Original Article

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

Selassie Tagoh[1], Samuel Kyei[1,2], Michael Agyemang Kwarteng[3], Evans Aboagye[1]

[1]Department of Optometry, Faculty of Sciences and Engineering, Bindura University of Science Education, Bindura, Zimbabwe, [2]Department of Optometry and Vision Science, School of Allied Health Sciences, College of Health and Allied Sciences, University of Cape Coast, Cape Coast, Ghana, [3]Discipline 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

Address for correspondence: Samuel Kyei, Department of Optometry and Vision Science, School of Allied Health Sciences, College of Health and Allied Science, University of Cape Coast, Cape Coast, PMB, Ghana.
E-mail: skyei@ucc.edu.gh
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Introduction

Globally, uncorrected refractive error (URE) remains the leading cause of visual impairment.[1,2] Auspiciously, a URE can easily be measured and corrected with optical corrective devices such as contact lenses, spectacles, and refractive surgeries.[1,2] Spectacles provide a safe and inexpensive solution to UREs. As high as ninety percent (90%) of persons with URE live in low- and middle-income countries.[3] This points to the fact that even though the majority of refractive errors cases are treatable, it remains a public health challenge in low- and middle-income countries.[4]

Several barriers have been identified to affect access to refractive error services, and these include the limited number of eye care personnel and resources for refraction, unavailability of refractive error services in rural areas, and the

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high cost of spectacles.[5] The high cost of spectacles has been highlighted as an important barrier to spectacle use in India,[6] East Africa,[7] and China.[8] An important problem in Zimbabwe is the lack of access to optimum refractive error services capable of providing accurate refractive error correction.[9] Again, unaffordability has been identified as a significant barrier to the utilization of eye health services.[7,8]

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.[10] Retinoscopy is a less expensive technology potentially suitable for use in the developing world, but the need for rigorous training has limited its use.[10]

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.[11,12] It also has a dramatic impact on their learning process and educational capacity increasing the rate of absenteeism, drop-out, and poor career prospects.[12] 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.[10] 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.[10]

Zimbabwe has sixteen ophthalmologists with no optometrist in public health institutions, but two ophthalmic nurses trained in refraction.[13] The national eye health strategy has reported that refractive error accounts for 5% of visual impairment in Zimbabwe, with presbyopia accounting for 70%.[13] 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*.[9] 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.[14] 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*.[9] 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.[15]

Where N = Sample size, Z = 1.96 (to produce a 95% confidence interval [CI] of the prevalence), P (estimated prevalence) = 0.5 (50% prevalence), d (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) × 480 = 95 participants
2. Mukumbura: Number of participants required = (13,242/53,344) × 480 = 119 participants
3. Mushumbi: Number of participants required = (12,073/53,344) × 480 = 109 participants
4. Muzarabani: Number of participants required = (17,423/53,344) × 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 Mukumbura, 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.

Table 1: Distribution of age groups according to gender

Age group	Gender of participants		Total (%)
	Females (%)	Males (%)	
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.[14] 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.[17] The prevalence of visual impairment in this study was high [Table 3] compared to similar studies conducted in developing countries.[9,18-29] 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.[18-28] 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*.[9] 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

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

Visual acuity	Age group				Total (%)
	Children (%)	Youth (%)	Adult (%)	Elderly (%)	
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.
VI: Visual impairment

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

Parameters	Blindness (*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 (%)		Male	Female	
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

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

national eye health report of 70%[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.[30-32] It can be concluded that Africans have earlier onset of presbyopia than the reported age of presbyopia in literature.[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.[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.[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.[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].[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.[23,28]

Hypermetropia was the most common refractive status among the participants. This confirms the notion that hyperopia is common in non-industrialized communities.[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.[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.

References

1. Pascolini D, Mariotti SP. Global estimates of visual impairment: 2010. Br J Ophthalmol 2012;96:614-8.
2. Naidoo KS, Leasher J, Bourne RR, Flaxman SR, Jonas JB, Keeffe J, *et al*. Global vision impairment and blindness due to uncorrected refractive error, 1990-2010. Optom Vis Sci 2016;93:227-34.
3. Resnikoff S, Pascolini D, Mariotti SP, Pokharel GP. Global magnitude of visual impairment caused by uncorrected refractive errors in 2004. Bull World Health Organ 2008;86:63-70.
4. Ono K, Hiratsuka Y, Murakami A. Global inequality in eye health: Country-level analysis from the Global Burden of Disease Study. Am J Public Health 2010;100:1784-8.
5. American Optometric Association. Optometric Clinical Practice Guideline: Care of the Patient with Visual Impairment (Low Vision Rehabilitation); 2007. Available from: https://www.aoa.org/documents/optometrists/CPG-14.pdf. [Last accessed on 2020 Jan 01].
6. Ramke J, du Toit R, Palagyi A, Brian G, Naduvilath T. Correction of refractive error and presbyopia in Timor-Leste. Br J Ophthalmol 2007;91:860-6.
7. Marmamula S, Keeffe JE, Raman U, Rao GN. Population-based cross-sectional study of barriers to utilisation of refraction services in South India: Rapid Assessment of Refractive Errors (RARE) Study. BMJ Open 2011;1:e000172.
8. Laviers HR, Omar F, Jecha H, Kassim G, Gilbert C. Presbyopic spectacle coverage, willingness to pay for near correction, and the impact of correcting uncorrected presbyopia in adults in Zanzibar, East Africa. Invest Ophthalmol Vis Sci 2010;51:1234-41.
9. Chirunga G, Minnies D, Tigere D. Rapid Assessment of Avoidable Blindness: Manicaland Province, Zimbabwe. IAPB; 2016. Available from: https://www.iapb.org/wp-content/uploads/CEHI-RAAB-ZIM-

Final-report-1.pdf. [Last accessed on 2020 May 26].

10. Abokyi S, Ilechie A, Nsiah P, Darko-Takyi C, Abu EK, Osei-Akoto YJ, *et al*. Visual impairment attributable to uncorrected refractive error and other causes in the Ghanaian youth: The University of Cape Coast Survey. J Optom 2016;9:64-70.
11. World Health Organization. Action Plan for the Prevention of Avoidable Blindness and Visual Impairment; 2009-2013. Available from: https://www.iapb.org/resources/who-action-plan-for-the-prevention-of-avoidable-blindness-and-visual-impairment-2009-2013/. [Last accessed on 2020 May 26].
12. Gudlavalleti VS, Allagh KP, Gudlavalleti AS. Self-adjustable glasses in the developing world. Clin Ophthalmol 2014;8:405-13.
13. Zimbabwe National Eye Health Strategy (2014 – 2018). Refractive error: 3.2.4: 23. Available from: https://zdhr.uz.ac.zw/xmlui/bitstream/handle/123456789/1384/Eye%20Health%20Strategy.pdf;jsessionid=A471B6D069F94AEFE2D67856942180C9?sequence=1. [Last accessed on 2020 May 26].
14. Zimbabwe National Population Census; 2012. Available from: http://www.zimstat.co.zw/sites/default/files/img/publications/Population/National_Report.pdf. [Last accessed on 2020 May 26].
15. Hashemi H, Pakzad R, Ali B, Yekta A, Ostadimoghaddam H, Heravian J, *et al*. Prevalence of refractive errors in Iranian University Students in Kazerun. J Curr Ophthalmol 2020;32:75-81.
16. World Health Organization. Blindness and Visual Impairment. Available from: http://www.who.int/news-room/fact-sheets/detail/blindness-and-visual-impairment. [Last accessed on 2020 May 26].
17. World Health Organization. Coding Instructions for the WHO/PBL Eye Examination Record (Version III). PBL/88.1. Geneva: WHO; 1988. p. 1-17.
18. Guzek JP, Anyomi FK, Fiadoyor S, Nyonator F. Prevalence of blindness in people over 40 years in the Volta region of Ghana. Ghana Med J 2005;39:55-62.
19. Wiafe B, Quainoo A, Antwi P. Ghana Blindness and Visual Impairment Study 2015, Ghana Health Service. Accra, Ghana: Operation Eyesight Universal; 2015.
20. Tafida A, Kyari F, Abdull MM, Sivasubramaniam S, Murthy GV, Kana I, *et al*. Poverty and Blindness in Nigeria: Results from the National Survey of Blindness and Visual Impairment. Ophthalmic Epidemiol 2015;22:333-41.
21. Flaxman SR, Bourne RR, Resnikoff S, Ackland P, Braithwaite T, Cicinelli MV, *et al*. Global causes of blindness and distance vision impairment 1990-2020: A systematic review and meta-analysis. Lancet Glob Health 2017;5:e1221-34.
22. Resnikoff S, Pascolini D, Etya'ale D, Kocur I, Pararajasegaram R, Pokharel GP, *et al*. Global data on visual impairment in the year 2002. Bull World Health Organ 2004;82:844-51.
23. Malhotra S, Vashist P, Kalaivani M, Gupta N, Senjam SS, Rath R, *et al*. Prevalence and causes of visual impairment amongst older adults in a rural area of North India: A cross-sectional study. BMJ Open 2018;8:e018894.
24. Naidoo K, Kempen JH, Gichuhi S, Braithwaite T, Casson RJ, Cicinelli MV, *et al*. Prevalence and causes of vision loss in sub-Saharan Africa in 2015: magnitude, temporal trends and projections. Br J Ophthalmol. 2020:bjophthalmol-2019-315217. doi: 10.1136/bjophthalmol-2019-315217. Epub ahead of print. PMID: 32229517.
25. Dineen B, Bourne RR, Jadoon Z, Shah SP, Khan MA, Foster A, *et al*. Causes of blindness and visual impairment in Pakistan. The Pakistan national blindness and visual impairment survey. Br J Ophthalmol 2007;91:1005-10.
26. Wu M, Yip JL, Kuper H. Rapid assessment of avoidable blindness in Kunming, China. Ophthalmology 2008;115:969-74.
27. Abdull MM, Sivasubramaniam S, Murthy GV, Gilbert C, Abubakar T, Ezelum C, *et al*. Causes of blindness and visual impairment in Nigeria: The Nigeria national blindness and visual impairment survey. Invest Ophthalmol Vis Sci 2009;50:4114-20.
28. Hashemi H, Yekta A, Jafarzadehpur E, Doostdar A, Ostadimoghaddam H, Khabazkhoob M. The prevalence of visual impairment and blindness in underserved rural areas: A crucial issue for future. Eye (Lond) 2017;31:1221-8.
29. Lewallen S, Lowdon R, Courtright P, Mehl GL. A population-based survey of the prevalence of refractive error in Malawi. Ophthalmic Epidemiol 1995;2:145-9.
30. Uche JN, Ezegwui IR, Uche E, Onwasigwe EN, Umeh RE, Onwasigwe CN. Prevalence of presbyopia in a rural African community. Rural Remote Health 2014;14:2731.
31. Obajolowo TS, Owoeye J, Adepoju FG. Prevalence and pattern of presbyopia in a rural Nigerian community. J West Afr Coll Surg 2016;6:83-104.
32. Naidoo KS, Jaggernath J, Martin C, Govender P, Chinanayi FS, Chan VF, *et al.* Prevalence of presbyopia and spectacle coverage in an African population in Durban, South Africa. Optom Vis Sci 2013;90:1424-9.
33. Benjamin WJ. Borish's clinical refraction. 2nd ed. UK: Butterworth-Heinemann; 2006.
34. Hashemi H, Fotouhi A, Yekta A, Pakzad R, Ostadimoghaddam H, Khabazkhoob M. Global and regional estimates of prevalence of refractive errors: Systematic review and meta-analysis. J Curr Ophthalmol 2018;30:3-22.