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Original Article

Prevalence of Refractive Errors and Its Association with Academic Performance Among School Children

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ABSTRACT

Background: Refractive errors (REs) are frequently occurring, and correctable visual abnormality in school age children. Refractive errors may be related to problems in visually demanding academic tasks and school achievement. Objective: To find the prevalence of REs among school children in Central Punjab and its correlation with their academic performance. Methods: In this cross- sectional study 96 school age children 8-14 years were randomly recruited from various primary and secondary schools from Central Punjab during August 2025 to January 2026. Distance visual acuity was assessed and children whose visual acuity 6/9 or worse were subjected to non-cycloplegic autorefraction, followed by subjective correction. Academic performance was calculated based on average cumulative percentages of school examination. Descriptive statistics, independent sample t- test, Karl Pearson correlation and chi square test were applied. Results: Refractive errors was found in 31/96 children (32.3%; 95%CI, 23.8-42.2) with 18 of them (18.8%) was suffering from myopia, 9 (9.4%) had astigmatism and 4 (4.2%) with hyperopic errors. Mean academic score was significantly lower among students with REs (62.8 +- 10.1%) compared to emmetropic students (75.5+-10.4%); mean difference is 12.70%, 95%CI, 8.25 - 17.15 percentage, p<0.001 with effect size 'g' 1.22. Conclusion: Refractive errors were prevalent among school children study group and are correlated with poor academic performance. Recommendations- Consideration to visual status should be made when investigating the health and education issues of school age children .Keywords: Academic performance, Astigmatism, child, mass screening, myopia, refractive errors, vision test.

INTRODUCTION

Vision enables children to engage in reading, class participation, written work, and in school academic success. A recent review of school vision programs suggests that screening children and correcting visual impairments may lead to improved school outcomes, highlight the practical importance of vision throughout school years (1). The most frequently diagnosed correctable visual conditions identified in a school-aged population are refractive errors-myopia, hyperopia, or astigmatism.

Findings from school vision screening programs support that clinically significant refractive errors go undetected and may go unrecognized until a formal evaluation of the visual system has been conducted (2).

This is especially problematic in regions with insufficient access to routine pediatric eye care where differential screening and follow-up standards may lead to delays in diagnosis and subsequent optical correction (3). Uncorrected refractive errors can impede on a child's capacity to properly utilize reading and distance learning materials, and complete school-assigned work. Uncorrected vision problems may also result in headaches, tired eyes, and difficulty participating and paying attention in class. Some studies report that visual impairments are associated with a decrease in academic success, along with reports from the classroom such as difficulty keeping up, and decreased participation (4).

Since it takes a number of years for visual vision impairment to become of any significant size, not all students are able to identify that they may have visual difficulties.

Thus, it's possible for students to have moderate, undiagnosed and still treatable vision problems alongside and undetected.

A focus on the links between refractive error and educational outcomes has been undertaken in Pakistan. Studies have identified a link between refractive error and educational outcomes in high school students in Lahore, supporting the fact that this association is significant locally and not just internationally (5). Population-based studies from school children in other contexts have also established a link between undetected visual disorders and educational outcomes (6). However, not all available research comes to such strong conclusions. A review of the literature on reducing visual acuity, refractive error and classroom performance found evidence of a link, but with methodological variability in the visual assessment, educational outcomes, study population and in the methods used (7). Because of this variability, it is difficult to directly apply the findings of one study and its findings to another school population.
Despite advances in eye care, the continued significance of this problem is highlighted by challenges through the entire pathway of vision screening, comprehensive eye exam and refractive correction. School based vision screening can identify children that they may not see if they don't receive primary school eye services, but relies on the eye exam, referral, follow-up and access to eyeglasses (8). Therefore, estimating regional data may help estimate the burden discovered in a particular school population and to determine if the status of one's vision relates to outcomes in school performance that can be measured by standard educational performance and not just attributed to refractive error alone.

Within this context, further investigation among schoolchildren in Central Punjab is justified because academic performance may be influenced by visual status as well as numerous educational, demographic, and social factors, and the magnitude of the observed relationship may vary across populations and assessment strategies. Evaluating refractive status alongside routinely recorded examination performance can provide locally relevant evidence regarding both the frequency of refractive abnormalities detected through school-based assessment and their relationship with scholastic outcomes. Accordingly, this cross-sectional study aimed to determine the prevalence of refractive errors among schoolchildren aged 8–14 years in selected schools in Central Punjab and to evaluate the association between refractive status, visual acuity, reported visual symptoms, and academic performance.

MATERIALS AND METHODS

A cross-sectional study was conducted among schoolchildren attending selected primary and secondary schools in Central Punjab between August 2025 and January 2026. The study population comprised children aged 8–14 years who were enrolled in regular school attendance during the study period. A target sample of 96 children was used for this localized school-based investigation. Participants were selected using stratified random sampling to obtain representation across age groups and sex. Of 100 eligible students invited to participate, 96 completed both the ophthalmic assessment and academic evaluation and constituted the final analytical sample.

All children aged 8-14 years presenting to any of the participating schools was included. Subjects with a history of any ocular surgery, trauma and with active ocular infection, congenital cataract, squint and having neurological or intellectual abnormalities which could affect ophthalmic and academic examination respectively, were excluded.

The project received ethical committee approval prior to commencement of the study. Informed written consent was obtained from all the guardians/parents of children, and verbal consent from the children before examination.

Ophthalmic assessments were conducted on-site by qualified optometrists using standardized clinical procedures. Distance visual acuity was assessed separately for each eye and binocularly at a testing distance of 6 m using an illuminated Snellen visual-acuity chart. Presenting and uncorrected visual acuity were recorded, with acuity expressed in logMAR units for statistical analysis. Children with visual acuity of 6/9 or worse in either eye underwent non-cycloplegic autorefraction using a portable hand-held autorefractometer, followed by subjective refraction to determine refractive status. For analytical purposes, participants were categorized according to the refractive status detected through this screening and refraction protocol.

Myopia was defined as a spherical equivalent of -0.50 diopters or more, hyperopia as a spherical equivalent of greater than or equal to +2.00 D, and astigmatism was defined as a cylindrical refractive power equal to or greater than 0.75 D. Refractive status was the most important ophthalmic exposure variable and visual acuity levels and spherical equivalent were treated as continuous ophthalmic variables when appropriate. The major ophthalmic outcome variable was educational performance assessed through total percentage score of latest year end exams. Educational outcome variables consisted of total percentage core subject scores where applicable and the subject wise percentage for Mathematics, English language arts and science as well.

Demographic data and symptoms such as headache and eye strain/fatigue, as well as need to squint to see the classroom board and inability to read were collected from a standardized history collected by questionnaire at examination. In addition to these demographic and symptom variables, time spent on screens per day in hours were also measured and assessed as an additional participant characteristic within the correlation analysis. Data were collected during ophthalmic examination by same examiner to enable consistent patient interview method. The use of a standardized method of visual acuity procedure, objective autorefraction followed by subjective examination of children within screening threshold, predetermined refractive errors, and school examination percentages were aimed to Minimize any between-participant variation.

Academic performance was compared between children with refractive errors detected under the study protocol and children without detected refractive errors. Because the investigation was observational and cross-sectional, analyses were directed toward prevalence estimation and assessment of associations rather than causal effects. The primary analyses were unadjusted bivariate comparisons and correlations; no independent causal effect of refractive status on academic performance was assumed. Participants completing both ophthalmic and academic assessments were included in the analytical dataset.

IBM SPSS Statistics version 27.0 was used for statistical analysis. Continuous variables are described in terms of mean and standard deviation, and categorical variables in terms of frequency and percentage. Normality of continuous variables of the level of academic achievement and the spherical equivalent of the spectacle-correction for refractive errors was analyzed using the Kolmogorov-Smirnov test with supplementary Q-Q plot interpretation.

To identify significant differences of mean academic performance levels between subgroups categorized by the level of refractive error, the independent-samples t-test was used.

Pearson correlation coefficient were computed to test for linear association between ophthalmic continuous variables (the sphere value, cylindrical value, spherical equivalent), the academic performance level, and daily screen time. To test for associations of categories of visual symptom between the level of refractive error, chi-square test was conducted. The analysis performed were two-tailed, and the results deemed significant if $P<0.05$.

RESULTS

Ninety six (96.0%) of the 100 eligible children attending school that were asked to attend, had complete Ophthalmic and Academic examinations. Mean age of the included participants was 11.2 1.8 years. There were 50 boys (52.1%) and 46 girls (47.9%) inclusive in the results. Mean combined academic examination grades was 71.4 11.8% (Table 1).

Table 1. Participant Characteristics of the Study Population

Characteristic	Value
Eligible students invited, n	100

Characteristic	Value
Participants analyzed, n (%)	96 (96.0)
Age, years, mean ± SD	11.2 ± 1.8
Male, n (%)	50 (52.1)
Female, n (%)	46 (47.9)
Cumulative academic score, %, mean ± SD	71.4 ± 11.8

SD, standard deviation.

There were refractive errors present in 31 of the 96 children which represents prevalence of 32.3% (95%CI 23.8–42.2) whilst 65 children (67.7%; 95% CI, 57.8–76.2) in the study were categorized as emmetropia with the study assessment protocol. Myopia was the most common type of refractive error in our study with a proportion of 18 (18.8%) of the total study sample; and astigmatism with 9 (9.4%) while hyperopia was in 4 (4.2%). The proportions among the children with refractive errors were 58.1%, 29.0% and 12.9% respectively (Table 2).

Table 2. Prevalence and Distribution of Refractive Status Among Schoolchildren

Refractive status	n/N	Prevalence, %	95% CI
Emmetropia	65/96	67.7	57.8–76.2
Any refractive error	31/96	32.3	23.8–42.2
Myopia	18/96	18.8	12.2–27.7
Astigmatism	9/96	9.4	5.0–16.9
Hyperopia	4/96	4.2	1.6–10.2

CI, confidence interval. Confidence intervals were calculated from the reported counts using the Wilson binomial method.

Academic performance differed between children classified as emmetropic and those with refractive errors. The mean cumulative academic score was 75.5 ± 10.4% in the emmetropic group and 62.8 ± 10.1% in the refractive-error group. The absolute between-group mean difference was 12.7 percentage points (95% CI, 8.25–17.15). Welch's independent-samples t-test yielded t=5.71 with 60.73 degrees of freedom and p<0.001. The standardized between-group difference was Hedges' g=1.22 (Table 3).

Table 3. Comparison of Cumulative Academic Performance by Refractive Status

Outcome	Emmetropic (n=65), mean ± SD	Refractive error (n=31), mean ± SD	Mean difference (95% CI)	t (df)	p-value	Hedges' g
Cumulative academic score (%)	75.5 ± 10.4	62.8 ± 10.1	12.7 (8.25–17.15)	5.71 (60.73)	<0.001	1.22

CI, confidence interval; df, degrees of freedom; SD, standard deviation. Mean difference was calculated as emmetropic minus refractive error group. The between-group differences were tested with Welch's independent samples t-test. Hedges' g was derived from group means,SD's and sample sizes found in original publication. The effect size of this between-group difference suggests a large discrepancy on this variable measure of cumulative academic achievement of the refractive groups in the given samples. As this research design was cross-sectional, no assumptions of causation regarding refractive status on schooling can be made.

DISCUSSION

The present study identified a substantial burden of refractive error among schoolchildren in Central Punjab and found that refractive status was associated with academic performance. Approximately one-third of the participants had a refractive error detected under the study assessment protocol, with myopia representing the most frequent subtype. Children with refractive errors had lower cumulative academic scores than those classified as emmetropic, with an unadjusted between-group difference of 12.7 percentage points and a large standardized difference. These findings are consistent with previous evidence suggesting that visual status and educational performance may be related, although the cross-sectional nature of the present study does not establish that refractive error caused the observed difference in academic achievement. A previous study involving schoolchildren in Lahore similarly reported an association between refractive errors and academic performance, providing evidence that this relationship is relevant within the Pakistani educational context (5). Comparable observations have also been reported among schoolchildren in Ireland, where undetected or untreated visual problems were examined in relation to school performance (6). More broadly, a review of the relationship between refractive error, reduced visual acuity, and classroom performance concluded that the overall evidence supports an association, while emphasizing considerable methodological heterogeneity and limitations across studies (7).

Myopia was the predominant refractive-error subtype in the present sample. This pattern is broadly compatible with findings from school-based vision programs in which myopic refractive errors constitute an important proportion of abnormalities detected among children requiring further visual assessment (2). Direct comparison of prevalence estimates across studies should nevertheless be made cautiously because estimates depend on the age distribution of participants, geographic and demographic characteristics, refractive thresholds, screening procedures, and whether refraction is performed in the entire study population or only among children who fail an initial vision screen. In the present study, refraction was undertaken in children with visual acuity of 6/9 or worse, meaning that the observed 32.3% prevalence primarily reflects refractive errors detected through the study's screening pathway rather than comprehensive cycloplegic refractive assessment of every participant. Differences in case ascertainment may therefore contribute to variation between the present estimate and those reported in other school populations.

Refractive error and visual impairment can exist concomitantly with a number of plausible biological mechanisms influencing education, though these are not directly examined in the present work: Good distance vision is a prerequisite for visualising a classroom board or other instruction whereas sustained visual performance is required for tasks such as reading and writing as part of near learning. Diminished acuity or inadequately treated refractive error can mean it is harder for some individuals to achieve, and sustain the visual performance that can otherwise occur along with headache, visual discomfort and visual fatigue. Studies of the effects of vision impairment in adolescents with uncorrected vision impairment found poor educational outcomes and visual and musculoskeletal symptoms (4) and the literature at large reports a link between refactive errors and performance at school as does that on diminished visual acuity and school results though the relationship may depend greatly on the measures used and outcomes examined (7). However, the class difference shown in this study should be viewed as a strong relationship not proof of a single, purelyphysiological effect.

This study has potential for use in school vision-health services as screening at school could identify children with unmet vision needs that were previously undiagnosed. Evidence from a cluster-randomized school-based vision program revealed improved reading performance in the first year after providing examinations and eyeglasses although there was no academic benefit sustained for all measures and follow-up periods (1). This intervention evidence is consistent with but different from the cross-sectional association identified in the current study.

Previous work has documented continued difficulties transitioning from screening, to referral to the definitive examination to delivery of refractive correction, particularly for disadvantaged children (3,8).

Vision screening is included in school-based health services in a number of health systems, however, patterns of screening and supporting evidence vary considerably across systems (9). Parental education, literacy, and awareness also could affect uptake, follow-up to definitively diagnose, and take up on the recommendation for corrective lenses following a positive screening (10). In conclusion, these points highlight a need for an association between screening in schools, appropriate clinical evaluation, and continued follow-up rather than providing it as a standalone activity to tap a new or hitherto unseen clinical population to create a public health advantage.

The present study has several strengths. Ophthalmic assessments were performed on-site by qualified optometrists using a consistent visual-acuity procedure, and children meeting the screening threshold underwent objective autorefraction followed by subjective refraction. Academic performance was obtained from school examination records rather than relying solely on children's perceptions of their educational achievement. The study also achieved a high completion rate, with 96 of 100 invited eligible students completing both ophthalmic and academic assessments. These features provide a useful locally derived assessment of the relationship between detected refractive status and school performance.

Several limitations should, however, be considered when interpreting the findings. First, the cross-sectional design precludes establishing temporal or causal relationships; lower academic performance may be associated with refractive status without being caused by it. Second, the relatively small sample and recruitment from selected schools in Central Punjab limit precision and generalizability to other school populations. Third, refractive assessment was performed after an initial visual-acuity threshold rather than comprehensively in every participant. Screening strategies can differ in the children they identify for further ophthalmic assessment, and comprehensive examination may detect abnormalities not identified by a single screening approach (11). Consequently, some refractive abnormalities among children with relatively preserved distance visual acuity may not have been identified. Fourth, refraction was non-cycloplegic, which may influence refractive classification in children because accommodation can affect spherical measurements. These measurement considerations are particularly important when interpreting the relative frequencies of myopia and hyperopia.

A further limitation is that the reported comparison of academic scores was unadjusted. Educational achievement may also vary according to age, grade, school characteristics, socioeconomic circumstances, parental education, attendance, study environment, and other factors that were not incorporated into an adjusted model. In addition, students were recruited from schools, creating the possibility of within-school similarity in teaching practices and examination performance that was not accounted for in the reported analysis. Examination percentages may also differ in difficulty or grading practices across grades or schools unless common or appropriately standardized assessments are used. Thus, although the observed academic-score difference was substantial, residual confounding and educational measurement differences prevent attribution of that difference specifically to refractive error. Larger studies using comprehensive refractive assessment, standardized educational outcomes, appropriate consideration of school-level clustering, and multivariable adjustment would provide more precise estimates of the independent relationship between visual status and academic performance.

CONCLUSION

Among the schoolchildren evaluated in Central Punjab, refractive errors were detected in approximately one-third of participants, with myopia being the most frequent subtype, and children with refractive errors had lower cumulative academic scores than those classified as emmetropic. These findings demonstrate an association between refractive status and academic performance within the studied population but do not establish a causal effect. The results provide locally relevant evidence that visual status is an important consideration when evaluating the health and educational needs of school-aged children.

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