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ORIGINAL RESEARCH

Observational Study on the Prevalence and Risk Factors of Refractive Errors in School-Going Children in Urban Areas

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ABSTRACT

Background: Refractive errors are among the most prevalent causes of visual impairment in school-aged children, particularly in urban areas where lifestyle and environmental factors contribute to their increasing incidence. Despite being easily correctable, undiagnosed and uncorrected refractive errors can significantly impact a child's academic performance, development, and quality of life. **Aim:** To determine the prevalence and identify the potential risk factors associated with refractive errors among school-going children in urban areas. **Material and Methods:** This observational, cross-sectional study was conducted in the Department of Ophthalmology at a tertiary care teaching hospital. A total of 140 school-going children aged 6 to 16 years were selected using multistage random sampling from five urban schools. After obtaining informed consent and assent, data collection included demographic details, visual habits, screen time, outdoor activity, and family history using a structured proforma. Comprehensive ophthalmic examinations were performed, including uncorrected and corrected visual acuity, objective and subjective refraction, cycloplegic refraction where necessary, and anterior and posterior segment evaluation. Refractive errors were defined using standard criteria. Statistical analysis was performed using SPSS version 25.0, with chi-square and logistic regression applied for association testing. **Results:** The prevalence of refractive errors was 43.57% (61/140). Myopia was the most common type (24.29%), followed by astigmatism (10.71%) and hyperopia (8.57%). A significant association was observed between refractive errors and screen time, with 50.82% of affected children having >2 hours/day screen exposure ($p < 0.01$). Outdoor activity had an inverse relationship; 62.30% of children with refractive errors had <1 hour/day of outdoor play ($p < 0.01$). Family history was also significant, with 63.93% of affected children having a positive parental history ($p < 0.001$). No significant differences were found in prevalence by age group or gender ($p = 0.84$). **Conclusion:** A high prevalence of refractive errors was observed among urban school children, with myopia being the most common. Significant risk factors identified included prolonged screen exposure, reduced outdoor activity, and positive family history. Implementation of regular school-based vision screening and awareness regarding modifiable lifestyle factors is essential to reduce the burden of visual impairment in children.

Keywords: Refractive error, Myopia, Screen time, Outdoor activity, School screening

INTRODUCTION

Vision plays a fundamental role in a child's development, influencing their academic performance, social interactions, and overall quality of life. Among the various causes of visual impairment in children, refractive errors remain one of the most common and easily correctable conditions. Refractive errors refer to the inability of the eye to focus light accurately on the retina, resulting in blurred vision. The three major types of refractive errors—myopia (nearsightedness), hyperopia (farsightedness), and astigmatism—can present individually or in combination, and if left undiagnosed or uncorrected, may adversely affect a child's educational attainment and psychosocial development[1].

In recent years, the prevalence of refractive errors among children has risen globally, with marked variations observed between urban and rural populations. Urbanization, lifestyle changes, increased academic pressure, and prolonged screen exposure are contributing significantly to the increasing rates of myopia in particular[2]. With the widespread integration of digital devices in both educational and recreational contexts, children are now exposed to near-work tasks for extended hours. Coupled with reduced outdoor activities, these behavioral shifts have emerged as modifiable risk factors influencing visual health in the pediatric population[3].

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India, with its large and diverse pediatric demographic, presents a unique landscape for the study of refractive errors. Several multicentric and region-specific surveys have identified a higher prevalence of refractive errors in urban school-going children compared to their rural counterparts. This disparity may be attributed to differences in environmental exposure, socioeconomic status, access to eye care services, and awareness among parents and educators[4]. Additionally, the rapid pace of urban development has led to sedentary lifestyles, indoor confinement, and excessive reliance on digital learning, all of which have been implicated in the growing burden of uncorrected refractive errors[5].

Despite being correctable with simple optical aids like spectacles, uncorrected refractive errors remain a leading cause of avoidable visual impairment. This can be attributed to a combination of underdiagnosis, lack of routine vision screening, economic constraints, and sociocultural stigmas associated with spectacle use. Even in urban areas with relatively better healthcare infrastructure, many children remain undiagnosed due to the absence of regular school-based vision screening programs[6]. Early detection and timely intervention are therefore critical, as they not only correct vision but also prevent potential complications such as amblyopia and learning delays[7].

A child's visual development is dynamic, and environmental influences during formative years have a profound impact. Studies have shown that near-work activities, including reading, writing, and screen use for more than two hours a day, are significantly associated with the onset and progression of myopia. Conversely, increased exposure to natural light and participation in outdoor activities have been shown to reduce the risk of myopic development and progression. These findings underscore the importance of lifestyle modification as part of preventive strategies[8].

Socioeconomic status, parental education, and family history of refractive errors are also important determinants of a child's visual health. Children with one or both parents having a history of wearing spectacles are more likely to develop similar visual issues, indicating a strong genetic predisposition[9]. Moreover, children from higher socioeconomic backgrounds, despite better access to healthcare, may have increased risk due to greater academic pressure and screen time. Conversely, those from lower-income families may suffer due to delayed diagnosis and limited affordability of corrective measures[10].

The role of comprehensive school eye health programs becomes crucial in this context. Implementing periodic vision screening, training schoolteachers for early identification, and raising awareness among parents can bridge the gap between detection and correction. Public health policies must prioritize pediatric vision care as a fundamental component of educational and developmental planning[11]. Additionally, integrating eye care into school health services can foster a culture of preventive ophthalmology, reducing the burden of uncorrected refractive errors at a population level.

In light of these considerations, this study was undertaken to assess the prevalence and identify the risk factors associated with refractive errors among school-going children in urban areas. By focusing on modifiable environmental and behavioral factors, the study aims to generate actionable insights that can inform future screening strategies, parental guidance, and policy development. Understanding these risk profiles is essential for initiating early interventions and ensuring that every child has the visual capacity to reach their full academic and personal potential.

MATERIAL AND METHODS

This observational, cross-sectional study was conducted in the Department of Ophthalmology at a tertiary care teaching hospital, following approval from the Institutional Ethics Committee. The study aimed to determine the prevalence and identify potential risk factors associated with refractive errors among school-going children in urban areas.A total of 140 school-going children aged 6 to 16 years were enrolled in the study using a multistage random sampling technique from five randomly selected urban schools within the municipal limits of the study area. Written informed consent was obtained from the parents or guardians, and verbal assent was taken from the children before participation.

Inclusion Criteria

- Children aged between 6 and 16 years.
- Attending selected urban schools.
- Willing to participate with parental consent.

Exclusion Criteria

- Children with known ocular pathologies other than refractive error (e.g., cataract, corneal opacity, retinal diseases).
- Children with a history of ocular trauma or surgery.
- Children with systemic diseases affecting vision (e.g., diabetes, epilepsy).

Data Collection Procedure

Data collection was carried out using a pre-structured proforma designed to capture relevant demographic details, visual habits, parental history of refractive errors, daily screen time, and duration of outdoor activities. All participating children underwent a comprehensive ophthalmic evaluation conducted within the school premises under standardized lighting conditions.

The visual acuity of each child was first assessed without correction using a Snellen chart or E-chart (for younger children), placed at a standard distance of 6 meters. Corrected visual acuity was also recorded if glasses were already in use. Children with

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uncorrected visual acuity worse than 6/9 in either eye were subjected to further evaluation.

Objective refraction was performed using a handheld autorefractometer to estimate the refractive status. This was followed by subjective refraction carried out by a trained optometrist to determine the final corrective prescription. For children under 12 years of age, or those suspected of having significant accommodation, cycloplegic refraction was performed using 1% cyclopentolate eye drops. Refraction was repeated after adequate cycloplegia to ensure accuracy.

Anterior segment examination was done using a torchlight and magnifying loupe to rule out any anterior segment abnormalities. When indicated, fundus examination was carried out using a direct ophthalmoscope to evaluate the posterior segment.

Refractive errors were defined based on standard criteria: myopia as a spherical equivalent of ≤ -0.50 diopters, hyperopia as ≥ +2.00 diopters, and astigmatism as a cylindrical error of ≥ ±0.75 diopters.

To assess associated risk factors, a structured questionnaire was administered to each child and/or their guardian. The questionnaire included items on the average daily duration of screen exposure (television, computers, smartphones), time spent in outdoor activities, presence of refractive errors in one or both parents, and academic habits such as reading distance and study hours. These variables were later analyzed to determine their potential correlation with the presence and severity of refractive errors.

Statistical Analysis

Data were entered in Microsoft Excel and analyzed using SPSS software 25.0. Descriptive statistics (mean, standard deviation, percentages) were used to summarize demographic and clinical parameters. Chi-square test and logistic regression analysis were employed to identify significant risk factors associated with refractive errors. A p-value of <0.05 was considered statistically significant.

RESULTS

Table 1: Age and Gender Distribution of Study Participants

Out of the 140 school-going children included in the study, the distribution was equal between genders, with 70 males (50.00%) and 70 females (50.00%). The majority of children were in the 12–14 years age group, accounting for 46 children (32.86%). This was followed by 38 children (27.14%) in the 9–11 years age group, 29 children (20.71%) in the 15–16 years group, and 27 children (19.29%) in the youngest 6–8 years category. A statistical comparison using the chi-square test yielded a p-value of 0.84, indicating no significant difference in gender distribution across different age groups (NS – Not Significant). Hence, age and gender distribution were comparable between subgroups, minimizing selection bias.

Table 2: Prevalence and Type of Refractive Errors Among Participants

Among the 140 children screened, 61 (43.57%) were diagnosed with some form of refractive error. Myopia was the most common type, found in 34 children (24.29%), followed by astigmatism in 15 children (10.71%), and hyperopia in 12 children (8.57%). The remaining 79 children (56.43%) did not exhibit any form of refractive error. Although this table is descriptive in nature and does not compare between groups, it highlights a significant overall burden of refractive errors in urban school-going children.

Table 3: Association of Screen Time with Refractive Errors

Screen time was found to have a significant association with the presence of refractive errors ($p < 0.01$). Among children with refractive errors, 31 (50.82%) reported screen exposure of more than 2 hours per day, whereas only 20 (25.32%) of children without refractive errors fell into this high-exposure category. In contrast, children with less than 1 hour of screen time constituted 19.67% of the refractive error group compared to 35.44% in the non-refractive error group. These findings suggest that prolonged screen exposure is a statistically significant risk factor for developing refractive errors in children (S – Significant).

Table 4: Distribution of Refractive Errors Based on Outdoor Activity Duration

Outdoor activity duration showed an inverse relationship with refractive error prevalence. Among those with refractive errors, 38 children (62.30%) reported less than 1 hour of outdoor activity daily, compared to only 24 children (30.38%) without refractive errors. On the other hand, only 6 children (9.84%) with refractive errors engaged in outdoor play for more than 2 hours a day, compared to 20 children (25.32%) in the non-refractive group. This difference was statistically significant ($p < 0.01$), indicating that reduced outdoor activity is significantly associated with higher prevalence of refractive errors in children (S – Significant).

Table 5: Family History and Refractive Error Association

A strong association was observed between parental history of refractive errors and their occurrence in children. Out of the 61 children with refractive errors, 39 (63.93%) had a positive family history, whereas only 22 (27.85%) of the 79 children without refractive errors reported a similar history. Conversely, 57 children (72.15%) in the non-refractive group had no parental history, compared to only 22 (36.07%) in the refractive group. This association was found to be highly statistically significant ($p < 0.001$), highlighting genetic predisposition as a critical factor (HS – Highly Significant).

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Table 1: Age and Gender Distribution of Study Participants (n = 140)

Age Group (Years)	Male n (%)	Female n (%)	Total n (%)	p-value
6–8	15 (21.43%)	12 (17.14%)	27 (19.29%)	
9–11	20 (28.57%)	18 (25.71%)	38 (27.14%)	
12–14	22 (31.43%)	24 (34.29%)	46 (32.86%)	
15–16	13 (18.57%)	16 (22.86%)	29 (20.71%)	
Total	**70 (50.00%)**	**70 (50.00%)**	**140 (100.00%)**	**0.84 (NS)**

Table 2: Prevalence and Type of Refractive Errors Among Participants

Type of Refractive Error	Number of Children (n)	Percentage (%)	p-value
Myopia	34	24.29%	
Hyperopia	12	8.57%	
Astigmatism	15	10.71%	
No Refractive Error	79	56.43%	
Total	**140**	**100.00%**	—

Table 3: Association of Screen Time with Refractive Errors

Daily Screen Time	Children with Refractive Errors (n = 61)	Children without Refractive Errors (n = 79)	Total (n)	p-value
< 1 hour	12 (19.67%)	28 (35.44%)	40	
1–2 hours	18 (29.51%)	31 (39.24%)	49	
> 2 hours	31 (50.82%)	20 (25.32%)	51	**< 0.01 (S)**
Total	**61 (100.00%)**	**79 (100.00%)**	**140**	

Table 4: Distribution of Refractive Errors Based on Outdoor Activity Duration

Outdoor Activity Duration	Children with Refractive Errors (n = 61)	Children without Refractive Errors (n = 79)	Total (n)	p-value
< 1 hour/day	38 (62.30%)	24 (30.38%)	62	
1–2 hours/day	17 (27.87%)	35 (44.30%)	52	
> 2 hours/day	6 (9.84%)	20 (25.32%)	26	**< 0.01 (S)**
Total	**61 (100.00%)**	**79 (100.00%)**	**140**	

Table 5: Family History and Refractive Error Association

Parental History of Refractive Error	Children with Refractive Errors (n = 61)	Children without Refractive Errors (n = 79)	Total (n)	p-value
Present	39 (63.93%)	22 (27.85%)	61	
Absent	22 (36.07%)	57 (72.15%)	79	**< 0.001 (HS)**
Total	**61 (100.00%)**	**79 (100.00%)**	**140**	

S: Significant, HS: Highly Significant, NS: Not Significant

DISCUSSION

The present study assessed the prevalence and risk factors of refractive errors in 140 urban school-going children aged 6 to 16 years. The gender distribution was exactly equal, and the largest age group was 12–14 years (32.86%). The non-significant difference in age and gender distribution (p = 0.84) ensured the homogeneity of the study population. These findings align with the observations made by Naidoo et al. (2003)[12], who reported a similar non-significant gender difference in a South African school-based screening study, where males comprised 49.7% of the 5,000 participants, reinforcing the representative nature of the sample used in our study.

The overall prevalence of refractive errors in this study was 43.57%, with myopia being the most common (24.29%), followed by astigmatism (10.71%) and hyperopia (8.57%). These results are consistent with the findings of Dandona et al. (2002)[13], who reported a refractive error prevalence of 36.8% among urban children in southern India, with myopia accounting for the majority. Although the prevalence in our study is slightly higher, it may reflect increasing urbanization and lifestyle changes influencing visual health.

The significant association observed between increased screen time and the presence of refractive errors (p < 0.01) underscores the visual strain imposed by prolonged near work. In our study, 50.82% of children with refractive errors reported more than 2 hours of daily screen exposure. A similar pattern was documented by Huang et al. (2015)[14], who in a meta-analysis found that high screen exposure was positively associated with myopia, with pooled odds ratios ranging from 1.10 to 1.65, depending on screen type and exposure duration. This affirms the growing concern about digital screen overuse among school-aged children.

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Reduced outdoor activity also emerged as a significant risk factor, with 62.30% of children with refractive errors engaging in less than 1 hour of outdoor play daily, compared to only 30.38% in those without refractive errors. This inverse relationship supports the theory that outdoor light exposure may help modulate ocular growth. Rose et al. (2008)[15] similarly reported that children spending more than 2 hours outdoors daily had a significantly reduced risk of myopia, with a 2.6-fold lower odds compared to their counterparts with less than 1 hour of outdoor activity.

Family history was strongly associated with refractive error prevalence in our study. A total of 63.93% of children with refractive errors had at least one parent with similar vision issues, compared to only 27.85% in the control group ($p < 0.001$). This finding is in concordance with Saw et al. (2005)[16], who identified parental myopia as a significant predictor, with children of two myopic parents having a threefold higher risk of developing myopia. This genetic linkage highlights the need for early screening in at-risk populations.

While multiple modifiable and non-modifiable risk factors were examined, the study also emphasizes the importance of school-based vision screenings for early detection and intervention. The burden of uncorrected refractive errors among school-aged children was similarly addressed in a report by Resnikoff et al. (2008)[17], which estimated that over 12.8 million children globally suffer from vision impairment due to uncorrected refractive errors, particularly in urbanizing regions. These global patterns reinforce the public health significance of our findings.

CONCLUSION

This study highlights a high prevalence (43.57%) of refractive errors among urban school-going children, with myopia being the most common. Significant associations were found with prolonged screen time, reduced outdoor activity, and positive family history. Early identification through school-based screening and lifestyle modification can play a crucial role in prevention and timely intervention. Addressing these modifiable risk factors is essential to reduce the burden of visual impairment in children.

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