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Visual impairment in children with multiple disabilities in schools for children with special needs in South India

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Purpose: To understand/assess ocular and functional vision impairment in children with multiple disabilities with a functional vision assessment battery in addition to standard ophthalmic examinations in an outreach setting. **Methods:** Seven schools for children with special needs, 243 children in total, were screened for ocular disorders and functional vision impairment through school camps. **Results:** Among them, 37% had refractive errors needing spectacle correction. With standard ocular testing methods, the visual impairment was around 32%, but when functional vision was assessed, the functional vision impairment amounted to 70% in these children. The presence of functional vision impairment was found to be independent of the associated disability. Assessment of visual capacities such as visual closure, saccade pursuits, optic ataxia, and developmental milestones early on can help in suspecting the presence of CVI. **Conclusion:** Children with multiple disabilities are more at risk of functional vision impairment, which significantly impairs their ability to function in daily life. A complete functional vision assessment becomes essential to plan early intervention for these children. The significant proportion of vision impairment and functional vision loss in our study indicates the need for coordinated structured programs to address vision-related problems in children with multiple disabilities.

Key words: Cerebral visual impairment, functional vision assessment, multiple disabilities, special school vision screening

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Visual impairment and blindness affect approximately 18–19 million adults and 1.5 million children worldwide. Most of the affected children are living in low-income countries.[1-3] The disability-adjusted life years (DALY) loss in a blind child is significantly more compared to adults with blindness.[4] Children with blindness have delays in developmental milestones, are more frequently hospitalized, and are more likely to die during childhood than a sighted child.[2] Severe vision loss also affects schooling and education, activities of daily living, orientation, and mobility from the early stage of life.

Population-based estimates of the prevalence of blindness in children vary from 0.6 to 1.06 per thousand, and the prevalence of visual impairment varies between 2.05 and 13.6 per thousand children in India.[1,5-10] Surveys of children at blind schools are used to estimate the preventable, curable, and unavoidable causes of ocular morbidity that lead to severe visual impairment or blindness in children.[11-14] However, these approaches have not considered the possible impact of cerebral visual impairment (CVI) and hence may underestimate the actual prevalence of childhood visual impairment and blindness in India. CVI is a leading cause of childhood vision impairment in developed countries.[15] There are few reports of CVI from India, although a previous study had reported an estimated 28% of CVI in children with cerebral palsy.[16]

We designed a cross-sectional study to screen children with multiple disabilities in an outreach setting to estimate the prevalence of ocular and functional vision impairment among schools for children with special needs in Madurai district of Tamil Nadu state, South India. Children who were found to have VI were referred to the base hospital for complete evaluation and intervention.

Methods

The study protocol prescribed a cross-sectional design. The tenet of the Declaration of Helsinki was approved by the institutional review board and ethics committee, and appropriate permissions were obtained from local government Departments of Health and Education of Madurai district. Seven schools for children with special needs were selected by simple random sampling and 243 children were screened.

A consent form to obtain permission from the parents of the students was handed over to the head of the selected schools and a mutually convenient date for ophthalmic assessments was decided. The researcher collected the name, age, phone number, demographic details, the type of disability included in the school, and the number of teachers and caretakers in the school. These details were codified and tabulated in a spreadsheet. Parents were sensitized through the teachers on

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eye examination, the need for dilated examination, and the importance of bringing all the medical reports of their child. An information sheet in the local language with the purpose and importance of eye examination, the procedure of screening, and the intended treatment/follow-up to be provided, with a written consent form was sent to every parent. Parents were encouraged to be present on the day of school screening with the prior medical records of the child. Children with consent forms signed by the parents were included for the screening.

A maximum of 25 children with multiple disabilities was included in each screening session. The screening team included the researcher, refractionist, ophthalmic technician, optician, rehabilitationist, special educator, and ophthalmologist. The medical history of the children was obtained from available medical records. Information on the primary disability, such as autism spectrum disorder (ASD), attention deficit hyperactivity disorder (ADHD), cerebral palsy (CP), hearing impairment, and mental retardation (MR); pre, peri, and post-natal complications; and the concerns on of the parent regarding the vision of the child were recorded. The primary systemic diagnosis as provided by the treating pediatrician/pediatric neurologist was recorded for every child from his/her medical record.

Ophthalmic evaluation

The details of the ophthalmic and functional vision assessments have been previously described and are presented briefly.[17] The visual acuity of each child was assessed using the age-appropriate charts, namely teller acuity, lea symbol distance chart, and single optotype. Near vision was assessed with Lea symbol, number, and alphabets. The accommodation reflex was assessed and an ocular assessment for the presence of squint and nystagmus, anterior segment evaluation, including the pupil and intraocular pressures, was done. Complete orthoptic evaluation was performed in the presence of strabismus. Cycloplegic refraction using homatropine 2% eye drops was performed. A refractive error of ≥−1.00 DS was categorized as myopia; ≥+1.0 DS, as hyperopia; and cylinder of ≥0.75 D as astigmatism. Refractive error was classified as per AAO classification.[18,19] Children who were confirmed to have refractive error were prescribed spectacles and referred to the tertiary eye care center for functional vision assessment later with refractive correction. Children with anterior segment abnormality such as cataract, corneal opacity, and strabismus were referred to the tertiary eye care center for further medical intervention. Children with functional vision impairment at the camp site were suspected of CVI and referred to tertiary eye care center for further evaluation and intervention. Functional vision impairment was considered if the child was unable to perform a given visual capacity in the presence of good visual acuity and appropriate age.[17]

Functional vision assessment

Functional vision assessments were performed for all children. Reaction to face and mirror was assessed with 5″ smiley face and a mirror sized 1″ × 1″. These were shown one behind one in-front of the child's face at 30 cm, and the duration of fixation was recorded by the examiner in seconds. Contrast sensitivity in nonverbal children was assessed by the Hiding Heidi low-contrast test and with pellirobson chart for verbal children. The control plate and the plano gray plate were moved in opposite direction with the same speed in front of the child at 30 cm. Contrast sensitivity of ≤5% on Hiding Heidi and ≥2% on Pelli–Robson was considered normal. Color vision assessment was performed using Ishihara pseudoisochromatic plates. Children who were nonverbal were asked to trace the pattern or number on the plates. The validated Nova Southeastern University College of Optometry (NSUCO) test was used to assess the ocular motility. The ability of the children, accuracy, head movements, and body movements to complete saccades and pursuit were noted. The scoring was based on a 5-point scale, with 5 being the highest; a score of ≤3 was a failure, and a score >3 was considered normal.[20] Visual field was measured by confrontation or leg raising method. The Lea mailbox was used to assess the recognition of line directions. The children were asked to insert a card into the slot in three different directions (horizontal, vertical, and oblique).[21] Lea puzzle (Good Lite, Elgin, IL) was used to assess visual discrimination (same/different). The children were asked to match the 3D puzzle using colors and shapes. The Lea rectangle game (Good Lite, Elgin, IL) was used to measure the ability to recognize size. The child was asked to match the five sets of rectangles according to their size and length.[17] The problem of simultagnosia was recorded based on the history provided by the mother/teachers, by observing if the child had difficulty with crowded background or cluttered objects during examination or an inability to focus on two or more objects at a given point.[17] Optic ataxia was assessed by holding a linear stick by the examiner in front of the child in right and left fields, and the child was expected to reach out and grasp the stick. Inaccuracy, difficulty, or asymmetry of the grasp was recorded as presence of optic ataxia.[22] The child was asked to arrange a familiar story card or daily life activity, such as brushing or dressing up, to assess the visual sequencing skill. The skill was considered defective if the child was not able to arrange it in correct sequence. Figure–ground discrimination was assessed by placing several familiar objects in a tray and the child was asked to pick up a specific one. Emoticons of sad, angry, happy, and fear were shown to the child and asked to name the emotions. If the child fails/wrongly identified two out of four, it was recorded as defective. Visual closure was assessed by showing a familiar picture partially hidden in view and the child was asked to name or match the complete object/picture. Functional vision was considered defective if any one of the visual capacities was defective.

Statistical analysis

Data were initially entered into an MS Excel spreadsheet and exported into the STATA (V number) statistical software for analysis. The distribution of continuous variables was expressed as mean (SD) and that of categorical variables as a proportion. The normality of data was assessed using the Shapiro–Wilk test and an appropriate parametric or nonparametric test used for analysis. The Kruskal–Wallis test was used to determine the correlation between visual impairment and reaction to face and mirror. The Spearman test was used to determine the correlation between reaction to face and reaction to mirror.

Results

Of the sampled children, the mean age was 14.79, of which two-thirds, that is, 154 (63%), were males.

About one-third of the children had NDD 79 (33%), followed by cerebral palsy 37 (15%), downs syndrome 25 (10%), and ASD 7 (3%). Multidisability was found in 78 (32%) of children. The result inferred that NDD and multidisability were observed in most of the sampled children.

The result highlighted that 90 (37%) children had refractive errors [Table 1]. Of those, 43 (18%) had myopia, 25 (10%) had astigmatism, 11 (5%) had high myopia. 6 had hyperopia, and 5 had high hyperopia.

Other ocular disorders such as optic disc pallor (5 children), strabismus (19 children), cataract (2 children), and retinal dystrophy (2 children) amounted to 12%; 57% of children had no detectable ocular disorder.

Visual impairment

The visual impairment data revealed that 57 children (24%) had mild to moderate VI and 39 children (16%) had profound VI; 38 children (17%) could not be tested, and 109 children (45%) were not having visual impairment. Ocular visual impairment was graded as per WHO criteria.[23]

Functional vision assessment

Reaction to face

More than half of the children (132 children) (54%) had the range of 0–5 s as far as reaction is concerned, whereas more than one third of them had the range (38%, 91 children) of 6–10. Only 19 children (8%) of the children could not be tested.

Reaction to mirror

Almost a similar result was obtained here compared to the reaction to face, with 55% (134 children) having 0–5 range and 37% (91 children) having 6–10 range; it was not testable for 18 (7%) children.

The functional vision parameters [Table 2] among the sampled children depicts that more than one fourth of the children could not be tested for visual capacities such as visual sequencing, simultagnosia, color vision, size, visual closure, emotional recognition, figure–ground discrimination, and 22% (55 children) for optic ataxia.

Viewing the defective column of the vision parameters, the dimensions such as saccades, pursuit, figure–ground discrimination, and size account for more than half of the children ranging from 51% to 72%, whereas the dimensions such as emotional recognition, visual sequencing, shape, and simultagnosia account for more than one-fourth of the children, ranging from 32% to 49%. The remaining dimensions, namely color vision (56 children, 26%), visual field, directionality, and visual closure comprised less than 25% of the children.

The functional vision by visual range among the children did not show any significant differences. The severity of visual impairment and the presence or absence of VI was independent of the associated disability in these children. The nature of neurological disability did not influence the presence or absence or severity of functional vision impairment.

Functional vision compared against associated disability categories of the study sample revealed that among all the disability dimensions, visual closure, saccades, pursuits, optic ataxia, and developmental milestone were significant at 5% level of probability. This result confirms that these visual capacities when defective were significantly manifesting as visual impairment [Table 3].

There is a significant association between visual impairment (standard ocular testing methods) and functional vision impairment ($P = 0.008$) [Table 4].

There is no statistical significance between associated disability and functional vision and refractive error and functional vision.

Table 1: Refractive error in children with multiple disabilities

Refractive Error	*N* (%)
No Refractive Error	150 (62)
Myopia	43 (18)
Astigmatism	25 (10)
High Myopia	11 (5)
Hyperopia	6 (2)
High Hyperopia	5 (2)
Not testable	3 (1)

**N* – Number of children. *Not testable – Not able to attend/perform the specified test

Table 2: Functional vision assessment in children with multiple disabilities

Functional visual capabilities	Normal *N* (%)	Defective *N* (%)	Not testable *N* (%)
Contrast	143 (59)	7 (30)	26 (11)
Color vision	97 (44.70)	56 (25.81)	90 (29.49)
Saccades	4 (18.11)	176 (72.43)	23 (9.47)
Pursuit	49 (20.25)	171 (70.66)	23 (9.09)
Visual field	153 (62.96%)	55 (22.63%)	35 (14.40%)
Directionality	177 (73.14)	54 (22.31)	12 (4.55)
Shape perception	127 (52.48)	106 (43.80)	10 (3.72)
Size	51 (20.99)	123 (50.62)	69 (28.40)
Simultagnosia	89 (36.93)	7 (31.95)	77 (31.12)
Optic ataxia	162 (66.67)	26 (10.70)	55 (22.63)
Visual sequencing	31 (14.42)	104 (48.37)	108 (37.21)
Figure ground discrimination	103 (42.39)	75 (60.86)	65 (26.75)
Emotion recognition	58 (23.87)	119 (48.97)	66 (27.16)
Visual closure	121 (50.21)	54 (22.41)	68 (27.93)

**N* – Number of children. *Normal – Able to complete the specific test. *Defective – Not able to complete the specific test. *Not testable – Not able to attend/perform the specific test

Reaction to mirror correlated significantly with reaction to face test. Both reaction to face and reaction to mirror can be used as screening tests to pick up poor eye contact and inattention in children at an earlier stage.

Discussion

The study provides estimates of the distribution of visual acuity and functional vision parameters among children with multiple disabilities. From an epidemiological perspective, children with multiple disabilities are not usually included in the sample estimates of childhood ocular morbidity or blindness. The larger number of males in the study may be due to the poor enrolment of girl children in special schools. The results of our study show that a significant proportion (almost 70%) of children with multiple disabilities have vision impairment and functional vision loss. The estimates of childhood blindness in India will be underestimated if these children are not included in the screening process.

The prevalence of refractive errors in children with multiple disabilities was around 37% as opposed to the normal population, where it is 8%.[24] With standard ocular testing methods, such as visual acuity, the visual impairment in these children amounted to around 32%. However, it is now established that children with multiple disabilities or any insult to the developing brain are prone to cerebral visual impairment or functional vision impairment. The study results highlight the fact that more than 70% of these children have some form of functional vision difficulty (at least one impaired visual capacity), which makes them susceptible for cerebral visual impairment, thereby increasing the percentage of vision impairment from 32% to around 70% in this target population.

In today's scenario, these children are not included in routine school screening, which aims to screen for refractive errors and treatable ocular conditions. Children with multiple disabilities are more at risk of functional vision impairment, which significantly impairs their ability to function in daily life, which means standard ocular testing for visual acuity and ocular structures is not enough to unearth the visual impairment suffered by these children. A complete functional vision assessment becomes essential to plan early intervention for these children.

The presence of functional vision impairment was found to be independent of the nature of the associated disability/diagnosis. This shows that any associated disability may put a child at risk of CVI and that the severity of vision impairment cannot be determined by the nature of the primary diagnosis.

This study also proves that outreach comprehensive school screening is possible in these children as evidenced by the level of testability for most of the tests.

The prevalence of vision impairment and functional vision defects in children with multiple disabilities is important from a service delivery and planning perspective as well. Children with multiple disabilities are a vulnerable population with limited access to optimal services. Identification of a vision-related problem can lead to possible improvements in

Table 3: Association between functional visual capacities and associated disabilities

Functional visual capabilities	Response	ASD *N* (%)	CP *N* (%)	DS *N* (%)	MD *N* (%)	NDD *N* (%)	Others *N* (%)	Association value
Visual closure	Normal	0	16 (13.22)	13 (10.74)	39 (32.23)	44 (36.36)	9 (7.44)	0.003*
	Defective	3 (5.56)	15 (27.78)	3 (5.56)	7 (12.96)	23 (42.59)	3 (5.56)	
Saccades	Normal	0	10 (22.73)	4 (9.09)	6 (13.64)	22 (50)	2 (4.55)	0.017*
	Defective	6 (3.41)	21 (1.93)	18 (10.23)	61 (34.66)	55 (31.25)	15 (8.52)	
Pursuits	Normal	1 (2.04)	12 (24.49)	5 (10.20)	6 (12.24)	23 (46.94)	2 (4.08)	0.009*
	Defective	5 (2.92)	19 (11.11)	17 (9.94)	61 (35.67)	54 (31.58)	15 (8.77)	
Optic ataxia	Normal	6 (3.70)	19 (11.73)	17 (10.49)	51 (31.48)	57 (35.19)	12 (7.41)	0.045*
	Defective	0	16 (29.09)	6 (10.91)	14 (25.45)	17 (30.91)	2 (3.64)	
Developmental milestones	Normal	0	0	0	5 (71.43)	0	2 (28.57)	0.018*
	Defective	6 (2.64)	37 (16.30)	24 (10.57)	69 (30.40)	78 (34.36)	13 (5.73)	

Note: Other visual capacities, namely contrast, visual field, directionality, shape and size perception, color vision, simultagnosia, figure–ground discrimination, emotion recognition, visual sequencing, and reaction to face and mirror were nonsignificant. *ASD – Autism Spectrum Disorder; *CP – Cerebral Palsy; *DS – Down syndrome. *MD – Multiple Disability; *NDD – Neuro-Developmental Disorder. **N* – Number of children. *Normal – Able to complete the specific test. *Defective – Not able to complete the specific test

Table 4: Comparison between visual impairment range and functional vision

Visual Impairment range	Functional vision		Total *N* (%)	Association value
	Normal *N* (%)	Defective *N* (%)		
Mild to moderate	0	57 (24.46)	57 (23.46)	0.008
Profound VI	0	39 (16.74)	39 (16.05)	
No VI	10 (100)	99 (42.49)	109 (44.86)	
NT	0	38 (16.31)	38 (15.64)	
Total	10 (100)	233 (100)	243 (100)	

**N* – Number of Children. *VI – Visual Impairment. *NT – Not testable - Not able to attend/perform the specific test

visual acuity; vision rehabilitation strategies that can further improve educational and other training provided to children with multiple disabilities. This may help provide some improvement in the general quality of life of these children and may help some of them achieve a level of functional independence or reduce functional dependence. From a planning perspective, the inclusion of these data and this subgroup of children will help refine current strategies to reduce pediatric vision impairment and blindness in India. The expansion of eye screening services to include centers for children with multiple disabilities is feasible as an extension of services provided to children at schools for the blind.

Appropriate assessments are key to visual rehabilitation, and the results of this study suggest that training for detailed functional vision assessments must be integrated into the general ophthalmology and optometry curriculum. The detailed ophthalmic and functional vision assessment and documentation are the strengths of the study. The assessments used in the study are affordable, available, and easy to use without complex instrumentation.

The limitation of this study is that not all children have details of their IQ assessment and neuroimaging in their medical records maintained in the schools and hence could not be included in the study. This is a maiden attempt at screening children with multiple disabilities for functional vision impairment; thus, only a suspicion of CVI was recorded.

Conclusion

Significant proportion of vision impairment and functional vision loss in our study indicate the need for coordinated structured programs to address vision-related problems in children with multiple disabilities. Assessment of visual capacities such as visual closure, saccade pursuits, optic ataxia, and developmental milestone assessments early on can help in suspecting the presence of CVI earlier. However, this needs further large-scale studies to prove its utility. The capacity building in developing a skill to screen for functional vision impairment with prescribed protocol warrants the necessity to impart training skills in this area. This will include more studies from different parts of India to better understand the magnitude of the problem, training, and skill upgradation for functional vision assessments in children, coordination between ophthalmologists, optometrists, vision rehabilitation specialists, and pediatricians.

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Conflicts of interest

There are no conflicts of interest.

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