Original Article

Tribal Odisha Eye Disease Study (TOES) report # 5: Comparison of prevalence and causes of visual impairment among tribal children in native and urban schools of Odisha (India)

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Purpose: To compare the prevalence and causes of blindness and visual impairment in tribal school students in the rural day-care and in a residential urban school. **Methods:** This was a cross-sectional comparative study. The 4-Stage screening in the native habitat of the tribal students performed in the school and hospital involved the trained school teachers, optometrists, comprehensive ophthalmologist, and pediatric ophthalmologist. The 2-Stage screening in the urban school involved only the optometrists and pediatric ophthalmologist. In both instances, vision (presenting and best corrected) was recorded and refraction performed. In addition, fundus photo was taken in all students in the urban school using a non-mydriatic fundus camera. **Results:** The comparison of blindness, visual impairment, and ocular anomalies were between tribal children (153,107 children; mean age 9.3 ± 2.7 years) examined in the native school and tribal children (10,038 children; mean age 8.8 + 1.64 years) in an urban residential school. Mild and moderate visual impairment was higher in the urban settings ($P < 0.05$), but severe visual impairment and blindness were similar in both settings. Refractive error, amblyopia, and posterior segment anomaly were detected more often in an urban settings ($P < 0.05$). Vitamin A deficiency (Bitot's spot) was detected only in children studying in the native schools ($P < 0.05$). **Conclusion:** The location, urban or rural, did not influence the visual impairment profile of tribal children. The food habit and environment seem to impact nutritional status.

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Fourteen million children in the world are blind and 0.27 million of them live in India.[1-4] Childhood blindness is a challenge because of the long span of still remaining life.[5] A number of "blind person years" resulting from blindness starting in childhood is second only to cataract.[6]Approximately, 500,000 children become blind every year and 70 million blind person-years are added each year because of childhood blindness.[7,8] There is always a level of urgency about treating childhood eye disease.

Tribal Odisha Eye Disease Study (TOES) reports are from systematic evaluation of various eye health aspects of people in the tribal districts of Odisha, India. We have already reported the eye health status of tribal students in an urban location.[9]The present report compares the prevalence and causes of blindness and visual impairment in tribal day-care school students in their native habitat with the students in the urban residential school.

Methods

The school screening in the native tribal district (Rayagada, Odisha, India) was done between August 2016 and July 2017 and covered all schools of the district. The screening included all students of either gender, 5–16 years. The study was approved by the local administration (Rayagada district) and by the Institute ethics committee (LV Prasad Eye Institute; Bhubaneswar; 2016-15-CB-14). The protocol adhered to the provision of the Declaration of Helsinki for research involving human beings. The school authorities provided consents for all the students in the specific school for vision testing and eye examination by optometrists in the school premises. Written informed consent was obtained from the parents of the children who were referred and examined in the hospital. The methodology of multi-stage school screening, in brief, consisted of a 4-Stage screening conducted in the school (Stages 1 and 2) and in the hospital (Stages 3 and 4). The screening personnel included the school teachers who tested vision and performed a flashlight examination (Stage 1), vision technicians who examined the children referred by teachers with a repeat measurement of visual acuity and refraction (Stage 2), optometrists and comprehensive ophthalmologist who examined the children referred by the vision technicians (Stage 3), and pediatric ophthalmologist who examined the children referred by the comprehensive ophthalmologist (Stage 4).The detailed methodology is described earlier.[10] In

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brief, we trained 216 school teachers, and most of them were males for travel logistics in hilly tribal district. The sensitivity and positive predictive value for vision screening were high, but specificity and negative predictive value were low.[10] In the urban school, it was done in 2 Stages between July 2015 and April 2016. Stage 1 included visual acuity measurement, slit lamp examination, intraocular pressure measurement, and undilated fundus photography by the optometrist, and Stage 2 included detailed evaluations of the referred children by the pediatric ophthalmologist.[9] In either situation, the subjective vision was tested both for distance and near. Color vision was not tested. In addition, non-mydriatic fundus photos were obtained in the urban school only because of proximity to the tertiary center, it was not considered in the children in the native schools because of difficult logistics and high opportunity cost.

The school teachers were expected to detect eye problems such as squint, eyelid problem, Bitot spot, redness, eye injury, corneal problems, and cataract as mentioned in our earlier publication.[10]

The data were entered into Microsoft excel sheet. Data were double-checked on the day of entry, and any unusual and spurious results and outliers were rechecked. The prevalence was calculated as-number of children affected/total number of children.

Definitions

Amblyopia was defined as best-corrected visual acuity (BCVA) ≤20/40 in the affected eye without any underlying structural abnormality of the visual pathway, a 2-line difference between the two eyes, and the presence of an amblyogenic factor.[10] Visual impairment definitions were as per the International Classification of Diseases (ICD 10) that defined visual impairment according to presenting vision: Mild or no visual impairment (<20/60–20/200); severe visual impairment (<20/200–20/400); and blindness (<20/400 to light perception).[11]

Difference between the methodology in urban and rural settings are shown in Table 1.

Results

In the tribal district, 159,985 students were enrolled for the study, 4,389 students were excluded (absent on the day of examination, scabies, and other similar contagious diseases), and finally, 153,107 (95.7% of enrolled- 77,837 male, 50.83%; 75,270 female, 49.16%) students were screened in the program. The mean age of students was 9.3 ± 2.7 (range 5–15) years. At the time of examination, 2,044 (1.3% of screened) were wearing spectacles. The difference in demography between the children from schools in the tribal district and in the urban school is shown in Table 1.

Teachers referred 8,363 (5.4% of screened) students for the following 3 reasons- 3,844 for poor presenting vision (<20/30), 3,433 for ocular anomalies, and 1,086 for both. A total of 5,990 (71.6% of referred) were examined in Stage 2; this included 2,643 children referred for poor vision, 2,625 children for ocular anomaly, and 722 children for both. A total of 883 and 142 students were referred to Stage 3 and 4, respectively.

The visual impairment was calculated according to the presenting [Table 2] and best-corrected [Table 3] vision. The causes of all ocular abnormalities are shown in Table 4. On the basis of both presenting vision and best-corrected vision in the better eye, mild and moderate visual impairment was more in students in urban schools compared to the students in the native schools. The prevalence of severe visual impairment and blindness was similar in the two locations.

The details of ocular anomalies are shown in Table 4. Refractive error and posterior segment diseases were more often detected in students in an urban location. Vitamin A deficiency, particularly Bitot's spot, was not seen in any of the students in the urban school. There was more risk of having Bitot's spot in tribal habitat ($P < 0.05$).

There was no blind child in urban school, and there were 22 blind children in tribal schools. The causes of bilateral blindness in school children in tribal habitat included corneal scar s/p congenital glaucoma surgery ($n = 1$), bilateral cataract ($n = 9$), whole globe anomaly such as microcornea with microphthalmos and uveal coloboma ($n = 9$) and anophthalmos ($n = 1$), and posterior segment anomaly ($n = 2$). Children with cataract were operated in the tertiary eye centre and had regained useful vision after amblyopia therapy; the detailed outcome is not part of this report.

Table 1: Demography and methodology of urban and native rural school screening in Rayagada, Odisha (India)

Setting	Time	Stage 1	Stage 2	Stage 3	Stage 4
Urban	July 2015-April 2016, *n*=10, 038, M: 58%, F: 42%, Age: 8.8 (6-17)	Optometrist exam in school ETDRS Vision IOP Slit lamp examination NM fundus photo	Pediatric ophthalmologist exam in tertiary hospital ETDRS Vision IOP Slit lamp examination Cycloplegic refraction Dilated fundus examination Medical and surgical correction, *n*=335	-	-
Rural	August 2016-July 2017, *n*=153,107, M: 51%, F: 49%, Age: 9.3 (5-15)	School teachers exam in school Snellen Vision Flashlight exam	Vision technician exam in school Snellen Vision Photo-refraction Subjective correction Flashlight examination *n*=5990	Comprehensive ophthalmologist exam in rural eye center ETDRS vision Cycloplegic refraction Slit lamp exam Dilated fundus exam Medical therapy, *n*=883	Pediatric ophthalmologist exam in tertiary hospital Surgical correction, *n*=142

ETDRS: Early Treatment Diabetic Retinopathy; F: Female; IOP: Intraocular Pressure; NM: Non Mydriatics, M: Male

Table 2: Prevalence of visual impairment according to presenting visual acuity

Visual impairment (VI)	PVA in worse eye			PVA in better eye			PVA in at least 1 eye		
	Rural, *n*=1,53,107, (95% CI)	Urban, *n*=10,038 (95% CI)	Significance	Rural, *n*=153,107, (95% CI)	Urban, *n*=10,038, (%, 95% CI)	Significance	Rural, *n*=1,53,107, (95% CI)	Urban, *n*=10,038, (%, 95% CI)	Significance
Mild VI <20/20-20/60	494; 0.32%, (0.30-0.35)	75; 0.75%, (0.60-0.94)	*P*<0.0001, Urban worse	357; 0.23%, (0.21-0.26)	53; 0.53%, (0.40-0.69)	*P*<0.0001, Urban worse	851; 0.56%, (0.52-0.59)	128; 1.28%, (1.07-1.51)	*P*<0.0001, Urban VI more
Moderate VI <20/60-20/200	186; 0.12%, (0.11-0.14)	30; 0.30%, (0.21-0.43)	*P*<0.0001, Urban worse	115; 0.08%, (0.06-0.09)	17; 0.17%, (0.11-0.27)	*P*<0.0028, Urban worse	301; 0.20%, (0.18-0.22)	47; 0.47%, (0.35-0.62)	*P*<0.0001, Urban worse
Severe VI <20/200-20/400	31; 0.02%, (0.01-0.03)	9; 0.09%, (0.05-0.17)	*P*<0.0001, Urban worse	14; 0.01%, (0.01-0.02)	1; 0.01%, (0.00-0.06)	*P*=1, No difference	45; 0.03%, (0.02-0.04)	10;0.10%, (0.05-0.18),	*P*<0.0002, Urban worse
Blindness (<20/400-no light perception)	137; 0.09%, (0.08-0.11)	15; 0.15%, (0.09-0.25)	*P*<0.0570, Urban worse	31; 0.02%, (0.01-0.03)	3; 0.03%, (0.01-0.09)	*P*=0.4990, No difference	168; 0.11%, (0.09-0.13)	18; 0.18%, (0.11-0.28)	*P*<0.0444, Urban worse
≤20/40	625; 0.41%, (0.38-0.44)	111; 1.11%, (0.92-1.33)	*P*=0.0001, Urban worse	860; 0.56%, (0.53-0.60)	57; 0.57%: (0.44-0.73)	*P*=0.8966, No difference	1485;0.97% (0.92-1.02)	168; 1.67%, (1.44-1.94)	0.0001, Urban worse

CI: Confidence interval; PVA: Presenting visual acuity

Table 3: Prevalence of visual impairment according to best-corrected visual acuity

Visual impairment	BCVA in worse eye			BCVA in better eye			BCVA in at least one eye		
	Tribal, *n*=1,53,107, (95% CI)	Urban, *n*=10,038 (95% CI)	Significance	Tribal, *n*=153,107, (95% CI)	Urban, *n*=10,038, (95% CI)	Significance	Tribal, *n*=1,53,107, (95% CI)	Urban, *n*=10,038, (95% CI)	Significance
Mild visual impairment <20/20-20/60	138; 0.09% (0.08-0.11)	49; 0.49% (0.37-0.64)	*P*=0.0001, Urban worse	97; 0.06%, (0.05-0.08)	26; 0.26%, (0.18-0.38)	*P*=0.0001, Urban worse	235; 0.15% (0.14-0.17)	75; 0.75%, (0.60-0.94)	0.0001, Urban worse
Moderate visual impairment <20/60-20/200	60; 0.04% (0.03-0.05)	17; 0.17%, (0.11-0.27)	*P*=0.0001, Urban worse	27; 0.02% (0.01-0.03)	5; 0.05%, (0.02-0.12)	*P*=0.0488, Urban worse	87; 0.06% (0.05-0.07)	22; 0.22%, (0.14-0.33)	0.0001, Urban worse
Severe visual impairment <20/200-20/400	18; 0.01%, (0.01-0.02)	3; 0.03% (0.01-0.09)	*P*=0.0670, No difference	2; 0%, (0.0-0.0)	0; 0%, (0.00-0.04)	*P*=1, No difference	20; 0.01%, (0.01-0.02)	3; 0.03%, (0.01-0.09)	*P*=0.0670, No difference
Blindness (<20/400- NLP)	116; 0.08% (0.06-0.09)	13; 0.13%, (0.08-0.22)	*P*=0.0921, No difference	22; 0.01% (0.01-0.02)	0; 0%, (0.00-0.04)	*P*=0.3164, No difference	138 (0.09, 0.08-0.11)	13 (0.13, 0.08-0.22)	*P*=0.2015, No difference
≤20/40	490; 0.32% (0.29-0.35)	54; 0.54%, (0.41-0.70)	*P*=0.0002, Urban worse	256; 0.17%, (0.15-0.19)	13; 0.13% (0.08-0.22)	*P*=0.3425, No difference	746; 0.49%, (0.45-0.52)	67; 0.67%, (0.53-0.85)	*P*=0.0134, Urban worse

BCVA: Best corrected visual acuity; CI: Confidence interval; NLP: No light perception

Table 4: Causes of ocular anomalies

Baseline Causes	Tribal Child-Tribal location		Tribal Child-Urban location		Inference	*P* (Chi-square test)
	No of children	Prevalence *n*=153,107	No of children	Prevalence *n*=10,038		
Refractive error	632	0.41	100	0.99	Urban worse	< 0.0001
Amblyopia	67	0.04	29	0.28	Urban worse	< 0.0001
Bitot's spot	70	0.045	0	0	None in urban	0.03
Corneal scar*	29	0.02	8	0.08	Urban worse	0.002
Pseudophakia/Aphakia	11	0.007	1	0.009	Similar	0.8
Cataract	23	0.02	3	0.02	Similar	1
Posterior segment	31	0.02	50	0.5	Urban worse	< 0.0001

Discussion

The children population of the world is at least a quarter of the world population.[12] Approximately, 30% of Indian population is below 16 years, and in the Indian state of Odisha, it counts to approximately 10 million. Blindness and severe visual impairment are serious problems, and reportedly, 30–72% of them are avoidable in developing countries.[13] There are marked regional differences in the prevalence and causes of childhood blindness and visual impairment, apparently depending on socio-economic factors, education, and the healthcare services available in the area. The current study compared the status

of visual impairment and blindness profile in students of similar origin (tribal Odisha) in the different ecosystem- native rural (tribal)[10] and relocated urban[9] locations.

This study detected a higher prevalence of mild to moderate visual impairment, correctable with appropriate spectacles in the tribal children in an urban location. This could be related to higher indoor activities in urban settings. The prevalence of presenting and BCVA <20/40 was comparable with other Indian studies.[14-16] This prevalence was lower than a few other studies from India.[17,18] This could be ascribed to 2 reasons- (1) we did not include the blind schools in the (tribal) district, and (2) the optometrists examined only 71% of the children referred by the teachers in the tribal district. In urban school, low prevalence of severe visual impairment and blindness is explained by the fact that blind children would not be admitted to the normal school.

This study showed that severe visual impairment and blindness were more often seen in rural than urban location, but it was statistically not significant. The prevalence of refractive error is less in our series in comparison to studies done in Maharashtra and rural Andhra Pradesh,[16,17] and urban prevalence was higher than report from Karnataka.[17] Myopia is less in tribal district in comparison to the urban school as seen in other studies,[19,20] which is probably explained by the fact that the outdoor activity is relatively less in children of an urban school in comparison to children living in the tribal district.[21,22]

Although the proportion of amblyopia among the visually impaired was comparable, the prevalence of amblyopia in the tribal district was low at 0.04%, whereas in the urban school, prevalence was comparable to rural Maharashtra.[18] Again tribal incidence might be less because of the many children who missed their examination by optometrist team.

This study detected Bitot's spot only in students in native school. This obviously directly relates to the general health awareness, the ecosystem of the area, and the proximity of care. The urban school was a boarding school, and thus, possibly the children had a more balanced diet than the children in rural habitat.

Conclusion

Inspite a marginally different methodology in the primary examination, school teachers in native schools, and optometrists in an urban school, the prevalence of visual impairment among tribal children, in their native surrounding or in the urban school surroundings is not higher than other Indian school studies. A clear difference lies in the nutritional causes of ocular morbidity and this needs special attention. Mandatory yearly screening of the school students in the entire population of the state and inclusion of ocular anomalies detection beyond refractive error would help reduce these preventable and treatable problems.

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Conflicts of interest

There are no conflicts of interest.

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