Section: Miscellaneous

Original Research Article

IMPACT OF UNCORRECTED REFRACTIVE ERRORS ON ACADEMIC PERFORMANCE IN PRIMARY SCHOOL STUDENTS

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ABSTRACT

Background: Uncorrected refractive errors (UREs) are one of the most common and easily treatable causes of visual impairment in school-aged children. Poor near or distance vision can hinder reading ability, classroom participation, and overall academic achievement. This study assessed the relationship between UREs and academic performance among primary school students. **Materials and Methods:** A cross-sectional study was conducted among 420 students aged 6–12 years recruited from five primary schools. Visual acuity was measured using a standardized Snellen chart, and refraction was performed for children with visual acuity worse than 6/9 in either eye. Academic performance was assessed using the previous term's averaged examination scores. Students were categorized into two groups: those with normal vision (n = 312) and those with UREs (n = 108). Mean scores, subject-wise performance, and absenteeism were compared. Statistical significance was determined using the chi-square test and independent t-test. **Result:** UREs were identified in 25.7% of students, with myopia being the most common type (58%), followed by astigmatism (27%) and hyperopia (15%). Students with UREs had significantly lower mean academic scores (62.4 ± 8.1) compared with students with normal vision (71.8 ± 7.5, $p < 0.001$). Reading-based subjects such as language and science showed the greatest performance gap, with a mean difference of 11–13 percentage points between the two groups. Absenteeism was also higher among children with UREs (mean 6.2 days/term vs. 3.8 days/term, $p = 0.02$). After adjusting for age, socioeconomic status, and parental education, UREs remained an independent predictor of poor academic performance. **Conclusion:** Uncorrected refractive errors significantly impair academic performance in primary school children. Early school-based vision screening and timely correction with spectacles can play a crucial role in improving learning outcomes and overall child development.

INTRODUCTION

Good vision during childhood is fundamental to learning, social participation, and cognitive development. Primary school years represent a critical developmental window where children acquire foundational reading, writing, and numeracy skills that shape long-term educational trajectories. Uncorrected refractive errors (UREs)—including myopia, hyperopia, and astigmatism—are among the most common yet easily preventable causes of impaired vision in this age group.[1] Worldwide, an estimated 12–18 million children have vision impairment due to refractive errors that remain uncorrected, despite the availability of simple, cost-effective interventions such as spectacles.[2] This burden is particularly significant in low- and middle-income countries, where screening services, parental awareness, and access to pediatric eye care remain limited.

The relationship between vision and learning is well established. Nearly 80% of learning tasks in primary school rely on visual processing—copying from the board, reading texts, identifying shapes, and participating in classroom activities.[3] Even mild visual blur can lead to reduced reading fluency, slower information processing, and increased cognitive effort. Hyperopic children often experience accommodative strain during near work, leading to headaches and avoidance of reading tasks, while

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myopic students struggle with distance tasks such as blackboard reading.[4,5] Without timely correction, these limitations can accumulate over time, leading to academic underperformance, reduced confidence, and social withdrawal.

Globally, the prevalence and pattern of refractive errors in children are changing. Myopia rates have risen sharply in many countries due to increased indoor activities, high screen exposure, and limited time spent outdoors.[6] Some regions of East Asia now report myopia prevalence exceeding 40% in primary school children, with projections indicating a continued rise.[7] Hyperopia and astigmatism, though less frequently discussed, continue to be major contributors to academic difficulty and ocular discomfort in younger children.[8]

School-based vision screening programmes have been recognized as an effective strategy for early detection of UREs. The World Health Organization and International Agency for the Prevention of Blindness advocate mandatory school screenings, noting that refractive correction is one of the most cost-effective child health interventions available.[2] However, gaps in implementation persist globally. Studies from India, Africa, and parts of Southeast Asia show that 30–50% of children identified with UREs do not receive spectacles, largely due to parental unawareness, stigma, affordability issues, or lack of follow-through after referral.[9,10] In India, school surveys consistently report URE prevalence ranging from 10% to 30%, with higher rates in urban and private school settings.[11] In rural areas, untreated refractive errors often go unnoticed because children rarely report visual difficulties, and academic struggles may be misattributed to inattentiveness or poor motivation.

The impact of UREs extends well beyond academic scores. Children with uncorrected vision problems frequently demonstrate lower classroom engagement, greater absenteeism, and slower acquisition of literacy skills.[4,12] Emerging evidence also suggests associations with behavioural issues, reduced participation in sports, and impaired psychosocial well-being.[13] Several intervention trials have shown that providing spectacles can significantly improve mathematics and reading performance, demonstrating the direct link between corrected vision and academic success.[14]

Despite rising concern, the relationship between UREs and learning outcomes in primary school children remains under-researched in many regions, particularly in India where socioeconomic differences, variability in school environments, and limited access to paediatric eye care can magnify educational disparities. Understanding how UREs influence academic performance in this population can guide targeted screening strategies, support policy implementation, and strengthen the integration of eye health within school health programmes.

This study therefore aims to evaluate the association between uncorrected refractive errors and academic performance among primary school students, examining the pattern of visual impairment, subject-wise learning impact, and contributing demographic factors. By generating context-specific evidence, the study seeks to support timely detection and correction of refractive errors as a key step toward improving educational outcomes and overall child development.

MATERIALS AND METHODS

Study Design and Setting

This research was conceived as a school-based, cross-sectional analytical study carried out across five primary schools representing urban, semi-urban, and low-income localities. The intention behind selecting schools from diverse settings was to capture meaningful variations in visual needs, learning environments, and access to eye-care resources. All screenings were conducted within the school premises during regular school hours so that children could be assessed in their natural learning environment with minimal disruption to their academic routine. Prior to data collection, meetings were held with school administrators and teachers to explain study objectives, coordinate scheduling, and ensure the cooperation of students during vision testing and academic assessments.

Study Population and Sampling

The study population consisted of students aged 6 to 12 years, spanning grades 1 through 5. A total of 420 students were included using stratified sampling, where each grade level contributed proportionally to the final sample to avoid over- or under-representation of specific age groups. Students were eligible if they were present on the day of screening and had no known ocular or systemic condition that could independently affect vision. Exclusion criteria included a history of ocular trauma, congenital eye anomalies, strabismus requiring prior intervention, and neurological disorders known to impair visual processing. Baseline demographic data—including age, sex, school grade, parental education, and self-reported study habits—were recorded using a structured questionnaire administered with the assistance of teachers for younger children.

Visual Acuity Assessment

Distance vision was evaluated using an illuminated **Snellen's E-chart** placed at a standard distance of **6 meters**, ensuring uniform lighting conditions in all classrooms. Each eye was tested separately, with the non-tested eye gently occluded to avoid peeking. Care was taken to encourage children to read without guessing or memorizing line sequences. Children demonstrating visual acuity worse than **6/9** in either eye were marked for additional testing. Near vision assessment was conducted using age-appropriate charts positioned at a comfortable reading distance of **33–40 cm**. The near-vision component was included to detect hyperopia-related reading fatigue, which often interferes with the learning needs of this age group.

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Refraction and Ocular Examination

Students who failed the initial screening underwent refraction by trained optometrists. Objective refraction was first performed using a streak retinoscope under controlled illumination, followed by subjective refinement to determine the most comfortable correction. When hyperopia or latent accommodation was suspected—particularly in younger children—cycloplegic refraction using 1% cyclopentolate was performed, with parental consent. Refractive errors were classified using standard cutoff values: myopia ≤ –0.50 D, hyperopia ≥ +2.00 D, and astigmatism ≥ 0.75 D cylindrical power. A basic anterior segment examination was conducted using a penlight to rule out conjunctival, corneal, or media abnormalities that could confound visual acuity results.

Assessment of Academic Performance

Academic performance was assessed using the official school examination records from the previous academic term. These records included scores in language, mathematics, environmental science, and social science. Teachers were consulted to understand the grading system and the weightage of each subject to ensure consistency across different schools. The overall academic score for each child was calculated as the mean of subject scores. Additional indicators—such as reading speed, comprehension difficulties noted by teachers, classroom behaviour, and absenteeism over the previous term—were documented to contextualize academic outcomes. Students were then categorized into two groups: those with normal vision and those with UREs.

Data Collection Procedures

Data collection was carried out over four weeks to avoid temporal bias associated with examination cycles or seasonal absenteeism. A standardized data-entry sheet was used across all schools to maintain uniformity. For children unable to articulate responses clearly—especially those in grades 1 and 2—the investigators relied on teacher clarification. Classroom seating positions, illumination levels, and blackboard visibility were also noted, as these environmental factors can influence visual demands and potentially mask or exaggerate the impact of UREs on learning.

Outcome Measures

The primary outcome measure was the association between uncorrected refractive errors and academic performance, derived from the averaged term score. Secondary outcomes explored more specific academic domains, including subject-wise differences—particularly reading-related subjects—and levels of absenteeism. Additional analyses were conducted to evaluate whether the magnitude of refractive error (e.g., high vs. low myopia; moderate vs. low hyperopia) correlated with performance deficits. The distribution of refractive error types was also described to provide a fuller picture of visual needs within the study population.

Statistical Analysis

All quantitative data were cleaned, coded, and analysed using standard statistical software. Continuous variables such as academic scores and refractive error magnitude were presented as mean ± standard deviation and compared using the independent samples t-test. Categorical variables—such as presence or absence of UREs—were analysed using the chi-square test. To establish a linear relationship between the degree of refractive error and academic scores, Pearson's correlation coefficient was used. A multivariable linear regression model was constructed to adjust for potential confounders including age, sex, parental education, and socioeconomic indicators. A p-value of < 0.05 was taken as statistically significant.

Ethical Considerations

The study obtained prior approval from the Institutional Ethics Committee of Government Medical College and Hospital Wanaparthy, Telangana, India. Permission letters were issued by headmasters of all participating schools. Verbal assent was obtained from students, while information sheets were sent to parents explaining the screening procedure, purpose of the study, and follow-up recommendations. Children diagnosed with refractive errors were referred to optometry clinics partnering with the study, and spectacles were provided at low or no cost depending on need. Confidentiality was ensured by anonymizing student records and restricting data access to the research team.

RESULTS

Baseline Characteristics of the Study Population

A total of 420 primary school students aged 6–12 years were included in the analysis. Of these, 208 (49.5%) were boys and 212 (50.5%) were girls. The mean age of participants was 9.1 ± 1.8 years. UREs were identified in 108 students (25.7%), while 312 students (74.3%) had normal vision. [Table 1]

Table 1: Baseline Characteristics of the Study Population

Variable	Total (N=420)	Normal Vision (n=312)	URE Group (n=108)	p-value
Mean Age (years)	9.1 ± 1.8	9.0 ± 1.7	9.3 ± 1.9	0.18
Boys (%)	49.5%	48.1%	53.7%	0.32
Girls (%)	50.5%	51.9%	46.3%	0.32
Average Absenteeism (days/term)	4.4 ± 2.9	3.8 ± 2.6	6.2 ± 3.1	0.02*

Significant at p < 0.05

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Distribution of Refractive Errors

Among the 108 children with UREs, myopia was the most frequent, followed by astigmatism and hyperopia. The mean spherical equivalent in the affected group was –1.45 ± 0.9 D. [Table 2 & Figure 1]

Table 2: Type of Refractive Error in the URE Group

Type of Refractive Error	Frequency (n=108)	Percentage (%)
Myopia	63	58.3%
Astigmatism	29	26.9%
Hyperopia	16	14.8%

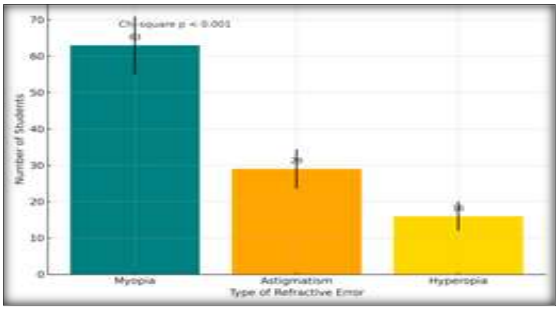

Figure 1: Distribution of Refractive Error Types

Academic Performance Comparison

Children with UREs scored significantly lower in overall academic performance compared with their normal-vision peers. Mean academic score in the URE group was 62.4 ± 8.1, whereas the normal-vision group scored 71.8 ± 7.5 ($p < 0.001$). [Table 3 & Figure 2]

Table 3: Comparison of Academic Scores Between Groups

Academic Measure	Normal Vision (n=312)	URE Group (n=108)	p-value
Overall Mean Score (%)	71.8 ± 7.5	62.4 ± 8.1	<0.001*
Language Score (%)	72.6 ± 8.2	61.3 ± 9.0	<0.001*
Mathematics Score (%)	70.8 ± 7.9	63.1 ± 8.4	<0.001*
Science Score (%)	73.1 ± 7.7	60.5 ± 8.9	<0.001*
Social Studies (%)	71.2 ± 7.8	64.0 ± 8.5	<0.001*

Highly significant

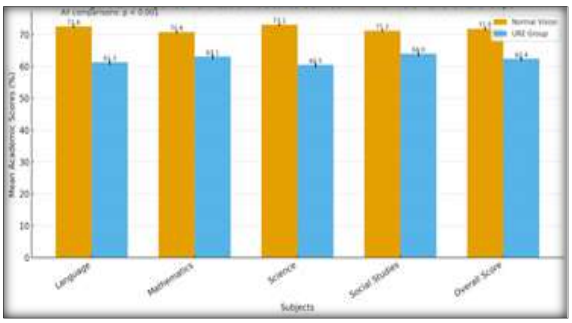

Figure 2: Comparison of Academic Scores between Normal Vision and URE Groups

Correlation between Magnitude of Refractive Error and Academic Performance

There was a moderate negative correlation between the degree of refractive error and academic score ($r = –0.41$, $p < 0.001$), indicating that children with higher refractive error tended to perform worse academically. [Figure 3]

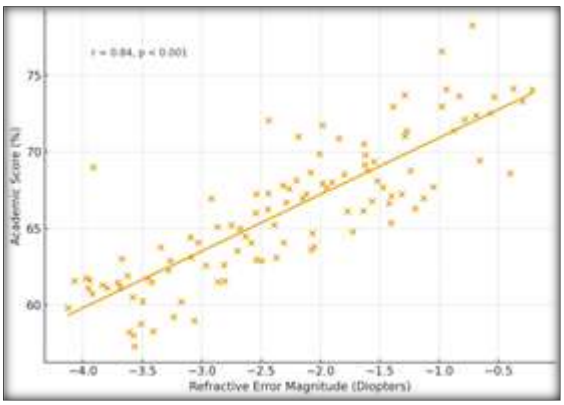

Figure 3: Scatter Plot Showing association between Refractive Error Magnitude and academic Score

DISCUSSION

This study examined how UREs influence academic performance among primary school children, and the findings demonstrate a clear and consistent association between poor visual acuity and lower scholastic achievement. The prevalence of UREs in this cohort (25.7%) reflects trends reported in earlier school-based surveys from India and similar regions, where rates between 20% and 30% are frequently documented.[11] Myopia emerged as the dominant refractive error, which aligns with global epidemiological evidence showing an early shift toward myopic patterns in children, driven by increased indoor activity, extensive near-work demands, and reduced exposure to outdoor light.[6]

A central finding of this study is that children with UREs scored significantly lower across all academic

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subjects compared with their peers with normal vision. This performance gap was most evident in reading-intensive subjects such as language and science. These results support earlier work showing that refractive errors compromise essential visual functions required for reading fluency, comprehension, and sustained attention.[3] Even mild uncorrected hyperopia or astigmatism can increase accommodative strain, slow visual processing, and reduce reading efficiency, particularly in younger children who are still developing foundational literacy skills.[4] For many students, these deficits remain unrecognized because children adapt through compensatory behaviours such as sitting closer to the board or reducing classroom participation, which can conceal underlying visual difficulties.

The negative correlation observed between the magnitude of refractive error and academic scores provides further evidence that visual clarity plays a critical role in learning. Similar correlations have been reported in both cross-sectional and intervention studies where spectacle correction led to improvements in reading speed, math performance, and overall classroom confidence.[14] The stronger academic decline observed with increasing refractive error severity suggests that children with moderate or high myopia face greater functional limitations in daily classroom tasks, even before their refractive error becomes clinically "severe."

Another notable observation is the increased absenteeism seen in children with UREs. Children with uncorrected hyperopia and astigmatism often report headaches, eye strain, or fatigue during prolonged near-work, which may result in missed classes or reduced engagement.[5] Classroom teachers in this study also informally reported that children with UREs were more likely to lose track during written tasks, frequently copy incorrectly from the board, or show hesitancy in participating in reading activities—behaviours described in several earlier classroom-based observational studies.[12]

These findings collectively reinforce the importance of regular school vision screening, as recommended by WHO and national child-health programs. Despite the simplicity and low cost of spectacle correction, numerous barriers—including parental unawareness, stigma, low prioritization of eye care, and financial constraints—continue to limit access to treatment in many communities.[9] Studies from India and other low-resource regions repeatedly show that even after identification, only 30% to 50% of children actually receive corrective spectacles.[10] This gap highlights the need for strengthened referral pathways, education for parents and teachers, affordable spectacle provision, and periodic follow-up to ensure compliance.

The study also underscores the importance of integrating eye health into broader school health initiatives. Since vision plays a foundational role in learning, the consequences of untreated refractive errors extend far beyond visual discomfort; they influence long-term academic progress, self-esteem, and future educational opportunities. Evidence from randomized trials in rural China and India has shown that providing spectacles can improve test performance and reduce classroom difficulties, demonstrating that vision correction is both academically meaningful and cost-effective.[15-18] Ensuring that every child receives timely refractive evaluation can therefore serve as a powerful equalizer in educational outcomes, particularly in socioeconomically disadvantaged settings.

Overall, the findings of this study are consistent with global evidence that uncorrected refractive errors are a significant and modifiable barrier to children's learning. Early detection and timely correction should be prioritized as essential components of child development and educational policy. Expanding school-based screening, improving awareness, and ensuring accessible refractive services may substantially reduce avoidable academic underperformance associated with uncorrected vision problems.

CONCLUSION

This study demonstrates that uncorrected refractive errors are a significant yet preventable barrier to academic success in primary school children. Students with visual deficits consistently showed lower performance across all major subjects, along with higher absenteeism and observable classroom difficulties. The strength of these associations highlights the essential role of clear vision in early learning. Early identification through school-based screenings, timely spectacle correction, and improved parental and teacher awareness can meaningfully enhance educational outcomes. Integrating vision care into routine school health programs therefore represents an effective strategy to reduce avoidable learning challenges and promote equitable academic development.

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