Original

Epidemiology of Uncorrected Refractive Error and Vision Impairment Among Pupils in Bindura, Zimbabwe: A Cross-sectional Study

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Abstract

Background: Uncorrected refractive error is a major global cause of vision impairment, affecting education, development, and productivity, especially in children. The study examined the distribution of refractive errors and vision impairment among primary school children in Bindura City.

Methods: This descriptive cross-sectional study was conducted in three primary schools in Bindura, Zimbabwe, from April 2022 to April 2024. A multistage sampling method was used to select schools based on their administrative type, and data were collected through questionnaires, visual acuity tests, refraction, and fundoscopy.

Results: 3038 pupils were recruited and screened for the study, with 50.2% females and age ranging from 4-15 years (mean age = 9.19 ± 2.86 years). The prevalence of uncorrected refractive error was 3.1% (95% CI: 2.5% - 3.8%), with myopia at 2.6%; (95% CI: 2.1% - 3.6%), and hyperopia 0.5%; (95% CI: 0.3% - 0.8%). The prevalence of distance vision impairment was 0.36% (95% CI: 0.18% - 0.65%), and chi-squared test revealed that it was significantly associated with geographical setting ($X^2 = 18.26$, df = 2, $p < 0.001$), but not with uncorrected refractive error ($X^2 = 2.626$, df = 4,p = 0.622) or age (F [11, 3026] = 0.648; p = 0.499). There was no significant association between a child's age and uncorrected refractive error (F [11, 3026] = 0.942; p = 0.499).

Conclusion: Although the prevalence of uncorrected refractive error and visual impairment amongst the pupils was lower than in similar studies in Zimbabwe, the most common type of refractive error was myopia.

Keywords: refractive error, vision impairment, children, pupils, Zimbabwe

How to cite this article

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Introduction

Uncorrected refractive error in children significantly impacts their general development, particularly their educational, social and emotional development [1]. Children infrequently complain about their eyesight and some of them may not even be aware of the presence of any ocular condition [2,3]. Uncorrected refractive errors result in reduced educational achievements as well as employment options, affecting the individual and the community at large [3]. If the refractive error is not corrected early, there will be a compromise in the neurological development of the visual system resulting in amblyopia [4], which can affect their quality of life [4–6].

According to current global estimates, about 2.2 billion people live with vision impairment (VI) [1], with most cases found in developing countries [1,7]. Global reviews show that uncorrected refractive error is the leading cause of VI accounting for 8% of avoidable blindness worldwide [1,7]. There is the need for good vision from childhood to adulthood for several educational activities, including studying and writing [1]. Generally, uncorrected refractive error has important economic significance with the most concerning being possible lost productivity [1]. This study focuses on spherical equivalents of myopia and hyperopia as the primary refractive errors, along with distance vision impairment, which can affect children's academic performance and overall well-being [6].

Access to refractive error services is hindered by several challenges, including scarcity of material resources and eye care professionals, limited availability of services in rural areas, and the high cost of spectacles [8,9]. In Zimbabwe, a school-based study among children in Harare and Bulawayo recorded 42% of visual problems [10], whilst a hospital-based study among children in Harare recorded presenting VI of 9.9% [11]. To the best of our knowledge, there is no literature on school-going children in other parts of the country; therefore, this study provides recent data in Bindura and in a larger sample in Zimbabwe. This study aimed to determine the prevalence of uncorrected refractive error and visual impairment among pupils in Bindura.

Materials and Methods

Study design

The study used a descriptive cross-sectional design in three primary schools (Chiwaridzo Primary, Salvation Army Primary, and Shashi Primary) in Bindura. The survey was done from April 2022 to April 2024 at the schools' premises.

Study area

Bindura is about 87 km North-East of Harare, the capital city of Zimbabwe [12]. Bindura District in Zimbabwe has 59 primary schools, with those with a high pupil population in Bindura City [13]. Among the schools, two are managed by the government and 57 by churches or the council [13].

Study population

All learners in the selected schools were involved in the study. The learners, both male and female participants were of similar ages in the schools. The majority of learners are from urban areas in Bindura, a district where large-scale agriculture and mining are prominent occupations [14].

Inclusion and exclusion criteria

The study included all enrolled pupils at the time of the study and pupils whose parents agreed for them to take part in the study. Pupils who did not come to school on the day of the examination were not included.

Sampling method and sample size

A multistage sampling method was used in this study. The schools were classified according to the administrative type (government-run, church-run, and council-run) [13] and the school with largest student population in each type was conveniently selected for the study. Three schools were conveniently selected schools from each school administration types within Bindura City.

Data collection and study instruments

Data were collected under the supervision of a licensed optometrist using a structured questionnaire comprising three sections. The first section was used to collect the pupils' demographic information, and the second for recording the visual acuity, auto-refractometer and subjective refraction results to determine the type of refractive error and vision impairment [1]. The last part was for recording fundoscopy results. Visual acuity was assessed with a tumbling E Snellen chart, and the refractive status was determined with an RK-160 autorefractor (CANTON optics) and subjective refraction. The ocular structures on the other hand were examined using the xyz ophthalmoscope (Chongqing Vision Star Optical Co Ltd). Visual impairment (VI) was

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classified according to the WHO [1] classification where No VI (6/6–6/12), Mild (less than 6/12–6/18), Moderate (less than 6/18–6/60). Also, myopia was defined as ≤ -0.50 DS and hyperopia as ≥ +2.00 DS as used in similar studies [11,15].

Data analyses

Data from the pupils were analysed using IBM Statistical Package for Social Sciences (SPSS) version 21. The data were grouped to show frequencies and percentages computed. A Chi-square and One-way ANOVA tests were done to find the relationship between refractive error and other variables such as age and gender.

Ethical consideration

The Bindura University of Science Education's Research and Ethics Committee approved the study with approval number 0019/2022. Permission was also obtained from the Heads of the schools (Chiwaridzo Primary, Salvation Army Primary and Shashi Primary) included in the study. Ethical considerations were observed during the study to avoid any harm to the participants and reduce the spread of Covid-19; the workspace and instruments were sanitised regularly. Parents of pupils involved in the study provided written informed consent following their agreement for their children to participate in the research while assent was obtained from the pupils themselves. Participation in the study was not mandatory, and participants were free to withdraw at any point. Confidentiality and privacy were maintained throughout the study using unique identification numbers. This prevented the identification of participants.

Results

Baseline characteristics of participants

A total of 3038 learners were recruited and screened for the study, and 50.2% (1525) were female. The ages of all participants ranged from 4-15 years. The mean age of the study participants was 9.19 ± 2.86 years. Most pupils (74.1%) were classified as living in the urban setting, while only about one-fifth were identified as living in the rural setting. According to the school's grading system, there was an approximately equal number of children in each school year, with no significant differences. Table 1 illustrates the baseline characteristics of all participants.

Table 1: Baseline characteristics of participants

Baseline characteristics	Male n (%)	Female n (%)
Sex	1513 (49.8)	1525 (50.2)
School		
Chiwaridzo Primary	513 (16.9)	572 (18.8)
Salvation Army Primary	636 (20.9)	565 (18.6)
Shashi Primary	364 (12.0)	388 (12.8)
Geographical setting		
Rural	276 (9.1)	299 (9.8)
Peri-urban	102 (3.4)	112 (3.7)
Urban	1135 (37.4)	1114 (36.7)
Age (years), mean	9.24 ± 2.89	9.13 ± 2.84
4	50 (1.6)	61 (2.0)
5	154 (5.1)	155 (5.1)
6	170 (5.6)	143 (4.7)
7	55 (1.8)	61 (2.0)
8	124 (4.1)	170 (5.6)
9	243 (8.0)	245 (8.1)
10	205 (6.7)	212 (7.0)
11	135 (4.4)	143 (4.7)
12	160 (5.3)	139 (4.6)
13	111 (3.7)	93 (3.1)
14	58 (1.9)	59 (1.9)
15	48 (1.6)	44 (1.4)
Year in school (grade)		
Early Childhood Development	183 (6.0)	184 (6.1)
Grade 1	187 (6.2)	188 (6.2)
Grade 2	185 (6.1)	185 (6.1)
Grade 3	177 (5.8)	184 (6.1)
Grade 4	179 (5.9)	182 (6.0)
Grade 5	184 (6.1)	184 (6.1)
Grade 6	184 (6.1)	184 (6.1)
Grade 7	185 (6.1)	185 (6.1)
Special class	49 (1.6)	49 (1.6)

N = number of participants

Refractive error and vision impairment

A total of 2944 (96.9%) participants were found to be emmetropic. The prevalence of uncorrected refractive error among the children examined was 3.1% (95% CI: 2.5% - 3.8%), with myopia being the most common cause (2.6%; 95% CI: 2.1% - 3.6%), followed by hyperopia (0.5%; 95% CI: 0.3% - 0.8%).

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The prevalence of distance vision impairment was found to be 0.36% (95% CI: 0.18% - 0.65%), with almost an equal prevalence of mild and moderate impairment. Table 2 illustrates the distribution and prevalence of vision impairment by gender.

Table 2: Prevalence of distance vision impairment

Presenting VI	Male n (%)	Female n (%)	Prevalence	95% CI
No VI	1507 (49.6)	1520 (50.0)	99.6	97.9 – 99.5
Mild VI	4 (0.1)	2 (0.1)	0.2	0.07 – 0.4
Moderate VI	2 (0.1)	3 (0.1)	0.16	0.05 – 0.38

N = number of participants, VI: visual impairment, CI: confidence interval
No VI (6/6–6/12), Mild (less than 6/12–6/18), Moderate (less than 6/18–6/60)

Relationship between age, geographical setting, refractive error, and vision impairment

A chi-squared test revealed statistically significant relationship between children's geographical setting and the development of distance vision impairment ($X^2 = 18.26$, df = 2, $p < 0.001$), however, there was no significant relationship with uncorrected refracted error ($X^2 = 2.626$, df = 4, p = 0.622). That is, the development of uncorrected refractive error is independent of geographical location, but vision impairment is not. A one-way ANOVA also revealed that there was no statistically significant association between the age of a child and uncorrected refractive error (F [11, 3026] = 0.942; p = 0.499) as well as distance vision impairment (F[11, 3026] = 0.648; p = 0.789).

Discussion

This study provides crucial information on VI and refractive error in Bindura. The prevalence of refractive error recorded in the current study was similar to 3.5% and 3.7% recorded in studies in Ethiopia [16] and Ghana [17], respectively. However, it was considerably lower than the 9.7% and 29.4% reported among school children in Nigeria [18], Egypt [19] and other places [20–24]. The prevalence in this study was also higher than 0.7%, 1.4%, 1.8% and 2.2% recorded in Tanzania [25], South Africa [26], Ghana [27] and Sudan [28] respectively. Differences in sample size could have contributed to the variations in the prevalence. For example, the 3038-sample size used in the current study was higher than the 998, 1705 and 2070 used in studies in Nigeria [18], Ghana [27] and Egypt [19], respectively. However, the current study age range was similar to the range of 5 to 15 years and 6 to 15 years used in studies in Nigeria [18] and Egypt [19], respectively.
Female pupils constituted a larger percentage of the student body than male pupils across all grade levels (from kindergarten through seventh grade and in special classes for learners with disabilities). This trend reflects the general demographics of children in Bindura District and Zimbabwe [29].

Myopia was the most prevalent refractive error recorded in this study, similar to findings from other studies [16–18,30,31]. This study recorded a prevalence of myopia similar to 2.6% and 2.9% reported in Ethiopia [16] and Nigeria [32] respectively. It was, however, lower than 4.5% and 62.7% recorded in Nigeria [18] and Egypt [20] respectively. Myopia is currently a significant public health problem in Africa [31], thus the need to initiate and implement myopia control strategies in school children, especially in Africa, cannot be overemphasised [31].

The prevalence of visual impairment recorded in this current study is lower than 1.3% reported among school children in Nigeria [18], 9.9%, 42% and 56.8% recorded in previous studies [9–11] in Zimbabwe. The fact that two of the previous studies on visual impairment in Zimbabwe were not school-based made it challenging to compare with the findings in the study. The age range of the school-based study in Zimbabwe [10] was wider (5-20 years) compared to that of this current study. More school-based studies with similar age ranges need to be done in Zimbabwe to compare with this study's results.
The prevalence of uncorrected refractive error is closely linked to the geographical location of individuals. Specifically, children in urban areas had higher prevalence of myopia compared to their rural counterparts [33]. This study also found a significant association between the development of distance vision impairment and geographical location. However, no significant relationship was observed between

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geographical location and uncorrected refractive error among children. Indeed, in Africa, reports suggest that myopia shows an upward surge among a large population of children at the age of 14 [26]. This study enrolled fewer children at this critical age, potentially explaining why no significant associations were found in that regard.

Similarly, age has been reported as a risk factor for refractive error, especially in adults where old age is associated with other age-related refractive anomalies like presbyopia. In children, there is continuous refractive modulation at birth until emmetropization is complete at around six years [34]. This predicts an association between age and uncorrected refractive errors due to lenticular and axial length growth with associated changes in initial refractive error during this period [35]. Nevertheless, this study found no association between the age of children and uncorrected refractive error. Two main factors could explain this; first, the prevalence of refractive error reported here, although consistent with previous studies, is low and, therefore, not large enough to reveal any reliable trends between age and uncorrected refractive error. Secondly, although emmetropization is complete at age six, participants in this study were between 4 and 15 years old. It can be noted that within this age group, most children in this study would have developed a stable refractive state and therefore show no significant changes in uncorrected refractive error relative to their age.

Strengths and limitations of the study

This study provides the first data of uncorrected refractive error among pupils in Bindura district. The large sample size of 3038 learners enhances the generalizability of the findings within Bindura. The use of a multistage sampling method also strengthens the study by ensuring representation across different school administrative types, including government-run, church-run, and council-run schools. However, there were some limitations. The study relied on measurement of refractive error using an autorefractor and subjective refraction, without cycloplegic refraction, which may have led to an overestimation or underestimation of myopia and hyperopia among the learners.

Conclusion

The prevalence of uncorrected refractive error and VI amongst the pupils was lower than in similar studies in Zimbabwe, the most common type of refractive error was myopia. Early detection and intervention to prevent further vision impairment and academic challenges for these pupils is of paramount importance. It is necessary to undertake more thorough research that consider other districts and provinces in order to determine the extent and nature of vision impairment in Zimbabwe.

Declarations

Authors' Contribution: MAK-Conceptualization, methodology, software, validation, formal analysis, resources, writing-original draft, writing -review and editing, visualization, supervision.
FAA- Software, methodology, validation, formal analysis, resources, writing-original draft, writing -review and editing, visualization
SK- Methodology, validation, resources, writing-original draft, writing -review and editing, visualization
AM- Data curation, resources, writing -review and editing, visualization, project administration
RM- Data curation, resources, writing -review and editing, visualization, project administration
SN- Data curation, resources, writing -review and editing, visualization, project administration
TJ- Data curation, resources, writing -review and editing, visualization, project administration.

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