Original Article

Prevalence of ophthalmic disorders among hearing-impaired school children in Guntur district of Andhra Pradesh

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Purpose: To estimate the prevalence, causes, and risk factors for visual impairment (VI) among children of school for hearing-impaired (HI) in Guntur district of Andhra Pradesh, India. **Methods:** Children between 6 and 16 years of age available in all the 12 special schools for HI were examined. Visual acuity (VA) testing, ocular motility, and examination of anterior and posterior segment for all children were done. Those having VA of less than 6/12 in better eye underwent cycloplegic refraction. For definition of VI, as per World Health Organization (WHO), VA of better eye was considered. HI was also classified as mild, moderate, severe, and profound as per WHO definitions. Examination for systemic diseases and other associated disabilities was also done. **Results:** In all, 402 children underwent examination. Ophthalmic abnormality was seen in 64 children with a prevalence of 15.9% [95% confidence interval (CI) 14.9%–16.8%], and VI was seen in 29 children with a prevalence of 7.2% (95% CI 4.9%–10.2%). Refractive errors [29 (7.2%)], retinitis pigmentosa (RP) [16 (4%)], and squint [8 (2%)] were the major ophthalmic abnormalities. Thirty-five (54.7%) of the abnormalities were either preventable or treatable. The major cause of VI was refractive error (18) followed by RP (5). Twenty of them (69%) with VI in this study group were treatable. Twenty-two (75.9%) children with eye problem were newly diagnosed. The only risk factor for VI was being mentally challenged (odds ratio: 5.63; 95% CI: 1.89–16.8). **Conclusion:** The prevalence of ophthalmic abnormalities and VI in school for HI was high, and the majority of them were not detected so far. As most of them are easily treatable, it is highly recommended to conduct regular eye examinations in these schools.

Key words: Hearing-impaired, ophthalmic disorders, schools for the hearing-impaired children, Usher's syndrome

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Sense of vision and hearing are crucial for learning. When one of these is defective, dependence on the other one is increased. A deaf child needs to depend more on vision to explore his world. If such a child has some visual impairment (VI), it significantly affects development of communication skills and ability to explore the world around.[1] Such children with visual disorders and deafness may require multiple environmental adaptations and appropriate support. Deafblindness is not just the sum of deafness and blindness; it is a unique and entirely different condition.[2]

Several studies have reported high prevalence of ophthalmic disorders in deaf children. Approximately 20%–60% of them have one or more ophthalmic problems that may remain undetected for years.[1,3-16] In these studies, there is wide variation in the tests used and in the definition of what constitutes an ophthalmic disorder. There is only one study reported from Western India that examined 901 children in 14 special schools.[7] As there are no data from any other part of the country, we planned to conduct this study in Guntur district in Indian state of Andhra Pradesh with the following objectives:

1. To estimate the prevalence and causes of VI in children in the schools for hearing-impaired (HI) (special schools) in Guntur district of Andhra Pradesh
2. To estimate the associated risk factors for the same.

Methods

This cross-sectional study was conducted in 12 special schools for HI children in Guntur district of Indian state of Andhra Pradesh [Fig. 1]. Eleven of these schools are run by different nongovernmental organizations and one is run by the state government.

The Institutional Review Board approved the study, and the study adhered to the Tenets of the Declaration of Helsinki. Appropriate approvals were also obtained from the local district authorities and school authorities.

Inclusion and exclusion criteria

All children between 6 and 16 years of age in the special schools, available for examination, were included. Those who were above 16 years of age, not willing to participate in the study,

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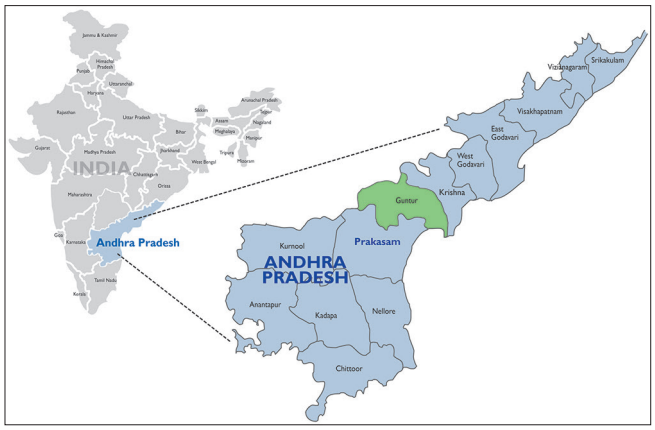

Figure 1: Indian state of Andhra Pradesh

not cooperative, and those who were not available at the time of examination were excluded.

Training the staff

The study team consisted of one ophthalmologist, two ophthalmic officers, and one program manager. All the team members were briefed about the study protocol. Ophthalmic officers were trained to collect requisite data from parents and school authorities, to measure height and weight, and to conduct visual acuity (VA) testing, refraction, and basic torch light eye examination. They were also trained to identify common eye problems in children, such as squint, cataract, nystagmus, ptosis, and identify gross systemic abnormalities. Interobserver variation test was done by the ophthalmic officers on 20 subjects for VA and refraction, and the overall agreement was more than 0.6.

Study tool

A questionnaire was designed, piloted on 20 subjects, and standardized. It consisted of demographic data, particulars regarding HI (mild/moderate/sever/profound), anthropometric measurements such as height and weight, history of systemic diseases, and details of comprehensive eye examination.

Definitions

For definition of VI, as per World Health Organization (WHO), VA of better eye was considered. Mild VI was defined as presenting VA less than 6/12 to 6/18, moderate VI as less than 6/18 to 6/60, severe VI as less than 6/60 to 3/60, and blindness as less than 3/60.

Those having VA of less than 6/12 in either eye and improving with refractive error correction to 6/12 or better were considered to have refractive error. Myopia was defined as a spherical equivalent refractive error of at least −0.50 D and hyperopia as +2.00 D or more and astigmatism as cylindrical correction of more than or equal to ±0.75 D. Cataract was defined as clouding that develops in the crystalline lens as seen in pupillary area.

HI was classified as mild, moderate, severe, and profound as per WHO definitions.[17] It was also classified as congenital HI when it was diagnosed within 1 year of birth and acquired when it was identified later.

Primary education was defined as those having education from grade 1 to 4, secondary education as grade 5 to 10, and higher education as ≥grade 11 and above. Consanguinity was defined as marriage between first, second, and third cousins.

Examination procedure

Initially, the demographic data, details of cause, and severity of hearing loss were noted as per history from parents, teachers, and records available with the school about each child. The students were examined in the presence of their teacher who helped with communication through sign language. History was obtained from every child along the following lines: any defective vision, history of wearing glasses, any problems with night vision, and so on. A systemic examination was performed to look for any systemic illness such as developmental delay, skeletal deformities, and any other associated disabilities. The height and weight of every child were measured.

VA was assessed using a log minimum angle of resolution (MAR) type "E" chart with five E optotypes on each line (Precision Vision, La Salle, IL, USA) and recorded as the smallest line read with one or no errors at 6 m. The student had to orient his fingers to match with the direction of arms of E on the chart. Each eye would be tested separately. The right eye was tested first and then the left, both with (presenting VA) and without glasses (uncorrected VA), if the child brought them. Lens power was measured with a lensometer. An enquiry will be made whether they use glasses regularly and if not what is the reason for the same.

Ocular motility examination was performed with cover–uncover and alternate cover test at both 0.33 and 6.0 m. Tropias were categorized as esotropia, exotropia, or vertical, with the degree of tropia measured using the corneal light reflex. Pupil in each eye was dilated with 1 drop of 1% cyclopentolate, followed by 1 drop of tropicamide 1% + phenylephrine 5% combination after 10 min, and cyclopentolate 1% will be repeated after 10 minutes. Light reflex and pupil dilation were evaluated after an additional 15 min. Cycloplegia was considered complete if the pupil was dilated to 6 mm or more and light reflex being absent. Refraction was performed in children after cycloplegia, regardless of their VA, using streak retinoscopy. Subjective refraction was performed in children with uncorrected VA of 6/12 or worse in either eye.

The ophthalmologist evaluated the anterior segment using a torch light and fundus using an indirect ophthalmoscope. Diagnosis of pigmentary retinopathy and other posterior segment pathologies were based on the clinical judgment of ophthalmologist. Children whose vision improved with refractive error correction in either eye were prescribed spectacles, and those children requiring subspecialty care or rehabilitation services were referred to the nearest tertiary care center. The findings were noted in the data collection form at the end for all children.

Data analysis

Following data collection, each data form was checked for completion and accuracy, and subsequently, fed into a database. Stata 13 was used to statistically analyze the data. Continuous variables were analyzed using Student's *t*-test. Categorical variables were analyzed using Chi-square test. Logistic regression was used for univariate and multivariate analyses to examine risk factors for VI. Hosmer–Lemeshow test was applied to assess the model fitness. A two-sided *P* value <0.05 was considered to be statistically significant.

Results

Demographic data

A total of 402 children with HI, from 12 special schools, were examined. The mean age for these children was 11.5 years [standard deviation (SD): 3.3 years]. The mean height was 139.4 cm (SD: 20.3 cm), and the mean weight was 33.4 kg (SD: 13.2 kg). The height and weight of all children were normal for their age except a 14-year-old girl who was dwarf (90 cm).

The demographic data of these 402 children are shown in Table 1. More than 60% of children were between 11 and 16 years of age, and there was male preponderance (59.5%). The parents of a majority of the children were either illiterate or with a primary level of education (72.9% of the mothers and 56.2% of the fathers) and had consanguineous marriages (64.2%). Most of them were having either severe or profound HI (67%), and the most common cause of HI was hereditary (95.3%) [Table 1].

General examination

In all, 26 (6.5%) children were intellectually challenged and 3 children had dysmorphic facial features. One had cleft lip and cleft palate (surgery done), and one child had no auditory canals in either of his ears.

Table 1: Demographic data of children in school for hearing impairment

Demographic character	Number	*n*=402, %
Age group (years)		
6-10	154	38.3%
11-16	248	61.7%
Gender		
Male	239	59.5%
Female	163	40.5%
Mother's education		
No education	225	56.0%
Primary education	68	16.9%
Secondary	77	19.2%
Higher	32	8.0%
Father's education		
No education	181	45.0%
Primary education	45	11.2%
Secondary	108	26.9%
Higher	68	16.9%
Consanguinity		
Yes	258	64.2%
No	144	35.8%
Level of hearing impairment		
Mild	76	18.9%
Moderate	57	14.2%
Severe	147	36.6%
Profound	122	30.4%
Causes of hearing impairment		
Hereditary	383	95.3%
Acquired	19	4.7%
Mentally challenged		
No	376	93.5%
Yes	26	6.5%

Ophthalmic disorders

Of the 402 HI school children, 64 were found to have one or more ophthalmic abnormalities. Thus, the prevalence of ophthalmic disorders was 15.9% [95% confidence interval (CI) 14.9%–16.8%]. The most common ophthalmic disorder was refractive error seen in 29 children (7.2%) followed by retinitis pigmentosa (RP) seen in 16 children (4%). Seven of these children with RP had associated refractive error. Squint was seen in eight children (2%), and one of these also had associated refractive error. Other abnormalities included lid abnormality (one), corneal opacity (one), vitamin A deficiency (one), cataract (four), glaucoma (one), retinal detachment (one), optic atrophy (three), macular pathology (five), microphthalmos (one), and microcornea (one). In all, 35 (54.7%) of the abnormalities were either preventable or treatable. Ophthalmic abnormalities were more common in children whose parents had consanguineous marriages (64.2%) than those who did not have consanguineous marriages (35.8%; $P < 0.0001$).

Visual impairment

Of the total 402 children, 29 were found to have VI as per WHO definition (presenting vision <6/12 in better eye). Thus, the prevalence of VI in our study was 7.2% (95% CI 4.9%–10.2%). Twenty-one of them had mild to moderate VI (presenting VA 6/12–6/60 in better eye) and eight had severe VI (presenting VA less than 6/60 in better eye). Of these 29 children, only 7 (24.1%) were known to have eye problems earlier and 22 (75.9%) were newly found during the study.

Refractive error was the most common cause of VI and was seen in 18 children, followed by RP (five) cataract (two), glaucoma (one), macular pathology (one), microcornea (one), and optic atrophy (one). Twenty of them (69%) with VI in this study group were treatable.

Risk factor analysis

Table 2 shows the univariable and multivariable analyses for risk factors for VI. Only those who were mentally challenged were at higher odds of having VI (odds ratio: 5.63; 95% CI 1.89–16.8)

Syndromic associations

By systemic and ocular features, the following cases of rare syndromes were identified in the study:

- Usher's syndrome: 16 cases (RP + sensory-neural hearing loss)
- Congenital rubella syndrome: two cases (microphthalmos, cataract, pigmentary retinopathy, intellectually challenged)
- Maroteaux–Lamy syndrome: one case (growth retardation, facial dysmorphism, corneal degeneration)
- Treacher Collins syndrome: one case (lid coloboma, microtia, atresia of external auditory canals, hypoplastic mid-face, malformed mandible).

Discussion

Overall, this study found the prevalence of ophthalmic disorders to be 15.9%, and nearly 55% of them were avoidable. Table 3 shows the prevalence of various ophthalmic disorders in different studies across the globe done at different points

Table 2: Univariable and multivariable analyses for risk factors for VI

Variables	No VI (*n*=373)	VI (*n*=29)	Unadjusted odds ratio (95% CI)	*P*	Adjusted odds ratio (95% CI)	*P*
Age in years	11.5 (SD: 3.29)	11.9 (SD: 3.17)	1.04 (0.93, 1.17)	0.49	1.07 (0.94, 1.23)	0.32
Gender						
Males	223 (93.3)	16 (6.7)	Reference		Reference	
Females	150 (92)	13 (8)	1.21 (0.56, 2.58)	0.63	1.26 (0.56, 2.82)	0.57
Mother's education						
No education	210 (93.3)	15 (6.7)	Reference		Reference	
Primary	62 (91.2)	6 (8.8)	1.35 (0.5, 3.64)	0.55	1.43 (0.45, 4.57)	0.54
Secondary	70 (90.9)	7 (9.1)	1.4 (0.55, 3.57)	0.48	1.47 (0.45, 4.74)	0.52
Higher	31 (96.9)	1 (3.1)	0.45 (0.06, 3.54)	0.45	0.55 (0.06, 5.53)	0.6
Father's education						
No education	169 (93.4)	12 (6.6)	Reference		Reference	
Primary	43 (95.6)	2 (4.4)	0.66 (0.14, 3.04)	0.59	0.64 (0.13, 3.24)	0.6
Secondary	97 (89.8)	11 (10.2)	1.6 (0.68, 3.76)	0.28	1.63 (0.57, 4.68)	0.37
Higher	64 (94.1)	4 (5.9)	0.88 (0.27, 2.83)	0.83	1.08 (0.25, 4.7)	0.9
Level of hearing impairment						
Mild	71 (93.4)	5 (6.6)	Reference		Reference	
Moderate	49 (86)	8 (14)	2.3 (0.72, 7.5)	0.16	2.0 (0.55, 7.43)	0.29
Severe	139 (94.6)	8 (5.4)	0.82 (0.26, 2.59)	0.73	0.83 (0.21, 3.2)	0.78
Profound	114 (93.4)	8 (6.6)	1.0 (0.31, 3.17)	0.99	1.09 (0.29, 4.07)	0.9
Causes of hearing impairment						
Hereditary	355 (92.7)	28 (7.3)	Reference		Reference	
Acquired	18 (94.7)	1 (5.3)	0.7 (0.09, 5.47)	0.74	0.45 (0.05, 4.3)	0.49
Consanguinity						
Yes	239 (92.6)	19 (7.4)	Reference			
No	134 (93.1)	10 (6.9)	0.94 (0.42, 2.1)	0.88	0.78 (0.32, 1.89)	0.59
Mentally challenged						
No	354 (94.2)	22 (5.8)	Reference		Reference	
Yes	19 (73.1)	7 (26.9)	5.9 (2.25, 15.6)	<0.001	5.63 (1.89, 16.8)	0.002

VI: Visual impairment; CI: Confidence interval; SD: Standard deviation

in time. Only one study was reported from India, and the prevalence of ophthalmic disorders found in our study was lower when compared with this study from India by Gogate *P et al*. They found that there were 24% children with various ophthalmic disorders.[7] The major difference in the two studies was in the prevalence of refractive errors. They found refractive errors in 18.5% of the children, whereas we found it in 7.2% of them. This difference could be because of urban–rural difference between the study population, that is, ours was rural and theirs was urban. Such a difference in the prevalence of refractive errors between urban and rural populations is well-known.[18,19] Apart from that, it is likely that children with reasonably good vision are likely to be admitted in schools for HI. Those with severe VI or having other multiple disabilities are likely to be either at home or in other special institutions. This could be another reason for less prevalence of refractive errors and VI in our study. However, compared with Gogate P *et al*.'s study, we had higher prevalence of RP (Usher's syndrome). This could be because of consanguineous marriages being more frequent in this population (64.2%). Similarly, the difference in prevalence between different studies could also be explained by the difference in methodology in different studies, different definitions, population, and the time period these studies were conducted.

The prevalence of VI in this group of children was found to be 7.2%. Approximately more than 75% of this VI was undetected so far. It is also important to note that nearly 70% of VI was treatable. Most of these children underwent an eye examination for the first time, and prior to our visit, none of these schools had any eye-screening program. Prevalence of VI (presenting VA <6/12) in children in general population in different Indian studies has been found to be ranging from 2.6% to 4.9%.[18-20] In our study, the prevalence of VI was 7.2%, which was a bit higher. This shows that VI is more prevalent in HI school children. Apart from this, nearly 75% of eye problems were newly diagnosed indicating lack of screening programs or ophthalmic examination for these children. Hence, there is a need for a regular eye examination program in schools for children with HI as most of these children rely entirely on their visual system for learning and having visually handicap, making the situation worse for them. This is further aggravated for unavoidable causes as they would need multiple interventions as well as various kinds of support services, including rehabilitation services. Hence, there is a need to sensitize the caretakers, that is, parents and teachers. There is also need for genetic counseling and social awareness about the risk involved to children born from consanguineous marriages as there were more chances of having ophthalmic abnormalities

Table 3: Comparison of the findings of our study with previous studies

Authors	No of subjects	Refractive errors	Extraocular motility disturbance	Pigmentary retinopathy
Fillman *et al.*[1]	210	48%	8%	3%
Alexander[3]	572	35%	12%	22%
Armitage *et al.*[4]	83	29%	20%	10%
Brinks *et al.*[5]	217	16%	5%	26%
Elango *et al.*[6]	165	14%	5%	35%
Gogate *et al.*[7]	901	18.5%	1.3%	0.6%
Guy *et al.*[8]	110	39%	6%	11%
Leguire *et al.*[9]	505	23%	11%	22%
Luhr and Dayton[10]	237	57%	NR	32%
Mohindra[11]	77	51%	19%	10%
Pollard and Neumaier[12]	511	25%	9%	7%
Quinsland *et al.*[13]	186	54%	NR	10%
Regenbogen and Godel[14]	150	27%	11%	5%
Stockwell[15]	422	45%	3%	4%
Woodruff ME[16]	460	30%	9%	NR
This study	402	7.2%	2%	4%

and other systemic abnormalities in those children born from consanguineous marriages.

Most of these children also have syndromic association and other ocular pathology. We could find multiple cases of syndromic associations, and some of them were mentally challenged too. Also, being mentally challenged was found to be independent risk factor for being VI. The presence of VI in these children will add to their agony, and hence, a through systemic work-up along with comprehensive eye examination, preferably by a pediatric ophthalmologist, is recommended.

One limitation of the study was uniform method of vision assessment rather than using different methods for children with other disabilities. However, with support from teachers, vision assessment could be done in all these children. Another limitation was lack of any diagnostic procedure performed on these children, especially electroretinogram due to high prevalence of Usher's syndrome in this group of children.

Conclusion

The prevalence of ophthalmic abnormalities in HI school children is more compared with children with normal hearing. However, there is need for more studies in the same region in children with normal hearing. Most of these abnormalities remain undetected since the frequency of eye screening in these schools is either very low or absent. Hence, we recommend that regular eye examination should be performed in such schools. Since the prevalence of posterior segment disorders in children is high, it may be preferable that such examinations are performed in the presence of an ophthalmologist.

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Conflicts of interest

There are no conflicts of interest.

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