Prevalence, Patterns and School-level Distribution of Refractive Errors and Digital eye strain Among School Children in Trichy District: A Cross-sectional Study

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Received: Jul 25, 2026 Accepted: Aug 22, 2026 Published: Aug 24, 2026

Introduction: Refractive errors are a primary, preventable cause of childhood visual impairment, significantly impacting educational and psychosocial development. Despite school screening initiatives, many children in semi-urban and rural areas remain undiagnosed due to limited access and awareness. Hence this study assesses the prevalence and patterns of refractive errors among students, specifically investigating the influence of digital eye strain and screen time among the school going children.

Methods: A school-based cross-sectional observational study was conducted through ophthalmic screening camps in 21 schools of Trichy district, Tamil Nadu, India, between September and November 2025. A total of 5,578 children aged 10-15 years underwent vision screening using Snellen chart at 6 meters at school camp. Around 1024 children were found to have reduced visual acuity and these children were referred for detailed ophthalmic evaluation, autorefraction, cycloplegic refraction, and spectacle prescription at Trichy SRM medical college hospital and research centre. Data were analyzed to compute prevalence with 95% confidence intervals, school-level variation, screening yield metrics, and near-work exposure patterns.

Results: Refractive errors were the most common ocular morbidity identified, with myopia affecting 863 children (15.47%), astigmatism 114 (2.04%), and hypermetropia 47 (0.84%), were detected. Spectacles were prescribed to 814 children after complete workup . Number needed to screen was 15.4 for myopia detection. Near-work exposure showed 32% children had 2-4 hours/day and 52 % had >4 hours/day screen time.

Conclusions: School screening effectively identified substantial refractive error burden, particularly myopia, among children. The high near-work exposure underscores the need for integrated digital eye health education, periodic screening, and spectacle services in school health programs to reduce avoidable visual impairment.

Keywords: Refractive error, myopia, school screening, visual impairment, screen time, spectacle coverage

Introduction

Refractive errors are the leading causes of visual impairment globally and remain a major preventable public health problem in children. Uncorrected refractive error can interfere with educational performance, psychosocial development, and quality of life during the formative school years, when clear vision is essential for learning and social participation.[1,2]

Among school-aged children, myopia, hypermetropia, and astigmatism constitute the major refractive disorders, with myopia increasingly emerging as the predominant subtype in many populations. In recent years, the visual environment of children has changed substantially because of increasing digitalization, online learning, and prolonged use of smartphones, tablets, computers, and other electronic devices. School screening programs serve as an effective strategy for identifying children with uncorrected refractive errors and facilitating timely referral, spectacle correction, and follow-up care, particularly in resource-constrained and underserved settings.[3,4]

Despite ongoing school eye health initiatives, many children with refractive errors continue to remain undiagnosed or uncorrected, especially in semi-urban and rural regions where awareness and access to pediatric eye care services may be limited.[2] Local data on the prevalence and pattern of refractive errors are essential for planning targeted school-based interventions, improving spectacle coverage, and guiding preventive strategies related to digital eye health. Therefore, the current study was undertaken to determine the prevalence, distribution, and pattern of refractive errors among school-going children and to assess the influence of increasing digitalization and screen time on the burden of myopia and other refractive errors in this population.

Materials and Methods

Study design and setting

A school-based cross-sectional observational study was conducted through ophthalmic screening camps in schools located in Trichy district, Tamil Nadu, India. The study population comprised school-going children aged 10 to 15 years who attended the selected school eye screening camps during the study period. Children of either sex who were present on the day of examination and underwent vision screening were included in the study. Children outside the specified age group, preschool children, adults, and those with acute ocular conditions that precluded proper refraction assessment were excluded.

Sample size and sampling

A total of 5,578 students from 21 schools were screened during the study period (8 September 2025 and 5 November 2025). The study used a camp-based consecutive screening approach, and all eligible children attending the school eye camps during the scheduled visits were examined and included in the analysis.

Study procedure

An eye care team consisting of ophthalmologists, optometrists, and camp coordinators visited the selected schools and conducted onsite vision screening. Distance visual acuity was assessed using a Snellen chart placed at 6 metres, which is a standard method for school vision screening in children. Children with reduced visual acuity on screening were referred to the Department of Ophthalmology, Trichy SRM, for detailed ophthalmic evaluation and confirmation of refractive status.

At the centre, children underwent objective and subjective refraction, and spectacles were prescribed according to the best-corrected visual acuity achieved. Children requiring further evaluation or management for ocular abnormalities other than refractive errors were sent for appropriate workup.

Ocular assessment and outcome measures

The primary outcome was the prevalence of refractive errors, categorized as myopia, hypermetropia, and astigmatism, based on clinical examination and refraction findings recorded during the screening program. Additional ocular morbidities identified during screening included amblyopia, squint, nystagmus, low vision, corneal opacity and related anterior segment abnormalities. The number of children prescribed spectacles and those with other ocular disorders identified for further evaluation were also documented as programmatic outcomes.

Digital exposure assessment

Information on near-work duration and screen-related exposure was collected and categorized according to daily duration of use. Near-work exposure was grouped as less than 2 hours/day, 2 to 4 hours/day, and more than 4 hours/day. These categories were used to describe the distribution of screen-related visual demand and to explore its possible relationship with myopia and other refractive errors.

Data collection and statistical analysis

Data collected during the camps were entered into a Microsoft Excel spreadsheet and checked for completeness and consistency before analysis. Descriptive statistics were used to summarize the distribution of ocular conditions across the screened population. For major outcomes, 95% confidence intervals for prevalence estimates were reported.

Ethical considerations

The screening was conducted as part of school eye health activities, and examination was performed after obtaining permission from school authorities and assent from parents/LAR.

Results

A total of 5,578 school-going children from 21 schools were screened during the study period. Refractive errors represented the most common ocular morbidity detected in the screening camps, with myopia emerging as the predominant refractive error. The overall prevalence of myopia was 15.47 %, followed by astigmatism at 2.04% and hypermetropia at 0.84 %. Among other ocular morbidities, amblyopia was identified in 1.09% (0.82%–1.37%) and squint in 0.54% of the screened children. (***Table 1***)

Considerable inter-school variation was observed in the burden of myopia. The median school-level myopia prevalence was 5.43%, with an interquartile range of 3.57% to 9.26%, indicating heterogeneity across the screened schools. Notably, 5 of the 21 schools (23.8%) had a myopia prevalence greater than 10%, indicating that a subgroup of schools contributed disproportionately to the overall burden. (***Table 2***)

Programmatic analysis of screening yield further demonstrated the utility of school-based vision screening. The number needed to screen to detect one case of myopia was 15.4 children, while 19.0 children had to be screened to identify one child requiring spectacles and 33.2 children to identify one child requiring referral to a higher centre.

With regard to digital exposure and near-work pattern, 2,900 children (52%) reported more than 4 hours/day of near-work or screen-related activity, 1785 (32%) reported 2-4 hours/day, and 893 (16%) reported less than 4 hours/day. (***Figure 1***)

Table 1. Distribution of ocular morbidities among screened school children

Condition	**Number of cases (n)**	**Prevalence (%)**	**95% CI**
Myopia	863	15.47	
Hypermetropia	47	2.04	
Astigmatism	114	0.84	
Nystagmus	17	0.30	0.16–0.45
Low vision	13	0.23	0.11–0.36
Corneal opacity/Bitot's spot/coloboma	5	0.09	0.01–0.17
PCIOL/Aphakia	6	0.11	0.02–0.19
Referred to higher centre	1024	18.35	

Table 2. School-level distribution and screening yield for myopia

Indicator	Value
Total schools screened	21
Median school-level myopia prevalence	5.43%
Interquartile range of school-level myopia prevalence	3.57%–9.26%
Schools with myopia prevalence >10%	5/21 (23.8%)
Number needed to screen to detect one myopia case	15.4
Number needed to screen to identify one child requiring spectacles	19.0
Number needed to screen to identify one child requiring referral	33.2

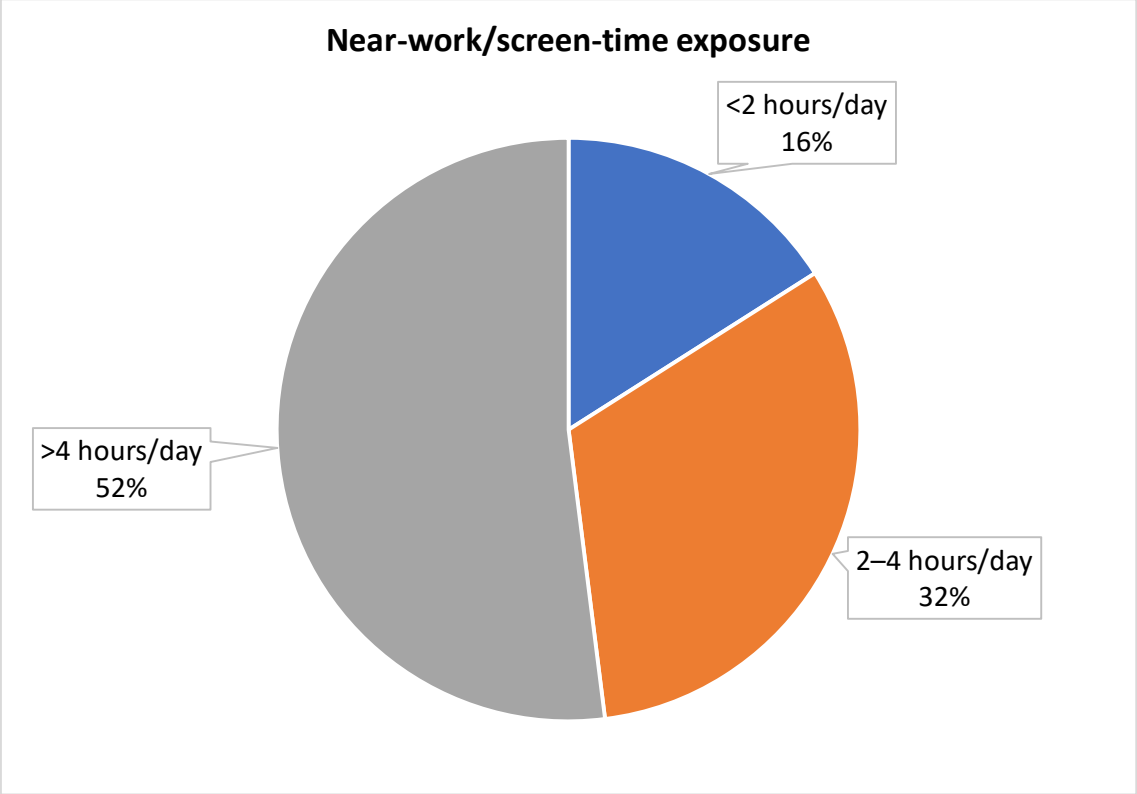

Figure 1: Distribution of near-work/screen-time exposure

Discussion

The present school-based screening study demonstrated that refractive errors constitute an important component of ocular morbidity among school-going children, with myopia emerging as the predominant refractive error in the study population. Among 5,578 children screened, the prevalence of myopia was 6.51%, followed by astigmatism at 0.70% and hypermetropia at 0.30%. These findings reinforce the continued public health importance of early detection of refractive errors in school-aged children, particularly because uncorrected visual problems during childhood may adversely affect academic performance, psychosocial development, and quality of life.[1,4]

The prevalence of myopia observed in the present study is comparable to estimates reported among rural Indian schoolchildren and is slightly lower than pooled school-based estimates reported from India overall. For instance Agarwal D et al,[5] in a meta-analysis of Indian school children reported an overall crude myopia prevalence of 7.5%, with a prevalence of 6.1% in rural children and 8.5% in urban children, supporting to the burden observed in the present study, and consistent with a semi-urban or rural epidemiological pattern.

Similarly, a systematic review of refractive errors in Indian children by Sheeladevi S et al[4] had reported a school-based prevalence of refractive error of 10.8%, emphasizing that childhood refractive error remains a substantial public health issue requiring systematic identification and management. The predominance of myopia in this study is also in line with existing literatures showing that myopia is the most common refractive subtype among school-going children and that its prevalence tends to increase with age, literacy, and educational demand.[6,7]

Another notable finding of the current study was the marked inter-school variation in myopia burden. The median school-level myopia prevalence was 5.43%, with an interquartile range of 3.57%–9.26%, while five schools had prevalence values exceeding 10% and one school recorded a prevalence as high as 28.23%. This heterogeneity suggests that local contextual factors, such as differences in educational intensity, near-work behavior, digital device use, socioeconomic background, and outdoor activity, may influence the distribution of refractive errors even within the same district. Saxena R et al[8] had documented that burden of refractive errors were comparatively high among private schools, which aligns with the inter-school variations observed in our study. These variation is programmatically relevant and indicating the high-burden population that require targeted school eye health interventions.

The distribution of near-work and screen-time exposure in the present study further supports the relevance of digitalization as an emerging concern. Nearly half of the screened children reported 2–4 hours/day of near-work or screen-related exposure, and an additional 15.8% reported more than 4 hours/day. Existing evidence strongly supports a dose-response relationship between digital screen exposure and myopia risk.[9,10] For instance, systematic review and dose-response meta-analysis by Ha A et al[11] had reported that each additional hour of daily digital screen time was associated with 21% higher odds of myopia, with risk increasing notably between 1 and 4 hours/day. In this context, the observed distribution of near-

work exposure in the present cohort may have important implications for future prevention strategies, including education on screen hygiene, periodic visual breaks, and encouragement of outdoor activity.

Beyond refractive errors, the study also identified amblyopia in 1.09% and squint in 0.54% of screened children, along with smaller proportions of nystagmus, low vision, and anterior segment abnormalities. These findings underscore that school screening programs serve a broader role than spectacle detection alone, as they can identify potentially vision-threatening or amblyogenic conditions that may otherwise remain undetected in community settings. Early recognition of amblyopia and strabismus is especially important because delayed detection may reduce the effectiveness of treatment and increase the risk of persistent visual impairment.[12]

The programmatic yield observed in this study also highlights the practical value of school eye camps. Approximately one case of myopia was identified for every 15.4 children screened, one child requiring spectacles for every 19.0 children screened, and one child requiring referral for every 33.2 children screened. These findings support the role of regular school-based vision screening as a cost-effective strategy for early case detection and linkage to care.[3]

The present study should be interpreted with certain limitations. The data was aggregated at the school level, which precluded individual-level analysis of predictors such as age, sex, socioeconomic factors, family history, outdoor exposure, and direct linkage between screen-time category and refractive status. Further, screen-time distribution was available, causal inference regarding digital exposure and refractive error could not be established from the current study. Nevertheless, the large sample size, real-world school-camp setting, and inclusion of multiple ocular morbidities strengthen the relevance of the findings for community ophthalmology and school eye health planning.

Conclusion

The study revealed that refractive errors remain an important ocular health problem among school-going children, with myopia emerging as the predominant refractive error in the screened population, and also demonstrated that school screening camps are effective in detecting both refractive and non-refractive ocular morbidities requiring intervention. The observed burden of near-work exposure, together with current evidence linking digital screen time to myopia risk, further highlights the need to integrate visual health education, periodic screening, prompt spectacle provision, and behavioral risk reduction into school health programs. Strengthening regular school eye camps, especially in schools with a higher myopia burden, may help reduce undetected refractive errors and improve visual and educational outcomes among children.

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