African Vision and Eye Health
ISSN: (Online) 2410-1516, (Print) 2413-3183

Magnitude and causes of visual impairment amongst school children in the Bono Region of Ghana

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Dates:
Received: 16 May 2020
Accepted: 28 Apr. 2021
Published: 07 July 2021

How to cite this article:
Opoku-Yamoah V, Rampersad N, Gcabashe NT. Magnitude and causes of visual impairment amongst school children in the Bono Region of Ghana. Afr Vision Eye Health. 2021;80(1), a578. https://doi.org/10.4102/aveh.v80i1.578

Background: Information on the visual health of school children can assist in developing strategies to reduce preventable causes of visual impairment (VI) and maintain good vision.

Aim: This study aimed to determine the magnitude and causes of VI amongst basic school children aged 6–16 years in the Bono Region of Ghana.

Setting: The study site included five basic schools in 12 administrative districts of the Bono Region of Ghana.

Methods: A multistage random sampling technique was used to enrol 645 participants from five selected public schools.

Results: Overall, 1.4% of the sample had some form of VI that was worse than mild or no VI, and ocular conditions were present amongst 45.1% of the participants. Uncorrected refractive error (URE) was found amongst 9.8% of the study participants ($n = 63$) and was an important cause of VI. Other ocular conditions detected in the sample included allergic conjunctivitis ($n = 174$), cataract ($n = 2$) and keratoconus ($n = 2$). Overall, 632 (98.0%) participants recorded a visual acuity (VA) of 20/20 – 20/60, 11 (1.7%) participants had a VA of < 20/60 – 20/200, 1 (0.15%) participant had a VA of < 20/200 – 10/200 and 1 (0.15%) participant had a VA of < 10/200.

Conclusion: The presence of ocular conditions was high amongst the study participants (45.1%). However, the prevalence of VI was found to be low (1.4%) with URE being the most common cause. This study supports the need to intensify awareness of ocular conditions and/or VI in basic schools through regular vision health screening and education.

Keywords: visual impairment; ocular disease; childhood blindness; eye care; Bono Region, Ghana.

Introduction

Visual impairment (VI) is classified by the International Classification of Diseases (ICD-10) into different categories according to presenting distance visual acuity (VA). Distance VI categories consist of mild or no VI (presenting VA equal to or better than 20/70), moderate VI (presenting VA worse than 20/70 but equal to or better than 20/200), severe VI (presenting VA worse than 20/200 but equal to or better than 20/400) and blindness (presenting VA worse than 20/400).[1] Visual impairment is a common phenomenon amongst children of school going age. Congenital and childhood forms of VI have life-long consequences and can affect health, development, communication, learning, employment and quality of life.[2] Even though, the World Health Organization (WHO) has made efforts in developing programmes to target childhood blindness, not much attention has been given to uncorrected refractive error (URE) despite the fact that it is one of the leading causes of VI in different settings around the world[3,4,5,6] and the second most common cause of blindness.[7]

Available data show that out of the 45 million people who are blind worldwide, around 1.4 million are children under 16 years of age, and 75% of those affected live in developing countries.[1] Children are particularly susceptible to VI and/or blindness in their early years of life, especially when normal visual development is interrupted by an ocular disorder,[8] which may result in varying degrees of VI. Globally, it is estimated that 285 million people have VI, and of these, 19 million (6.6%) are children aged below 15 years.[9] It is further estimated that 1.4 million children have severe VI and/or blindness with higher proportions found in Asia (1 million) and Africa (300 000).[1] In Ghana, there is limited data on VI amongst children.[10,11] The consequences of VI and/or blindness in children are important public health issues with greater impact in developing

countries where about 80% of the blindness in children occurs.[12] Studies reveal that one-third to half of childhood blindness is either preventable or treatable.[13] During a child's first 12 years of life, about 80% of all learning occurs through vision[14] and yet most children may not have had a comprehensive eye examination prior to starting school. Children with poor vision may be labelled as weak students by teachers and/or peers, and this may indirectly reduce the level of expectation for the affected child's future. The prevention, early detection and prompt treatment of ocular diseases by regular screening of school children reduces the occurrence of ocular conditions, thereby ensuring that children can pursue their education to become socially and economically vibrant.[15]

Studies have reported that in Africa, there is a high prevalence of ocular conditions amongst school children who exhibit low uptake on visual health matters.[16,17] Surprisingly, the prevalence of URE has been reported to be low amongst children of African descent (ranging from 1.7% to 8.5%).[5,11,18] Possible reasons for the low prevalence of URE may be attributed to limited access to eye care data and services and inadequate eye care professionals working in well-resourced centers.[5] In spite of this, it has been shown that myopia accounts for approximately 35% to 65% of VI amongst children in Africa.[19,20] Furthermore, there is limited epidemiological data on ocular conditions in most developing countries in Africa, especially amongst children who are deemed as valuable assets for every country. Ocular diseases in children when undetected may have the potential to adversely affect performance in school and may cause severe ocular disability in the later part of life.[21,22] Children experience more visually demanding tasks at school than at home and may learn to adjust to poorly illuminated classrooms by sitting close to the chalk board, adjusting their reading distances by holding textbooks close to their eyes, squinting their eyes to force ocular accommodation and avoiding any form of near work altogether.[14] This may have serious consequences on their educational development, future employability and other long-term socio-economic implications including poverty, limited career choices and poor interactions.[21] It therefore becomes necessary for parents and school teachers to be aware of interventions that will help in recognising symptoms of ocular morbidity and refractive error amongst school children.

This study aimed to determine the magnitude and causes of VI amongst school children in the Bono region of Ghana. The data on causes of VI included URE and ocular conditions and aimed to contribute to the limited data on VI in the Bono region.

Materials and methods

Study design and setting

An observational cross-sectional study was carried out amongst school children in five public basic schools in the Bono Region of Ghana. Ghana is located in the West African sub-region and has an approximate population of 25 million inhabitants, 50.9% of whom live in urban centers.[23] The Ghana Statistical Service[23] indicated in its 2010 census report that VI was a major cause of disability in the country. In terms of healthcare, about 40% of the country's population access medical care using the National Health Insurance Scheme (NHIS), which in eye care covers preliminary eye examinations such as ophthalmoscopy, refraction, visual fields and cataract extraction.[24] Institutions currently available for training eye care professionals in Ghana include one postgraduate physician training college in ophthalmology, two schools of optometry, one post-graduate diploma in ophthalmic nursing school and one optical dispensing technician school. A recent study[25] reported that the ratio of optometrists to the Ghanaian population was 1:82 000.

The Bono Region is one of the six newly created regions in Ghana by a referendum in 2018. It was carved out on the western part of the former Brong-Ahafo Region that covered an area of 39 557 km^2. The Bono Region shares boundaries with the Savannah Region to the north, the Ahafo and Western North Regions to the south, the Bono East Region to the east, the Ashanti Region to the southeast and La Cote d'Ivoire to the west. It has 12 administrative districts, with Sunyani as the regional capital (Figure 1). The region lies in the forest zone and is a major cocoa- and timber-producing area. The northern part of the region lies in the savannah zone and is a major grain- and cash crop-producing region. The regional capital, Sunyani covers a total land area of 506.7 km^2. It is located at the heart of Brong-Ahafo Region lying between latitudes 70 20'N and 70 05'N and longitudes 20 30'W and 20 10'W. It is bordered on the north by Sunyani West District, west by Dormaa East District, south by Asutifi District to the South and east by Tano North District. The population of the Municipality according to the 2010 Population Housing Census stands at 123 224.[26]

Study population, sampling and sample size

The study was carried out from August to September 2019 and was limited to school children aged between 6 years and 16 years, according to the United Nations Convention's

FIGURE 1: A map of Bono Region showing the administrative districts.

definition for children.[27] A multistage random sampling technique was used to randomly select five basic schools in the districts. The districts, which were all in the Bono Region of Ghana, included Sunyani Municipal District, Sunyani West District, Berekum Municipal District, Berekum West District, Dormaa Municipal District, Dormaa East District, Dormaa West District, Jaman North District, Jaman South District, Tain District, Wenchi District and Banda District. Simple random sampling was used to select school children from the selected schools for the study. This was carried out through simple balloting to select children from every class with the use of their class registers. A minimum sample size of 350 children was estimated, in consultation with a statistician, using the expression:

$$n = z^2 p\,(1-p)/d^2 \quad \text{[Eqn1]}$$

where n is the minimum sample size, p is the anticipated prevalence (0.7),[28] d is the margin of error taken as 5% and z = 1.96 for a 95% confidence interval (CI). A minimum number of 70 children were targeted to be selected from each school for inclusion in the study.

Research team, pilot study and study criteria

The research team comprised of two registered optometrists including the principal investigator (researcher), two research assistants and an enumerator. Prior to the commencement of the data collection phase of the study, a 2-day training exercise was organised for the research team. After obtaining ethical approval, a pilot study was carried out on 9 August 2019 in a selected basic school which was not sampled for the study. This was used for refining the data collection procedures and data collection tools. All public-school children at the basic level whose age was within 6–16 years could take part in the study. School children whose ages fell outside 6–16 years were excluded from the study. Each participant's age was confirmed using the class register.

Data collection instruments

A questionnaire comprising of questions relating to participant's demographic and ocular characteristics such as age, sex, class, name of school, past ocular history assessing frequency of eye clinic visits and knowledge on eye care was solicited from the participants. Ophthalmic diagnostic tests such as distance VA testing with Snellen charts, retinoscopy and ophthalmoscopy were employed to assess the anterior and posterior segment of the eye. The following equipment were used in obtaining the relevant data to meet the study objectives: pen torch, head loupe magnifier, ophthalmoscope, retinoscope, trial frame and trial lens set.

To determine the presence, cause and type of VI, three tests were carried out on each study participant, namely, the VA measurement, examination with pen torch and ophthalmoscope. Visual acuity was measured in well-illuminated rooms using Snellen acuity charts at 20 feet. For participants with uncorrected VA worse than 20/30, the VA measurement was repeated with the use of a pinhole. Retinoscopy and subjective refractions were carried out on participants whose VA improved with the pinhole to determine the type and magnitude of refractive error as for previous studies.[17,29] Refractive error was defined as myopia if the sphere value in the spectacle correction was –0.50 dioptre (D) or worse,[30,31] hyperopia if the sphere value was +0.75 D or worse,[32,33] and astigmatism if the cylinder value in the spectacle correction was –0.50 D or worse.[30,31] A best-corrected VA better than or equal to 20/60 was graded as mild or no VI, VA measurements worse than 20/60 to 20/200 was graded as moderate VI, VA measurements less than 20/200 to 10/200 was graded as severe VI and VA worse than 10/200 to no light perception was regarded as blindness.[1]

Ocular health assessments were carried out for all participants using ocular motility testing, anterior segment evaluation with a pen torch and head loupe magnifier and posterior segment evaluation with a direct ophthalmoscope. The anterior segment examination was used to examine the ocular adnexa including the eye lids, eye lashes, cornea, conjunctiva and sclera for signs of conditions including but not limited to blepharitis, trachoma and corneal opacities. For participants suspected of having a dry eye condition (based on complaints of burning or stinging ocular sensation, foreign body sensation, tearing and redness), tear break up time (TBUT) was estimated using fluorescein strips observed under cobalt blue filter light of the ophthalmoscope where a TBUT of less than 10 s indicated the presence of dry eye syndrome amongst the participants. The posterior segment examination was used to identify conditions including but not limited to uveitis, lenticular and vitreous opacities and retinal abnormalities such as scarring and glaucoma suspects through undilated pupils.

Statistical analysis

The data were checked for completeness and then captured in the Statistical Package for the Social Sciences (SPSS) (International Business Machines Corporation Released 2011. IBM SPSS Statistics for Windows, version 20.0. Armonk, NY, United States [US]). Data were analysed using descriptive statistics (means, standard deviations, ranges, percentages and frequencies) to describe the ocular conditions existing amongst the study participants.

Ethical considerations

Ethical approval (BE 386/19) was obtained from the Biomedical Research and Ethics Committee (BREC) at the University of KwaZulu-Natal, and approval was granted by the Education Directorate of the Ghana Education Service in the Brong Ahafo Region. Permissions were obtained from the head of the districts and the heads of the selected basic schools. Informed parental consent and the assent of the school children sampled for the study were obtained before they could participate in the study. The study conformed to the principles of the Declaration of Helsinki.

Results

A total of 645 school children were examined comprising of 297 (46.0%) males and 348 (54.0%) females representing a gender ratio of 1:1.2. Their ages ranged from 6 years to 16 years with a modal age of 13 years and mean age of 11.12 ± 3.09 years. The age group with the highest frequency of participants was the 12–14 years, whilst the lowest frequency was amongst the 15–16 years. Across all four age groups, there were more female than male participants (Table 1).

Participants answered closed-ended questions pertaining to their knowledge or education on eye care, if they have been examined by an eye professional in the past and if so, how long ago was the examination conducted. It was found that only 95 (14.7%) participants had some knowledge and education on eye care in the form of advice or instructions from an eye professional. Furthermore, less than 30% (n = 175) of the sample had an ocular examination prior to data collection in this study (Figure 2). In terms of gender, a similar percentage of male (28.3%) and female (26.1%) participants reported having had a previous ocular examination. Of those who had a previous ocular examination, 89 (50.9%) had their ocular examination within 1 year, 85 (48.6%) were examined 1–5 years ago and only one (0.6%) participant was examined 6–10 years ago.

Based on the best-corrected VA of the participants, 636 (98.6%) had mild or no VI, 7 (1.1%) had moderate VI and 1 (0.2%) each had severe VI and blindness. This implies that overall, VI (moderate, severe and blindness) was found in only 9 (1.4%) of the study participants. In relation to gender, 4 males and 3 females were found to have moderate VI, whilst 1 male each had severe VI and blindness, respectively. The results showed that for the right eye, 632 (98.0%) had a best-corrected VA measurement better than or equal to 20/60, 11 (1.7%) had VA of worse than 20/60 to 20/200, 1 (0.2%) had a VA of worse than 20/200 to 10/200 and 1 (0.2%) had a VA of worse than 10/200. For the left eye, 630 (97.7%) had a VA better than or equal to 20/60, 9 (1.4%) had a VA of worse than 20/60 to 20/200, 4 (0.6%) had a VA of worse than 20/200 to 10/200 and 2 (0.3%) had a VA of worse than 10/200.

Myopia was the most common refractive error found and was present in 44 (6.8%) participants comprising 20 males and 24 females. Hyperopia was found amongst 13 (2.0%) participants comprising 7 males and 6 females, whereas 6 (0.9%) participants comprising of 2 males and 4 females had astigmatism. In terms of age distribution, a greater number of participants aged 12–14 years were found with myopia and astigmatism, whilst participants aged 6–8 years recorded most hyperopia cases (Table 2). Moderate VI was identified amongst two females with myopia aged 12–14 years and a male with astigmatism aged 15–16 years.

Generally, most participants in the two gender groups (n = 171 male and n = 192 female) reported that they did not experience any ocular symptoms. The remaining participants reported experiencing several ocular symptoms, and their frequency and type stratified for gender are shown in Figure 3. The ocular symptoms as experienced by the participants included 158 (24.5%) with itchiness and discharges, 71 (11.0%) with blurred vision, 46 (7.1%) with pains or burning sensations and 7 (1.1%) with tearing and redness in their eyes (Figure 3). Overall, there were more females that reported the presence

TABLE 1: Distribution of the participants' gender in the different age groups.

Age (years)	Gender of participants		Total
	Male (n)	Female (n)	
6–8	80	85	165
9–11	82	92	174
12–14	89	105	194
15–16	46	66	112
Total (%)	**297†**	**348‡**	**645§**

†, 46.0%; ‡, 54.0%; §, 100.0%.

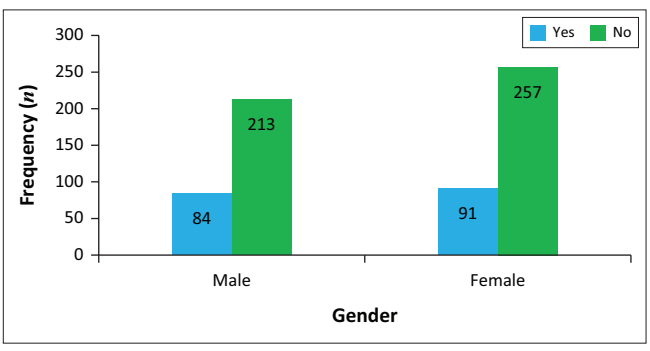

FIGURE 2: Frequency of previous ocular examination stratified for gender.

TABLE 2: Age distribution of refractive error amongst participants.

Age (years)	Refractive error												Total	
	Myopia				Hyperopia				Astigmatism					
	M		F		M		F		M		F			
	n	%	n	%	n	%	n	%	n	%	N	%	N	%
6–8	0	-	2	-	4	-	2	-	0	-	1	-	9	1.4
9–11	5	-	4	-	2	-	2	-	1	-	2	-	16	2.5
12–14	9	-	11	-	1	-	1	-	0	-	1	-	23	3.6
15–16	6	-	7	-	0	-	1	-	1	-	0	-	15	2.3
Total	**20**	**3.1**	**24**	**3.7**	**7**	**1.1**	**6**	**0.9**	**2**	**0.3**	**4**	**0.6**	-	-

Note: Overall: Myopia: n = 44, 6.8%; Hyperopia: n = 13, 2.0%; Astigmatism: n = 6, 0.9%, Total: n = 63, 9.8%.

M, males; F, females.

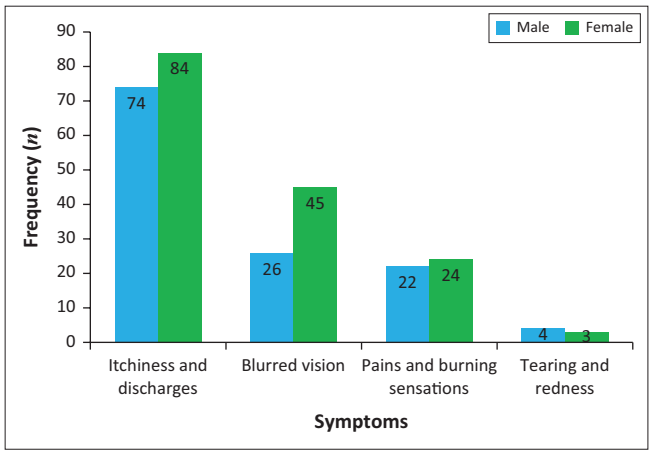

FIGURE 3: Distribution of ocular symptoms experienced by participants stratified for gender.

of all the ocular symptoms except for tearing and redness. The ocular symptom with the greatest gender difference was blurred vision where almost two-times more females (n = 45) complained of this symptom than males (n = 26).

Overall, ocular conditions were identified in 291 participants, and the type of conditions together with their frequencies and percentages is shown in Table 3. The prevalence of ocular conditions was 45.1% in the study, and the most common condition was allergic conjunctivitis as it was found in 174 (27.0%) participants, followed by 63 (9.8%) participants with URE. In addition, 29 (4.5%) participants were diagnosed with dry eye syndrome, 14 (2.2%) participants were glaucoma suspects, two (0.3%) participants had keratoconus and two (0.3%) participants had cataract. One participant each presented with uveitis, strabismus, corneal scar, retinal scar and hordeolum externum (Table 3). The ocular conditions that resulted in VI in study participants included URE (n = 3), cataract (n = 2), keratoconus (n = 2), corneal scars (n = 1) and retinal scars caused by toxoplasmosis (n = 1). In terms of the category of VI, URE, cataract, corneal and retinal scars resulted in moderate VI. The two cases of keratoconus that were found were categorised as causes of severe VI and blindness. Patients with ocular conditions, such as allergic conjunctivitis, refractive error, glaucoma suspects, keratoconus and cataracts that required further care and attention, were appropriately referred to minimise avoidable negative consequences.

Discussion

The study assessed the magnitude and causes of VI of school children aged 6–16 years in the Bono Region of Ghana. The results of this study showed a male to female ratio of 1:1.2 indicating a slightly higher preponderance of female participants in the study sample. In the 2010 population census of Ghana, the population structure of children under 15 years in the Bono region consisted of 48.9% males compared with 51.1% females.[34] This may account for the gender ratio observed in the study sample as it reflects the gender distribution of the region in which this study was conducted. The higher number of females observed in this study is similar to the reports of other ocular assessment studies conducted in different parts of the country[11,16,17,35] and across nations such as Nigeria (1:1.3),[15] Kenya (1:1.3)[36] and Saudi Arabia (1:1.3).[37] It is likely that the higher number of females reported in these studies[15,36] may be accounted for by gender differences in census figures of the regional populations in these countries.[38,39,40,41] In addition, the method of sampling used in these studies could also explain the higher numbers of females in these samples, particularly if there were more female students in the sampled schools. The participants' ages ranged from 6 to 16 years, with a modal age of 13 years. The mean age was 11.12 ± 3.09 years, and the 12–14 years age group recorded the highest frequency of participants amongst school children examined. This is similar to the results from a prevalence study in a neighbouring region in Ghana that reported a mean age of 12.6 ± 2.25 and also identified that the majority of participants were from the 12–14 years age group.[17] This finding may be because of the method of sampling adopted in this study or perhaps suggest that children of this age group are enthusiastic to participate in health programmes in their schools.

TABLE 3: Ocular conditions shown with frequencies and percentages.

Ocular condition	Frequencies (n)	Percentages
Allergic conjunctivitis	174	27.0
Refractive error	63	9.8
Dry eye syndrome	29	4.5
Glaucoma suspect	14	2.2
Blepharitis	2	0.3
Keratoconus	2	0.3
Cataract	2	0.3
Uveitis	1	0.2
Strabismus	1	0.2
Corneal scars	1	0.2
Retinal scars	1	0.2
Hordeolum externum	1	0.2
Total	**291**	**45.1**

This study showed low levels of eye care education amongst participants as only 14.7% had some knowledge on eye care. Furthermore, less than one-third (27.1%) of participants reported having an ocular examination prior to this present study. The low levels of eye care education amongst the study participants may have contributed to the inadequate attention given to ocular examinations. Both these findings suggest that either participants or more likely their parents or guardians relate little importance to routine eye care possibly as a result of several factors including insufficient knowledge on eye care, considering other aspects of life more relevant than routine ocular health and/or limited access to eye care facilities. This is similar to the findings of an eye care seeking behaviour study that revealed that most people refuse to undergo ocular examinations mainly because of two reasons. Firstly, the belief that eye diseases are minor, irrelevant and not likely to cause any serious problems. Secondly, that accessing eye care is too expensive, especially for individuals who have not enrolled on the National Health Insurance Programme.[42] Furthermore, the percentage of participants who reported having had a previous ocular examination prior to the present study (27.1%) is higher than the 13.3% reported amongst school children in a study conducted in Agona Swedru, Ghana.[35] Thus, there is a crucial need to improve public education and access to eye care facilities in the Bono Region as this may help to improve the awareness and sensitisation on ocular health matters. Such initiatives would aid to reduce the burden of eye diseases from preventable causes, especially amongst children.

The estimated prevalence of childhood blindness is 0.07%,[43] but it has been recognised that the prevalence of VI and blindness varies from country to country. To this extent, several studies have reported that the prevalence of blindness ranges between 0.02%[44] and 4.00%.[12] The differences in prevalence may be because of differences in sample sizes used in previous studies, the definition of

blindness adopted and the methods of measurements used in these different studies. The prevalence of blindness in the present study (0.2%) is slightly higher than the worldwide estimate. When compared with studies conducted in Ghana, the prevalence of blindness observed seems to be midway between that reported from the Central Region of Ghana (0.1%)[16] and from the Ashanti Region (0.29%).[11] However, the prevalence of blindness in this study was considerably lower than 4% as reported by Kumar et al.[12] in a developing country. Overall, the prevalence of VI was found to be 1.4%, and this is similar to the prevalence of VI as reported in the Cape Coast Municipality of Ghana (1.4%)[16] and the Kwabre East District (1.5%).[17] Similar studies in Ghana, however, reported higher prevalences of VI, 3.6%[11] and 4.5%[35] in their samples. The prevalence of VI is similar to that observed in studies in South Africa[5] and Nigeria[15] that reported prevalences of 1.2% and 1.4%, respectively. In contrast to the prevalence of VI in the present study, relatively higher prevalences have been reported in studies conducted in China[45] and Brazil[46] that were 7.7% and 2.67%, respectively. Causes of VI such as URE, cataract and corneal scars found in this study have been reported in earlier studies in different parts of Ghana.[10,11] A slightly higher number of male participants had VI compared with female participants, and this trend is similar to other studies that reported prevalence of VI in children.[12,47] However, available evidence amongst adult populations in Africa, Asia and other developed countries reported that females account for approximately two-thirds of the number of people with blindness and/or VI.[48] This gender discrepancy might be explained by the increased life expectancy amongst elderly women than men particularly in developed countries, as well as factors such as poverty and lack of access to eye care services particularly in developing countries.[49]

Most of the participants (n = 363) had no complaints with regard to ocular symptoms, whilst others had diverse ocular complaints. The most common amongst them was itchiness and discharges (n = 158, 24.5%) and blurred vision (n = 71, 11%). Studies in the Kumasi Metropolis and Kwabre East District reported similar most common symptoms of itchiness.[17,50] Overall, a higher number of females reported that they were experiencing ocular symptoms, and this could be because of the greater number of females in the sample. An alternate explanation may be that the female participants were more articulate in describing their ocular state at the time of the examination. However, the findings of this study suggest that early identification of ocular symptoms amongst children would assist in the early diagnosis and treatment of ocular conditions.

In this study, the presence of ocular conditions was 45.1%, and this is similar to the 47.1% reported by Ben et al.[17] in the Kwabre District of Ghana. However, the presence of ocular conditions in this study differs from similar studies by Ajaiyeoba et al.[19] and Bedi et al.[31] who reported prevalences of 15.5% and 15.98%, respectively, amongst school children. The differences in prevalence in these studies involving children may be explained by several factors including differences in geographic location of the study,[45] the characteristics of the study participants and the methods used to assess and classify the ocular conditions. It should also be observed that not all the ocular conditions that were observed in the sample resulted in VI. Furthermore, the grouping of all conditions detected in this study, which included those that were treatable such as refractive error and those that may not have resulted in a significant impact on participant's comfort and vision such as dry eye syndrome, blepharitis and allergic conjunctivitis, should be interpreted with caution as this may be different from the way other studies have reported on and/or group ocular conditions that were detected. Overall, the presence of ocular conditions was higher amongst females (54.3%) than males (45.7%), and this is similar to the findings of Bedi et al.[31] who also reported the same gender-related trend. The high presence of ocular conditions amongst females has been attributed to a low level of eye care education amongst females particularly in other developing countries.[49,51] Furthermore, studies have also reported that females show poor visual health-seeking behaviours and lack of social support possibly as a result of stereotypical cultural barriers.[49,51] Consequently, it is likely that these factors could also contribute to the trend observed in the present study and previous studies.[31,49]

Allergic conjunctivitis was the most common condition and was present in 27.0% of the study participants. The prevalence of allergic conjunctivitis in this study is higher than that reported in the Ashanti region of Ghana (17.3%)[17] and in Nigeria (2.9%).[15] The high prevalence of allergic conjunctivitis in the present study may be attributed to wet seasonal changes resulting in high concentration of allergens such as pollen and dusty mist in the atmosphere and these are consistent with the findings in the West African sub-region.[17,19] Kumah et al. reported a higher prevalence of allergic conjunctivitis of 39.9% amongst school children in Kumasi, Ghana,[50] and this might be because of differences in study areas. This is a probable explanation as even though both studies were conducted in Ghana, the study of Kumah et al. was conducted in the Ashanti region that has more vegetative cover compared with the Bono region.[26] Although allergic conjunctivitis does not usually lead to blindness, previous studies have revealed that it is a major cause of absenteeism amongst school children.[52,53] This may have a negative impact on the daily school activities of children, thereby compromising their educational potential and quality of life.

The presence of URE was observed as the second most common condition (9.8%), and its frequency is comparatively lower than the reports of Ben et al.[17] (26.3%) and Ovenseri-Ogbomo[35] (13.4%) for studies undertaken in different parts of Ghana. This variability may be because of different factors such as the method of assessing and grading the refractive error, ethnic variations, different lifestyles and living conditions in different study areas.[54] It was found that 6.8% of the study participants had myopia, 2.0% had hyperopia and 0.9% had astigmatism. Ovenseri-Ogbomo[35] and Nakua et al.[30] who also conducted studies in Ghana

reported that the frequency of myopia was 1.7% and 2.1%, respectively, in their samples. The higher frequency of myopia in the present study may be because of the constant near work amongst school children, especially those in the upper basic level of education in the study sample. This is a likely explanation as studies have shown that factors associated with developing myopia may include working at near for prolong periods and would include tasks such as reading, playing computer and mobile video games.[5,6,55,56] Furthermore, Hu et al.[57] asserted that the assessment of refractive error without the use of cycloplegic drugs shows a tendency towards myopia. In addition, cycloplegic refraction reveals latent and low refractive errors that could be missed without the use of cycloplegic drugs.[35] Therefore, it is likely that the higher presence of myopia than hyperopia observed in this study may be because of the methodology adopted for this study where participants whose VA was 20/30 or better were not refracted unless it was deemed necessary if the participant showed any refractive symptoms. Another probable reason may be the use of a non-cycloplegic refraction to assess URE.

The results of this study show that although the presence of VI is low in this study, its occurrence could negatively impact children's education and future prospects. Therefore, there is the need to increase awareness of the presence of ocular conditions amongst school children. Making parents and teachers more aware of this may help in the early detection and management of causes VI and blindness amongst school children. As the presence of URE was the most common cause of VI, more effort should be directed towards developing strategies to provide access to refractive services for school children in Ghana. Moreover, to protect children from the effects of ocular conditions, vision health education needs to be incorporated into the Ministry of Education's curriculum for school health and education programme at the basic level. Finally, proper planning, coordination and supervision of vision health programmes will aid in reducing the occurrence of avoidable VI amongst children.

The strengths of this study included the use of a large representative sample recruited using multistage random sampling method adopted for schools and participants, as well as accuracy and consistency of results gathered. This highlight was made possible through the support of the Ministry of Education, heads of selected schools and parents of sampled children for various assistance prior to data collection. The results of this study are not generalisable to the entire population of Bono region of Ghana as the sample was school-based and not population-based. It is recommended that future studies be conducted in other areas of the Bono region of Ghana and include participants of wider age range in the sample. Another limitation of this study is that objective and subjective refraction were only conducted on participants with VA worse than 20/30. This implies that the results pertaining to the prevalence of hyperopia are probably underestimated and should be interpreted with caution as they would likely not include participants with low hyperopia.

Conclusion

The presence of ocular conditions was found amongst 45.1% of the school children examined; however, the prevalence of blindness and VI was low (0.2% and 1.4%, respectively). The causes of VI included URE, cataract, keratoconus, corneal scars and retinal scars (due to toxoplasmosis). Participants were found to have low level of knowledge on eye care and low attendance for ocular health check-ups prior to the study. Creating awareness on visual health issues through routine health screening at the basic school level could reduce the occurrence of preventable ocular conditions that can potentially impair vision. This information will be essential for policy-makers involved in the planning of ocular health programmes for basic school children to promote the agenda of eliminating avoidable blindness in Ghana.

Acknowledgements

The authors wish to acknowledge the tremendous contributions of the Eye Department of Salvation Army Hospital, Wiamoase, for lending to the project ophthalmic instruments for data collection. The efforts of the outreach team members including Gertrude Manu, Priscilla Onumah, Priscilla Opoku, Maxwell and Asiedu are greatly appreciated.

Competing interests

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

Authors' contributions

V.O.-Y. was responsible for student project work, project conception, proposal writing, data collection, analysis and manuscript writing. N.R. was involved with project supervision and provided input to the content of the manuscript. N.T.G. was involved in project co-supervision and provided input to manuscript writing.

Funding information

The research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Data availability

Data sharing is not applicable to this article.

Disclaimer

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