

## Prevalence of Ocular Comorbidity among Students with Hearing Impairment

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### Abstract

**Objective:** To assess the magnitude of ocular comorbidity among hearing-impaired students at Hosanna boarding school for hearing impairment.

**Methods:** A descriptive cross-sectional study was conducted at Hossana boarding school for hearing impairment. The study took place from April 1 to May 3, 2023. Sociodemographic information, ocular complaints, comorbidity details, and previous ophthalmic service utilization information were collected through semi structured questionnaires with the assistance of a sign language interpreter. A comprehensive ophthalmic examination was conducted. Cycloplegia refraction was performed for visually impaired students under the age of 10 years, while those aged 10 years and older underwent autorefraction. Subjective refraction was performed. Data analysis was performed using SPSS software version 26.0.

**Results:** A total of 218 hearing-impaired students (50% female) were included in the study. Their ages ranged from 7 to 25 years. Ocular comorbidity was observed in 43 (19.7%) students, while visual impairment was found in 22 (10.1%) students. Only 2.3% of the students had previously utilized ophthalmic services. Of the 13 students with refractive errors, only one student wore spectacles, which accounted for 7.7% of the spectacle correction coverage. There was no ocular screening conducted before enrolment for any of the students.

**Conclusion:** The prevalence of ocular comorbidities and visual impairment was greater among hearing-impaired students. Implementing regular screening programs, raising awareness, improving accessibility to eye care services, and fostering collaboration among relevant stakeholders can contribute to better eye health outcomes for hearing-impaired students.

**Keywords:** Ocular Comorbidity; Visual Impairment; Hearing Impairment; Refractive Error; Ethiopia

### Introduction

Hearing impairment is the most common sensory disability worldwide, and it is a growing concern. The World Health Organization estimates that, globally, there are approximately 466 million people with disabling hearing loss (DHL), corresponding to a global prevalence of 6.12%, of whom children account for 34 million. It is estimated that by 2050, more than 900 (9.6%) million people will have DHL [1]. Sub-Saharan Africa (SSA) is a region with a large number of people with DHL, with an estimated prevalence of 4.55%, followed by South Asia and East Asia, with prevalences of 4.57% and 6.85%, respectively [1].

A systematic review and meta-analysis of childhood hearing impairment in SSA patients revealed that the pooled prevalence of childhood hearing impairment was 10% [2]. There is a scarcity of data on hearing impairment in children at the national level in Ethiopia. Hearing impairment was the most commonly reported disability in children in eastern rural Ethiopia (1.93%) [3].

Sensory inputs are critical in children's development of higher functions. Hearing and vision are the most important in this regard because they provide approximately 95% of all collected information, with touch, smell, and taste playing a minor role in comparison [4].

There is now clear evidence of a close connection between the functions of multiple sensory organs, especially between the eyes and ears. This is typical because between the sixth and seventh weeks of gestation, the cochlea and retina both develop from the same embryonic layers [5].

Among the prevalence of additional disabilities related to hearing impairment, visual impairment was the second most common comorbidity (4 - 57%) in hearing-impaired populations, followed by speech-language impairment (61 - 88%) [6]. The hearing-impaired population may compensate by using more visual-perceptual cues than their normal hearing peers; thus, even a mild refractive error may reduce the visual cues available to a hearing-impaired person [7].

This descriptive cross-sectional study explored the prevalence and causes of ocular comorbidities among students attending a hearing-impaired school in Ethiopia. The researchers collected sociodemographic information and ocular history information and conducted a comprehensive ophthalmic examination on the participating students.

### Aim of the Study

This study aimed to provide valuable data for planning and evaluating preventive and curative services, as well as special education on dual sensory deficit and low vision services for hearing-impaired students.

### Methods

**Method and setting:** This study was conducted at the Hossana boarding school for hearing impaired, which is a full cycle boarding school at Hosanna town, located 231 kilometers southeast of Addis Ababa, Ethiopia. The study involved 218 participants, with the majority being primary (grades 1 - 8) school students (n = 131), followed by secondary (grades 9 - 12) school students (n = 69) and preschool (grade 0) students (n = 18). All students in the school were included in the study, regardless of the severity of their hearing impairment.

**Ethics:** The study was approved by the Research and Ethical Committee of the Department of Ophthalmology, School of Medicine, College of Health Science of Addis Ababa University, and the study followed the principles outlined in the Declaration of Helsinki. Additionally, necessary approval was obtained from local district authorities and boarding school authorities, who are the legal guardians of the students. Students provided their verbal consent during the examination process.

**Study tool:** The interviewer and examiner conducted an interview using a semi structured questionnaire following a specific format designed for the study. This format included sections for sociodemographic information, ocular history, prior utilization of ophthalmic care, and a comprehensive examination to record findings from unaided visual acuity to fundoscopy.

### Operational definitions

Ocular comorbidities were defined as any ocular abnormalities that might or might not affect vision.

**Visual impairment:** For the purpose of this study, visual impairment was defined as unaided distance or near visual acuity worse than 6/9 in any eye or a difference of two or more lines between both eyes and/or unaided near acuity worse than distance visual acuity [8]:

- Mild visual impairment - unaided visual acuity < 6/9 - 6/18.
- Moderate visual impairment - unaided visual acuity < 6/18 - 6/60.
- Severe visual impairment - unaided visual acuity < 6/60 - 3/60.
- Blindness - unaided visual acuity < 3/60.

Refractive error was defined as unaided visual acuity < 6/9 and best corrected visual acuity 6/9 or better [9]. Classified by their subjective refraction into:

- Myopia was defined as a negative 0.5 spherical equivalent diopters or less.
- Hyperopia is defined as a positive 2.0 spherical power diopters or more.
- Astigmatism is defined as greater than or equal to cylinder power of +/- 0.75 diopters.

Amblyopia: Best corrected visual acuity < 6/9 or a difference of 2 visual acuity lines between two eyes in the absence of apparent organic pathology.

Spectacle correction coverage: Defined as the percentage of students with REs who corrected spectacles at the time of the study [10].

**Procedure:** The students communicated with the assistance of their teachers using sign language. Sociodemographic information, as well as their previous ocular history and any examinations or treatments they had, was collected. Additionally, their current ocular complaints were recorded. Visual acuity was measured for both distance and near vision using a tumbling E chart at 6 meters and 40 centimeters, respectively. Color vision was assessed using the Ishihara plate, while pupillary examination was conducted under both lit and dim conditions. Ocular alignment was checked using cover tests at a target distance of 6 meters and 40 centimeters. Anterior segment examination was performed using a magnifying loop and a pen flashlight for illumination. Each student's eyes were dilated with 1% tropicamide eye drops, and fundus examination was completed using a direct ophthalmoscope.

Objective refraction was performed using an autorefractor for students aged 10 years and older and with wet retinoscopy for students aged less than 10 years for those with uncorrected visual acuity worse than 6/9. Subsequently, subjective refraction was conducted on the following day.

Students who had treatable eye conditions were prescribed medication, whereas those who required corrections were provided with spectacle prescriptions. Students who required follow-up and additional care were referred to a nearby ophthalmic center for further management.

**Data analysis:** After the collection of the data, each data point was thoroughly reviewed for both completeness and accuracy. The validated data were then entered into a database. SPSS 26.0 software was used for the statistical analysis. Student's t test was used to analyze continuous variables, while the chi-square test was used for categorical variables. Furthermore, logistic regression analysis was utilized to explore the risk factors associated with visual impairment (VI).

## Results

### Sociodemographic characteristics

Two hundred eighteen students with hearing impairment participated in the study, with an equal distribution of males and females. The age of the students ranged from 7 to 25 years, with an average age of 15.97 +/- 4.08 years.

**Ocular comorbidities**

In this study, 43 of the 218 students (19.7%) had ocular comorbidities, while only 2 students had multiple comorbidities. The most common ocular comorbidity was refractive error, which was observed in 13 patients (5.96%), followed by amblyopia in 8 patients (3.7%) and non-syndromic heterochromia in 6 patients (2.8%) (Table 1).

Primary Diagnosis	Frequency	Percentage
Normal	175	80.3%
Refractive Error	13	5.9%
Amblyopia	8	3.7%
Nonsyndromic Heterochromia*	6	2.8%
Conjunctival Nevus	4	1.8%
Allergic Conjunctivitis	4	1.8%
Usher Syndrome**	3	1.4%
Red–green Color vision Defect	2	0.9%
Chalazion	1	0.5%
Traumatic Iridodialysis	1	0.5%
Developmental Cataract	1	0.5%
Duane’s Retraction Syndrome	1	0.5%
Waardenburg Syndrome***	1	0.5%

**Table 1:** Prevalence of ocular comorbidity among students with hearing impairment at the hosanna boarding school for hearing impairment.

\*Non-syndromic heterochromia, no other associated findings found to name a syndrome. \*\*One student with Usher syndrome had refractive error. \*\*\*Student with Waardenburg syndrome had refractive error.

**Visual impairment**

Among the 218 students, 186 had 6/6 vision in both eyes, while 10 had 6/9 vision in one eye and 6/6 vision in the other eye. Visual impairment was found in 10.1% (22) of the students. The majority of the visual impairments were mild (59%), followed by moderate, blindness and severe (29.3%, 9.1%, and 4.5%, respectively) (Table 2).

Visual status	Number of Students	Percentage
Normal vision	196	89.9%
Mild visual impairment	13	5.9%
Moderate visual impairment	6	2.8%
Severe visual impairment	1	0.5%
Blindness	2	0.9%
Total	218	100%

**Table 2:** Prevalence and severity of visual impairment among students with hearing impairment at the hosanna boarding school for hearing impairment.

Among the causes of visual impairment in our study, 13 (59.1%) students had refractive error, 8 (36.4%) had amblyopia, and 1 (4.5%) had an untreated bilateral developmental cataract (Table 3).

Among the 13 students who experienced refractive error, the majority (11 students) had a single ocular comorbidity, refractive error. Within this subgroup, 8 students were diagnosed with myopia, 2 students had astigmatism, and 1 student had hypermetropia. In addition, 2 students with syndromes had refractive errors-one with astigmatism in Usher syndrome and the other with hypermetropia in Waardenburg syndrome.

Of the cases of amblyopia, 6 were caused by anisometropia, 1 was caused by strabismus, and 1 was caused by deprivational, treated congenital cataract.

Binary logistic regression analysis was performed to identify risk factors for visual impairment, and age, sex, and grade were not significantly associated with visual impairment.

Cause of impairment	Number students	Percentage
No impairment	196	89.9%
Refractive error	13	5.9%
Myopia	8	
Astigmatism	3	
Hypermetropia	2	
Amblyopia	8	3.7%
Anisometropic	6	
Strabismic	1	
Deprivational (Treated Congenital Cataract)	1	
Cataract	1	0.5%
Developmental Cataract (Untreated)	1	
Total	218	100%

**Table 3:** Causes of visual impairment among students with hearing impairment at the hosanna boarding school for hearing impairment.

**Prior utilization of ophthalmic services**

In our study, we discovered that a small percentage of students had previously sought ophthalmic care services. Out of the 218 students included in the study, only 5 individuals, accounting for 2.3%, had utilized ophthalmic services in the past. Interestingly, all five of these students had ocular comorbidities. One student had received cataract surgery for congenital cataract, one student had been diagnosed with refractive error and received spectacle correction, and the remaining three students had been diagnosed with allergic conjunctivitis and treated.

The spectacle correction coverage in our study was calculated to be 7.7%. The main reasons for this low coverage in our study were a lack of awareness of ocular comorbidities and the absence of pre-enrollment comprehensive ocular screening.

**Discussion**

**Ocular comorbidity**

Our findings indicate that ocular comorbidities were observed in 19.7% of the students, with a low rate (0.9%) of coexisting ophthalmic comorbidities. In a study conducted in Nigeria [11], a higher incidence of ocular abnormalities was reported at 56.1%, with 22.4% having

coexisting ocular abnormalities. An Indian study [12] revealed a lower rate of ocular abnormalities, with 15.9% of the participants affected. The highest incidence of ocular abnormalities was reported in a study conducted in Yemen [13], with 61.3% of participants affected. The variation in prevalence between these studies could be attributed to differences in methodology, definitions, populations, and the time period in which the studies were conducted.

In our study, we identified syndromic ocular and hearing dual sensory conditions in three students with Usher syndrome (1.4%) and one student with Waardenburg syndrome (0.5%). Similar findings were reported in Yemen [13], with Usher syndrome being the most common syndrome, followed by Waardenburg syndrome. An Indian study [12] also revealed Usher syndrome to be the most common syndrome association, with a prevalence rate of 4%. Notably, simple non-syndromic heterochromia (2.8%) was a common finding in our study and was not reported in other studies. Furthermore, optic nerve, macular, and corneal disorders were not found in our study. These findings highlight the potential disabling nature of these ocular conditions for enrollment in special schools for hearing impairment.

In terms of preventability and treatability, 60.5% of ocular comorbidities in our study were found to be preventable or treatable. This finding is comparable to that of an Indian study [12], which reported that 55% of ocular abnormalities were either preventable or treatable.

### Prevalence of visual impairment

The prevalence of ocular comorbidities among normal-hearing students in various studies conducted in Ethiopia differs from the prevalence rates reported in this study, which are specific to hearing-impaired students. It is important to note that the prevalence of visual impairment among hearing-impaired students in this study (10.1%) was greater than that in studies involving normal-hearing school students. Previous school-based studies in Gondar [14], the Gurage zone [15], Addis Ababa [16] and Sekela woreda [17] reported prevalence rates ranging from 1.8% to 8%. However, the prevalence of visual impairment in this study is comparable to that in a study performed in the Assossa zone [18], which reported a prevalence of 10.4%. It is essential to consider that the cutoff points used for defining visual impairment vary among studies. While some studies [14,15] have used the World Health Organization's cutoff point of less than 6/12, including this study, the remaining studies used less than 6/9 as the cutoff point per the Refractive Error Study in Children (RESC) protocol [9]. Despite this variation, the findings underscore the greater prevalence of visual impairment among hearing-impaired students and the need for attention to this issue.

As this study is the first of its kind, it was not possible to directly compare it to previous studies conducted in Ethiopia. However, various studies conducted in schools for hearing-impaired students globally have reported different prevalence rates of visual impairment. For instance, in Ghana, Kwarteng, *et al.* reported a decrease in the incidence of visual impairment of 6% [19], and Ovenseri-Ogbomo, *et al.* reported a decrease of 7.3% [20]. Perehe, *et al.* in India [12] and Salem, *et al.* in Yemen [13] both reported a prevalence of 7.2% and 7.3%, respectively. On the other hand, higher prevalence rates were documented in Nigeria, with Abikoye, *et al.* reporting 19% [21] and Majekodunmi, *et al.* reporting 34.6% [11]. Notably, there were variations in the cutoff points used for defining visual impairment among these studies, with some using the World Health Organization's cutoff point of less than 6/12, while others [21], such as our study, used less than 6/9 as the cutoff point.

### Causes of visual impairment

The main contributing factors to visual impairment in our study were uncorrected refractive errors (59.1%), amblyopia (36.4%), and untreated bilateral developmental cataracts (4.5%). These findings align with similar studies conducted in Nigeria [11,21], Ghana [20], Yemen [13] and India [12], where uncorrected refractive errors were also identified as the leading cause of visual impairment, ranging

from 47.4% to 61.1%. Amblyopia was found to be the second main cause of visual impairment in our study, which is consistent with the results of a Nigerian study [21]. However, a study conducted in India identified retinitis pigmentosa as the second main cause of visual impairment [12]. Amblyopia has also been reported as a second cause of visual impairment in normal-hearing students in Ethiopia [15,16], while corneal opacity has been reported as a second cause of visual impairment in studies performed in the Amhara region, where the prevalence of trachoma is high [17].

In terms of refractive errors, myopia (61.5%) was the most common in our study, followed by astigmatism (23.1%) and hyperopia (15.3%). It is important to note that different studies have reported varying patterns of refractive errors, with no uniform trend. Similar findings have been reported in other studies, where myopia was also found to be the most prevalent refractive error. However, some studies have reported different patterns, with hyperopia being the most common [11] or astigmatism being more prevalent [20,21]. In studies conducted among normal-hearing students in Ethiopia, myopia has also been reported to be the most prevalent refractive error [14-16].

The severity of visual impairment in our study was predominantly mild, followed by moderate, blindness, and severe. These findings are similar to those reported in a study conducted in Nigeria by Abikoye, *et al* [21]. Notably, all causes of visual impairment in our study were treatable, which is greater than the number of reported treatable cases in an Indian study [12].

### Utilization of prior ophthalmic care services

In our study, a small number of students had sought ophthalmic care services in the past. Out of the 218 students included, only 5 individuals (2.3% of the sample) utilized such services. The spectacle correction coverage in our study was 7.7%. These rates are lower than those reported in a similar study conducted in Nigeria [11], where the prior ophthalmic evaluation rate was 8% and the spectacle correction coverage was 11%. Majekodunmi, *et al.* reported a much greater rate of ophthalmic service utilization (43.9%) [22], which may be due to the living conditions of the students in their study, who lived with their parents, unlike the students in our study, who attended boarding school for 11 months. The low rates of ophthalmic service utilization and spectacle correction in our study were attributed to a lack of awareness, the absence of comprehensive pre-enrollment ocular screening, and the limited involvement of stakeholders, both governmental and non-governmental.

We found that none of our participants underwent ophthalmic screening before they joined school, which is similar to the findings of similar reported studies in India [12] and Nigeria [11].

### Strengths of the Study

The strength of this study lies in its unique contribution to the field as the first of its kind to assess the prevalence and causes of ocular comorbidities among hearing-impaired students in Ethiopia. The researchers conducted a comprehensive examination of all students included in the study, ensuring that all ocular comorbidities were identified and addressed.

### Limitations of the Study

One limitation of the study is its small sample size, as it included only 218 hearing-impaired students from a single boarding school in Ethiopia. It is important to acknowledge that this study cannot be considered a comprehensive representation of ocular comorbidities and visual impairment among all hearing-impaired children in the community. This is particularly true for those who were unable to attend a hearing-impaired school or those with severe dual sensory deficits, which may have led them to remain at home. Moreover, the study did not examine the severity and causes of hearing impairment, which could impact the prevalence and causes of ocular comorbidities. Therefore, caution should be exercised when generalizing the findings of this study to the broader population of hearing-impaired students.

### Conclusion

In conclusion, this study highlighted the high prevalence of ocular comorbidities and visual impairment among students attending school for hearing impairment. The findings emphasize the need for increased attention and interventions to address these issues. Implementing regular screening programs, raising awareness, improving accessibility to eye care services, and fostering collaboration among relevant stakeholders can contribute to better eye health outcomes for hearing-impaired students.

Further research is needed at the community level in preschool hearing-impaired children who might leave home due to disabling visual impairment and a critical period for early detection and interventions.

### Author Contributions

All the authors contributed to the conception and design, acquisition, analysis, and interpretation of the data.

### Funding Support

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### Conflict of Interest

None.

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