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Original Research Article

Prevalence of Refractive Errors and Their Educational Implications: A Cross-Sectional Study Among Rural School Students

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Abstract:

Background: Refractive errors (REs) are one of the leading causes of visual impairment that occurs in childhood, ultimately affecting academic performance and development. Vision screening for children in rural community settings is sometimes not accessible, leading to delayed diagnosis and care.

Aim: To determine the prevalence of refractive errors among rural school children and the consequences for education.

Methodology: A cross-sectional study was carried out on 100 students, aged from 6 to 15 years, in five rural schools in Patna District, Bihar. Visual acuity was screened using Snellen chart and autorefractometry and cycloplegic refraction was performed on students with either subnormal vision or if no clarity was obtained using the chart. Academic performance, screen time and parental knowledge and awareness regarding eye health were assessed using structured questionnaires. The data was analyzed using SPSS 25 with t-tests and chi-squared test for associations.

Results: Refractive errors were identified in 49% of the students, with myopia (32%) being the most prevalent, followed by hyperopia (11%) and astigmatism (6%). Students who presented with refractive errors had statistically significant lower mean scores on their academic performance (63.1% compared to 72.8% ($p < 0.001$). The affected students also had borderline significance for higher screen time. Interestingly only 28% of parents acknowledged the need to have a yearly eye examination, with 63% of all students with refractive errors never having an eye check-up.

Conclusion: It is common to find refractive errors among rural school children, which are related to lower academic success. Early vision screenings and parental education are needed in order to help prevent educational disadvantages that could result from uncorrected refractive errors.

Keywords: Refractive Errors, Myopia, Hyperopia, Astigmatism, Rural Schoolchildren, Academic Performance, Eye Health Awareness.

Introduction

Refractive errors (REs) comprise structural and functional ocular disorders related to the refractive properties of the eye. In REs, parallel light that enters the eye is not focused at the retina, creating a reduction in visual acuity. The major categories of refractive errors include myopia (commonly referred to as nearsightedness), hyperopia (commonly referred to a far sightedness), and astigmatism [1]. Most of these occur because of either the axial length of the eye being too long or too short relative to the refractive power of the cornea, which is often viewed as situation develops during childhood when ocular growth and visual development are especially critical [2]. Myopia, specifically, is defined by the elongation of the eye in relation to the accommodating power of the eye, and thus individuals can't see objects at a distance effectively clearly. Hyperopia, on the other hand, occurs when the eye shorten isn't shortened enough to see objects close by in a clear manner. Astigmatism is also a refractive error that is a misshaped cornea or lens, which creates distorted vision both at near and far.

Refractive errors develop due to a variety of contributing factors, including both genetic as well as environmental factors. Genetic factors often predispose individuals in a hereditary manner, while behavioral factors and environmental exposures, for example, long near work hours, excessive screen time, and reduce outdoor play, can contribute to the increase in

the onset and consecutive progression of refractive errors [3]. Despite knowledge and understanding of some of the contributing factors, current research focuses on understanding the exact mechanisms that influence the onset and progression of refractive errors. Timely identification and correction of refractive errors is important as uncorrected refractive errors can represent a significant cause of childhood visual impairment, which carries important implications for their overall growth and development [4].

Childhood uncorrected visual impairment has the potential to affect many aspects of life. If a child has uncorrected refractive errors, the child would have difficulties in reading the educational materials, experience lower levels of participation in the classroom, lower engagement in extracurricular activities, and ultimately, poorer academic outcomes. Chronic visual problems that are not treated could lead to restrictions on future employment opportunities and reduce quality of life [5]. The situation is worse because children rarely complain if they have vision problems, which makes detection and treatment delays occur. This highlights the importance of preventative screening programs that can help with early detection of refractive error and prevention of chronic visual impairment [6].

Vision loss in childhood from uncorrected refractive errors is a critical public health issue, active at the global level. It's estimated that around 19 million children worldwide are affected by vision loss, about 12 million from uncorrected refractive errors alone, according to the World Health Organization. This problem is particularly significant in India. A systematic review and meta-analysis in 2023 reported an overall prevalence of refractive error among school-going children in India, of 11%, with myopia being the most common type of refractive error at 8%. A state level report from Karnataka indicated that of 6.2 million children screened in schools, about 1.73 lakh (2.8%) were screened as having a refractive error. A cross-sectional study from Raichur in 2024, also indicated that at a tertiary care level, 35% of children had a refractive error, with myopia being the most prevalent. This suggests that there is not only a high prevalence of refractive error among school aged children, but also the disparities which are observable in regions, age groupings, rural and urban groupings.

The significance of childhood vision loss as a public health issue, led to the initiation of the National Programme for Control of Blindness (NPCB) in India in 1976. The School Eye Screening Programme was followed in 1994 to identify and manage eye conditions among school children. At the world stage, the World Health Organization also launched the "Vision 2020: The Right to Sight" initiative to tackle avoidable blindness by the year 2020 [11]. In spite of all these significant initiatives, many are still gravely disadvantaged by barriers to accessing eye health – particularly in rural areas where children may have no access to vision screening, obtaining spectacles or receiving specialist eye care. As a result of this lack of access we have extensive levels of unassessed and untreated refractive conditions that will undoubtedly contribute to additional learning and development challenges.

Because uncorrected refractive errors substantially affect academic success, social development, and overall quality of life, it is important to understand the associated variables and prevalence of these issues in particular populations. This research study was restricted to children aged 5 to 15 years in rural schools, to investigate the prevalence of refractive errors, examine factors related to screen time and the use of screen-based devices, and investigate the effects of visual impairment on academic performance. The study also can assess the knowledge of parents and health-seeking behaviors regarding visual health in children and assist in planning for efforts to increase awareness and early-identification of refractive errors in rural areas. These variables should all contribute to the creation of interventions that are evidence-based and can be informed by policy, in the area of screening vision in schools, and in terms of community awareness and addressing refractive errors early on. The purpose of this research is to raise awareness to the academic and social impact of childhood visual impairment with indicated a way to develop specific interventions toward decreasing preventable vision loss, and to promote the academic success of rural children in school.

Materials and Methods

Study Design: This was a cross-sectional descriptive study aimed at assessing the prevalence of refractive errors among rural school students and exploring their educational implications.

Study Area: The study was conducted in collaboration with the Department of Ophthalmology at Patna Medical College and Hospital in Patna, Bihar, India, and included five schools in rural Patna District.

Study Duration: The study was conducted over 12 months

Sample Size and Sampling: Stratified random sampling was used to pick a total of 100 students. The sample size was determined under the assumptions of a 25% prevalence, 5% margin of error, and a 95% confidence interval.

Study Population: The study population consisted of children aged 6–15 years, residing in rural areas, and enrolled in the selected schools.

Inclusion Criteria

- Children aged 6–15 years.
- Residing in rural areas and enrolled in the selected schools.

- Parental/guardian consent and child assent obtained.

Exclusion Criteria

- Children are already wearing spectacles.
- Children with previously diagnosed ocular conditions such as cataracts, strabismus, or retinal disorders.

Data Collection: The data collection process involved clinical evaluations and assessments using questionnaires. The ocular assessment took place over three steps. Visual acuity was first assessed using a Snellen chart. Children with a visual acuity worse than 6/6 in either eye were assessed further using a portable autorefractometer, and complete appropriate correction was given. If the student did not demonstrate improvement post eye refraction, they were referred to the Ophthalmology Outpatient Department in Patna Medical College and Hospital and underwent a comprehensive ophthalmic assessment which included a slit-lamp examination of the anterior segment, cycloplegic refraction using 0.5 percent cyclopentolate eye drops, streak retinoscopy, and a fundus examination by slit-lamp bio microscopy to examine the posterior segment for any abnormalities. Spectacles were prescribed according to the final prescription, and the refractive error classification (myopia, hyperopia or astigmatism) was also recorded for future analysis.

Questionnaire: A standardized questionnaire was also utilized to gather demographic data such as age, gender, and socioeconomic status. Data regarding screen time exposure such as hourly exposure per day, type of device used, and viewing distances were also obtained. Academic achievements were rated by using the most recent report card marks that were compared to school records. Parental perception on the necessity for eye examinations and awareness of vision outcomes was also recorded. This enabled environmental and educational factors that may be related to refractive conditions to be evaluated.

Procedure: Prior to starting the research, approval was received from the educational organization for the study. Testing for visual acuity was done at the school level, and the student was required to have had an eye examination at some point prior to being referred to the hospital for further evaluation. It was documented in detail the types and degrees of refractive error, the student's demographics, the screen time exposure, and educational achievement. Finally, the research examined educational achievement in relationship to the refractive error.

Statistical Analysis: Data were systematically coded and analyzed using the SPSS statistical package (Version 25). The dataset was described using descriptive statistics that included means, standard deviations, and percentages. To examine the association of categorical variables, Chi-square tests were conducted and mean academic scores of child participants with refractive errors, and without refractive errors were analyzed using independent t-tests. Logistic regression analysis was performed to identify potential risk factors associated with refractive errors, after adjusting for confounding factors".

Result

Table 1 presents the demographic profile of the research participants (N = 100). The mean age of the participants was 10.2 ± 2.3 years. The gender ratio was nearly equal: 52% boys (52 students) and 48% girls (48 students).

Table 1: Demographic Profile of Study Participants (N = 100)

Variable	Number of Students	Percentage (%)
Mean age (years)	10.2 ± 2.3	–
Gender		
– Boys	52	52
– Girls	48	48

Table 2 shows the prevalence of refractive errors in the pupils. The most prevalent refractive error was myopia, which was present for 32% (32 pupils), hyperopia (11% or 11 pupils) was the second most prevalent error, and astigmatism was third (6% or 6 pupils). In total, there were 49 pupils (49%) with any type of a refractive error.

Table 2: Prevalence of Refractive Errors

Type of Refractive Error	Number of Students	Percentage (%)
Myopia	32	32
Hyperopia	11	11
Astigmatism	6	6
Total	49	49

Table 3 shows the association between daily screen time and refractive errors. Among students with more than 2 hours/day of screen time, 35.7% had refractive errors (30 of 84 students), whereas among

those with 2 hours or less, only 18.8% were affected (3 of 16 students). This suggests a higher prevalence of refractive errors with increased screen exposure.

Table 3: Association of Screen Time with Refractive Errors			
Screen Time (hours/day)	**Total Students**	**Students with Refractive Errors**	**Percentage (%)**
>2	84	30	35.7
≤2	16	3	18.8

Note: Chi-square (χ^2) = 1.066, p = 0.302 (Not significant)

Table 4 compares academic performance for students with, and without, refractive errors. Students with refractive errors had a lower mean academic score (63.1%, SD 7.5) than students without refractive errors (72.8%, SD 6.3), supporting the conclusion that uncorrected refractive errors may be related to decreased academic performance.

Table 4: Academic Performance of Students with and Without Refractive Errors		
Group	**Mean Academic Score (%)**	**Standard Deviation**
With Refractive Errors	63.1	7.5
Without Refractive Errors	72.8	6.3

Note: t-statistic = -6.989, $p \approx 4.0 \times 10^{-10}$ (Highly significant)

Table 5 describes the awareness of parents regarding eye examination. Less than a third of parents (28%) understood that a child needed to get their eyes checked annually, while many thought a child's eyes should be inspected for vision only in the presence of symptoms (42%). Also concerning was the fact that 63% of children with refractive errors have never had their eyes checked. This demonstrates a void in preventive eye care and the awareness of parents.

Table 5: Parental Awareness Regarding Eye Checkups		
Awareness Category	**Number of Parents/Children**	**Percentage (%)**
Aware of need for annual eye checkups	28	28
Believe eye checkups are needed only when symptoms appear	42	42
Children with refractive errors who never had eye exam	31	63

Discussion

The current research established a fairly high prevalence of refractive errors in rural school pupils, with 49% of participants having the condition. The most common condition was myopia, which occurred in 32% of pupils, followed by hyperopia (11%) and astigmatism (6%). This result concurred with several studies that have documented myopia as the most frequent condition in schoolchildren. For example, Dandona et al. (1999) [12] reported the prevalence of myopia to be 5% and 2.5% in the urban and rural population respectively, while Khandekar et al. (2009) [13] documented myopia in 3.16% of urban and 1.45% of rural children. While the prevalence of our study seems higher than the above studies, the prevalence pattern for myopia having the highest prevalence is the same and indicates that educational demands and way of living may also play a role in visual morbidity. The enhanced prevalence in our study may result from greater near-work activities like reading or screen time or sample selection and diagnostic criteria."

Age-associated patterns for refractive errors in our study are consistent with previous studies showing greater prevalence in higher ages. A majority of the participants in the current study were approximately 10 years of age, an age where myopia frequently comes to prominence. Cheng et al. (2003) [14] noted that prevalence for refractive error by age goes up for school-age children by age group. Yadav et al. (2023) [15] also documented a gradual increment in refractive errors for the child population aged between 9–15 years. Conversely, higher levels of refractive error have been noted by Khandekar et al. (2009) [13] in lower ages (9–12 years), again reflecting possible variation by area or research technique. These aspects also highlight the importance for comparison purposes to take notice of area environmental factors together with schooling factors when evaluating patterns for refractive error.

Gender prevalence in the current research was equalized by having 52% boys and 48% girls, while the prevalence of refractive errors was slightly higher in boys. This agrees in part with that of Khandekar et al. (2009) [13], where higher uncorrected refractive errors were noted in boys but gender disparities were not significant. On the contrary, research conducted by Xiao et al. (2015) [16] revealed female preponderance for refractive errors such that gender-oriented vulnerability may differ in

between or among populations and may depend on the influence of behavioral or genetic predispositions.

Screen time in our population also revealed a tendency towards greater prevalence of refractive defects between participants having greater than two hours of screen exposure per day (35.7% vs. 18.8%), but the association failed to attain statistical significance. Similar results have been noted by Saw et al. (2000) and Dandona et al. (1998) [17,18], who noted that extensive exposure to computers or television viewing entailed a higher risk for refractive defects. Rakhi et al. (2002) [19] also noted that excessive near vision activity went along with higher levels of defective vision amongst school-going children. The evidence indicates that whereas screen time possibly plays a role in visual issues, genetic risk, outdoor activity, and schooling requirements are presumably simultaneous factors.

The educational effects of refractive errors came through in this research, where students suffering from visual impairment managed significantly lower (mean 63.1%) than their normal-seeing counterparts (mean 72.8%). This supports previous evidence that learning outcomes are negatively impacted by uncorrected vision defects. Dandona et al. (2001) [20] and Rani et al. (2010) [21] documented the adverse effects of refractive defects on educational performance and level of cognitive functioning and the need for early detection and intervention. Cumulative learning losses may occur by failing to correct vision defects, further supporting the importance of regular screening in school health initiatives.

Parental knowledge about eye health was poor in our series, where only 28% of the participants acknowledged the importance of regular eye testing every year. Most of the children suffering from refractive errors (63%) never received an eye check. Comparable knowledge gaps in the parents were documented by Ma et al. (2023) [22], who further noted that ignorance about the condition and preventive measures affect early identification of eye conditions in children. This result further indicates the importance of educational measures for the parents and the teachers besides incorporating vision screening activities in the health program for the schools to reduce the gap between the prevalence of the refractive errors versus preventive measures for eye conditions.

Overall, this study finds a high prevalence of refractive error among rural schoolchildren, particularly myopia, and serious adverse impacts for educational performance. Findings are generally consistent with previous studies in India and elsewhere, although estimates of prevalence vary due to differences in demography, environment, and methodology. Screen time and poor awareness by the parents were found to be important risk factors, and the overall need for rounded solutions that incorporate corrigible medical treatment and community awareness for improved child eye health outcomes.

Conclusion

The study demonstrates a significant prevalence of refractive errors among rural school children, with nearly half of the participants affected by myopia, hyperopia, or astigmatism. While the study did not find a statistically significant relationship between daily screen viewing and the prevalence of refractive errors, the findings do indicate that those with a condition tended to have a greater number of hours of screen time, as opposed to students who did not have a refractive error. Students with uncorrected refractive errors had statistically significant poorer academic performance compared to students who did not suffer visual disturbances, substantiating the potential impact of Uncorrected vision problems on student academic performance. The study also highlighted a concerning disparity in parental awareness regarding the need for regular eye examinations, as the majority of the children with refractive errors had never undergone an eye examination and many of mothers believed that eye care was only needed when signs of an eye problem were visible. The findings in this study support the need for public health-initiated eye health programs, such as periodic screening programs in schools, eye health education for parents, and also timely detection and treatment of eye and vision conditions, in order to maintain the eye health and educational outcomes of rural school age children.

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