

## Status of eye health among tribal school children in South India

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**Purpose:** Global trends show a high prevalence of refractive errors among children. The prevalence of vision impairment due to uncorrected refractive errors among school children is increasing and the need for management of other ocular conditions is also reported. This study presents the status of eye health and pattern of daily activities among the school children of a tribal location in Tamil Nadu, South India. **Methods:** A cross-sectional study was conducted in 13 schools of Karumandurai cluster, Salem district in Tamil Nadu, India. A three-phased comprehensive school screening protocol was conducted to understand the prevalence of vision impairment, refractive error, and other ocular conditions along with a survey about the daily activities of the children at school and home. **Results:** Among the 3655 children screened, the prevalence of vision impairment was found to be 0.62% ( $n = 23$ , 95% confidence interval [CI] 0.42–0.94) and prevalence of refractive error was 0.30% ( $n = 11$ , 95%CI 0.17–0.54), among which 0.11% ( $n = 4$ ) were already wearing spectacles. A total of 44 children (1.20%; 95%CI 0.90–1.61) were found to have other ocular problems and among them, 14 (0.38%) had visual acuity less than 20/30 (6/9). Almost 84% of children required surgical or specialty eye care services. Vision impairment was more in children with other ocular conditions compared to refractive errors ( $P < 0.001$ ). **Conclusion:** The prevalence of vision impairment and refractive errors in this tribal area was less. Ocular conditions were more prevalent than refractive errors in this tribal region with the majority of children needing specialty or surgical eye care services. This implies the need for access to secondary or tertiary eye care centers.

**Key words:** Refractive errors, school children, tribal eye health, vision impairment, vision screening

Studies predict 50% of the world population to be myopic by 2050.<sup>[1]</sup> Reports show a high prevalence of refractive errors among school-going children in East Asian countries ranging between 49.3% and 73.1% in China,<sup>[2,3]</sup> Japan,<sup>[4]</sup> Singapore,<sup>[5]</sup> and South Korea.<sup>[6]</sup> But the prevalence is seen to be comparatively lesser among the urban (6.3%),<sup>[7]</sup> rural (2.7%),<sup>[8]</sup> and tribal Indian children (1%).<sup>[9]</sup>

Not only the refractive errors, but the profile of ocular morbidities was also found to vary between 4% and 11% among school-aged children in India,<sup>[7,8,10,11]</sup> and 0.15% among tribal children from eastern India.<sup>[9]</sup> There are wide variations in the prevalence of ocular conditions among populations of different countries, especially among children. It is crucial to understand the variations and cater to their specific needs.

If ocular conditions were not managed early, the number of blind years children have to live with is increased.<sup>[12]</sup> Children often are not able to voice their complaints as they remain unaware of their problems.<sup>[10]</sup> The importance of early detection and management of ocular conditions in children has been widely emphasized in many studies.

Our study team planned to screen and understand the status of eye health among school children in a tribal location in South

India. This study aims to report the status of vision impairment, the prevalence of refractive error, and profile of other ocular conditions among school children located in a tribal region in Tamil Nadu, South India.

### Methods

#### Study setting and subjects

India has one of the largest tribal settlements and the lifestyle, literacy, occupation, food habits, nutritional status, and knowledge of the tribal population varies widely. A cross-sectional study was conducted to assess the eye health of the school children located in Karumandurai, a village panchayat in Kalvarayan hills. The tribal region can be defined as a group of people living together in a rural setting, sharing a common language, and culture.<sup>[13]</sup> Karumandurai village is regarded as tribal settlement as per the Ministry of Adi Dravidar and Tribal Welfare Department by the Government of Tamil Nadu.<sup>[14]</sup> The hill station is located 2700–4000 feet high with secluded tribal settlements, 70 km interior to Salem district in Tamil Nadu. The majority of the population in these tribal settlements are into agriculture and are from low socioeconomic conditions.

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There were 13 schools within the 5-km radius of the Karumandurai cluster of Chinnakalvarayan block. All these schools were screened under the school vision screening program conducted by the institution. The nine government-run schools included a residential school and four private schools. All the children belonged to the same cluster of the tribal settlement.

The study was approved by the institutional review board (IRB) and the ethics committee of the vision research foundation and followed the tenets of the Declaration of Helsinki. The vision screening included three stages, namely, pre-screening, during screening, and post-screening.<sup>[15]</sup> The pre-screening stage included planning and obtaining permission from the Government Departments of Education, Health, the District Blindness Control Society (DBCS), and the school authorities in the tribal region. An initial visit was conducted by the social workers to collect information about the school and to explain the requirements to conduct screening to the school authorities. The screening was conducted as per the three-phased school children's vision screening protocol by trained optometrists and optometry students. All the examiners were trained, evaluated, and certified by the institution to perform community outreach services for school children. Retraining was done whenever necessary or when someone failed the training evaluation.

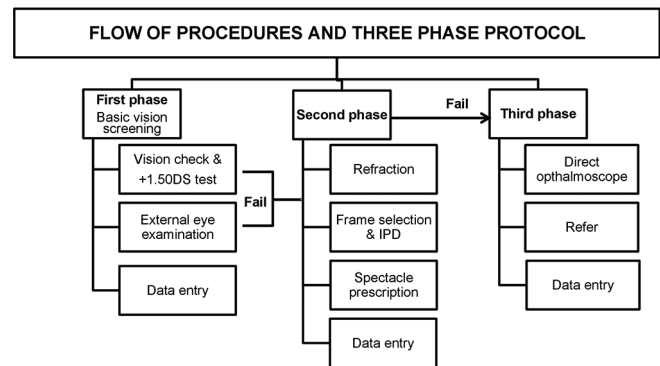
The first phase included basic vision screening that was performed by optometry trainees in a pre-identified place at the school campus. The vision was assessed with ESO's Pocket Vision Screener (a LogMAR chart with three rows of optotypes of a size corresponding to 6/9), modified clinical technique (MCT) using +1.50 DS test to screen for hyperopia, and torchlight examination to assess the eye health.<sup>[16,17]</sup> Children who were not able to read the 6/9 optotype during vision assessment, those who were able to read the letters with the +1.50 DS lens (MCT), and those who were already wearing spectacles were referred for the second phase.

The second and third phases included objective refraction using retinoscopy, subjective refraction, and direct ophthalmoscopy if vision did not improve with spectacle correction. These two phases were performed by experienced and trained optometrists at a pre-identified room in the school campus. Children identified with uncorrected refractive errors were provided spectacles free of cost and those with other ocular abnormalities were referred for further management. Fig. 1 represents a three-phased protocol and the flow of procedures followed.

A pilot survey to understand the daily activities of children in and outside the school was sought for a class-wise random sample of children between 11 and 17 years of age. Questions included academic and play-time activities at school, weekend activities, and possible use of gadgets by the children.

### Definitions

Vision impairment was defined as presenting visual acuity worse than 20/30 (6/9). Blindness was defined as presenting visual acuity worse than 3/60. The prevalence of vision impairment and blindness was calculated based on the presenting visual acuity in both better and worse eye at the person level. Vision impairment and refractive error data are represented at the person-level for all the analyses. Refractive errors were classified into myopia, hyperopia, and astigmatism. Spherical equivalent (SEQ) refractive error less than -0.50 dioptre (D) was defined as myopia, more than +1.00D as hyperopia, and between -0.50D and +1.00D as "Other refractive errors."<sup>[18]</sup> Children with other ocular problems were classified based on



**Figure 1:** Flow of procedures and the three-phase protocol of the screening

the structures involved. Children studying in kindergarten to class grade 5 were considered primary (age 4–10 years), class grades 6–8 were considered middle (age 11–13 years), and class grades 9–12 were considered high school (age 14–17 years). The schools were categorized into public and private schools based on the fee structure issued by the Government of India.<sup>[19]</sup>

### Data management

Data were entered in Microsoft excel 97–2003, cleaned, coded, and analyzed using statistical package for social sciences (SPSS) version 17.0. The outcome measure includes proportions of vision impairment, refractive errors, and other ocular conditions (Chi-squares) and their association with variables such as gender, class grades, and different type of schools using logistic regression.

### Results

The school eye screening was completed by 13 teams comprising of 100 members including clinical optometrists and academic faculty of optometry, optometry trainees, and social workers of the institution. The first phase was handled by the trainees and the second and third phase by the optometrists. A total of 4362 children were enrolled for school eye screening from 13 schools. There were 3655 (83.79%) children who were present during the day of vision screening. The mean age was  $9.89 \pm 3$  years (range: 4–17 years). There were 2009 (59.96%) boys and the number of children in primary was 2097(57.37%), 939 (25.69%) in middle and 619 (16.93%) in high school. The strength of the schools ranged between 100 and 1220.

### Visual impairment

Presenting visual acuity of less than or equal to 20/30 (6/9) in at least one eye, in better-seeing eye, and the worst-seeing eye was found in 23 (0.62%), 13 (0.36%), and 8 (0.22%) children, respectively. Four (0.11%) children had visual acuity less than 20/200 (6/60) in the better eye and three (0.08) children had visual acuity less than 20/200 in the worse eye. There was one (0.03%) child who was identified to be blind in both the eyes due to cataract. Best-corrected visual acuity of less than or equal to 20/30 in at least one eye, in better-seeing eye, and the worst-seeing eye was found in 14 (0.38%), 9 (0.24%), and 5 (0.13%) children, respectively. Table 1 provides the categories of vision impairment according to presenting visual acuity.

Among children who underwent the second phase of the screening, there were seven (0.19%) children with uncorrected refractive error and 14 (0.38%) children with other ocular

conditions. There were two (0.05%) children with special needs whose visual acuity was non-recordable. There was no significant association between vision impairment and middle school ( $P = 0.06$ ), high school class grades ( $P = 0.51$ ), gender ( $P = 0.43$ ), or type of schools ( $P = 0.53$ ). Table 2 gives the prevalence of vision impairment, refractive errors, and other ocular conditions among the type of schools, gender, and class grades.

**Refractive errors**

The prevalence of spherical equivalent refractive error was found to be 0.30% ( $n = 11$ ). Myopia and “other refractive errors” was found in 0.22% ( $n = 8$ ) and 0.08% ( $n = 3$ ) children, respectively. The median spherical equivalent refractive error was found to be  $-1.75 \pm 1.75D$ . There were four (0.11%) children who were already wearing spectacles, of which one child (0.03%) had visual acuity less than 6/60 in both the eyes. One child was wearing the same spectacles for nearly 8 years and others had changed the spectacles 3 months before the screening. Though the overall prevalence was less, refractive errors were identified to be 17 times (95% CI 3.95–74.41) ( $P < 0.001$ ) more in high school when compared to primary school children. There was no significant association between refractive errors and

gender ( $P = 0.51$ ), the odds of private school children having refractive error was 15 times (95%CI 3.39–65.44) ( $P < 0.001$ ) more when compared to public school children.

The age-adjusted prevalence of vision impairment and refractive errors in the tribal region was found to be 0.65% (95%CI: 0.63–0.66) and 0.38% (95%CI: 0.36–0.39), respectively.

**Daily activities of children**

A survey was conducted among 105 children. Academic time including reading and writing was for a maximum time of 3–4 h at school and 1–2 h at home every day for 41% ( $n = 43$ ) and 33% ( $n = 35$ ) children, respectively. Remaining children reported spending further lesser academic hours. Almost 89.5% ( $n = 94$ ) played outdoor for an hour at school. Weekend activities were mostly outdoor for 79.04% ( $n = 83$ ) that included coal picking, sheep rearing, and forest works. On average, outdoor activities per week was for about 7.5 h. Screen time was mostly confined to watching television for less than an hour by 61% ( $n = 64$ ) children, while 77% of children ( $n = 81$ ) had never used a mobile or computer.

**Table 1: Categories of vision impairment according to presenting visual acuity represented at person-level**

Categories of VI	Presenting vision acuity in the better eye $n$ (%) (95%CI)	Presenting vision acuity in the worse eye $n$ (%) (95%CI)	Presenting vision acuity in at least one eye $n$ (%) (95%CI)
Mild vision impairment 6/12-6/18	1 (0.03) (0.001-0.15)	2 (0.05) (0.02-0.20)	3 (0.08) (0.03-0.24)
Moderate vision impairment 6/18-6/30	9 (0.25) (0.13-0.47)	2 (0.05) (0.02-0.20)	11 (0.30) (0.17-0.54)
Severe vision impairment 6/60-3/60	2 (0.05) (0.02-0.20)	4 (0.11) (0.04-0.28)	6 (0.16) (0.08-0.36)
Blindness worse than 3/60	1 (0.03) (0.001-0.15)	0	1 (0.03) (0.001-0.15)
Total*	13 (0.36) (0.21-0.61)	8 (0.22) (0.11-0.43)	21 (0.57) (0.38-0.88)

\* - two non-recordable visual acuity.  $n$  - Number of cases; CI - Confidence interval

**Table 2: Details of the outcome measures and their association with gender, class grades, and type of schools**

Categories	Vision impairment (in atleast one eye) $n$ (%) (95%CI)	Logistic regression OR (95%CI)	Refractive errors $n$ (%) (95%CI)	Logistic regression OR (95%CI)	Other ocular condition $n$ (%) (95%CI)	Logistic regression OR (95%CI)
Overall (3655)	23 (0.62) (0.42-0.94)		11 (0.30) (0.17-0.54)		44 (1.20) (0.90-1.61)	
Gender						
Female (1646)	10 (0.62) (0.36-1.06)	1	6 (0.36) (0.17-0.79)	1	19 (1.15) (0.74-1.80)	1
Male (2009)	13 (0.65) (0.38-1.10)	0.71 (0.31-1.64) ( $P=0.43$ )	5 (0.25) (0.11-0.58)	1.49 (0.44-4.98) ( $P=0.51$ )	25 (1.24) (0.84-1.83)	1.16 (0.63-2.13) ( $P=0.62$ )
Class grades						
Primary school (2097)	13 (0.67) (0.40-1.12)	1	4 (0.19) (0.07-0.49)	1	28 (1.34) (0.93-1.92)	1
Middle school (939)	5 (0.53) (0.23-1.24)	0.14 (0.01-1.10) ( $P=0.06$ )	2 (0.21) (0.06-0.77)	2.43 (0.43-13.59) ( $P=0.31$ )	11 (1.17) (0.66-2.09)	0.89 (0.43-1.85) ( $P=0.76$ )
High school (619)	5 (0.81) (0.35-1.88)	1.40 (0.49-3.96) ( $P=0.51$ )	5 (0.81) (0.35-1.88)	17.15 (3.95-74.41) ( $P<0.001$ )	5 (0.81) (0.35-1.88)	0.62 (0.23-1.70) ( $P=0.36$ )
Type of school						
Public (2313)	12 (0.56) (0.30-0.90)	1	3 (0.13) (0.04-0.38)	1	26 (1.12) (0.77-1.64)	1
Private (1342)	11 (0.82) (0.46-1.46)	1.33 (0.54-3.25) ( $P=0.53$ )	8 (0.60) (0.30-1.17)	14.90 (3.39-65.44) ( $P<0.001$ )	18 (1.34) (0.85-2.11)	1.06 (0.55-2.04) ( $P=0.84$ )

Binary logistic regression. Reference - Female, Primary school, Public school Significant at a 95% level of significance;  $n$  - Number of cases; OR - Odds Ratio; CI - Confidence interval

### Other ocular conditions

A total of 44 children were identified with other ocular conditions, of which 14 (0.38%) had visual acuity less than 20/30 (6/9). There were two (0.05%) children with mild visual impairment, six (0.16%) with moderate, five (0.13%) with severe vision impairment, and one (0.02%) child was blind because of ocular conditions other than refractive errors. Among the 14 children, nine (0.25%) had amblyopia, two (0.05%) had lens-related abnormalities such as cataract and pseudophakia in both the eyes and three (0.08%) had nystagmus. The majority (84%) of these conditions require specialty eye care or surgical services. Unilateral vision impairment was seen in five children (0.13%), all of whom presented with strabismus. There was no significant association of ocular conditions between gender ( $P = 0.62$ ), middle school grade ( $P = 0.76$ ) or high school grade ( $P = 0.36$ ), and type of schools ( $P = 0.84$ ). Ptosis ( $n = 7$ , 0.19%) was identified to be the common lid abnormality present in this population, especially in males ( $n = 6$ , 0.16%). The odds of males having a lid-related abnormality were 5.6 times (95%CI 1.06–30.08) more when compared to females. The proportion of children with vision impairment was more, among those with other ocular problems (0.47%) than those with uncorrected refractive errors (0.19%) ( $P < 0.001$ ). The profile of ocular problems and their association with the type of schools and gender are provided in Table 3. The causes and proportion of ocular problems are represented in Fig. 2.

### Discussion

The study has shown prevalence estimates on vision impairment from a tribal settlement in Kalvarayan Hills, South India. To our knowledge, our study has also reported a very low prevalence of refractive errors in a population amidst evidence on the growing prevalence of refractive errors around the world.<sup>[20-22]</sup>

Despite using a stringent screening cutoff of 20/30 (6/9), 99.38% of children were found to have normal vision. This was unlike the data from rural and urban regions of India where 97.3% and 93.6% of the children had normal vision using a cutoff of 20/40 (6/12).<sup>[7,8]</sup> Such a lesser prevalence of vision impairment was scarcely reported in the literature. It was also noted that other ocular conditions were the major cause of visual impairment, unlike the previously reported studies where refractive errors were the major reason for visual impairment.<sup>[7-10]</sup> This emphasizes the need for management

of other ocular problems added to the provision of spectacles through school eye health programs in such regions.

There were differences in the prevalence of refractive errors between different class grades and types of schools, but this information should be considered keeping in mind that the overall prevalence of refractive errors was 0.30%, which is much lesser when compared to the refractive error prevalence observed in the urban and rural population in India.<sup>[7,8]</sup> A recent study from a tribal location in India identified 1% of children with refractive errors,<sup>[9]</sup> but the current study reports still lesser prevalence. An average of 7.5 h of weekly outdoor activities was presented from the survey. This observation is in alignment with the results from a meta-analysis of a 2% reduction in myopia with an increase in weekly 1 h of outdoor activities.<sup>[22]</sup> Elaborate studies in tribal areas for understanding the prevalence and outdoor activities would help in planning possible recommendations on hours of outdoor activities as strategies for myopia control.

The study reports “Other refractive errors” which are defined as spherical equivalent refractive errors between -0.50D and +1.00D, in three children. This range may seem insignificant but it should be dealt with caution as this range might also contain significant mixed astigmatism and compound hyperopic astigmatism. Reporting of these refractive powers are also crucial while dealing with the overall prevalence of refractive errors in a population.

There were 44 (1.20%) children who were referred to the hospital for further examination and treatment which is nearly four times that of the children with refractive errors ( $n = 11$ , 0.30%). Higher proportions of children were identified to have

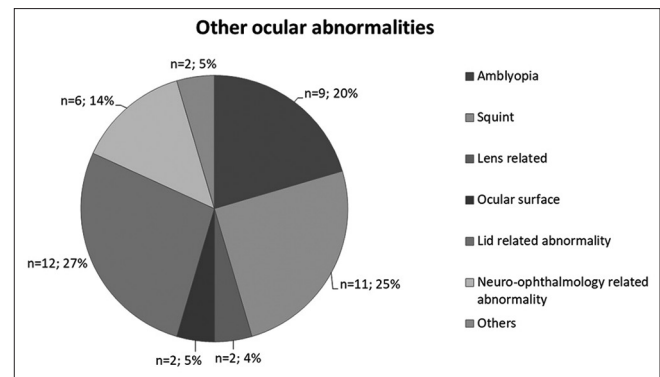


Figure 2: Causes and proportions of ocular diseases

Table 3: Profile of ocular conditions between gender and type of schools

Ocular abnormalities	Public $n=2313$ $n$ (%) (95%CI)	Private $n=1342$ $n$ (%) (95%CI)	Significance	Male $n=2009$ $n$ (%) (95%CI)	Female $n=1646$ $n$ (%) (95%CI)	Significance
Amblyopia	7 (0.30) (0.15-0.62)	2 (0.14) (0.04-0.54)	0.34	4 (0.19) (0.08-0.51)	5 (0.30) (0.13-0.71)	0.49
Squint	7 (0.30) (0.15-0.62)	4 (0.29) (0.12-0.76)	0.52	3 (0.14) (0.05-0.44)	8 (0.48) (0.25-0.96)	0.06
Lens-related	2 (0.08) (0.04-0.31)	0	0.6	2 (0.09) (0.03-0.36)	0	0.22
Ocular surface	1 (0.04) (0.01-0.24)	1 (0.07) (0.01-0.42)	0.69	1 (0.04) (0.01-0.28)	1 (0.06) (0.01-0.34)	0.78
Lid-related abnormality	5 (0.21) (0.04-0.51)	7 (0.52) (0.25-1.07)	0.11	10 (0.49) (0.27-0.91)	2 (0.12) (0.03-0.44)	0.04
Neuro-ophthalmology-related abnormality	4 (0.17) (0.04-0.44)	2 (0.14) (0.04-0.54)	0.42	3 (0.14) (0.05-0.44)	3 (0.18) (0.06-0.53)	0.72
Others	0	2 (0.14) (0.04-0.54)	0.07	2 (0.09) (0.03-0.36)	0	0.72
Total	26 (1.12) (0.77-1.64)	18 (1.34) (0.85-2.11)	0.55	25 (1.24) (0.84-1.83)	19 (1.15) (0.74-1.80)	0.81

Chi-square test. Significant at a 95% level of significance.  $n$  - Number of cases; CI - Confidence interval

moderate and severe vision impairment due to other ocular conditions. It is estimated that only 3% of the 45 million blind people are children population, but the number of years a child is expected to live with the blindness is ten times more than that of an adult.<sup>[23]</sup> This highlights the importance of restoring vision in children with vision impairment due to other ocular conditions, especially in early childhood. Among those who were referred for their ocular problems, 76% of them had visible ocular signs like strabismus and ptosis. Around nine children had visual acuity less than 20/200 (6/60), seven of these children have not had any previous eye examination; only two children have had a previous eye examination at the hospital and were surgically managed for cataract. A study regarding the eye-care seeking behavior showed that visible ocular signs prompted parents' behavior for seeking care which was not the case in this study.<sup>[24]</sup> This highlights two important aspects of screening children in the tribal regions. There is a need for a screening protocol to ensure early detection of such conditions and the availability of a professional screening team to diagnose conditions other than vision impairment and refractive errors. Apart, there is a strong need for creating awareness among the public in this region, about the impact of such conditions on vision and the need for early management.

Another aspect is access to treatment facilities closer to their location. Children who were referred were sent to the closest government facility to ensure better compliance. Karumandurai being uphill and highly interior to the main city, the baseline eye care center was located approximately 100 km away. Farther distance to the treatment center was also previously reported to be the most common barrier in eye care-seeking behavior.<sup>[25]</sup> It should be borne in mind that the management of the majority of these children required surgical interventions or specialty eye care services which might not be accessible in a non-eye care specialty center.

## Conclusion

Unlike other populations, refractive error was not the major reason for vision impairment among these tribal school children. A higher proportion of ocular conditions in this region compared to the refractive errors needs attention. Appropriate planning and execution of eye health services for these conditions and raising awareness among the public is essential in these regions.

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## Conflicts of interest

There are no conflicts of interest.

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