Profile of ocular conditions from school eye screening in Southern India

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Purpose: To profile the presentation of ocular conditions among school children aged 6 to 17 years from the south Indian state of Tamil Nadu. Methods: The study was conducted as part of a school eye health program in Kanchipuram district, Tamil Nadu that aimed to address the refractive needs of children (6–17 years) between July 2016 and June 2019. The study followed a three-phase protocol, which included visual acuity test, modified clinical test, color vision test, binocular vision assessment, objective and subjective refraction, dispensing spectacles, posterior segment evaluation using direct ophthalmoscopy, and referral to the base hospital. The demographics, clinical details, and ocular conditions (classified under 16 categories) were analyzed. Profiling and association of ocular conditions among different locations, types of schools, class grades, and gender were presented. Results: Data of 2,45,565 children were analyzed from 1,047 schools, of which 4,816 (1.96%) children were identified with ocular conditions other than refractive errors. The common reasons for referral were high myopia 901 (0.37%), strabismus 819 (0.33%), and amblyopia 691 (0.28%). Retinal problems (odds ratio [OR]: 1.65, 95% confidence interval [CI]: 1.22–2.22, \( P < 0.001 \)) and strabismus (OR: 1.41, 95% CI: 1.21–1.65, \( P < 0.001 \)) were the conditions prevalent in the rural location. Cataract and related conditions (OR: 5.73, 95% CI: 4.10–8.01, \( P < 0.001 \)) and retinal problems (OR: 4.76, 95% CI: 3.37–6.72, \( P < 0.001 \)) were common in children studying in public schools. Of the 16 categories, 13 conditions were seen among primary school children. Vernal keratoconjunctivitis (OR: 3.64 95% CI: 2.12–6.23 \( P < 0.001 \)) was common among males. Conclusion: The study profiled ocular conditions among school children. Most ocular conditions warrant prolonged care and specialty eye care services. Ensuring the availability of such services and follow-up after school eye screening would safeguard the visual development of these children.

Key words: High myopia, ocular conditions, school children, school screening, strabismus

Management of visual impairment (VI) in children is crucial considering its impact on their developmental, psychological, and educational aspects.

VI in children is also significant considering the number of life-years lived with the VI if not detected and managed early. School eye screening (SES) programs precisely concentrate on VI caused by refractive errors and there are many reports on VI and blindness among school children due to refractive errors. However, only a few studies report other ocular conditions among children. Fewer studies provide details on congenital, retinal, and other ocular conditions among children that contribute to 20–40% of VI and blindness in them.

However, a profile of the diverse ocular conditions and differences in presentation among different locations, types of schools, or age groups is missing. This report profiles the presentation of ocular conditions among school children aged 6 to 17 years from the south Indian state of Tamil Nadu.

Methods

The study was conducted in Kanchipuram district, Tamil Nadu, south India. The district is situated adjacent to Chennai, the capital city of the state, and is the third-largest district in Tamil Nadu by population. Kanchipuram is divided into four divisions and 13 blocks. The SES program was conducted as a part of a national project named REACH (Refractive Error Among Children), which aimed to address the refractive needs of the Indian children (6–17 years) between July 2016 and June 2019.

The study was approved by the Institutional Review Board and ethics committee of the Vision Research Foundation, Chennai. The study followed the tenets of the Declaration of Helsinki. Government Order (GO) from the State Education and Health Department was obtained to conduct the SES program.

The schools were selected from the District Information System for Education. A copy of the GO was submitted to the administrative head of the schools and informed consent was obtained to conduct the screening on the school premises. Screening dates and steps involved in the SES were informed to the school before the screening.

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Children with more than one ocular condition were grouped under the primary cause. Children with mild inflammatory conditions such as meibomitis, blepharitis, conjunctivitis, and stye were not referred and hence not grouped under any reason mentioned in this study.

Data analysis
The results of all the tests were documented in software and retrieved information was cleaned, coded, and analyzed using Microsoft Excel (version 2017) and Statistical Package for the Social Sciences version 17.0 (SPSS Inc., Chicago, IL, USA).

Demographic and clinical details were also collected. The data were classified based on the class grades, namely primary (5–10 years of age), middle (11–13 years of age), high school (14–15 years of age), and higher secondary school (16–17 years of age), location (rural and urban) and type of schools (public and private). The proportion of the ocular conditions among children screened in the SES is the primary outcome measure. Multinomial logistic regression was used to assess the association between ocular conditions and other variables. The adjusted odds ratio (OR) is presented with 95% confidence interval (CI) and a significance level of less than 0.05.

Results
There were 2,50,052 children between 6 and 17 years of age who were screened from 1,047 schools in the Kanchipuram district [Fig. 1]. The average age of the children was 11.19 ± 3.31 years. Because of incomplete information, data of n = 4,487 (1.79%) children were excluded. Among the remaining 2,45,565 children, there were n = 16,151 (6.57%) identified with refractive errors and n = 4,816 (1.96%) children identified with ocular conditions.

The common reasons for referral from SES were high myopia (901, 0.37%), strabismus (819, 0.33%), amblyopia (691, 0.28%), cataract and related complications (227 0.10%), retinal problems (206, 0.08%), neuro-ophthalmic conditions (208, 0.09%), ptosis (133, 0.06%), corneal problems (129, 0.05%), and conditions related to oculoplasty (104, 0.04%). The details of ocular conditions and other variables are provided in Table 1a and 1b.

Adjusted for other variables, ocular conditions associated with rural location were retinal problems (odds ratio [OR]: 1.65, 95% confidence interval [CI]: 1.22–2.22, P = 0.001), strabismus (OR: 1.41 95% CI: 1.21–1.65 P < 0.001), cataract and related conditions (OR: 1.38 95% CI: 1.04–1.84 P = 0.025).

Public schools were associated with cataract and related conditions (OR: 5.73 95% CI: 4.10–8.01 P < 0.001), retinal problems (OR: 4.76 95% CI: 3.37–6.72 P < 0.001) and strabismus (OR: 4.00 95% CI: 3.39–4.73 P < 0.001). Ocular conditions associated with males were VKC (OR: 3.64 95% CI: 2.12–6.23 P < 0.001), glaucoma (OR: 2.47 95% CI: 1.10–5.56 P = 0.028) and strabismus (OR: 1.16 95% CI: 1.01–1.35 P = 0.034).

The ocular conditions associated with primary schools were VKC (OR: 7.14 95% CI: 2.74–18.59 P < 0.001), amblyopia (OR: 5.77 95% CI: 4.39–7.58 P < 0.001) and strabismus (OR: 4.02 95% CI: 3.17–5.10 P < 0.001). The ocular conditions associated with middle schools were VKC (OR: 3.05 95% CI: 1.14–8.18 P = 0.026), amblyopia (OR: 2.25 95% CI: 1.69–3.01 P < 0.001), and strabismus (OR: 1.92 95% CI: 1.50–2.45 P < 0.001).
The ocular conditions associated with high schools were amblyopia (OR: 1.38 95% CI: 1.00—1.90 \( P = 0.048 \)) and strabismus (OR: 1.34 95% CI: 1.02—1.74 \( P = 0.031 \)). The association of the ocular problems and other variables are given in Table 2.

There were (111, 0.05%) children with ocular injuries. There were (87, 0.04%) children with an ocular injury who had cataract and related complications, glaucoma, corneal problems, oculoplasty-related disorders, and among them (78, 0.03%) had vision impairment. Ocular injuries were more among public schools (92, 0.04%) and male children (70, 0.03%). Besides, 16 children had one eye fitted with prosthetics, ten of them were female and six were male. There were children with special-needs (58, 0.02%) who required detailed eye examination, and the majority of them were in public schools (44, 0.02%).

Ocular conditions contributing to VI were high myopia (374, 7.77%), strabismus (310, 6.44%), retinal problems (168, 3.49%), cataract, and related complications (165, 3.43%) and corneal problems (73, 1.52%). Children studying in primary (1616, 33.55%), public schools (1599, 33.20%), and staying in urban regions (2185, 45.37%) had more VI comparatively. VI for ocular conditions are given in Table 1a and 1b. Almost (397, 0.16%) children had blepharitis, sty, chalazion, conjunctivitis, and bitot spots. Out of the 4,816 children identified with ocular conditions, only (945, 0.38%) children were already under

### Table 1a: Distribution of ocular conditions among gender and location along with visual impairment

| Ocular condition                      | Total   | Gender | Location | Visual impairment |
|---------------------------------------|---------|--------|----------|-------------------|
|                                       | Male    | Female | Rural    | Urban             | Ocular conditions (4816) |
|                                       | 318 (0.13%) | 501 (0.2%) | 663 (13.77%) |
| Strabismus                            | 403 (0.16%) | 416 (0.17%) | 721 (2.99%) |
| Amblyopia                             | 346 (0.14%) | 345 (0.14%) | 139 (0.06%) |
| High myopia                           | 413 (0.17%) | 488 (0.2%) | 721 (2.99%) |
| Cataract and related complication     | 128 (0.05%) | 99 (0.04%) | 165 (3.43%) |
| Retinal problems                      | 105 (0.04%) | 101 (0.04%) | 168 (3.49%) |
| Neuro-ophthalmic conditions           | 108 (0.04%) | 100 (0.04%) | 118 (2.45%) |
| High hyperopia                        | 22 (0.01%) | 21 (0.01%) | 33 (0.06%) |
| Corneal problems                      | 72 (0.03%) | 57 (0.02%) | 73 (0.15%) |
| Phtosis                               | 76 (0.03%) | 76 (0.03%) | 23 (0.48%) |
| Oculoplasty                           | 60 (0.02%) | 44 (0.02%) | 30 (0.06%) |
| VKC                                   | 54 (0.02%) | 38 (0.02%) | 5 (0.01%) |
| Keratoconus                           | 25 (0.01%) | 20 (0.01%) | 35 (0.73%) |
| Glaucoma                              | 18 (0.007%) | 9 (0.004%) | 16 (0.33%) |
| Uveal problems                        | 11 (0.004%) | 12 (0.005%) | 10 (0.21%) |
| CTC                                   | 551 (0.22%) | 502 (0.2%) | 875 (18.17%) |
| Unidentified cause                    | 59 (0.02%) | 76 (0.03%) | 95 (1.97%) |

### Table 1b: Distribution of ocular conditions among class grade and school type

| Ocular conditions | Class grade | School type |
|-------------------|-------------|-------------|
|                   | Primary     | Middle      | High        | Higher secondary | Public | Private |
| Strabismus        | 357 (0.15%) | 228 (0.09%) | 135 (0.05%) | 99 (0.04%)       | 603 (0.25%) | 216 (0.09%) |
| Amblyopia         | 359 (0.15%) | 175 (0.07%) | 91 (0.04%)  | 66 (0.03%)       | 322 (0.13%) | 369 (0.15%) |
| High myopia       | 174 (0.07%) | 264 (0.11%) | 232 (0.09%) | 231 (0.09%)      | 370 (0.15%) | 531 (0.22%) |
| Cataract and related complication | 87 (0.04%) | 74 (0.03%) | 32 (0.01%) | 34 (0.01%) | 181 (0.07%) | 46 (0.02%) |
| Retinal problems  | 61 (0.02%)  | 62 (0.03%)  | 43 (0.02%)  | 40 (0.02%)       | 162 (0.07%) | 44 (0.02%) |
| Neuro-ophthalmic conditions | 83 (0.03%) | 55 (0.02%) | 41 (0.02%) | 29 (0.01%) | 171 (0.07%) | 37 (0.02%) |
| High hyperopia    | 14 (0.01%)  | 15 (0.01%)  | 7 (0.003%)  | 7 (0.003%)       | 34 (0.014%) | 9 (0.004%) |
| Corneal problems  | 40 (0.02%)  | 34 (0.01%)  | 33 (0.01%)  | 22 (0.01%)       | 109 (0.04%) | 20 (0.01%) |
| Phtosis           | 54 (0.02%)  | 38 (0.02%)  | 27 (0.01%)  | 14 (0.01%)       | 114 (0.05%) | 19 (0.01%) |
| Oculoplasty       | 43 (0.02%)  | 27 (0.01%)  | 19 (0.01%)  | 15 (0.01%)       | 77 (0.03%)  | 27 (0.01%) |
| VKC               | 37 (0.02%)  | 21 (0.01%)  | 9 (0.004%)  | 5 (0.002%)       | 58 (0.02%)  | 14 (0.01%) |
| Keratoconus       | 9 (0.004%)  | 11 (0.004%) | 12 (0.005%) | 13 (0.01%)       | 33 (0.01%)  | 12 (0.005%) |
| Glaucoma          | 11 (0.004%) | 5 (0.002%)  | 5 (0.002%)  | 6 (0.002%)       | 18 (0.007%) | 9 (0.004%) |
| Uveal problems    | 9 (0.004%)  | 6 (0.002%)  | 6 (0.002%)  | 2 (0.001%)       | 17 (0.007%) | 6 (0.002%) |
| CTC               | 808 (0.33%) | 153 (0.06%) | 51 (0.02%)  | 41 (0.02%)       | 356 (0.14%) | 697 (0.28%) |
| Unidentified cause| 88 (0.04%)  | 27 (0.01%)  | 11 (0.004%) | 9 (0.004%)       | 57 (0.02%)  | 78 (0.03%) |
| Ocular conditions       | Location* | Type of school† | Gender‡ | Class grade§ |
|-------------------------|-----------|-----------------|---------|--------------|
|                         | Rural OR (95%CI), P | Public school OR (95%CI), P | Male OR (95%CI), P | Primary school OR (95%CI), P | Middle school OR (95%CI), P | High school OR (95%CI), P |
| Strabismus              | 1.41 (1.21-1.65) P<0.001 | 4.00 (3.39-4.73) P<0.001 | 1.16 (1.01-1.35) P=0.034 | 4.02 (3.17-5.10) P<0.001 | 1.92 (1.50-2.45) P<0.001 | 1.34 (1.02-1.74) P=0.031 |
| Amblyopia               | 0.92 (0.76-1.10) P=0.373 | 1.40 (1.19-1.65) P<0.001 | 1.07 (0.92-1.25) P=0.342 | 5.77 (4.39-7.58) P<0.001 | 2.25 (1.69-3.01) P<0.001 | 1.38 (1.00-1.90) P=0.048 |
| High myopia             | 1.00 (0.84-1.19) P=0.966 | 0.86 (0.74-0.99) P=0.041 | 0.94 (0.82-1.08) P=0.413 | 0.72 (0.58-0.89) P=0.002 | 0.93 (0.77-1.12) P=0.464 | 0.99 (0.82-1.20) P=0.962 |
| Cataract and related complications | 1.38 (1.04-1.84) P=0.025 | 5.73 (4.10-8.01) P<0.001 | 1.62 (1.24-2.12) P<0.001 | 2.87 (1.89-4.35) P<0.001 | 1.79 (1.18-2.71) P=0.006 | 0.90 (0.55-1.47) P=0.69 |
| Retinal problems        | 1.65 (1.22-2.22) P=0.001 | 4.76 (3.37-6.72) P<0.001 | 1.33 (1.01-1.76) P=0.042 | 1.62 (1.06-2.47) P=0.024 | 1.24 (0.82-1.87) P=0.298 | 1.03 (0.66-1.59) P=0.893 |
| Neuro-ophthalmic conditions | 1.37 (1.02-1.85) P=0.034 | 6.64 (4.60-9.59) P<0.001 | 1.36 (1.03-1.80) P=0.027 | 3.34 (2.14-5.20) P<0.001 | 1.59 (1.01-2.53) P=0.045 | 1.38 (0.85-2.23) P=0.186 |
| High hyperopia          | 0.66 (0.32-1.38) P=0.278 | 6.00 (2.82-12.76) P<0.001 | 1.32 (0.72-2.43) P=0.356 | 2.86 (1.12-7.30) P=0.028 | 2.06 (0.83-5.12) P=0.118 | 1.04 (0.36-2.98) P=0.94 |
| Corneal problems        | 1.73 (1.19-2.51) P=0.004 | 7.18 (4.40-11.71) P<0.001 | 1.65 (1.16-2.35) P=0.005 | 1.92 (1.11-3.22) P=0.018 | 1.21 (0.70-2.09) P=0.491 | 1.40 (0.81-2.42) P=0.219 |
| Ptosis                  | 1.52 (1.06-2.19) P=0.022 | 8.70 (5.29-14.31) P<0.001 | 1.68 (1.19-2.39) P=0.003 | 4.33 (2.35-7.96) P<0.001 | 2.20 (1.18-4.10) P=0.013 | 1.83 (0.95-3.51) P=0.067 |
| Oculoplasty             | 1.58 (1.04-2.40) P=0.03 | 4.05 (2.57-6.39) P<0.001 | 1.67 (1.13-2.48) P=0.01 | 2.95 (1.59-5.44) P<0.001 | 1.41 (0.74-2.68) P=0.291 | 1.19 (0.60-2.36) P=0.609 |
| Vernal Keratoconjunctivitis | 1.69 (1.03-2.75) P=0.034 | 6.61 (3.62-12.06) P<0.001 | 3.64 (2.12-6.23) P<0.001 | 7.14 (2.74-19.58) P<0.001 | 3.05 (1.14-8.18) P=0.026 | 1.58 (0.52-4.75) P=0.41 |
| Keratoconus             | 1.12 (0.56-2.23) P=0.749 | 3.62 (1.83-7.15) P=0.001 | 1.65 (0.91-3.00) P=0.097 | 0.78 (0.32-1.98) P=0.588 | 0.71 (0.31-1.61) P=0.415 | 0.90 (0.40-1.98) P=0.795 |
| Glaucoma                | 1.59 (0.69-3.65) P=0.271 | 2.87 (1.25-6.6) P=0.013 | 2.47 (1.10-5.56) P=0.028 | 1.72 (0.60-4.89) P=0.308 | 0.62 (0.18-2.06) P=0.437 | 0.75 (0.23-2.5) P=0.651 |
| Uveal problems          | 3.99 (1.64-9.66) P<0.002 | 3.06 (1.16-8.03) P=0.023 | 1.09 (0.47-2.49) P=0.834 | 3.41 (0.70-16.52) P=0.126 | 1.92 (0.38-9.75) P=0.428 | 2.60 (0.52-12.97) P=0.244 |
| CTC                     | 0.57 (0.48-0.67) P<0.001 | 1.04 (0.90-1.2) P=0.053 | 1.09 (0.96-1.25) P=0.164 | 21.47 (15.58-29.58) P<0.001 | 3.27 (2.30-4.63) P<0.001 | 1.26 (0.83-1.91) P=0.266 |
| Unidentified cause      | 0.74 (0.49-1.12) P=0.165 | 1.29 (0.90-1.85) P=0.199 | 0.80 (0.57-1.13) P=0.221 | 10.98 (5.46-22.08) P<0.001 | 2.67 (1.25-5.71) P=0.011 | 1.26 (0.52-3.05) P=0.606 |

*Children in urban locations were kept as reference, †Children studying in private schools were kept as reference, ‡Female children were kept as reference, §Children studying in higher secondary schools were kept as reference.
ophthalmic care with the stable ocular conditions. The majority of them were in urban locations (740, 0.30%).

Discussion

The results of this study are significant considering the huge data from the southern Indian children. The prevalence of ocular conditions seen in this study was 1.96%. Extrapolating the results to the country population, there would be around 6.49 million children in this age range in India in need of management to their ocular conditions. Another study from the same geographic location done between 2011 and 2015 among public schools showed the prevalence of ocular conditions of 1.46%.

The ocular conditions were more prevalent among children in public schools, rural locations, male children, primary, and middle schools. High myopia, conditions related to cataract, amblyopia, corneal problems, retinal problems, and oculoplasty often need special care at a tertiary eye care center. More than seven conditions were significantly associated with primary and middle schools such as strabismus, amblyopia, ptosis, neuro-ophthalmic conditions, cataract and related complications, and VKC. The majority of these conditions seen in primary school require early detection and management of the disease for a better prognosis, thereby avoiding amblyopia. The male preponderance of certain diseases such as VKC due to its pathogenesis or conditions related to injury could have added to the higher male preponderance in ocular problems.

Management of ocular conditions such as VKC or strabismus requires periodic visits to the eye care professionals and the treatment for ocular conditions mentioned in this study may vary from spectacles prescription, medical management to surgeries. Professional expertise is required to identify and manage such conditions. Apart, considering the current trends on the increased prevalence of high myopia, projected raise, especially in private schools, such schools could include “myopia care division” in their medical centers that would act as a bridge between schools, beneficiaries, and eye care service providers.

The number of children who were already under care with stable ocular conditions were only 0.38% and from urban populations. This could be because many specialty eye care services are established in urban locations and accessibility for children from rural locations would be difficult. Though children with ocular conditions require management at the hospital, the SES should aim at follow-up of children in need of sustained management or specialty-based eye care through registries or a central database. Eye health diaries for children that would help them avail of specialty care at a closer facility should be a follow-up of the SES process. It is also a concern that such specialty services are usually not available at primary or secondary centers close to the beneficiaries who are living in rural locations.

Ocular injuries are a serious threat to vision and almost 2.61% of ocular conditions were because of injuries. Male children and children in public schools were specifically prone to injury. This might be because of less attention given to the children at schools where the student-teacher ratio is less. This could also be because of working parents who could not be available at home, leaving the children on their own. Educating about eye safety and precautions to avoid injuries during awareness sessions to children and stakeholders of SES, could be an effective intervention to be studied in the future.

The major cause of VI among the common ocular conditions in this study was high myopia, strabismus, retinal problems, and amblyopia. Though VI was seen less in conditions such as ptosis, VKC, and those related to oculoplasty, these children were referred for comprehensive eye examination and treatment to restore normal functioning of the visual system. SES that is usually based on vision screening alone might not refer these children for further management and potential vision development. Studies have reported that parents seek eye care for their children when there is a presence of noticeable vision difficulty or visible ocular signs and they also believe myths about strabismus being a sign of luck. Thus eye care professionals delivering school eye screening should also be trained in counseling the parents regarding the ocular conditions that are not visibly seen.

A diagnosis or a primary cause could be ascertained for the referred children, except for 135 (0.06%) children. Almost 0.43% of children were referred to the base hospital for cycloplegic refraction because the screening team was limited with respect to the use of any eye drops at the school premises as per the Government guidelines.

Conclusion

This study reports common ocular conditions seen among school children and their association with respect to the gender, class grade, location, and type of school from the SES in south India. High myopia, strabismus, and amblyopia emerge as the major reasons for referral. Based on the results of prevalent conditions, myopia care clinics at schools, provision of specialty eye care services through a central facility with a centralized database or registry, integrating counseling by professionals involved in SES would be the recommended strategies following SES that needs to be further tested.

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Conflicts of interest
There are no conflicts of interest.

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