one each from Mbire and Muzarabani rural districts. The sample frame (total population size for the 4 communities, i.e., 53,344) was obtained from the 2012 national census data. The minimum sample size was determined from the sample frame and proportionately assigned to each community per their population size.

The sample size was estimated using the single population proportion formula. With a refractive error, the prevalence of 5.8% for males, 6.8% for females, and 94.2% when presbyopia is included according to a study by Chirunga et al. An estimated 50% prevalence was used to increase the sample size, and considering a Type I error of 0.05, and precision of 0.04, a sample size of 430 was estimated. With an intercluster correlation co-efficient (ICC) of 0.02 and a resultant design difference of 1.1 after adding 10% to the calculated sample size, the final sample size was 480.

Where \( N = \text{Sample size, } Z = 1.96 \) (to produce a 95% confidence interval [CI] of the prevalence), \( P = \text{estimated prevalence} = 0.5 \) (50% prevalence), \( d = \text{precision} = 0.05 \) (precision set to 5%). The ICC was 0.02 and the design difference, 1.1.

The adjusted sample size was proportionately assigned as follows:

1. Kamustenzere: Number of participants required = \( (10,606/53,344) \times 480 = 95 \) participants
2. Mukumbura: Number of participants required = \( (13,242/53,344) \times 480 = 119 \) participants
3. Mushumbi: Number of participants required = \( (12,073/53,344) \times 480 = 119 \) participants
4. Muzarabani: Number of participants required = \( (17,423/53,344) \times 480 = 157 \) participants

Total = 480 participants

The required samples were selected from each of the four communities by first spinning a bottle at a central location or center of the community and the direction the bottle faced was followed. Every other household along that direction in the community was selected. All household members were invited to the community health center after giving their consent to participate in the study for a comprehensive eye examination and clinical refractive errors. The community health center was at most 20 min walk from the furthest house. Households were examined until the required
number of participants in a given community was exhausted, with each household providing at most three participants. The selection of three participants was based on a feasibility study done prior to the data collection which revealed that the average family size in the study area was 4 ± 2 (standard deviation [SD]). In households with more than 3 members, the lottery system was used to select the participants. For participants who were under 18 years, parental consent was sought and assented to by the participant in each case. The team then moved to the next selected community to repeat the same procedure until the required number of participants in the study sample was obtained. The study spanned for a period of 8 months including weekends, and subjective refraction was done by a single optometrist with 10 years of practical experience following autorefraction.

The study included all natives of the four communities who had been residing in the community for at least 2 years to the commencement of the study.

The study adhered to the tenets of the declaration of Helsinki and was approved by the Research Ethics Committee of the Research and Postgraduate Center of Bindura University of Science Education, Zimbabwe. Both written and oral informed consent of the participants was obtained. An assent was sought from minors following parental consent. There were no risks and/or discomfort associated with participating in the study, and no financial remunerations were offered to the participants. Participation in this study was voluntary, and participants were informed that they could withdraw at any point and that in the event of refusal/withdrawal of participation, they will not incur penalty or loss of treatment or other benefits to which they would normally be entitled. All those with refractive errors had their errors corrected with a pair of spectacles for free.

No vision impairment: Presenting VA better than 6/12 (0.0–0.30 logMAR); mild vision impairment: Presenting VA worse than 6/12 (0.32–0.50 logMAR); moderate vision impairment (0.52–1.00 logMAR): Presenting VA worse than 6/18; severe vision impairment: Presenting VA worse than 3/60 (1.02–1.30 logMAR); and blindness: Presenting VA worse than 3/60 (4.0–1.80 logMAR).16

Presenting near VA worse than N6 or M.08 after best correction.16

Data collection involved the use of a data extraction sheet to collect the data on demographics and ocular assessment sheet.

These assessments included

1. Measuring VA with the Tumbling “E” distance logMAR Chart at a distance of four meters from the participant. The habitual distance VA of the right eye followed by the left eye was recorded.

2. Habitual near VA was recorded using the Adult Near Contrast Test (Early Treatment of Diabetic Retinopathy Study format letters and continuous reading examples) at 40 cm. This test distance was used because it is the recommended test distance for normal vision.

3. An examination of the anterior segment was performed on each participant using a slit-lamp biomicroscope.

4. An examination of the posterior segment of the eye was conducted with an ophthalmoscope and slit-lamp biomicroscope.

5. Autorefraction was performed among participants using KR 9000 Auto REF (Perlong Medical Equipment Co., Ltd., Jiangsu, China).

6. Subjective refraction was performed on participants who had improvement in pinhole VA.

Data was analyzed using the IBM SPSS version 21 (SPSS Inc., Chicago, IL, USA). Categorical data were presented as frequencies. Descriptive statistics were computed for all variables after the data had been screened and normality test carried out. Normal approximation for CI was used for proportions with large rate, and binomial exact approximation for CI was used for smaller rates.

**Results**

A total of 519 (85.1%) out of 610 invitees within the four communities of the three districts honored the invitation to partake in this study. This was higher than the calculated sample size despite the response rate. One hundred eight (20.8%) of the participants were from Kamustenzere, 127 (24.5%) were from Mushumbi, 115 (22.1%) were from Mushumbi, and 169 (32.6%) were from Muzarabani. Their ages ranged from 5 to 100 years (mean age = 50.94; SD ± 21.12 years). Of the 519 participants, 233 (44.9%) were male, and 286 (55.1%) were female, as shown in Table 1.

Two hundred and ninety-five (56.8%) participants were visually impaired in the better eye at the time of the study. Sixty-eight (13.1%) were blind in the better eye, and the remaining 156 (30.1%) had normal vision [Table 2].

The prevalence of visual impairment based on presenting VA (N = 519) was 56.8% [95% CI: 55.7–67.2], as shown in Table 3. The prevalence of near visual impairment based on presenting near VA was 408, 78.6% (95% CI: 78.1–85.4) among 519 participants.

A total of 160 (54.2%) out of the 295 participants who were visually impaired were due to URE followed by cataract (24.8%), as shown in Table 4. A total of 28 (41.2%) out of the 68 participants with blindness were diagnosed with cataract followed by Glaucoma (32.4%), as shown in Table 4.

| Age group | Females (%) | Males (%) | Total (%) |
|-----------|-------------|-----------|-----------|
| Children (<18) | 18 (6.3) | 24 (10.3) | 42 (8.1) |
| Youth (18-35) | 63 (22.0) | 48 (20.6) | 111 (21.4) |
| Adults (36-59) | 99 (34.6) | 72 (30.9) | 171 (32.9) |
| Elderly (>60) | 106 (37.1) | 89 (38.2) | 195 (37.6) |
| Total | 286 (100) | 233 (100) | 519 (100) |
Out of the 160 participants with refractive error, 69 (43.1%) were myopes (31 males; 38 females), and 91 (56.9%) were hyperopes (42 males; 49 females) as according to the spherical equivalent, as shown in Table 5.

**DISCUSSION**

This is the first study to report the prevalence of URE and visual impairment in rural Zimbabwe covering a wider age group. The four communities involved in this study had no access to public and private eye care services within their catchment areas. The main occupation in Zimbabwe is agriculture, and a huge proportion (54.9%) of the population in Mashonaland central province are reported to be in communal farming. It can be extrapolated that in rural communities, farming is the main occupation along with an adult population.

Presenting VA was used as the basis for the determination of visual impairment and not best corrected VA. The prevalence of visual impairment in this study was high [Table 3] compared to similar studies conducted in developing countries. This may be due to differences in sampling techniques, access to eye care services, and research methodologies used in these studies. The major causes of visual impairment were refractive errors followed by cataract, which is consistent with the trends in most developing countries. This resulted from the poor distribution of optometrists, inadequate optometric care, and cataract surgery services which account for the unmet visual needs among the study sample.

The prevalence of near visual impairment in this study was lower than that of Chirunga et al. who reported a prevalence of 94.2%. This can be attributed to the loss of accommodation among the age group (50 and above) of participants involved in their study. However, the prevalence in this study was higher than the

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**Table 2: Distribution of visual impairment base on presenting visual acuity in the age groups**

| Visual acuity | Children (%) | Youth (%) | Adult (%) | Elderly (%) | Total (%) |
|--------------|--------------|-----------|-----------|-------------|-----------|
| Normal vision| 9 (21.4)     | 26 (23.4) | 69 (40.4) | 52 (26.7)   | 156 (30.1) |
| Mild VI      | 3 (7.1)      | 3 (2.7)   | 12 (7.0)  | 71 (36.4)   | 89 (17.1)  |
| Moderate VI  | 11 (26.2)    | 18 (16.2) | 38 (22.2) | 10 (5.1)    | 77 (14.8)  |
| Severe VI    | 17 (40.5)    | 58 (52.3) | 50 (29.2) | 4 (2.1)     | 129 (24.9) |
| Blindness    | 2 (4.8)      | 6 (5.4)   | 2 (1.2)   | 58 (29.7)   | 68 (13.1)  |
| Total        | 42 (100)     | 111 (100) | 171 (100) | 195 (100)   | 519 (100)  |

Blindness=4.0-1.80 logMAR, Severe VI=1.02-1.30 logMAR, Moderate VI=0.52-1.00 logMAR, Mild VI=0.32-0.50 logMAR, Normal vision=0.0-0.30.

**Table 3: Prevalence of blindness and visual impairment in the better eye**

| Parameters | Blin(d (n) | Prevalence (%) (95% CI) | VI (n) | Prevalence (%) (95% CI) |
|------------|------------|-------------------------|--------|-------------------------|
| Age group  |            |                         |        |                         |
| Children   | 2          | 4.8 (0.7-17.8)          | 31     | 73.8 (66.6-95.8)         |
| Youth      | 6          | 5.4 (1.3-10.6)          | 79     | 71.2 (69.0-87.6)         |
| Adults     | 2          | 1.2 (0.1-4.6)           | 100    | 58.5 (56.2-72.5)         |
| Elderly    | 58         | 29.7 (25.6-39.8)        | 85     | 43.6 (40.3-55.6)         |
| Gender     |            |                         |        |                         |
| Male       | 36         | 15.5 (11.9-22.1)        | 134    | 57.5 (56.3-70.3)         |
| Female     | 32         | 11.2 (8.3-16.3)         | 161    | 56.3 (55.6-68.2)         |
| Total      | 68         | 13.1 (11.2-17.6)        | 295    | 56.8 (55.7-67.2)         |

VI: Visual impairment, CI: Confidence interval with design effect of 1.1, n: Number of participants

**Table 4: Gender distribution of the causes of visual impairment and blindness**

| Diagnosis in better eye | Gender (VI) | Total (%) | Gender (BL) | Total (%) |
|-------------------------|-------------|-----------|-------------|-----------|
|                         | Male (%)    | Female (%)| Total (%)   | Male (%)  | Female | Total (%) |
| Refractive error        | 73 (54.5)   | 87 (54.0) | 160 (54.2)  | -         | -      | -         |
| Cataract                | 35 (26.1)   | 38 (23.6) | 73 (24.8)   | 13 (36.1) | 15 (46.9)| 28 (41.2) |
| Glaucoma                | 19 (14.2)   | 28 (17.4) | 47 (15.9)   | 12 (33.3) | 10 (31.2)| 22 (32.4) |
| Others                  | 3 (2.2)     | 6 (3.7)   | 9 (3.1)     | 3 (8.3)   | 5 (15.6)| 7 (10.2)  |
| Corneal opacity         | 4 (3.0)     | 2 (1.2)   | 6 (2.0)     | 8 (22.2)  | 2 (6.3) | 11 (16.2) |
| Total                   | 134 (100)   | 161 (100) | 295 (100)   | 36 (100)  | 32 (100)| 68 (100)  |

VI: Visual impairment, BL: Blindness, Others: Macular degeneration, macular star, optic neuritis, uveitis
national eye health report of 70%\(^\text{13}\) in Zimbabwe. This report was not on evidence-based data on refractive error in the country. Near visual impairment in this study was among participants aged 36 and above, which is consistent with similar studies in Africa.\(^\text{30–32}\) It can be concluded that Africans have earlier onset of presbyopia than the reported age of presbyopia in literature.\(^\text{33}\)

Cataract was the second major cause of visual impairment and the leading cause of blindness among the study sample. This is consistent with reported studies in other developing countries.\(^\text{18–28}\) The burden of cataract was high in this study because of the mean age of the study sample and buttresses the positive association between cataract and age. Also, Zimbabwe has only 16 ophthalmologists with 3 other trained cataract surgeons in public hospitals which can lead to a huge backlog of cataract cases.\(^\text{13}\)

Visual impairment was highest among adults in this study, which is consistent with studies in developing countries that have reported that there is a positive association between age and visual impairment.\(^\text{23–28}\) The outcome of this study shows that the easily correctable cause of visual impairment, which is refractive error, was prominent among the causes. The provision of spectacles and increased uptake of cataract surgery will be the key strategies in the elimination of avoidable blindness among rural Zimbabweans. Also, the training of optometrists in the country along with equitable distribution will reduce the prevalence of visual impairment. Furthermore, eye health education on eye conditions such as refractive error and cataract is needed among people living in rural communities of Zimbabwe. This can improve their utilization of refractive services and uptake of cataract surgery.

The most common cause of blindness among the participants was consistent with similar studies conducted elsewhere in developing countries [Table 4].\(^\text{18–28}\) The results from these studies show that there are no marked regional variations in the major causes of blindness among participants in developing countries. However, the prevalence of visual impairment is 1.6–6-fold higher and 2.8–11.7-fold higher for blindness in rural Zimbabwe compared to other rural areas in developing countries.\(^\text{23–28}\)

Hypermetropia was the most common refractive status among the participants. This confirms the notion that hyperopia is common in non-industrialized communities.\(^\text{29}\) Also, a high number of the aged were involved in this study. Aging affects the refractive status due to changes in the crystalline lens leading to hyperopia.\(^\text{34}\)

There is a high prevalence of visual impairment and blindness in rural communities of Zimbabwe. URE and cataracts were the most common cause of visual impairment, but cataract is the number one cause of blindness. Accessibility to refractive error services and cataract surgery services remains a key strategy in dealing with this menace in rural Zimbabwe.

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**Conflicts of interest**

There are no conflicts of interest.

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**Table 5: Gender distribution per type of refractive error**

| Refractive error | Distribution of refractive error type per gender | Total (%) | Comparison of percentages proportions of refractive error types with respect to gender |
|------------------|-----------------------------------------------|---------|-----------------------------------------------|
|                  | Male (%) | Female (%) |         | Male (233) (%) | Female (286) (%) |
| Myopia           | 31 (42.5) | 38 (43.7) | 69 (43.1) | 13.3 | 13.3 |
| Hypermetropia    | 42 (57.5) | 49 (56.3) | 91 (56.9) | 18.0 | 17.1 |
| Total            | 73 (100)  | 87 (100)  | 160 (100) | 31.3 | 30.4 |

Myopia: At least −0.50 diopters, hypermetropia: At least +0.50 diopters
