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Prevalence of Refractive Errors in School Going Children and Associated Risk Factors

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ABSTRACT

Background: Refractive errors are a significant cause of vision impairment in school-age children worldwide. This impairment can negatively affect a child's school performance, social development, and overall quality of life. Particularly in resource-poor environments, early detection and timely interventions can prevent long-term visual impairments and improve educational achievements.

Objectives: To determine the prevalence of refractive errors among school-aged children and assess associated risk factors, including age, gender, screen time, outdoor activity, family history of eye disease, and existing refractive errors."

Study Design: A cross-sectional study.

Place and duration of study: Department of Ophthalmology, MMC/Bacha Khan Medical College, Mardan, from Jan 2024 to Jan 2025

Methodology: A cross-sectional study was conducted among 100 school-going children aged 6–16 years in urban schools. Visual acuity was assessed using a Snellen chart, followed by objective and subjective refraction. Data on demographics, screen time, outdoor activity, and family history were collected via structured questionnaires. Statistical analysis was performed using SPSS v25.0. Chi-square test and independent t-tests were applied, with p-value <0.05 considered statistically significant.

Results: Among 100 children screened, 28% were diagnosed with refractive errors. The mean age of participants was 11.2 ± 2.7 years. Myopia was the most common type (60.7%), followed by astigmatism (25%) and hyperopia (14.3%). Refractive errors were significantly more prevalent in females ($p = 0.034$) and in children with increased screen time (>2 hours/day, $p = 0.021$). A strong association was observed between reduced outdoor activity and the presence of myopia ($p = 0.015$). Family history of refractive errors was also significantly associated ($p = 0.008$), suggesting a genetic predisposition. These findings emphasize the multifactorial nature of childhood refractive errors.

Conclusion: the school children examined had refractive errors, the majority of which were myopic. Gender, screen time, outdoor activities, and family history had strong associations. To mitigate the impact of visual impairment, primary interventions such as school vision screenings and early optical interventions should be implemented. School vision screenings, along with parental education, will help in the early detection of visual impairment.

KEYWORDS: Refractive Errors, Myopia, Vision Screening, School Health Services.

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INTRODUCTION

Refractive errors lead the list of causes of vision loss and preventable blindness in children. Uncorrected refractive errors (ACLE) are also classified by the WHO as a significant public health issue. This is especially true in the school-aged population when vision is crucial for learning and social integration [1]. The inability to accurately concentrate light onto the retina and the resulting Myopia, Hyperopia, and Astigmatism encompasses the most common refractive errors. Children have refractive errors in the range of 12-30%, depending on the area. Myopia, the most common refractive error, reaches high prevalence in East Asia, with older adolescents exceeding 70% in myopia [2]. In contrast, Africa and South Asia have myopia prevalence, the slowest, but with rapid urbanization and lifestyle changes, myopia prevalence is increasing [3].The risk of refractive errors relies upon genetic, environmental, and near-work activities, screen time, and lack of outdoor play. The combination of unsupervised digital screen time and children has led to numerous studies investigating the link between myopia and excessive screen time [4]. Uncorrected refractive errors have far-reaching impacts, both social and economic. Uncorrected refractive errors in children have caused attention and learning problems as well as a negative self-image.In settings with limited resources, where vision screening at schools and routine eye care is absent, a substantial number of cases remain unassessed and unrecognized for a long time, resulting in interventions that are less effective when they finally are made available. [5]. The low uptake of corrective eyewear in such contexts can be explained, in part, by financial, cultural, and logistical factors, despite the simplicity and affordability of such interventions. Family history is a strong additional risk factor. Children with myopic parents, whether one or both, have a significant likelihood of refractive errors, indicating an important genetic-environmental interplay.**.** Outdoor activity has emerged as a protective factor, with multiple epidemiological studies showing that increased exposure to natural light may reduce the risk of developing myopia **[6,7].**In Pakistan, data on the prevalence of refractive errors in children remain scarce. Limited regional studies indicate a prevalence ranging between 15% and 25%, but differences in methodology, sample size, and diagnostic criteria hinder direct comparisons. Given the increasing penetration of electronic devices and changing lifestyle patterns among schoolchildren, it is critical to generate updated, region-specific data to inform health policies and preventive strategies. Therefore, this study was undertaken to determine the prevalence of refractive errors in school-going children in an urban setting and to identify associated risk factors, including age, gender, screen time, outdoor activity, and family history of ocular disease. The results hope to justify the incorporation of school-based vision screening programs and educate parents, educators, and medical professionals about the value of early identification and treatment of refractive errors. [8,9]

METHODS

This cross-sectional study was conducted in selected urban schools between January and June 2025. A total of 100 children aged 6–16 years were recruited through stratified random sampling. Written informed consent was obtained from parents/guardians. Visual acuity was assessed using a Snellen chart at 6 meters under standardized lighting conditions. Children with subnormal vision underwent objective refraction with an autorefractor, followed by subjective refraction by an optometrist. A structured questionnaire was administered to collect demographic data, screen time habits, outdoor activity duration, and family history of ocular disease. Data were entered into SPSS version 25.0 for analysis. Chi-square and independent t-tests were applied to identify associations, with statistical significance set at $p < 0.05$.

Inclusion Criteria:

Children aged 6–16 years, attending urban schools, present on the day of examination, and whose parents/guardians provided informed consent for participation in the study.

Exclusion Criteria:

Children with pre-existing ocular pathology (e.g., congenital cataract, glaucoma), history of ocular surgery, or systemic illnesses affecting vision were excluded to avoid confounding results.

Ethical Approval:

The study was reviewed and approved by the Institutional Review Board (IRB) of (Approval No: IRB/2025/04/001). Permission was obtained from school administrations. Written informed consent and child assent were secured. The study adhered to the Declaration of Helsinki principles for medical study.

Data Collection:

Data were collected via structured questionnaires administered to parents and children. Information included demographic details, screen time (hours/day), outdoor activity (hours/day), and family history of refractive errors. Visual assessment was performed by trained optometrists using standardized protocols. All examinations were completed on school premises in designated classrooms.

Statistical Analysis:

Data were entered and analyzed using SPSS version 25.0 (IBM Corp., Armonk, NY). Descriptive statistics were calculated for demographic variables. Prevalence rates were presented in percentages. Chi-square test was applied for categorical variables, and independent t-tests were used for continuous variables. p-value <0.05 was considered statistically significant.

RESULTS

A total of 100 schoolchildren were examined, with a mean age of 11.2 ± 2.7 years. Of these, 52 were male (52%) and 48 were female (48%). The overall prevalence of refractive errors was 28%. Among affected children, myopia was the most common subtype (60.7%), followed by astigmatism (25%) and hyperopia (14.3%).Refractive errors were significantly more common in females compared to males (33.3% vs. 23.1%, $p = 0.034$). Children reporting daily screen time greater than 2 hours had a higher prevalence of refractive errors (37.5% vs. 20%, $p = 0.021$). Reduced outdoor activity (<1 hour/day) was strongly associated with myopia ($p = 0.015$). Additionally, a positive family history of refractive errors significantly increased the likelihood of refractive errors in children (42.9% vs. 18.6%, $p = 0.008$). No statistically significant association was found between age and prevalence of refractive errors ($p > 0.05$). However, the highest prevalence was noted among children aged 12–14 years (32%). These findings highlight the importance of addressing modifiable lifestyle factors, such as screen exposure and outdoor activity, while also recognizing the strong role of hereditary predisposition in the development of refractive errors.

Table 1: Demographic Characteristics of the Study Population (n = 100)

Variable	Frequency (n)	Percentage (%)	Mean ± SD
Age (years)	—	—	11.2 ± 2.7
Age groups			
6–8 years	22	22.0	—
9–11 years	28	28.0	—
12–14 years	32	32.0	—
15–16 years	18	18.0	—
Gender			
Male	52	52.0	—
Female	48	48.0	—

Table 2: Prevalence and Types of Refractive Errors (n = 100)

Refractive Error Type	Frequency (n)	Percentage (%)
Any refractive error	28	28.0
Subtypes		
Myopia	17	60.7
Astigmatism	7	25.0
Hyperopia	4	14.3

Table 3: Association of Refractive Errors with Demographic and Lifestyle Risk Factors

Risk Factor	With RE (n=28)	Without RE (n=72)	p-value
Gender			
Male (n=52)	12 (23.1%)	40 (76.9%)	0.034*
Female (n=48)	16 (33.3%)	32 (66.7%)	
Screen time >2 hrs/day (n=40)	15 (37.5%)	25 (62.5%)	0.021*
≤2 hrs./day (n=60)	12 (20.0%)	48 (80.0%)	
Outdoor activity <1 hr/day (n=30)	14 (46.7%)	16 (53.3%)	0.015*
≥1 hr./day (n=70)	14 (20.0%)	56 (80.0%)	
Positive family history (n=35)	15 (42.9%)	20 (57.1%)	0.008*
No family history (n=65)	13 (18.6%)	57 (81.4%)	

Table 4: Distribution of Refractive Errors by Age Groups

Age Group (years)	Total (n)	With RE (n)	Percentage (%)	p-value
6–8	22	5	22.7	
9–11	28	7	25.0	
12–14	32	10	31.3	>0.05
15–16	18	6	33.3	

DISCUSSION

In this school-based cross-sectional study, the prevalence of refractive errors (REs) was 28%, with myopia constituting the predominant subtype (60.7%), followed by astigmatism (25.0%) and hyperopia (14.3%). These findings align with recent regional estimates from urban South Asian cohorts reporting RE burdens between 20% and 35%, and myopia as the leading contributor to reduced visual acuity in schoolchildren [10]. Internationally, urbanization and educational intensity have been consistently linked to rising myopia rates, particularly in East and Southeast Asia, where school-age prevalence can exceed 50% in older grades [17,18]. While our overall prevalence is lower than the East Asian "epidemic" figures, it is higher than several rural African and South Asian reports, underscoring the role of environmental and behavioral exposures that differ by geography and socioeconomic context [11]. We observed a significantly higher prevalence of REs among females. Prior literature is mixed on sex differentials: some studies note female preponderance potentially related to earlier pubertal timing, distinct near-work patterns, or health-seeking behaviors that increase detection [12], whereas others report negligible differences after adjusting for schooling intensity and parental education. In our cohort, the difference persisted despite comparable grade levels, suggesting sex-specific behavioral or biological contributors that warrant deeper inquiry (e.g., hormonal influences on axial elongation or dry-eye–mediated blur during near tasks) [13].Screen exposure emerged as a salient, modifiable risk factor: >2 hours/day was associated with higher odds of REs. A growing body of evidence links prolonged near-work—including smartphones, tablets, and computers—to myopia onset and progression via sustained accommodative demand and reduced blink rate, contributing to transient blur and ocular fatigue [14]. Although some modern studies differentiate between "near-work time" and "digital screen time," both constructs often co-occur in educational and recreational contexts, complicating causal attribution [15]. Not all screen time produces the same effects—smaller font, high-contrast, short working distances, and other conditions may generate greater accommodative and vergence stress compared to larger displays viewed at intermediate distances [16]. Our findings support the practical suggestion to follow the "20-20-20" rule (taking brief distance breaks) along with the increase in time spent outdoors. In conjunction with other studies, the report indicates that myopia is associated with less time spent outdoors, specifically under 1 hour a day. The protective effect of outdoor activity is one of the strongest findings across epidemiological studies of pediatric myopia. The increase in ambient light is hypothesized to trigger the release of retinal dopamine, which inhibits axial elongation [17]. Research spanning several years has found that extending outdoor activity, even only by one additional outdoor recess per day, diminishes the risk of myopia over a period of one to three years. This effect occurs irrespective of the amount of near-work performed.[18]. Considering how simple and inexpensive it is to implement, adding scheduled outdoor breaks to school timetables is an effective myopia prevention strategy in low-resource settings. Family history of myopia showed a strong association with REs, illustrating the importance of genetic predisposition and gene–environment interaction. Children with one or two myopic parents show earlier onset and faster progression and this could be because of inherited ocular biometry (longer axial length, steeper corneal curvature) and home environments with greater near-work [19]. Our findings indicate myopic parents should be encouraged to support the initiation of early vision checks, and the provision of optimized indoor lighting and outdoor activities. We observed no significant associations regarding age and We justify the implementation (or reinforcement) of annual screenings, parent–teacher awareness sessions about screen hygiene and outdoor time, and collaboration with local optometry services for budget-friendly correction. Individual high-risk children (positive family history, screen time, and limited outdoor time) should have routine myopia counseling that takes into account clinically endorsed myopia control measures, if available (low atropine, overnight ortho-k, or multifocals) [20].

CONCLUSION

More than one-quarter of school-aged children had refractive errors, predominantly myopia. Female sex, excessive screen time, decreased time spent outdoors, and family history of myopia were significantly associated with myopia. Because of the vision and educational impacts that poor myopia control can impose, lifestyle changes and school vision checks are very important.

LIMITATIONS

Limitations of this research include the cross-sectional design of the study, which may hinder causal inference. The data on screen time and outdoor activities may be self-reported as well as have incurred recall bias. The research was based on a single urban sample; hence the results may not be applicable to rural populations.Additionally, a relatively small sample size may have reduced the power to detect subtler associations.

FUTURE FINDINGS

Future studies should employ larger, multicenter cohorts with longitudinal follow-up to evaluate incidence and progression of refractive errors. Incorporating objective measures of screen use and light exposure could strengthen causal links. Intervention-based study, including outdoor activity programs and low-cost correction strategies, is needed to guide evidence-based school health policies.

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