Original Article

Causes of vision impairment and blindness among children in schools for the blind in South Indian States of Andhra Pradesh and Telangana

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Purpose: To study the causes of severe vision impairment (SVI) and blindness among children in Andhra Pradesh (AP) and Telangana State (TS) in South India. **Methods:** A total of 299 children from 10 schools for the blind were examined between January and December 2017. The schools were chosen from 3 districts of AP (Guntur, Krishna and West Godavari) and 2 districts of TS (Adilabad and Mahabubnagar). The World Health Organization Prevention of Blindness' eye examination protocol for children with blindness or visual impairment (VI) was followed. **Results:** Based on presenting visual acuity (PVA), 248 children (82.9%) were blind, 16 children (5.3%) had SVI, 18 (6%) had moderate VI, and 17 (5.7%) were normal. The most common anatomical cause of blindness or SVI was whole globe anomaly (32%), followed by an abnormality in the retina and vitreous (26.6%). While whole globe anomalies were high both in AP (33.8%) and TS (21.6%), lens-related pathologies were higher in TS (29.7%) and retina-related abnormalities were higher in AP (29.3%). The most common cause was related to heredity (40.5%). Etiology was unknown in 33.5% of cases. Overall, 37.1% of the causes were avoidable. In AP, 33.4% were avoidable whereas in TS nearly 60% were avoidable. **Conclusion:** Whole globe anomaly constitutes a major cause of SVI and blindness, especially in AP. Lens-related pathologies were higher in TS. Nearly 40% of the causes were avoidable. Hence, robust screening methods and strategies must be established for timely intervention to reduce the burden on VI in children.

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Control of childhood blindness (CB) is one of the priorities of VISION 2020: The right to sight[1] and there are several reasons for this.[2] To address the issues, there is a need for the systematic data collection on the magnitude as well as to find out causes of childhood blindness. There are several methods for collecting data on childhood blindness. In some high-income countries, population-based registers for vision impairment are used to compute the prevalence and magnitude of blindness in children.[1,3] Childhood vision screening and active surveillance have also been adopted in these countries.[3] In the low- and medium-income countries, affordable alternative methods have been used such as (a) taking under-five mortality rates as a proxy measure for estimating childhood blindness; (b) studying data from community-based rehabilitation (CBR) programs; (c) using key informants (KI) from the community as a means to collect data.[4] However, given the practical difficulties in undertaking epidemiological research on vision impairment (VI) in children, an understanding of the pattern and cause of blindness in children can be obtained by studying children in schools for the blind.[5] Repeating the exercise at an interval of 5–10 years would be useful to detect changes in the trends causing childhood blindness.[5]

Based on the available data, the prevalence and causes of blindness in children vary by region and in relation to socio-economic development.[5] Recent estimates show that 19 million children are vision impaired and of these 1.26 million are blind.[6] Two-thirds of blind children are in developing countries.[7]

In India the proportion and the causes of CB vary from region to region and based on the time frame when the study was conducted; the estimates range from 0.5/1000 to 1.06/1000.[8] There are an estimated 280,000–320,000 children blind in India.[9] As it is difficult to conduct population-based studies, an alternative approach to obtain information is to

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conduct a survey in schools for the blind. Some studies have been done in schools for the blind in India.[9-19] These studies suggest that about 30–40% of the children suffer from easily preventable and treatable causes of blindness, mainly corneal diseases and lens-related disorders. The remaining children suffered due to unavoidable causes such as congenital anomalies and genetic diseases. However, due to regional variations in causes and the differences between urban and rural areas, strategies should be customized to each region rather than having a single strategy for the entire country.

Methods

We conducted this study, as part of a large ongoing project 'Initiative for Screening Children for Refractive Errors and other Eye Health Needs (I-SCREEN) in the two Indian states of Andhra Pradesh (AP) and Telangana (TS)' [Fig. 1]. Children from 10 schools for the blind in AP ($n = 8$) and TS ($n = 2$) were studied to understand the causes of vision loss in children as well as the changing trends.

The protocol was approved by the Institutional Review Board (IRB) and adhered to tenets of Helsinki Declaration. All students attending the 8 schools for the blind in the three districts of AP (Guntur, Krishna and West Godavari) and two districts of TS (Adilabad and Mahabubnagar) were examined between January to December 2017. There were four schools from Guntur district, three from Krishna district, one from West Godavari in AP and one each from Adilabad and Mahabubnagar district in TS. Permission to examine the children was obtained from the district collector and social welfare officers at the district level and the principal or teacher-in-charge in the schools. The examination was noninvasive. The World Health Organization (WHO) Prevention of Blindness' eye examination protocol for CB or VI was followed. Demographic information was collected from the teachers, children, and their parents. A brief history of the family, place of residence, and consanguinity of the parents were recorded. Information on additional disabilities (e.g., intellectual disability, physical disability, hearing loss, multiple disabilities etc.) was obtained from the children's records. A detailed eye examination was performed by a team of optometrists and paediatric ophthalmologists. The WHO definitions were used to categorize the causes of severe vision impairment (SVI) and blindness.[20] The WHO defines blindness as presenting visual acuity (PVA) of less than 3/60 in the better eye; SVI as PVA of less than 6/60 to 3/60 in the better eye; and moderate vision impairment (MVI) as presenting vision acuity of less than 6/18 to 6/60 in the better eye.

Distance visual acuity was measured using a log MAR E-chart and near vision was equivalent to N18. If visual acuity was <6/60 then it was measured at 3 m; if it was <3/60 then the child was progressively taken closer to the chart until he/she was able to read the top letter. If the top letter could not be read at 1 m then counting fingers was tried and perception of light and projection of light in four quadrants were tested. The vision was tested separately for each eye. For low vision, the functional vision was assessed to determine if the child had a useful residual vision for independent mobility (ability to navigate without assistance between two chairs set 2 m apart in a well-lit room). Social interaction (ability to recognize faces at a distance of 2 m) and near vision (ability to recognize or describe the shape of three symbols of 2 cm at any near distance) were also measured.

The anterior segment was examined using a handheld slit lamp (BA 904 Haag Streit, USA). Intraocular pressure was measured with a Perkin's tonometer (Perkins Mk3 Haag Streit, USA). The posterior segment was examined using an indirect ophthalmoscope (Volk Optical Inc, Mentor, Ohio, USA) after dilating the pupils. One major anatomical site and the underlying cause was selected for each eye in each child. If there were two causes, the preventable or treatable cause was coded first. The need for optical, surgical, or medical interventions was recorded and the visual prognosis was assessed. Children requiring further investigations and treatment were referred to the nearest tertiary centre. All personal data and clinical findings of each child were recorded on the 'WHO/Prevention of Blindness Eye Examination Record for Children with

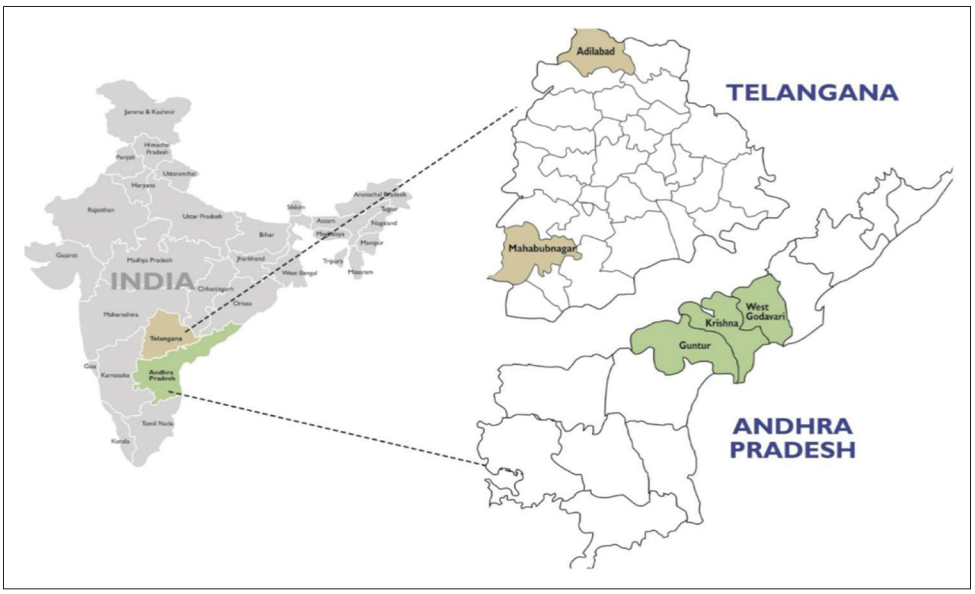

Figure 1: Map showing study districts of Andhra Pradesh and Telangana

Blindness and Low Vision' in accordance with the coding instructions.[21] Data were recorded on an Excel sheet and analysed using the STATA13 (StataCorp LLC, Texas, USA).

Results

A total of 299 children in 10 schools for the blind were enumerated and examined. The mean age was 11 ± 4.8 years (range: 4–15 years). There were 186 (62.2%) boys and 113 (37.8%) girls; with 157 (63.6%) boys and 90 girls (36.4%) in AP and 29 (55.8%) boys and 23 girls (44.2%) in TS. A family history of eye disease was present in 86 children (28.7%); 65 (26.3%) in AP and 21 (40.4%) in TS. History of consanguinity among parents was present in 113 children (37.8%); 96 children (38.9%) in AP and 17 children (32.7%) in TS. Systemic disability was seen in 20 (6.7%) children; 17 (6.9%) in AP and 3 (5.8%) in TS; and the most common was intellectual disability found in 12 children of AP (4.9%).

The presenting and best-corrected visual acuity in the better eye was recorded [Table 1]. Based on PVA, 16 children (5.3%) had SVI, 248 children (82.9%) were blind (214 in AP and 34 in TS), and 35 children (11.7%) had no VI or moderate VI. After BCVA, 51 children (17%) had no or moderate vision impairment.

Table 2 shows the anatomical classification of VI in all the children and in the two states. Five children did not co-operate beyond visual acuity measurement and were excluded from the anatomical and etiological classification. The most common anatomical cause of blindness or SVI was whole globe anomaly (32%), followed by an abnormality in the retina and vitreous (26.6%). While whole globe anomalies were high both in AP (33.8%) and TS (21.6%), lens-related pathologies were higher in TS (29.7%) and retina-related abnormalities were higher in AP (29.3%).

Table 3 shows the etiological classification of SVI and blindness stratified by states. The most common cause was hereditary (40.5%). Etiology was unknown in 33.5% of cases. Between the two states, intrauterine causes were higher in AP (13.5%) and postnatal causes were higher in TS (13.5%).

Table 4 shows the avoidable causes of SVI and blindness in these two states. Overall, 37.1% were avoidable (11.6% were preventable and 25.5% were treatable). In AP, 33.4% were avoidable whereas in TS nearly 60% were avoidable. The most common avoidable causes of VI were related to the lens seen in 44 (16.9%) cases. Of those with lens-related causes, 21 children had previous surgery. Despite surgery, they had SVI or blindness because of associated problems such as posterior capsular opacity in 4 children, pseudophakia with stimulus deprivation amblyopia in 4 children, and aphakia with stimulus deprivation amblyopia in 13 children. This indicates that a strategy is required for early detection and intervention.

Discussion

Given the practical difficulties in undertaking population-based epidemiological research on blindness and VI in children, most of the estimates on blindness in children are obtained from data collected in schools for the blind. Repeating the exercise at an interval of 10–15 years would be useful in detecting changes in the pattern of the causes of childhood blindness.[5] A 2000 study conducted in the same states revealed that the diseases of retina and vitreous are major causes of SVI and blindness (31.1%) followed by corneal conditions (24.3%).[15] Previous studies in south India also showed corneal conditions as one of the major causes of SVI and blindness[9,12] Subsequently, our study found a significant reduction in corneal causes (11.2%); and the major causes identified were whole globe anomalies (29.3%) and diseases of the retina and vitreous (26.3%), which were mostly unavoidable. Retinal dystrophies were the major cause among retinal problems. A high degree of consanguinity could be responsible for retinal dystrophies and most of the globe anomalies. One of the reasons for a decline in corneal causes could be the good immunization coverage for measles as well as nutritional programs run by the government.[22] In contrast, recent studies from the north and north-east parts of the country report that corneal conditions continue to be one of the major cause of SVI and blindness.[10,11,19] Hence, depending on the causes, a region-specific strategy would be more effective rather than a generic strategy for the country.

In the present study, nearly half of those with lens-related causes had been operated previously but they had SVI or blindness because of associated co-morbidities including amblyopia. This emphasizes the need for early detection, intervention and appropriate correction, as well as amblyopia therapy at an early stage.

In terms of aetiological causes, hereditary was the most common; which could be due to a high prevalence of consanguineous marriages. However, our study showed that intrauterine causes are also responsible for blindness or SVI, suggesting that causes such as retinopathy of prematurity (ROP) are gaining significance. Similar to previous studies, it is also worth noting that in nearly one-third of the cases, aetiology could not be identified.[9,11,12,15,16,18,19] This could be due to nonavailability of parents during school screening to elicit a complete history. Hence, it would be helpful to

Table 1: Presenting and best-corrected visual acuity in children

VI[$] category	PVA* (*n*=247)	BCVA** (*n*=247)	PVA* (*n*=52)	BCVA** (*n*=52)	Total PVA* (*n*=299)	Total BCVA** (*n*=299)
	Andhra Pradesh		Telangana State		Both the states	
	PVA *n*=247 *n* (%)	BCVA *n*=247 *n* (%)	PVA *n*=52 *n* (%)	BCVA *n*=52 *n* (%)	PVA *n*=299 *n* (%)	BCVA *n*=299 *n* (%)
No VI	10 (4)	12 (4.9)	7 (13.5)	8 (15.4)	17 (5.7)	20 (6.7)
Moderate VI	10 (4)	18 (7.3)	8 (15.4)	13 (25)	18 (6)	31 (10.3)
Severe VI	13 (5.3)	13 (5.3)	3 (5.8)	1 (1.9)	16 (5.4)	14 (4.68)
Blindness	214 (86.6)	204 (82.6)	34 (65.4)	30 (57.7)	248 (82.9)	234 (78.2)

*PVA: Presenting visual acuity; **BCVA: Best-corrected visual acuity; [$]VI: Vision impairment

Table 2: Anatomical classification of the causes of severe vision impairment and blindness

	Andhra Pradesh (*n*=222)	Telangana State (*n*=37)	Total (*n*=259)
Anomalies	*n* (%)	*n* (%)	*n* (%)
Whole globe anomaly	75 (33.8)	8 (21.6)	83 (32)
Phthisis bulbi	17 (7.7)	2 (5.4)	19 (7.3)
Anterior Staphyloma	15 (6.8)	1 (2.7)	16 (6.2)
Anophthalmos	12 (5.4)	1 (2.7)	13 (5.0)
Microphthalmos with microcornea and coloboma	21 (9.5)	2 (5.4)	23 (8.9)
Buphthalmos	6 (2.7)	1 (2.7)	7 (2.7)
Cryptophthalmos	3 (1.4)	0 (0)	3 (1.1)
Retinoblastoma	1 (0.5)	1 (2.7)	2 (0.8)
Cornea	27 (12.2)	2 (5.4)	29 (11.2)
Corneal opacity	27 (12.2)	1 (2.7)	28 (10.8)
Keratoconus	0 (0)	1 (2.7)	1 (0.4)
Uvea	1 (0.5)	0 (0)	1 (0.4)
Occlusio papillae	1 (0.5)	0 (0)	1 (0.4)
Lens	33 (14.9)	11 (29.7)	44 (17)
Congenital cataract, (unoperated)	17 (7.7)	5 (13.5)	22 (8.5)
Aphakia with stimulus deprivation amblyopia	9 (4.1)	4 (10.8)	13 (5.0)
*PCIOL with posterior capsular opacification	3 (1.4)	1 (2.7)	4 (1.5)
Subluxated lens	0 (0)	1 (2.7)	1 (0.4)
Pseudophakia with stimulus deprivation amblyopia	4 (1.8)	0 (0)	4 (1.5)
Retina and vitreous	65 (29.3)	4 (10.8)	69 (26.6)
Retinal dystrophy	28 (12.6)	0 (0)	28 (10.8)
Retinitis Pigmentosa	27 (12.2)	3 (8.1)	30 (11.6)
Stage 5 retinopathy of prematurity	2 (0.9)	0 (0)	2 (0.8)
Albinism	4 (1.8)	1 (2.7)	5 (1.9)
Leber's congenital amaurosis	3 (1.4)	0 (0)	3 (1.2)
Vitreous opacity	1 (0.5)	0 (0)	1 (0.4)
Optic Nerve	15 (6.8)	4 (10.8)	19 (7.3)
Optic atrophy	13 (5.9)	4 (10.8)	17 (6.6)
Optic disc hypoplasia	2 (0.9)	0 (0)	2 (0.8)
Globe appears normal	6 (2.7)	8 (21.6)	14 (5.4)
Cerebral vision impairment	3 (1.4)	1 (2.7)	4 (1.5)
High hypermetropia with ametropic amblyopia	1 (0.5)	4 (10.8)	5 (1.9)
High myopia with ametropic amblyopia	2 (0.9)	3 (8.1)	5 (1.9)

*PCIOL: Posterior chamber intraocular lens

Table 3: Etiological classification of the causes of severe vision impairment and blindness

Etiology	Andhra	Telangana State	Total
	No of Children (*n*=222)	No of Children (*n*=37)	No of Children (*n*=259)
Hereditary	86 (38.7)	19 (51.4)	105 (40.5)
Intrauterine	30 (13.5)	1 (2.7)	31 (12)
Perinatal/neonatal	11 (5)	2 (5.4)	13 (5.0)
Postnatal/infancy/childhood	13 (5.9)	5 (13.5)	18 (6.9)
Unknown	82 (36.9)	10 (27)	92 (35.5)

encourage the attendance of parents in future when such studies are conducted. Interacting with the parents would give an opportunity for identifying the etiology as well as counseling them about the risks of consanguineous marriages, and educating them about early and continuous treatment and rehabilitation.

Overall 37.1% of the causes were avoidable. Compared to previous studies, the preventable causes have decreased and treatable causes have increased.[9,12,15] In contrast to this, a study conducted in the north and northeast parts of the country and in Maharashtra found a higher percentage of preventable causes.[10,11,13,18] Based on the control of blindness

Table 4: Preventable and treatable causes of blindness and SVI

	Andhra Pradesh (*n*=222)	Telangana State (*n*=37)	Total (*n*=259)
Anomalies	*n* (%)	*n* (%)	*n* (%)
Avoidable			
Preventable	29 (13.1)	1 (2.7)	30 (11.6)
Corneal opacity	27 (12.2)	1 (2.7)	28 (10.8)
Stage 5 retinopathy of prematurity	2 (0.9)	0 (0)	2 (0.8)
Treatable	45 (20.3)	21 (56.8)	66 (25.5)
Buphthalmos	6 (2.7)	1 (2.7)	7 (2.7)
Retinoblastoma	1 (0.5)	1 (2.7)	2 (0.8)
Keratoconus	0 (0)	1 (2.7)	1 (0.4)
Occlusion pupillae s/p uveitis	1 (0.5)	0 (0)	1 (0.4)
Congenital cataract	17 (7.7)	5 (13.5)	22 (8.5)
Aphakia	9 (4.1)	4 (10.8)	13 (5)
*PCIOL with posterior capsular opacification	3 (1.4)	1 (2.7	4 (1.5)
Subluxated lens	0 (0)	1 (2.7)	1 (0.4)
Pseudophakia with stimulus deprivation amblyopia	4 (1.8)	0 (0)	4 (1.5)
Vitreous opacity	1 (0.5)	0 (0)	1 (0.4)
High hypermetropia with ammetropicamblyopia	1 (0.5)	4 (10.8)	5 (1.9)
High myopia with ametropic amblyopia	2 (0.9)	3 (8.1)	5 (1.9)
Unavoidable	148 (65.3)	15 (40.5)	163 (61.8)
Phthisis bulbi	17 (7.7)	2 (5.4)	19 (7.3)
Anterior staphyloma	15 (6.8)	1 (2.7)	16 (6.2)
Anophthalmos	12 (5.4)	1 (2.7)	13 (5.0)
Microphthalmos with microcornea and coloboma	21 (9.5)	2 (5.4)	23 (8.9)
Cryptophthalmos	3 (1.4)	0 (0)	3 (1.2)
Retinal dystrophy	28 (12.6)	0 (0)	28 (10.8)
Retinitis pigmentosa	27 (12.2)	3 (8.1)	30 (11.6)
Albinism	4 (1.8)	1 (2.7)	5 (1.9)
Leber's congenital amaurosis	3 (1.4)	0 (0)	3 (1.2)
Optic atrophy	13 (5.9)	4 (10.8)	17 (6.6)
Optic disc hypoplasia	2 (0.9)	0 (0)	2 (0.8)
Cerebral vision impairment	3 (1.4)	1 (2.7)	4 (1.5)

*PCIOL: Posterior chamber intraocular lens

and vision impairment in children, with the reduction in avoidable causes over a period of time, nonavoidable causes are gaining significance and controlling these will become a challenge. Research is also required to identify the causes of whole globe involvement as well as hereditary retinal diseases. There is also a need for good genetic counselling, considering the complex social, economic, and cultural factors involved in these conditions.

Based on presenting visual acuity (PVA), 11.7% (35) had normal vision or moderate VI; and based in best-corrected visual acuity (BCVA), 17% (51) had normal vision or moderate VI which is similar to previous studies.[9,12,15] However, a recent study showed a much higher percentage with MVI or normal vision in children.[19] This could be due to inappropriate use of recent government schemes that are introduced to support the education and rehabilitation of children with disabilities. Periodic screening in these schools would help to detect these children and move them to regular mainstream schools.

Systemic disability was seen in 20 children and the most common was intellectual disability present in 12 children of AP (4.9%). This is similar to previous studies in India where there is under-representation of children with multiple disabilities.[10,11,13,19] It is likely that children with multiple disabilities are often not admitted to schools for the blind, but admitted in schools for children with other disabilities.

There are some inherent biases in any study of children conducted in schools for the blind. Children with multiple disabilities, pre-school-aged children, children from the lower socio-economic groups, and from rural communities are likely to be under-represented in schools for the blind compared to population-based studies where these children are included. It is estimated that in developing countries only 10% of blind children attend school for the blind.[1] The major factors for low attendance could be a lack of awareness among parents and geographic inaccessibility to schools for those residing in remote and deprived areas. Mistrust and scepticism exist in some tribal and village communities regarding such centres which further hinders access. Also, while the results from studies in blind schools give an understanding of the relative magnitude of different causes of blindness in a particular

region, they do not give any information on cause specific prevalence in the population. Another limitation for this study would be that the children in school for the blind in these two states may not be representative of the entire population of children in school for the blind. Hence, the regional difference could also be due to the way schools were selected.

Conclusion

The major cause of SVI and blindness in children in AP seems to be whole globe anomaly. Lens-related pathologies were relatively higher in TS. Nearly 40% of the causes were avoidable. Hence, robust screening methods and strategies must be established for timely intervention to reduce the burden on VI in children.

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Conflicts of interest

There are no conflicts of interest.

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