Original Article

A population-based study on the prevalence and causes of childhood blindness and visual impairment in North India

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Purpose: This was a population-based study to determine the prevalence and causes of visual impairment in children less than 16 years in Urban North India. **Methods:** This cross-sectional study was conducted in 40 clusters of urban Delhi. 20,955 children aged less than 16 years underwent visual acuity screening using age-appropriate visual acuity charts. Unaided visual acuity of enumerated children aged over 2 years was assessed by using Lea symbols chart in 3-5 years age group and logMAR tumbling E charts for the 6-15 years age group. For children aged 0-2 years, fixation and following to torch light was assessed. All the children with unaided visual acuity of <6/12 in any eye in age group 3–15 years and inability to follow the light in age <3 years were referred for detailed ophthalmic examination. **Results:** Amongst 20,955 children examined for visual acuity a total of 789 children were referred to the central clinic for detailed ophthalmic examination. Of these referred children, a total of 124 had presenting visual acuity <6/18 in the better eye. The prevalence of visual impairment (VI) was 5.92 per thousand (95% CI: 4.96-7.05). The prevalence of moderate to severe visual impairment was maximum in the age group of 11 to 15 years. The main cause of avoidable VI in these children was a refractive error (75.7%). The prevalence of blindness was 0.42 per thousand. **Conclusion:** Optic nerve abnormalities were the most important cause of blindness in children. Refractive error is the most important cause of visual impairment amongst children and needs to be addressed.

Access this article online

Website: www.ijo.in

DOI: 10.4103/ijo.IJO_2408_20

Quick Response Code:

Key words: Blindness, visual impairment, children, causes, prevalence

Visual impairment (VI) has profound implications in terms of reduced educational, recreational, and social opportunities in children. Globally, around 1.4 million blind children less than 16 years of age are blind, of this approximately 75% of them are from developing countries. The prevalence of blindness in children varies from 0.3 per thousand children in developed countries to 1.5 per thousand in developing countries.[1,2]

In India, there are numerous gaps in knowledge about epidemiology of childhood blindness with very few community-based studies available in northern part of India compared to southern part of the country.[3-9] There is a consistent lack of evidence on the epidemiology and varied cause of childhood blindness in the north. To deal with the problems, several interventions have been introduced to address childhood blindness in the past few decades under NPCB (National Program for control of blindness) in India. Due to these interventions implemented across the country by World Health Organisation (WHO) and NPCB, a paradigm shift in the causes of childhood blindness has been reported especially in south India.[3,5,7,9-11] While there are numerous community-based surveys from southern India,[3,5-7] similar studies from the north are not available. As there are numerous differences in the availability and accessibility of health care services and cultural practices, these regional studies may not be reflective of the whole of India. Region-wise data is essential to plan and augment available resources and provide a comprehensive eye care approach. The aim of this study was to determine prevalence and causes of childhood visual impairment in a cross-sectional population-based study.

Methods

This population-based cross-sectional study was conducted during January 2015 to August 2018 in East Delhi district of North India. The study was initiated after taking due permission from District Blindness Control Programme officer of East Delhi District and approval by the ethics committee of AIIMS. All children aged <16 years at the time of visit and staying in East-Delhi district for 6 months or more were included for the study. The sample size was calculated to be 20,000 based on an estimated 3.34 per thousand prevalence of visual impairment (presenting visual acuity <6/18 in better eye).[3] Cluster random sampling (CRS) methods were used to select 40 clusters in the district with target sample size of 500

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Received: 27-Jul-2020 Revision: 27-Sep-2020
Accepted: 24-Jan-2021 Published: 21-May-2021

Cite this article as: Wadhwani M, Vashist P, Senjam SS, Gupta V, Saxena R, Tandon R. A population-based study on the prevalence and causes of childhood blindness and visual impairment in North India. Indian J Ophthalmol 2021;69:1381-7.

children in each cluster and 90% coverage. The team included field workers, social workers, and optometrists who were trained in study methods before the initiation of the study after providing them a 1 week training on visual acuity examination and filling of enumeration form. There were two phases in the study, enumeration phase, and detailed ophthalmic examination phase.

Enumeration and screening

A detailed house to house visual acuity examination was conducted by the study team. Parents of all the children were informed about the nature of the study after taking an informed written consent. Demographic details about the parents and eligible children in visited households were recorded. Besides this, socioeconomic status was elicited using Modified Kuppuswamy criteria that included occupation, education of head of household and family income per month.[12] The children who were not able to communicate and parents of children refusing for giving consent were excluded from the study. History of common ocular symptoms was elicited for each eligible child. Unaided visual acuity of enumerated children aged over 2 years was assessed by using Lea symbols chart in 3-5 years age group and logMAR tumbling E charts for the 6-15 years age group. For children aged 0-2 years, fixation and following to torchlight was assessed. All children with unaided visual acuity <6/12 in any eye, children wearing glasses, and children who did not fix and follow were referred to a centrally located clinic for detailed ophthalmic examination. At the clinic, all referred children underwent detailed visual acuity examination using Cardiff acuity cards for children <3 years, Lea charts for 3-5 years ages and log MAR E chart for 6-15 years age group.

Clinical examination

All the children with unaided visual acuity less than 6/12 in any eye were referred for clinical examination in a centrally based clinic. There an ophthalmologist and optometrist conducted a detailed ophthalmic examination including repeat assessment of visual acuity using retro-illuminated logMAR E charts, dry and cycloplegic refraction, anterior segment examination and a dilated posterior segment evaluation. Detailed anterior segment examination included Hirschberg test, slit lamp biomicroscopic examination. Pupils were dilated using 2% homatropine or 0.5% tropicamide in case the child was >10 years with no strabismus. Refraction was performed after minimum 45 minutes of instillation of cycloplegic drops (homatropine 2%) and achieving adequate pupillary dilatation. Lensometry was done to check the power of glasses already worn by the children. To ensure uniformity between refraction inter-observer variation assessment was conducted between the four optometrists with one of the available ophthalmologists as a gold standard. The kappa for this was 0.74 signifying adequate agreement.

The posterior segment was examined by an ophthalmologist using direct and indirect ophthalmoscopes. The causes of VI were classified according to WHO PBL form that divides the form into anatomical and etiological categories.[8] Anatomical section consisted of eye wise sections related to abnormalities in ocular structures like: whole globe, cornea, lens, uvea, retina and optic nerve, along with the subsections related to each category to define the further abnormalities in them. Etiological sections consisted of six major sections of hereditary, intrauterine, perinatal, postnatal, cannot determine with the further subsections to be filled for appropriate categorization.[12] Where two or more anatomical sites were involved for VI the major site was selected or if two sites contributed equally, the most treatable condition was selected. The standard classification of visual impairment and blindness were followed as per International classification of disease (ICD 10) and for the children less than 3 years that were unable to fix and follow the light were considered blind. Children with major eye problems like pediatric cataract, strabismus, congenital nasolacrimal duct abnormality, retinal degeneration etc., were referred to the base hospital and their treatment was facilitated by the study team. Referred children jn the field who did not visit the central clinic even after repeated requests were visited at home by the clinical team to minimize attrition.

Statistical analysis

The analysis was done after entry of the data in a specifically designed database in Epi data. The entered data was exported and final data analysis was done using Stata 14. The distribution of participants with respect to age, gender, residence type, education status, income, etc., was tabulated. A value of $P < 0.05$ was considered statistically significant. Categories of visual impairment and blindness was as per ICD-10 that categorized the visual impairment using the criteria of presenting visual acuity in better eye as mild, moderate and severe visual impairment and blindness.[13]

Results

In the 40 clusters, a total of 9859 households were visited, 21,532 children were enumerated, and 20,955 of which underwent screening. A total of 20,166 (96.2%) children had unaided visual acuity >6/12 unaided in both eyes and 789 (3.8%) children were referred by optometrists for detailed ophthalmic examination. Among these, 722 (91.5%) children underwent detailed ophthalmic examination [Fig. 1]. Of the 789 children referred, 453 (57.4%) were aged between 11-15 years followed by 286 (36.3%) children in the age group of 6-10 years and 46 (5.8%) children between 3-5 years and the remaining 4 (0.5%) children were less than 3 years. 384 (48.7%) were females whereas 405 (51.3%) were males.

The prevalence of blindness was 0.43 per thousand (95% CI: 0.22-0.83). The prevalence of MSVI (moderate–severe visual impairment) was 5.49 per thousand (95% CI: 4.57-6.58). This includes severe visual impairment (SVI) 0.24 per thousand (95% CI: 0.10-0.57) and moderate visual impairment (MVI) 5.25 per thousand (95% CI: 4.36-6.32). The prevalence of MSVI was maximum in the age group of 11 to 15 years. Over all visual impairment according to ICD 10 with the criteria of less than 6/18 to absence of perception of light was 5.92 per thousand (95% CI: 4.96-7.05) the prevalence of visual impairment was more in male children 6.25 per thousand (95% CI: 4.94-7.91) [Table 1 and Fig. 2].

The multivariable analysis of visually impaired children, in the age group of less than 16 years, revealed that after age and gender adjustment, the odds of having VI increased with increasing age, ($P < 0.001$). There was no statistically significant difference in odds of having VI after adjusting with parents wearing glasses and parental education [Table 2].

Table 1: Age and gender wise prevalence of blindness and visual impairment in children (PVA better eye) (*n*=20955)

PVA Better eye	Total *n*	BL (<3/60)		MSVI (<6/18-3/60)		VI (<6/18)	
		n	Prevalence per 1000 (95% CI)	*n*	Prevalence per 1000 (95% CI)	*n*	Prevalence per 1000 (95% CI)
Age (Yrs.)							
<3	3376	4	1.18 (0.44-3.15)	0	0.00 (0.00-0.00)	4	1.18 (0.44-3.15)
3-5	3946	1	0.25 (0.04-1.8)	8	2.03 (1.01-4.05)	9	2.28 (1.19-4.38)
6-10	7085	2	0.28 (0.07-1.13)	48	6.77 (5.11-8.98)	50	7.06 (5.35-9.30)
11-15	6548	2	0.31 (0.08-1.22)	59	9.01 (6.99-11.61)	61	9.32 (7.25-11.96)
Gender							
Male	11032	6	0.54 (0.24-1.21)	63	5.71 (4.46-7.3)	69	6.25 (4.94-7.91)
Female	9923	3	0.30 (0.10-0.94)	52	5.24 (4-6.87)	55	5.54 (4.26-7.21)
Total	20955	9	0.43 (0.22-0.83)	115	5.49 (4.57-6.58)	124	5.92 (4.96-7.05)

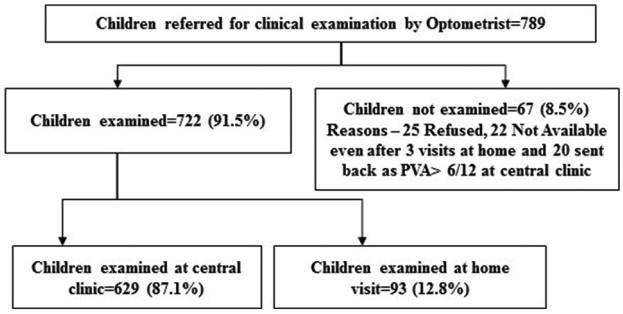

Figure 1: Details of ophthalmic examination of referred children

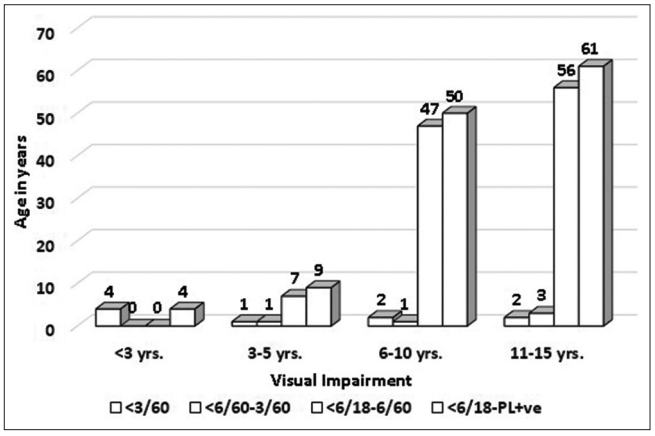

Figure 2: Age wise prevalence of visual impairment in children

On classifying these children according to the anatomical cause of blindness, using WHO PBL (World Health OrganiZation prevention of blindness and low vision) form[8] with the criteria of presenting visual acuity in better eye, 124 children had visual impairment.

A total of 9 children were blind, 6 (66.7%) male and 3 (33.3%) female and 115 children had moderate to severe visual impairment, of which 63 (54.8%) were male and 52 (45.2%) were female. In total, there were 124 visually impaired children with visual acuity <6/18 of these 69 (55.7%) were male and 55 (44.3%) were female.

Amongst these 9 blind children a total of 3 (33.3%) had optic nerve abnormalities (optic atrophy in 2 and glaucomatous optic nerve head cupping), 2 (22.2%) each with retinal (1 each with retinopathy of prematurity stage 5 and PHPV) and lenticular abnormalities (cataract), 1 (11.1%) had corneal (keratoconus) involvement and refractive error each. In the remaining 115 children with MSVI, a total of 14 (12.1%) children had retinal (4 with retinal dystrophy, 10 with myopic chorioretinal changes) abnormalities, three (2.6%) had uveal (coloboma) abnormality, one (0.9%) each had whole globe (anophthalmos) abnormality or corneal (scar) or optic nerve (coloboma) abnormality remaining 95 (82.6%) children had no anatomical cause involved and were suffering from refractive error or amblyopia [Table 3].

On classifying these 124 VI children for etiological abnormalities, according to presenting visual acuity (PVA) in better eye, In 9 children with blindness, 4 (44.4%) had perinatal (birth hypoxia) abnormality, 1 (11.1% each) had unoperated cataract and glaucoma, 1 (11.1% each) had hereditary (autosomal recessive), postnatal (trauma) abnormalities and refractive error respectively. Amongst the children diagnosed with MSVI, the major etiological cause was hereditary 4 (3.5%) (2 each with autosomal recessive and chromosomal anomalies) followed by 3 (2.6%) with undetermined cause. The remaining 108 (87.3% classified as others) had refractive error or amblyopia or idiopathic nystagmus [Table 4].

Discussion

Globally, 1.4 million children suffer from blindness and it is estimated that almost two-third of these live in developing countries. Overall, there are probably2,80,000-3,20,000 blind children in India.[1] This is a major North Indian population-based study on childhood visual impairment.

The prevalence of visual impairment is also influenced by the definition of blindness and visual impairment.[3-5,7,9,10,14] In the studies conducted by Kemmanu,[6] Dorairaj,[3] Nirmalan[5] and Dandona (APEDS)[10] *et al.* the criteria used for blindness was BCVA less than 3/60, RESC studies conducted by Dandona[7] and Murthy *et al.*[4] used the criteria of PVA less than 6/60. In this study, the criteria of blindness used was PVA <3/60. Using these criteria, the prevalence of childhood blindness in this study in the age group of 0-15 years was 0.42 per thousand. The prevalence of CHB in our study is lower than the other population-based studies, this variation could also be attributed to the difference in location of study and type of population (rural or urban) as these studies were mainly conducted in the central and southern

Table 2: Multivariable analysis demonstrating the prevalence of visual impairment adjusted for various socio demographic factors (*n*=20955) for children between <16 years of age

Characteristics	Total (*n*=20955)	Visual impairment (*n*=124)		adjusted OR (95% CI)	*P*
		n	Prevalence per 1000 (95% CI)		
Age (Yrs.)					
<3	3,376	4	1.2 (0.44-3.15)	1	
3-5	3,946	9	2.3 (1.19-4.38)	1.9 (0.59-6.23)	0.279
6-10	7,085	50	7.1 (5.35-9.30)	6.0 (2.15-16.53)	0.001
11-15	6,548	61	9.3 (7.25-11.96)	7.8 (2.81-21.45)	<0.001
Gender					
Male	11,032	69	6.3 (4.94-7.91)	1	
Female	9,923	55	5.5 (4.26-7.21)	0.9 (0.62-1.27)	0.527
Education of father					
Illiterate and Primary school	3,968	18	4.5 (2.86-7.19)	1	
Middle	3,717	20	5.4 (3.47-8.33)	1.0 (0.52-1.93)	0.997
High School	6,394	41	6.4 (4.72-8.7)	1.1 (0.61-2.05)	0.712
Intermediate	4,273	31	7.3 (5.11-10.30)	1.3 (0.65-2.58)	0.466
Graduate and above	2,603	14	5.4 (3.19-9.06)	1.1 (0.45-2.81)	0.792
Father wearing glasses*					
No	19,422	109	5.6 (4.65-6.77)	1	
Yes	1,201	15	12.5 (7.54-20.62)	1.8 (1.00-3.18)	0.052
Education of mother					
Illiterate Primary school	7,400	37	5.0 (3.62-6.89)	1	
Middle	4,191	31	7.4 (5.21-10.50)	1.5 (0.89-2.44)	0.129
High School	5,127	36	7.0 (5.07-9.72)	1.4 (0.81-2.27)	0.241
Intermediate	2,621	12	4.6 (2.60-8.05)	0.9 (0.43-1.85)	0.750
Graduate and above	1,616	8	5.0 (2.48-9.87)	1.1 (0.44-2.84)	0.813
Mother wearing glasses*					
No	19,843	115	5.8 (4.83-6.95)	1	
Yes	1,018	8	7.9 (3.93-15.64)	1.1 (0.51-2.23)	0.871
Socioeconomic status					
Upper middle (II)	2,526	13	5.1 (2.99-8.84)	1	
Lower middle (III)	6,959	49	7.0 (5.33-9.30)	1.3 (0.66-2.44)	0.474
Upper lower (IV)/lower (V)	11,470	62	5.4 (4.22-6.93)	1.1 (0.56-2.24)	0.756

*Indicates that further details for complete number were not available

regions of the country in rural settings with less access to health care services, whereas current study is from East Delhi in North India, which has urban population along with availability of eye care services. Therefore, the prevalence of blindness has reduced in this area [Tables 1 and 2].[5-7,10]

The prevalence of overall VI in our study was 5.92 per thousand as compared to 3.34 per thousand in the study conducted by Dorairaj *et al*.[3] and 2.05 per thousand in study conducted by Nirmalan *et al*.[5] This difference in prevalence could also be due to difference in the definition used for VI as in this study the definition used was PVA better eye as <6/18 whereas the criteria in Dorairaj[3] and Nirmalan *et al*.[5] was BCVA in better eye as <6/18. [Tables 3 and 4]. Globally, in a study conducted by Flanagan *et al*.[15] in Ireland, using the records from blind registries and estimated a prevalence of childhood visual impairment as 1.61 per thousand (BCVA, less than or equal to 6/18 in better eye) out of 47110 children examined between the age group of 0-19 years. Chong *et al*.[16] in 2009 examined records of 340 children aged between 0 to 16 years in Australia and using a cutoff of Snellen visual acuity <6/18 they estimated prevalence of visual impairment as 0.4 per thousand. The prevalence of VI was significantly affected by the education in mothers as compared to father's education, the reason for this could be that mothers are generally involved in child's overall well-being from seeking health care to education as compared to fathers being busy with financial growth of the family.

The prevalence of blindness in this study in males was 0.54 per thousand and in females was 0.30 per thousand. The main reason for this increased prevalence of VI in children was under 5 mortality rate is more in female children due to lack of health attention provided to them. Hence, female children are lost before the age of 5 years therefore accounting for lesser prevalence of blindness in them.[1] This is similar to the higher prevalence of blindness found in males in the study done by Kemmanu *et al*.[6] This gender-wise prevalence for blindness differed from the study conducted by Dandona *et al*.[10] and Dorairaj *et al*.[3] in whom the prevalence of blindness

Table 3: Distribution of anatomical causes of visual impairment among children based on presenting visual acuity (better eye) (0-15 years) (*n*=124)

Better eye: Presenting visual acuity	Causes	Male (%)	Female (%)	Total (%) (*n*=124)
BL (<3/60)	Cornea	1 (16.7)	0 (00.0)	1 (11.15)
	Lens	1 (16.7)	1 (33.3)	2 (22.2)
	Retina	1 (16.7)	1 (33.3)	2 (22.2)
	Optic nerve	2 (33.3)	1 (33.3)	3 (33.3)
	Others* (Etiological-refractive error/amblyopia)	1 (16.7)	0 (00.0)	1 (11.1)
	Total	6 (100.0)	3 (100.0)	9 (100.0)
MSVI (<6/18-3/60)	Whole globe	0 (00.0)	1 (1.9)	1 (0.9)
	Cornea	1 (1.6)	0 (0.0)	1 (0.9)
	Uvea	1 (1.6)	2 (3.8)	3 (2.6)
	Retina	10 (17.5)	4 (7.7)	14 (12.1)
	Optic nerve	1 (1.6)	0 (0.0)	1 (0.9)
	Others* (Etiological-refractive error/amblyopia)	50 (79.4)	45 (86.5)	95 (82.6)
	Total	63 (100.0)	52 (100.0)	115 (100.0)
VI (<6/18) (BL + MSVI)	Whole globe	0 (0.0)	1 (1.8)	1 (0.8)
	Cornea	2 (2.9)	0 (00.0)	2 (1.6)
	Lens	1 (1.5)	1 (1.8)	2 (1.6)
	Retina	12 (17.4)	7 (12.7)	19 (15.3)
	Optic nerve	3 (4.4)	1 (1.8)	4 (3.2)
	Others* (Etiological-refractive error/amblyopia)	51 (73.9)	45 (81.8)	96 (77.4)
	Total	69 (100.0)	55 (100.0)	124 (100.0)

*This included the children with causes other than anatomical abnormality i.e., the children suffering from refractive error or amblyopia

Table 4: Distribution of etiological causes of visual impairment among children aged <16 years (*n*=124)

Better eye: Presenting visual acuity	Causes	Male (%)	Female (%)	Total (%)
BL (<3/60)	Hereditary	0 (0.0)	1 (33.3)	1 (11.1)
	Perinatal	3 (50.0)	1 (33.3)	4 (44.4)
	Postnatal	1 (16.7)	0 (0)	1 (11.1)
	Undetermined etiology (Cataract/Glaucoma)	1 (16.7)	1 (33.3)	2 (22.2)
	Refractive error	1 (16.7)	0 (0.0)	1 (11.1)
	Total	6 (100.0)	3 (100.0)	9 (100.0)
MSVI (<6/18-3/60)	Hereditary	2 (3.2)	2 (3.9)	4 (3.5)
	Undetermined Abnormality since birth	2 (3.2)	1 (1.9)	3 (2.6)
	Others			
	Refractive error	50 (79.4)	40 (76.9)	90 (78.3)
	Amblyopia	7 (11.1)	9 (17.3)	16 (13.9)
	Idiopathic nystagmus	2 (3.2)	0 (00.0)	2 (1.7)
	Total	63 (100.0)	52 (100.0)	115 (100.0)
VI (<6/18)	Hereditary	2 (2.9)	3 (5.5)	5 (4.2)
	Perinatal	3 (4.4)	1 (1.8)	4 (3.3)
	Postnatal	1 (1.5)	0 (00.0)	1 (0.9)
	Undetermined etiology (cataract)	0 (00.0)	1 (1.8)	1 (0.9)
	Undetermined etiology (glaucoma)	1 (1.5)	0 (00.0)	1 (0.9)
	Abnormality since birth	2 (2.9)	1 (1.8)	3 (2.5)
	Others*			
	Refractive error	50 (72.4)	40 (72.7)	90 (72.6)
	Amblyopia	7 (10.1)	9 (16.4)	16 (12.9)
	Idiopathic nystagmus	2 (2.9)	0 (00.0)	2 (1.8)
	Total	69 (100)	55 (100)	124 (100)

was higher in females 1.0 per thousand and 1.9 per thousand respectively [Table 5].[3,7,17]

As under 5 mortality rate is another method of estimating childhood blindness and as it is estimated that a childhood

Table 5: Comparison of prevalence of blindness and visual impairment in different community based studies with this study

Parameters	Current study	Kemmanu	Dorairaj	Nirmalan	Dandona (APEDS)	Dandona (RESC)	Murthy (RESC)
Sample size	20955	23100	14423	10605	113514	4074	6447
Age group	0-15 years	≤15 years	0-15 years	0-15 years	0-15 years	7 to 15 years	5 to 15 years
Definition of visual impairment	<6/18 (PVA)	Not mentioned	<6/18 to 3/60 (BCVA) (better eye)	<6/18 to 6/60 (BCVA) (better eye)	Not mentioned	<6/18 (PVA) (better eye)	<6/18 (PVA) (better eye)
Definition of blindness	<3/60 to PL neg (PVA) (better eye)	<3/60 to PL neg (BCVA) (better eye)	<3/60 to PL neg (BCVA) (better eye)	<3/60 to PL neg (BCVA) (better eye)	<3/60 to PL neg (BCVA) (better eye)	<6/60 to PL neg (PVA) (better eye)	<6/60 to PL neg (PVA) (better eye)
Results	VI- 5.92/1000	VI- Not mentioned	VI-3.34/1000	VI-2.05/1000		VI- 7.3/1000	VI- 13.6/1000
	BL- 0.42/1000	BL- 0.8/1000	BL-1.06/1000	BL-0.62/1000	BL- 0.65/1000	BL- 2/1000	BL- 2.2/1000

blindness prevalence of 0.8 per thousand is associated with an under 5 mortality rate of 100-120 per thousand whereas a CHB of 0.3 per thousand is associated with under 5 mortality rate of <20 per thousand. In the absence of community-based studies, this method has been used extensively when generating estimates for global burden of childhood blindness. In this study, the prevalence of CHB of 0.4 per thousand well correlates to the present under 5 mortality rate of 24 per thousand in Delhi (NitiAyog, 2015).[13]

The main anatomical cause of blindness was optic nerve abnormalities in this study. This is similar to another population-based study conducted by Nirmalan *et al*.[5] but differed from Kemmanu *et al*.[6] and Dorairaj[3] *et al*., as in their studies the main anatomical site for blindness was posterior segment abnormalities and lenticular abnormalities respectively [Table 3].[7,10] The main anatomical cause for visual impairment in this study was posterior segment abnormalities, this is the similar to the findings reported by Kemmanu *et al.* and Dorairaj *et al*.[6,10] Currently, the NPCB definition of blindness has changed from PVA <6/60 to PVA <3/60 that has made refractive error as the major cause for visual impairment. In this study also refractive error is the most important cause of etiological visual impairment. This is similar to another community based visual impairment study conducted by Nirmalan *et al*.[5] and Kemmanu *et al.* in South India.[7] They also used the similar criteria of referring the children with visual acuity less than 6/12 in either eye for detailed ophthalmic examination to the central clinic and reported refractive error as the major cause of visual impairment and ocular morbidity respectively in their studies [Table 4].

On reviewing the data of various population-based studies for the cause of blindness with the blind school based studies, it was found that there is a paradigm shift in the anatomical causes of CHB from corneal causes as mentioned in the studies done in the 20th century to causes related to the whole globe in the 21st century as depicted by the study done by Rahi *et al*.[18] and Titiyal *et al*.,[19] in their study corneal causes were mainly responsible for CHB whereas in the studies done in 21st century by Israfil,[20] Bhalerao,[21] Gogate,[22] Krishnaiah[23] and in a recent systematic view published by Wadhwani *et al*.[24] also reported that now in this century whole globe abnormalities are the current major cause of blindness in children. Hence, the focus has shifted from preventable causes to irreversible causes. The major difference in causes in these school-based studies is due to improvement in health care facilities and socioeconomic status of the various countries. This change in the trend for causes of CHB indicates the successful implementation of various programs related to health care like immunization and vitamin A supplementation that have made a positive impact by decreasing the burden of childhood blindness.[1,25-27] There were 90 children with refractive error and 16 children with amblyopia in this study but this amblyopia was not purely due to refractive errors as the causes of amblyopia may be overlapping with other diseases as found in this a few children had this amblyopia secondary to cataract and squint surgery. Refractive error is still the cause of visual impairment but this prevalence of refractive error may be only the tip of ice berg as this study was conducted in urban area with relatively good access to primary healthcare services for the population residing in that area as nearly 48.5% of the children had corrected refractive error. So, the proportion of refractive error found in this study that is conducted in urban area may not be implemented to the rural population and other parts of country as the health care facilities in these areas are very limited. This emphasizes that there is still an urgent need of improving the refractive services by increasing the number of primary health care services with trained optometrists and providing free spectacles to children, as per NPCB around 9 lakh glasses are to be distributed free of cost to children and this target should be revised. It also states that there should be 5000 vision centres per 50,000 population but there are not even 2000 such vision centre depriving lack of eye care facilities in the form of basic need of refraction to all the age groups.[1,28]

On comparing the causes globally[29-31] with South East Asian regions, in a population-based survey using key informant done in Bangladesh, the main cause of blindness in these children was lenticular (33%) followed by corneal (27%) abnormalities.[29]

Limitations

The study was conducted in a small geographical area so the results cannot be generalized for the entire population. The location of study plays an important role as there is a difference in the development of various health care facilities across different geographical locations as in India. Also another important reason for underestimation of prevalence of refractive error cases was that the referral criteria was 6/12 in any eye, if it would have been 6/9 then the probable chance of refractive errors children was less.

Strength: An ophthalmologist evaluated all referred children so the accuracy of diagnosis for causes of blindness is likely to be more accurate compared to other studies where diagnosis was made by field workers.

Conclusion

In conclusion, refractive error is still the most common cause of visual impairment and is easily preventable by ensuring timely provision of these refractive error services to the children. Hence it is recommended that there is an urgent need to strengthen these refractive error services at primary health care level. There is a need to create awareness amongst parents and school teachers to educate children on importance of wearing glasses. Health promotion and prevention programs creating knowledge on importance of inclusion of dietary sources of vitamin A should done during immunization program. Anganwadi and ASHA workers can also be involved in screening of red reflex by using torch light for timely identification of cataract and other diseases leading to leucocoria (white reflex) for timely management. A timely approach for cataract surgery is required to decrease the visual impairment due to amblyopia and need to eliminate the barriers to utilization of services to children with low vision accessibility, with provision of low vision certificates. The management of surgical intervention for cataract and squint surgery by providing timely care is also important at tertiary care level to prevent amblyopia and proper visual rehabilitation of children.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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