Original Article

Tribal Odisha Eye Disease Study (TOES) # 7. Prevalence of refractive error in children in tribal Odisha (India) school screening

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Purpose: To describe the prevalence of refractive error in school children in a tribal district, Rayagada, Odisha state, India. **Methods:** In a cross-sectional school eye health study, the students with diminished vision and other ocular abnormalities were referred for a further eye examination to the vision technicians after initial screening by the trained school teachers. The examination by vision technicians consisted of an external eye examination, photorefraction using a Spot screener and subjective correction. Those not improving with subjective correction were referred to the ophthalmologist for further examination. **Results:** The school teachers measured vision in 153,107 children; 5,990 students reached a vision technician. There was a near equal number of boys (50.06%) and girls (49.94%). The average age was 10.5 ± 2.63 (range: 5–15) years. The prevalence of refractive error was 9.7% (95% [CI]; 9.0–10.5%) in the vision technician-examined children. Myopia (4.9%) and astigmatism (5.4%) were more common than hyperopia (0.2%). The presenting visual acuity (PVA) was worse in children with hypermetropia (PVA 20/100-20/200 in 40% of children). Spherical equivalent of refractive error did not have a good correlation with age (R^2 = 1.3); but increasing age was associated with increased risk of myopia (odds ratio 1.14; 95% CI 1.09–1.20; P < 0.001). **Conclusion:** The quantum of refractive error was close to other similar studies in India but the prevalence of myopia was relatively less.

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Uncorrected refractive error (URE) accounts for 48.9% of combined visual impairment and blindness in the world—53.7% visual impairment and 20.6% blindness.[1] This translates to over 7 million people blind and over 116 million people visually impaired. At 62.89%, the refractive error-related visual impairment and blindness in South Asia (includes India) are higher than the global average.[1] Over a decade and a half, 1990–2015, the crude prevalence of refractive error has reduced only by 2% from 1990 to 2015.[1] The estimated annual global economic loss due to URE is USD 269 billion.[2] The impact of refractive error is greater in children since it affects their social and mental well-being, education, and development.[3-5] The solution to the URE is simple refraction and dispensing of the required spectacles through the challenges lie in an inadequate number of eye health personnel,[6] training required for accurate retinoscopy, and in certain countries the cost and supply of spectacles. Between the strategies for screening for refractive error in children in the population and in the school, the latter is considered more cost-effective.[7]

In this communication, we report the prevalence of refractive error among the school students screened in the schools in the district Rayagada, one of the tribal districts of Odisha, India. In this school sight program (SSP) we examined 153,107 children and used Spot screener (Welch Allyn, New York, USA) after confirming its reliability in a specified range in children.[8] This communication is part of the Tribal Odisha Eye Disease Study (TOES).

Methods

The Rayagada district SSP is described in detail earlier.[9] In brief, it was a multistage screening of school students partly executed in the school and partly executed in a community eye hospital. The first-stage eye screening was performed by the trained schoolteachers in the school. In this stage, the trained schoolteachers (trained at the Rayagada-based secondary eye center to test vision by using Snellen E chart, basic eye anatomy, and common external eye disorders such as red-eye, white shining deposits suggestive of Bitot spot) screened the students in their school. Vision in each eye was tested separately (with spectacles, if any), at 6 m followed by an external eye flashlight examination and a Hirschberg test. Students with presenting visual acuity (PVA), 20/30, uncooperative students, and those detected to having any ocular anomaly were referred. The second stage was photorefraction using Spot screener; this was conducted in the school by the optical dispensing person specifically trained in photorefraction; this was followed by subjective correction by a vision technician in the school by placing the appropriate lenses

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in the trial frame and testing the vision with the chart placed at 6 m. The third stage of comprehensive eye examination was performed by an optometrist and an ophthalmologist in the community eye hospital. The final stage of surgical corrections, if any, was performed by a fellowship-trained pediatric ophthalmologist in a tertiary eye care facility. The institute ethics committee approved the study (2016-15-CB-14) and protocol adhered to the provision of the Declaration of Helsinki for research involving human beings. Written, informed consent was obtained from the teachers in the school for examination in their premises and from the parents when the children were examined in the hospital.

The presenting vision was tested for each eye separately (with spectacles, if any) in the school by placing the Snellen vision chart at 6 m distance under standard lighting conditions. The objective refraction was performed by Spot photo screener as described by us earlier.[10] Those with visual acuity of <20/20 received subjective refraction by a vision technician based on photo screener findings. Spectacles were provided to all those improving to 20/20 on photo screener-based refraction, and those who did not improve were referred to the community eye hospital. In general, the protocol and sequence of examination used the National Program for Control of Blindness and Visual Impairment (NPCB and VI) guidelines,[11] adhered to the international guidelines[12] and added the new technology of refraction.

Refractive error was considered as the diagnosis when the visual acuity was less than 20/40 and improved to ≥20/40 with correction. Myopia was defined as measured objective refraction of ≥−0.5 D spherical equivalent (SE) in one or both eyes. Hyperopia was defined as measured objective refraction of ≥+2.00 D SE in one or both eyes, provided neither eye was myopic. Astigmatism was defined as measured objective refraction of ≥0.75 D cylinder in one or both eyes. These refractive errors were categorized according to the Refractive Error Study in Children (RESC) Survey Group.[12] Data were entered into the Excel sheet and analyzed after cleaning and cross-checking.

Results

The teachers screened 153,107 students and referred 8,493 (5.5%) students for examination by the vision technicians/optometrists. This included 3,230 children in the 5–9 year age group (38% of 8,493 referred children) and 5,263 children in the 10–15 year age group (62% of 8,493 referred children). But only 5,990 students (70.5% of 8,493 referred children) reached the vision technician—2,082 students in 5–9 age group (65% of 3,230 children in this age group) and 3,908 students in 10–15 age group (74.3% of 5,263 children in this age group). The other children could not be examined despite several attempts. The optometrists referred 883 (14.7% of examined) children for ophthalmologist examination. There were an equal number of boys (2,999; 50.06%) and girls (2,991; 49.94%) in the examined children. The average age was 10.5 ± 2.63 years (age range 5–15 years). There were more children of the age of 10 years (n = 832, 13.8%) and 12 years (n = 799, 13.3%) and less number of children in the age group of 5 years (n = 125, 2%) and 6 years (n = 284, 4.7%).

Refractive error was detected in 583 students (prevalence: 9.7%; 95% CI: 9.0–10.5%). The refractive error distribution was as follows: myopia- 295 students (prevalence: 4.9%), hyperopia- 13 students (prevalence: 0.21%), and astigmatism- 324 students (prevalence 5.4%) (The addition of these numbers exceeds 583 since few children had astigmatism with myopia/hyperopia). The prevalence of myopia was higher in the age group of 7 years (8.85%) and 13 years (6.73%); the prevalence of astigmatism was higher in higher age groups 14–15 years (10.8% and 17.7%, respectively) [Table 1]. PVA was worse in children with hypermetropia (40% with PVA 20/100-20/200) than children with astigmatism and myopia (PVA 20/30-20/60 in 68.9% and 61.2%, respectively). [Fig. 1] SE of refractive error did not have a good correlation with age [$R^2 = 1.3$, $P < 0.05$; Fig. 2]. Increasing age was associated with an increased risk of myopia (odds ratio 1.14 [95% CI 1.0928–1.2034, $P < 0.001$]. Male gender was also associated with slightly increased risk. (odds ratio 1.03 [95% CI 0.80–1.32, $P < 0.001$] [Table 2]. Comparison with other Indian studies of refractive error screening in schools is shown in Table 3.

In addition to refractive error and amblyopia, few other ocular disorders were detected by the optometrists and/or ophthalmologists. These disorders were: Vitamin A deficiency, cataract, and posterior segment disorders. Details are described by us earlier.[13]

Discussion

This was the first prevalence study of refractive error covering nearly the entire student population in a predominantly tribal district of India. In this study, photorefraction (Spot screener; sensitivity and specificity in detecting amblyopia risk factors 93.3% and 96.9%, respectively[8]), manual refraction and cyclorefraction were done as appropriate.

Rayagada is a backward district in Odisha. It ranks 465 in 640 districts in India (2011 census) and the human development index (HDI) is 0.18.[22] The literacy rate in this district is only 42.13%.[23] The district has 2,272 schools (2,224 are public schools).[24] The Government of Odisha is now

Table 1: Age-specific prevalence of refractive error among children

Age (years)	Myopia (%)	Hyperopia (%)	Astigmatism (%)
5	0.8	0	1.6
6	0.35	0	1.0
7	8.85	0.22	1.5
8	1.34	0	2.3
9	2.54	0.31	3.5
10	2.52	0.10	3.4
11	3.12	0	4.97
12	3.37	0.37	4.13

Table 2: Gender-specific prevalence of refractive error among students

Gender	Total students	Myopia %	Hyperopia %	Astigmatism %
Male	2992	5.6	0.26	4.6
Female	2998	4.2	0.16	6.1
P (Chi-square test)		0.01	0.39	0.009

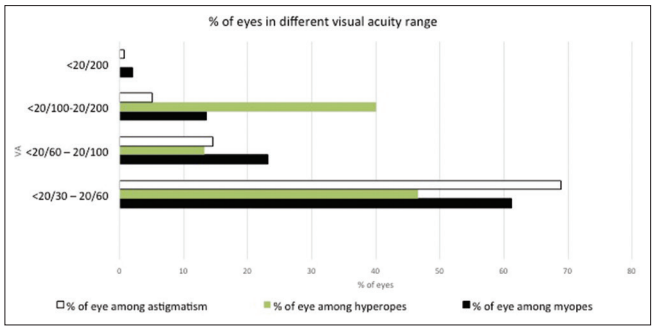

Figure 1: Presenting visual acuity versus refractive error

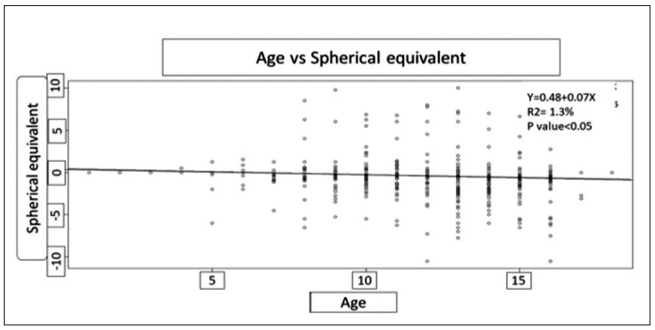

Figure 2: Linear regression showing spherical equivalent with age

Table 3: Comparison of school eye screening reports in India

Study	Indian State	Age	Category		Total Children	RE %	Myopia %	Hyperopia %	Astigmatism %
			U %	R %					
School-based study in India[12-17]									
Basu[14]	Gujarat	7-15	100	0	3002	15.2	13.9	0.7	0.6
Ghosh[15]	Bengal	6-14	100	0	2570	13.8	11.9	2.5	9.1
Uzma[16]	Telangana	7-15	46	54	3314	17.5	-	-	-
Saxena[17]	Delhi	5-15	100	0	9884	-	13.1	-	-
Padhye[18]	Maharashtra	5-15	60	40	12,422	3.7	2.1	0.6	0.2
Seema[19]	Haryana	6-15	-	100	1265	14.0	12.1	1.5	5.4
Current Study	Rayagada Odisha	5-15	-	100	5990	9.7	4.9	0.2	5.4
Population-based study in India[18,19]									
Dandona [20]	Andhra	7-15		100	4074	4.76	3.75	0.7	3.6
Nirmalan[21]	Tamil Nadu	0-15		100	10,605	0.6	-	-	-

R: Rural; RE: Refractive error; U: Urban

making every effort to encourage parents to admit the children in the schools by offering free and compulsory education through the "Right of Children to Free and Compulsory Education (RTE) Act, 2009."[25] A 2014 report had indicated 16.7% school dropouts in Odisha (boys: 17.5%; girls: 21.3%) and the main reason was the lack of interest in the students.[26] It is unclear if it was related to poor eyesight, too. A 2018 Government of Odisha report indicates an increase in the school enrolment.[27] But we suspect it may not be uniform across the state. In any case, it is known that correction of refractive error and wearing correcting spectacles are necessary for better academic performance in the school[26] and could also decrease school dropouts.

In the present study, 9.7% of the students were detected to have a refractive error. The prevalence in the entire school student population of the district was 0.4%. In general, the prevalence of myopia was less than comparable studies in different states of India.[14,15,17,19] However, the definition of refractive error was not uniform across the studies; few studies have considered any child with difficulty in the distance and near vision as a refractive error[14] whereas few others have considered all "plus" power and "minus" power as hyperopia and myopia, respectively.[15] We are equally unsure if this is related to late school entry and increased outdoor activities of the students in the tribal Rayagada district.[28,29] But we are unable to explain why a larger number of boys had myopia and a larger number of girls had astigmatism. There was also an increase in astigmatism with age. Hyperopia was less in this study, similar to all other reported studies [Table 3]. But this could also be attributed to the following reasons: (1) accommodation was not tested in children who read 20/20 on the Snellen chart; (2) Spot screener used in the study is known to underestimate hyperopia in children.[5]

The weakness of the study: the vision technicians examined only 70% of the referred students. Other students were unavailable for a number of reasons. We have earlier reported that the sensitivity and specificity of school teachers in detecting refractive error were 83% and 53.2%, respectively.[9] It is possible that we missed some of the students with decreased visual acuity.

Strength of the study: this was a first district-wide study performed systematically. Thus, this cohort was superior to cluster random sampling and/or convenient sampling used in other studies.[4,8]

Conclusion

In conclusion, refractive error in the tribal district of Odisha is comparable with the prevalence in another population-based study in the neighboring state of Andhra Pradesh, India. The region being resource-scarce; particular attention is required to increase the skilled manpower.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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