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ORIGINAL ARTICLE

Visual Impairment and Ocular Findings among Deaf and Hearing Impaired School Children in Central Region, Ghana

G. O. Ovenseri-Ogbomo[1,2], C. H. Abraham[1] and F. E. Kio[2]

[1]Department of Optometry, University of Cape Coast, Ghana; [2]Department of Optometry, University of Benin, Nigeria

The scourge of global blindness continues to be a concern for eye care professionals, International Non-governmental Development Organizations (INGDOs) and eye care workers. While emphasis has been placed on how to address this scourge in the general population, not much is being done among special needs group such as the deaf and hearing impaired. The study was conducted to investigate the prevalence of visual impairment and ocular findings among hearing impaired children in a school for the deaf in the Cape Coast Municipality of Ghana. A cross-sectional descriptive study design was undertaken amongst children in the school for the deaf who had been previously diagnosed of hearing impairment or deafness. A total of 243 children underwent comprehensive eye examination in the school with prior approval from the school board. The mean age of the 243 children examined was 15.9 ± 4.0 years with a range of 9 – 27 years. Fourteen children (5.8%) had moderate visual impairment (WHO grade 1 visual impairment i.e. VA < 6/18 to 6/60) in the right eye, while 15 (6.2%) had moderate visual impairment in the left eye. Refractive error was present in 75 (31.9%) of the children with astigmatism being the commonest form of refractive error. Anterior segment abnormalities were present in 27 (11.1%) while posterior segment abnormalities were present in 25 (10.3%). The overall prevalence of visual impairment was 5.8% among hearing impaired school children in the Central Region of Ghana. There were ocular abnormalities that were previously undiagnosed among the studied population. There is the need for regular eye examination for children diagnosed of hearing impairment.
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Keywords*:* Disability, eye, ear, refractive error, ocular deviation .

INTRODUCTION

Studies have indicated that the prevalence of ocular abnormalities among the deaf and hearing impaired is higher than the general population of comparable age group (Nikolopoulos *et al.,* 2006). This association has been suggested to be due to the close anatomical relationship of the retina and cochlea which develops from the same embryonic layer (Abah *et al.,* 2011). Of all the sense organs, visual and auditory inputs are responsible for 95% of information acquisition (Fillman *et al.,* 1987). It is also generally claimed that visual input accounts for 75% of information acquisition. Existing co-morbidity of hearing and visual impairment in children predisposes them to many challenges including difficulties in communication, learning and social interaction. Suchman (1967) reported that hearing and visually impaired children are significantly more debilitated, less cooperative, less able to lip read and less capable of manual tasks compared to hearing impaired children with normal vision.

In Ghana, there is a high prevalence of hearing impairment. Recent studies have reported a prevalence of 16 per 1000 persons (Amedofu *et al.,* 1997; Amedofu *et al.,* 2005). Notwithstanding this however, there is a paucity of published data on the prevalence of visual impairment and visual abnormalities among the hearing impaired. The aim of this study was to investigate the prevalence of visual impair-

Correspondence: *Dr. G. O. Ovenseri-Ogbomo, Department of Optometry, University of optometry, University of Cape Coast, Cape Coast, Ghana. Email: govenseri-ogbomo@ucc.edu.gh*

ment and ocular abnormalities among hearing impaired children in a school for the deaf in Ghana.

MATERIALS AND METHODS

Study site and participants

A cross-sectional descriptive study was conducted to determine the prevalence of visual impairment and ocular abnormalities among deaf and hearing impaired children in a school for the deaf in the Cape Coast Municipality of Ghana from February to April, 2011. The school is the only school for the deaf in Central Region of Ghana. Before admission, each child is examined by an otolaryngologist to certify their status as either being deaf or hearing impaired. Thus, the basis for considering a study participant as being deaf or hearing impaired was based on the status established upon being admitted into the school. None of the children had had a previous eye examination. Every child present in the school during the eye examination visits was eligible to participate in the study. The school is residential with every child living within the premises.

Eye examinations

All eye examinations were carried out by qualified and registered optometrists. Every participant underwent a comprehensive eye examination comprising presenting visual acuity testing using the Snellen Tumbling E chart, near point of convergence test (NPC), cover test, external and internal ocular health examination using a penlight and direct ophthalmoscope respectively as well as both objective and subjective non-cycloplegic refraction. Communication during the examination process was facilitated by a designated teacher from the school who also had responsibility of reporting the response of each child during the examination.

Visual impairment classification

The World Health Organization category of visual impairment was used to specify the category of visual impairment among the children (WHO, 2005). Refractive error was specified as follows: myopia was defined as spherical power of $\geq$ - 0.50D, hyperopia $\geq$ + 2.00D and astigmatism $\geq$ - 0.50D. Emmetropia was defined as spherical correction of $<$ - 0.50D and $<$ + 2.00D and cylindrical correction of $<$ - 0.50D. Ocular deviation of $\geq 10^{\Delta}$ was considered as significant.

Ethical clearance

The protocol for the study was approved by the research committee of the Department of Optometry, University of Cape Coast. Administrative approval was also obtained from the Metropolitan Education Office as well as the head teacher of the school. Given the challenge of securing parental consent as per the ages of the participants, the head teacher further granted institutional clearance. Notwithstanding the institutional clearance, participants were required to give assent to be examined for the study or opt out if they so whish. The purpose of the eye examination was explained to every child and the study was conducted in accordance with the Declaration of Helsinki (WHO, 2007).

Statistical analysis

The data on eye examination was entered electronically using Microsoft Excel 2007. Data analysis was done using Statistical Package for Social Sciences (SPSS 17) (IBM Boston, USA). For qualitative variables, frequencies, percentage proportion and their 95% confidence intervals were computed. Quantitative variables were expressed as means $\pm$ standard deviation.

RESULTS

Study Participants

There were a total of 243 children in the school at the time of the study comprising 141 (58%) males and 102 (48%) females who were enrolled into the study. The mean age of the participants was 15.9$\pm$4.0, (95% CI = 15.4 – 16.4) years with age range of 9 – 27 years. The mean age of the male participants was 16.3$\pm$4.3 years while the mean age of the females was 15.3$\pm$3.6 years. There was no significant difference between the mean ages of male and female participants ($p = 0.068$). One hundred and eighty-eight (77.4%) of the subjects were aged between 11 – 20 years (Table 1).

Table 1: Age and sex distribution of study participants

Parameters	Gender		Total
	Male (n = 141)	Female (n = 102)	(n = 243)
Age (yrs)	16.3 ± 4.3	15.3 ± 3.6	15.9 ± 4.0
Age grp			
6 – 10	15 (10.6)	10 (9.8)	25 (10.3)
11 – 15	48 (34.0)	42 (41.2)	90 (37.0)
16 – 20	56 (39.7)	42 (41.1)	98 (40.3)
21 – 25	20 (14.2)	7 (6.9)	27 (11.1)
26 – 30	2 (1.4)	1 (1.0)	3 (1.2)

Data are presented as mean ± SD, absolute counts and proportions.

Table 2: Visual acuity distribution among study participants (n = 243)

Visual acuity	Right Eye (%)	Left Eye (%)
≥ 6/6	191 (78.6)	189 (77.8)
6/9	19 (7.8)	20 (8.2)
6/12	6 (2.5)	6 (2.5)
6/18	3 (1.2)	4 (1.6)
6/24	3 (1.2)	2 (0.8)
6/36	5 (2.0)	10 (4.1)
6/60	6 (2.5)	3 (1.2)
HM & LP	1 (0.4)	1 (0.4)
Undetermined	9 (3.7)	8 (3.3)

HM = hand movement, LP = light perception

Visual Acuity for distance

The distribution of visual acuity presentations are is shown in Table 2. One hundred and ninety-one (78.6%) had normal vision (VA≥6/6) in the right eye and 189 (77.8%) had normal vision in the left eye. Another 28 (11.5%) and 30 (12.3%) had mild visual impairment in the right and left eye respectively.

Fifteen (4.9%) participants had severe visual impairment in the right eye while 16 (6.6%) had severe visual impairment in the left eye (Table 3). Thus using WHO classification, 219 (90.1%, 95% CI = 85.9 – 93.4) had WHO grade 0 visual impairment (i.e VA ≤ 6/18). Another 14 (5.8%; 95% CI = 3.3 – 9.3) and 15 (6.2%; 95% CI =3.6 – 9.8) had moderate visual impairment (WHO grade 1 visual impairment i.e. VA < 6/18 to 6/60) (WHO, 2005) in the right and left eye respectively. One participant had vision of 'hand movement' and another one had 'light perception' in one eye. The vision in the other eye was 6/5 and 6/4 respectively. This could not be categorized as visually impaired using the WHO classification which considers vision in the worse eye. Visual acuity could not be determined in right eyes of 9 (3.7%) and left eyes of 8 (3.3%) participants. This was usually due to the fact that the children could not respond to the examination routine.

Refractive Error

Refraction results were unreliable in 8 (3.3%) of the subjects and therefore were not included in the analysis. The results from the right eye were used to identify the refractive status of each participant as described by Dandona, *et al*, (2002). One hundred and sixty (68.1%) participants had emmetropia while 75 (31.9%) had various forms of refractive error which comprised of astigmatism, present in 57 (76.0%) participants, myopia, 13 (17.3%) and

Table 3: Distribution of visual impairment categories among study participants (n = 243)

Type of impairment	Right eye (%)	Left eye (%)
Normal (VA≥6/6)	191 (78.6)	189 (77.8)
Mild visual impairment (VA < 6/6 to ≥6/18)	28 (11.5)	30 (12.3)
Severe visual impairment (VA <6/18 to light perception)	15 (4.9)	16 (6.6)
Visual acuity could not be determined	9 (3.7)	8 (3.3)

hyperopia 5 (6.7%) (Figure 1). Thus the prevalence of astigmatism, myopia and hyperopia among the participants was 24.3%, 5.5% and 2.1% respectively. There were 47 (62.7%) males and 28 (37.3%) females with refractive error. Whether a participant had a refractive error was independent of the sex of the participants ($\chi^2 = 1.59$, $p = 0.207$).

Binocular vision

The cover test performed at 40 cm revealed that 50 (20.6%) participants had various forms of ocular deviations including exophoria, exotropia, esophoria

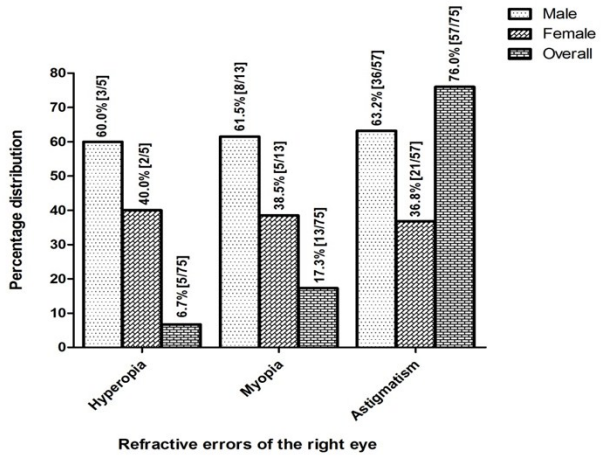

Figure 1: Distribution of refractive errors of the right eye among the participants

and esotropia while 184 (75.7%) had no deviation. Cover test could not be performed in 9 (3.7%) of the participants mainly because they were unable to maintain fixation at the fixation target. The results of the cover test are presented in Figure 2. Exophoria was the commonest ocular deviation being present in 39 participants out of the 50 who had ocular deviation (78%). Respectively, esophoria and exotropia were present in 8% (4/50) of the participants while esotropia was present in 6% (3/50) of the study participants.

Near point of convergence (NPC) could not be determined in 29 participants because they could not maintain fixation and respond to the test procedure. The mean NPC (break/recovery) was 5.6/7.4 ± 3.1/3.5 cm) with range of 1/1 to 25/28. Out of the 214 in which NPC was determined, 26 (12.1%) participants had values ≥ 8 cm for break while 21 (9.8%) had recovery values ≥ 11 cm. This proportion could estimate the proportion of participants who have convergence insufficiency.

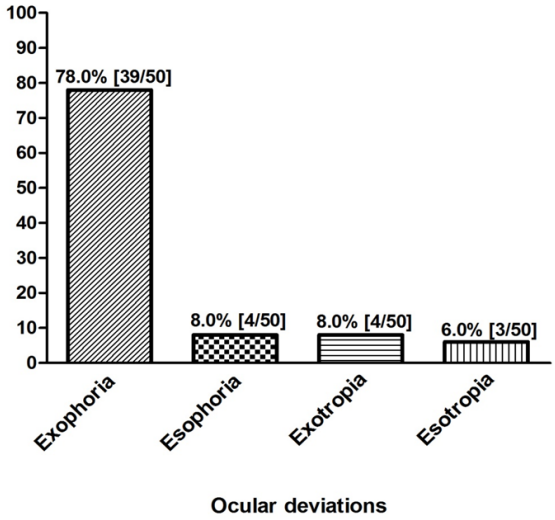

Figure 2: Distribution of ocular deviation among the participants

Ocular health

Ocular health was assessed in all 243 participants with some participants having a co-existence of anterior and posterior segment abnormalities. Anterior segment anomalies were found in 27 (11.1%) of the participants while posterior segment anomalies were found in 25 (10.3%). Table 4 shows the anterior and posterior segment anomalies found in the study.

DISCUSSION

The present study was conducted as an initial exploratory investigation of the ocular findings among the deaf and hearing impaired children in the Cape Coast Municipality of Ghana. Previous studies have reported the frequency of visual impairment and ocular abnormalities among hearing impaired subjects (Regenbogen, 1985; Fillman *et al.,* 1987; Nicoll and House, 1988; Armitage *et al.,* 1995; Mafong *et al.,* 2002; Hanioðlu-Kargý *et al.,* 2003; Nikolopulous *et al.,* 2006; Gogate *et al.,* 2009; Osaiyuwu and Ebeigbe, 2009; Bist *et al.,* 2011). Intepretative analy-

Table 4: Anterior and posterior segment anomalies among participants (N = 243)

Parameters	n (%)
Anterior Segment Abnormality	
Corneal abnormalities	5 (2.1)
Conjunctivitis	6 (2.5)
Lid	7 (2.9)
Nystagmus	1 (0.4)
Dacryocystitis	1 (0.4)
Heterochromia iridis	1 (0.4)
Posterior Segment Abnormality	
Lens	2 (0.8)
Choroid/retinal	13 (5.3)
Retinitis pigmentosa	3 (1.2)
Vitreous	2 (0.8)
Optic nerve/disc	4 (1.6)
Phthisis bulbi	1 (0.4)

sis from results of this study should therefore be done cautiously as a result of the considerable challenge presented in comparative analysis to studies conducted elsewhere due largely to variations in the criteria for reporting findings with typical examples being the cut-off points for visual acuity and the variations in ocular conditions presented.

In Nigeria, the frequency of visual disorders among the hearing impaired has been reported to range between 20.9 – 73.3% (Osaiyuwu and Ebeigbe, 2009; Abah *et al.,* 2011). Some of these studies have also indicated that the frequency of ocular abnormalities are higher among hearing impaired subjects compared to normal hearing subjects in the general population with similar age groups (Gogate *et al.,* 2009; Abah *et al.,* 2011). Recommendations for regular screening for the presence of visual disorders among the hearing impaired have been advanced by several authors so that appropriate remedial measures are taken to address the challenges faced by this cohort of subjects.

Some studies have reported on ocular abnormality findings among hearing impaired children without reporting the level of visual functioning at least as measured by visual acuity (Mafong *et al.,* 2002; Hanioðlu-Kargý *et al.,* 2003; Gogate *et al.,* 2009; Osaiyuwu and Ebeigbe, 2009; Abah *et al.,* 2011). From this study, 10.3% of the children for whom visual acuity was measured had a VA <6/9 with a further 7.3% having category I and II visual impairment. This is more than the 6.4% found by Nicoll and House (1988) in a study conducted in Western Australia but lower than 25.3% reported by Armitage *et al.,* (1995) in the UK. Armitage *et al.,* (1995) in their study had reiterated the fact that a deaf child is dependent on vision for communication and learning. There is no doubt therefore from this study that the estimated visual impairment prevalence rate of 7.3% may lead to this cohort of study participants having certain challenges in acquisition of communication skills.

Refractive error was present in 30.9% of the children for whom refractive error was determined. This is comparable to the estimated 28.9% and 29.8% reported by Armitage *et al.,* (1995) and Hanioðlu-Kargý *et al.,* (2003) in their respective studies. It was much higher compared to values reported by other authors: 7.9% (Abah *et al.,* 2011); 18.5% (Gogate *et al.,* 2009); 16.5% (Bist *et al.,* 2011) and much lower compared to the 73.3% reported by Osaiyuwu and Ebeigbe (2009). In terms of the commonest form of refractive errors, astigmatism was the most prevalent refractive error in this study. While this is consistent with the report of Hanioðlu -Kargý *et al.,* (2003), it was different from other reports. For example, hyperopia was the commonest refractive error reported by Abah *et al.,* (2011) and Mafong *et al.,* (2002) whereas myopia was the commonest refractive error reported by Gogate *et al.,* (2009), Bist *et al.,* (2011) as well as Osaiyuwu and Ebeigbe (2009). Nicoll and House (1988) reported an equal prevalence for myopia and hyperopia. The reason for this variation could be attributed to the differences in the definition and cut off point used by different authors in specifying the types of refractive errors.

A comparison of the prevalence of visual impairment and refractive error in the present study to two earlier studies on refractive error among school children without hearing impairment in Centreal

Region of Ghana by Ovenseri-Ogbomo and Omuemu (2010) and Ovenseri-Ogbomo and Assien (2010) shows that the 10.3% proportion of children with VA< 6/9 in this present study was significantly more than the 2.1% and 4.5% respective prevalence rates reported for school children without hearing impairment. The proportion of refractive error in this study 31.9% was also significantly more than the 25.6% and 13.3% reported by Ovenseri-Ogbomo and Omuemu (2010) and Ovenseri-Ogbomo and Assien (2010) respectively for school children without hearing impairment. This difference could even be more marked when one considers the fact that in the present study, cycloplegic refraction was not incorporated among the list of ocular problems as was the case in earlier studies conducted by Ovenseri-Ogbomo and Omuemu's (2010) or the use of higer cut-off point of +2.00D for hyperopia compared to +0.75D used by Ovenseri-Ogbomo and Assien (2010). Given that these studies were from children without hearing impairment within the same geographical and socio-cultural background, it might be inferred that children with hearing impairment have significantly higher proportion of visual impairment and refractive error compared to those without hearing impairment which finding is consistent with that of Brinks *et al.,* (2001) and Rogers *et al.,* (1988).

The ocular deviation proportion of 20.6% estimated in this study is greater than the 16.5% reported for Ghanaian school children without hearing impairment (Ovenseri-Ogbomo and Assien, 2010). In earlier studies conducted by Ovenseri-Ogbomo and Assien (2010) in children without hearing impairment and this study, exophoria happenened to be the commonest observed ocular deviation. Furthermore, the esophoria proportion of 8.0% estimated from this study is greater than the 2.0% estimated from the study conducted in children without hearing impairment by Ovenseri-Ogbomo and Assien (2010). This study recorded a squint prevalence of 2.5% in the children and this rate is higher than the 1.3% reported by Gogate *et al.,* (2009) for hearing impaired children in India.

The study noted the presence of previously undetected ocular abnormalities among the participants and this underscores the need for regular and more periodic scheduled eye examination for these groups of people as related by Gogate *et al.,*(2009) in their study. The occurrence of ocular abnormalities estimated in this study might have been underreported considering the fact that eye examinations in the school were conducted with direct ophthalmoscope which might have limitations in the diagnosis of some subtle ocular presentation that could have been uncovered with more sophisticated diagnostic procedure.

CONCLUSION

There are high proportions of refractive errors and other ocular abnormalities among the hearing impaired and deaf population of school going age. Given the high proportion of refractive error in this group, it is highly recommended that alongside otolaryngologic examination, children diagnosed of hearing impairment should have scheduled eye examination before placement in the school and during the duration of the schooling period. The relevant authorities should also ensure periodic reexamination of these children to detect any new ocular abnormality and evaluate on-going pathology. This high proportion of retinal/choroidal abnormalities could warrant a detailed retinal evaluation by experienced eye care practitioners. The detection of ocular abnormalities and taking prompt action will have a significant impact in the social interaction of the hearing impaired child.

COMPETING INTERESTS

The authors declare that they have no competing interests.

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