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Original Research

Prevalence and Patterns of Refractive Errors and Ocular Morbidity Among Tribal School children in Central India: An Epidemiological Study

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Abstract

Objective: To determine the prevalence of refractive errors and other ocular morbidities among school-aged children in the tribal regions of Central India and assess the effectiveness of school-based screening programs.

Methods: A cross-sectional, school-based study was conducted in Chandrapur district, Maharashtra, India, covering 386 government schools. A total of 81,962 students aged 5 to 15 years were screened using a three-tier approach involving ophthalmic assistants, optometrists, and ophthalmologists. Visual acuity testing, cycloplegic refraction, and fundoscopic examination were performed. Statistical analysis was conducted using STATA.

Results: A total of 1,874 (2.29%) children were referred for secondary-level screening due to visual impairment. The prevalence of refractive errors was 2.18%, with myopia (1.66%) being the most common, followed by hypermetropia (0.026%) and astigmatism (0.59%). Visual impairment was more common in girls (64%) than in boys (36%). The highest prevalence was seen in 8th-10th grade students (54.48%). Other ocular morbidities included amblyopia (1.55%), vitamin A deficiency (1.87%), squint (0.48%), allergic conjunctivitis (0.53%), and cataract (0.11%).

Conclusion: Refractive errors remain a significant cause of visual impairment in school-aged children, particularly among girls. Early screening and intervention in tribal schools can help reduce preventable blindness and improve quality of life. Further efforts are needed to improve access to eye care services in these underserved populations.

Keywords: Refractive errors, Myopia, Hypermetropia, Astigmatism, Ocular morbidity, School-based screening, Tribal children, Central India

Introduction

The prevalence of childhood blindness in India is 0.17%[1]. Treatable refractive error is the major cause (33.3%) of blindness in children[3], followed by preventable causes (16.6%) like vitamin A deficiency and post-cataract surgery amblyopia. In a recent systematic review, the prevalence of refractive errors among school children in India was reported to be 10.8%[2]. Uncorrected refractive error in children can lead to amblyopia and affects the physical, mental, and behavioral development of school-going children. Considering the fact that 30% of blind people in India lose their sight before the age of 20 years[4], early detection and timely treatment of visual impairment in children are crucial to preventing lifelong blindness. In low-income populations, utilization of eye-care services remains significantly low due to poor accessibility, financial constraints, and lack of awareness. Thus, school screening programs[5] play a

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critical role in reaching children from disadvantaged backgrounds, ensuring early detection of visual impairment and amblyopia, and providing timely treatment to prevent lifelong visual morbidity.
This study aims to evaluate the effectiveness of school-based screening programs for detecting refractive errors and ocular morbidity among school children in tribal areas of Central India, as no such data is reported from this region.

Materials and Methods

Study Design and Setting

This school-based cross-sectional study was conducted in Chandrapur district, a tribal belt in Maharashtra, Central India. The district comprises 15 talukas, and all 386 government schools were included in the study. These schools provide free education and cater primarily to students from lower socio-economic backgrounds. The study was conducted over 17 months (July 2021–December 2022), screening a total of 81,962 students aged 5 to 15 years.

Screening Procedure

A three-tier screening approach was implemented to ensure comprehensive eye examination and referral. In the primary level, ophthalmic assistants and trained school teachers performed visual acuity testing using Snellen's chart. Basic ocular health assessments, including torchlight examination, Hirschberg test, and cover-uncover test, were conducted. Students who had visual acuity ≤6/9 were referred to the secondary level, where trained optometrists and ophthalmologists at taluka-level peripheral centers performed cycloplegic refraction and fundoscopic examinations. Those requiring further evaluation, complex refractive error correction, expert opinion or surgical management were referred to the tertiary level at Government Medical College, Chandrapur, for advanced treatment.

Ethical Approval

The study was approved by the Institutional Ethical Committee. Informed consent was obtained from school authorities, and verbal consent was taken from students before participation.

Statistical Analysis

Data was recorded in Microsoft Excel and analyzed using STATA software. Descriptive statistics were used to summarize findings, and chi-square tests were applied to assess associations between variables.

Results

A total of 81,962 students were screened from 386 schools across 15 blocks of Chandrapur district. Among them, 1,874 children (2.29%) were referred for second-level screening due to suspected visual impairment. Refractive errors was found in 1,783 cases, while 91 cases had visual impairment due to other ocular conditions. The overall prevalence of refractive errors among screened children was 2.18% (1,783 out of 81,962 students).
The gender distribution of visual impairment showed that 63.98% of affected students were female, while 36.01% were male (Table 1). This indicates a significant gender disparity, with female students being more affected than their male counterparts.
The age distribution revealed that the mean age of affected students was 13.78 years. The majority of cases belonged to the 8th to 10th grade category (54.48%), followed by 5th to 7th grade (43.70%), as shown in Table 2. The prevalence of visual impairment increased with advancing school grades, suggesting the progressive nature of refractive errors in school-aged children.

Severity of Visual Impairment

The severity of visual impairment was classified based on visual acuity measured using Snellen's distant vision chart. As shown in Table 3, 87.94% of students had mild visual impairment (V1: 6/9–6/18), 7.84% had moderate impairment (V2: 6/24–6/60), and 2.02% had severe impairment (V3: <6/60). Notably, 2.18% of students referred for secondary screening had normal vision, suggesting a need for improved accuracy in primary-level screening.
Among the 1,874 students referred for secondary-level examination, 1,783 cases were attributed to refractive errors, while 91 cases had visual impairment due to other ocular conditions. A total of 426 children were referred to tertiary center for refinement of refractive error, detailed fundus examination, medical or surgical management.

Refractive Errors

The most common refractive error was myopia, observed in 1.66% of students. Of these, 70.01% had mild myopia (M1: <-2D), while 20.68% had high myopia (M2: >-2D) (Table 4). Girls (880 cases) had a higher prevalence of myopia compared to boys (482 cases).
Hypermetropia was diagnosed in 0.026% of students, with the majority (1.12%) having mild hypermetropia (H1: <+2D), and only one case of high hypermetropia (H2: >+2D) (Table 5).
Astigmatism was found in 0.59% of students. The most common subtype was SMA (simple myopic astigmatism), affecting 334 cases, followed by CMA (compound myopic astigmatism, 91 cases), SHA (simple hyperopic astigmatism, 10 cases), and CHA (compound hyperopic astigmatism, 5 cases). The distribution of severity of astigmatism is detailed in Table 6, where 21.77% of cases had mild astigmatism (A1: <1.5D), and 2.02% had high astigmatism (A2: >1.5D).

Other Ocular Disorders

In addition to refractive errors, 91 children were diagnosed with ocular conditions responsible for

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visual impairment (Table 8). Amblyopia was the most common disorder, affecting 1.55% of students (29 cases), with refractive amblyopia diagnosed in 20 cases. Vitamin A deficiency (Bitot's spots) was seen in 1.87% of cases. Other conditions included squint (0.48%), allergic conjunctivitis (0.53%), cataract (0.11%), corneal opacity (0.11%), and ptosis (0.11%). Less frequent conditions included nystagmus, keratoconus, and scleritis, each contributing to approximately 0.05% of cases.

Discussion

Our study findings are consistent with previous epidemiological studies conducted in India, which have reported the prevalence of refractive errors to range between 2.0% and 11.9%[8]. As we studied the tribal population, the prevalence of refractive errors was found to be 2.18%, with 97.82% of students had normal vision. Similar trends have been observed in earlier studies, highlighting a lower prevalence of refractive errors in rural and tribal populations compared to urban areas[6]. For instance, Dandona et al. reported 97.3% normal vision in rural Andhra Pradesh[1], whereas Murthy et al. observed only 93.6% normal vision in urban Delhi[3], indicating a higher burden of refractive errors in urban settings. The higher prevalence among girls observed in our study may be attributed to reduced outdoor activity and increased near work, a pattern also documented in other Indian and global studies[11].

Ghosh et al. observed a higher prevalence of myopia (11.9%) among low-income children in Kolkata[10]. In contrast, our study found a relatively lower prevalence of myopia (1.66%). This difference underscores the impact of urbanization, educational pressures, and prolonged near work on refractive error development.

Studies from China and Bangladesh report similar trends, where myopia is emerging as the predominant refractive error among school-aged children[12]. The increasing burden of myopia in urban and semi-urban settings highlights the need for targeted interventions, such as reducing screen time, promoting outdoor activities, and integrating vision screening into routine school health programs[13].

A study in Egypt by Yamamah et al. found that astigmatism was the most prevalent refractive error (62.85%), followed by hypermetropia and myopia[11]. This contrasts with findings from India, where myopia is the dominant refractive error. Such differences may be attributed to genetic predisposition, environmental factors, and regional variations in lifestyle habits.

Another study by Narayanan et al. in South India reported a prevalence of spherical equivalent refractive error at 4.42%, with myopia at 3.57% and hypermetropia at 0.03%[12]. This suggests that lifestyle, educational exposure, and socioeconomic status might contribute to varying prevalence rates of refractive errors across different regions.

Several studies suggest that the rising prevalence of myopia is linked to increased digital screen exposure and reduced outdoor activity. Rose et al. demonstrated that outdoor activity significantly reduces myopia progression in children[14]. Given the growing reliance on digital education tools and screen-based learning, structured school programs that incorporate outdoor activities may help mitigate the impact of near work and prolonged digital exposure on childhood refractive errors.

Despite the burden of refractive errors, access to vision care remains a challenge in tribal and rural areas. Financial constraints, lack of awareness, and inadequate ophthalmic infrastructure pose significant barriers to timely diagnosis and correction of refractive errors. Unlike urban areas where spectacle correction and follow-up care are readily available, rural regions suffer from low compliance rates and lack of accessibility to optometric services.

To address these challenges, government-supported school screening programs and community-based outreach initiatives should be strengthened. In India, similar efforts are being undertaken under the Rashtriya Bal SwasthyaKaryakram (RBSK), a National child health program aimed at early identification and intervention for children from birth to 18 years, which also includes screening for visual impairments. Strengthening and effectively implementing such programs at the grassroots level can play a vital role in reducing the burden of uncorrected refractive errors and improving the overall ocular health of children[7]. Countries such as China have successfully also implemented large-scale school screening programs with subsidized corrective lenses, significantly reducing the impact of visual impairment on academic performance and quality of life. Learning from similar models globally and implementing in India, particularly in tribal and underserved regions, could yield substantial public health benefits.

Future research should focus on longitudinal studies tracking the progression of refractive errors, particularly in rural populations. Additionally, exploring the role of genetic predisposition versus environmental factors in refractive error development can provide valuable insights. Advances in telemedicine and artificial intelligence-driven eye screening may further bridge gaps in eye care access, ensuring early diagnosis and timely interventions for children in remote areas.

Our study highlights the urgent need for early detection, targeted interventions, and policy-level initiatives to address refractive errors and ocular morbidity in school children. Strengthening vision care infrastructure, promoting parental awareness, and integrating school-based vision screening into national healthcare policies can play a pivotal role in reducing the burden of childhood visual impairment.

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Conclusion

Refractive errors remain a significant cause of visual impairment among tribal children. School-based vision screening programs are effective in identifying children in need of visual correction. However, further efforts are required to improve access to spectacles and specialized eye care services in these underserved populations.

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