

Research Article**Prevalence of Refractive Errors and Associated Risk Factors Among School-Aged Children in Pakistan: A Cross-Sectional Study**

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ABSTRACT: Refractive errors represent a major cause of correctable visual impairment among children, particularly in low- and middle-income countries where screening programs remain inconsistent. This cross-sectional study assessed the prevalence of refractive errors and associated risk factors among school-aged children in Pakistan, where urbanization and increased digital exposure may be influencing visual development. A total of 684 students aged 6 to 15 years underwent standardized vision screening, cycloplegic refraction, and risk-factor assessment through structured questionnaires. The prevalence of refractive errors was 32.3 percent, with myopia constituting the most common type, followed by astigmatism and hyperopia. Statistically significant associations were found between refractive errors and prolonged daily screen time ($p < 0.001$), limited outdoor activity ($p = 0.004$), and positive family history ($p < 0.001$). Mean spherical equivalent values were significantly more myopic in older age groups. A novel finding was the marked increase in myopia prevalence among children reporting more than three hours of daily device use, reinforcing emerging concerns regarding digital exposure. The

results indicate a substantial public health burden and emphasize the need for early school-based screening. **Keywords:** refractive errors, school-aged children, risk factors

INTRODUCTION: Refractive errors remain one of the most significant contributors to visual impairment among children, particularly in developing countries where environmental changes, lifestyle patterns, and educational demands are rapidly evolving. Vision plays a critical role in learning and cognitive development, and even mild refractive errors can impair academic performance, attention, and overall quality of life. Pakistan, like many South Asian countries, has witnessed a steady rise in school enrollment and increased academic competition, accompanied by substantial changes in visual habits. The early adoption of digital devices, extended indoor activities, and reduced exposure to natural daylight are increasingly noted among school-aged children. These lifestyle changes have intensified global concern over the shifting patterns of refractive errors, especially myopia, which appears to be emerging earlier and progressing more rapidly than in previous generations.¹⁻⁴

The epidemiology of refractive errors in childhood is shaped by an interplay of genetic, behavioral, and environmental factors. In regions with strong educational pressures and limited outdoor recreational opportunities, the prevalence of myopia has shown marked increases. Pakistani children, particularly in urban centers, are increasingly exposed to prolonged near-work activities and rapidly expanding digital learning environments. Although refractive errors are easily correctable with glasses, delayed detection remains common due to insufficient screening programs and socioeconomic disparities. Many children continue to experience unrecognized visual deficits that hinder academic performance, reduce participation in classroom activities, and may contribute to long-term educational inequalities.⁵⁻⁸

The relationship between modern lifestyle factors and the progression of refractive errors has gained significant scientific interest in recent years. Increased screen exposure, whether through smartphones, tablets, laptops, or online learning platforms, has been consistently associated with visual stress, accommodative imbalance, and myopia onset. The COVID-19 pandemic further accelerated digital dependence among children, intensifying concerns over visual health. At the same time, reduced outdoor activity has been recognized as one of the strongest protective factors against myopia. Exposure to natural light, visual diversity, and distance viewing are believed to influence ocular growth regulation, providing a biological explanation for the increasing rates of myopia in environments where outdoor playtime is limited.⁹⁻¹²

Although refractive error studies have been conducted in various global regions, there remains substantial variability in prevalence patterns due to socioeconomic, climatic, cultural, and behavioral differences. Pakistan's diverse population represents an

important context in which to study these variations. Children in urban and semi-urban schools may experience different environmental exposures and lifestyle behaviors, yet vision screening programs remain inconsistent across provinces. The lack of large-scale, standardized data limits the ability to design targeted interventions or develop nationwide screening policies. Furthermore, the contribution of family history, digital behaviors, and outdoor activity to refractive errors among Pakistani children remains insufficiently explored through analytical epidemiologic approaches.

Given the increasing educational demands placed on school-aged children and the escalating use of digital devices, understanding the magnitude of refractive errors and their risk factors is essential. The present study aims to determine the prevalence of refractive errors among school-aged children in Pakistan and examine key behavioral and hereditary risk factors that may contribute to visual impairment. By identifying statistically significant associations, this research provides new insight into emerging trends within the country and supports the development of preventive vision-health strategies tailored for school environments. The findings also highlight the importance of early detection through structured school-based screening programs, which may serve as a pivotal measure in reducing avoidable functional and educational consequences related to uncorrected refractive errors.

METHODOLOGY: A cross-sectional study was conducted at Ophthalmology Department, Alshifa Eye Trust Hospital, Rawalpindi over nine months, following institutional ethical approval and obtaining verbal consent from parents or guardians. Sample size was calculated using Epi-Info with an expected prevalence of 30 percent, 95 percent confidence level, and 4 percent

margin of error, yielding a requirement of 651 participants; 684 children aged 6 to 15 years meeting inclusion criteria were enrolled. Inclusion criteria comprised regular school attendance, absence of known ocular pathology, and no previous refractive surgery or systemic diseases affecting vision, while exclusion criteria included ocular trauma, congenital eye anomalies, or acute infection. Visual acuity assessment was performed using a standardized logMAR chart followed by cycloplegic refraction for students with

subnormal acuity. Refractive error classification followed conventional definitions for myopia, hyperopia, and astigmatism based on spherical equivalent values. Risk-factor evaluation included structured questionnaires assessing screen-time duration, outdoor activity levels, near-work habits, and family history of refractive errors. Data were analyzed using SPSS with chi-square tests, t-tests, and ANOVA applied to assess associations, maintaining a significance threshold of $p < 0.05$.

RESULTS: TABLE 1. Demographic Characteristics of Participants

Variable	Mean ± SD / Frequency
Age (years)	10.8 ± 2.6
Sex (Male/Female)	356 / 328
Average Daily Screen Time (hours)	2.9 ± 1.4
Outdoor Activity (hours/day)	1.2 ± 0.7

The study population showed balanced gender distribution and notable daily screen exposure with limited outdoor activity.

TABLE 2. Prevalence and Types of Refractive Errors

Category	Frequency (%)	Mean Spherical Equivalent (D ± SD)	p-Value
No Refractive Error	463 (67.7%)	+0.12 ± 0.38	—
Myopia	148 (21.6%)	−1.87 ± 0.92	<0.001
Astigmatism	52 (7.6%)	−0.74 ± 0.58	<0.001
Hyperopia	21 (3.1%)	+1.42 ± 0.61	0.003

Explanation: Refractive errors were present in nearly one-third of students, with myopia being the predominant type.

TABLE 3. Associations Between Refractive Errors and Risk Factors

Risk Factor	Mean Value $\pm$ SD	RE Present (%)	p-Value
Screen Time (>3 hours/day)	4.1 $\pm$ 0.6	51.2%	<0.001
Outdoor Activity (<1 hour/day)	0.6 $\pm$ 0.2	46.5%	0.004
Positive Family History	—	58.3%	<0.001

Explanation: Higher screen exposure, reduced outdoor time, and family history were significant predictors of refractive errors.

DISCUSSION: The present study highlights a substantial prevalence of refractive errors among school-aged children in Pakistan, reflecting growing public health concerns related to childhood vision. The identification of refractive errors in nearly one-third of participants underscores the scale of unmet visual needs within this population and aligns with global observations of increasing childhood myopia. The findings demonstrate the urgency of implementing systematic school-based visual screening programs, particularly in regions undergoing rapid technological integration and lifestyle shifts.¹³⁻¹⁵

A prominent outcome of this study was the predominance of myopia, which accounted for over two-thirds of all refractive errors detected. This trend aligns with emerging global patterns suggesting that environmental pressures, particularly rigorous academic environments and reduced outdoor exposure, contribute significantly to myopia onset. The progressive increase in myopia with age further supports the idea that sustained near-work demands may influence refractive development throughout school years.¹⁶⁻¹⁸

The role of prolonged screen time emerged as a particularly strong risk factor. Children who reported more than three hours of daily digital exposure had markedly higher rates of refractive errors. This association reinforces

concerns regarding the visual strain induced by continuous near-focus activities and the accommodative load associated with digital devices. These findings support growing evidence that screen-centered lifestyles may accelerate myopic shifts, particularly in settings where digital learning is expanding rapidly.¹⁹⁻²⁰

Outdoor activity demonstrated a protective association, with reduced exposure correlating with higher refractive error prevalence. The biological basis for this relationship is supported by hypotheses relating natural light intensity, dopamine release in the retina, and ocular growth regulation. The low average outdoor exposure recorded in this study suggests that many children may not be receiving adequate environmental stimuli to support normal ocular development.

Family history also demonstrated a significant association with refractive errors, consistent with genetic contributions to ocular growth patterns. Children with a positive family history showed a substantially higher prevalence of refractive errors, indicating that hereditary factors remain an important component of risk stratification. The combined effects of genetic predisposition and environmental stressors likely compound refractive progression in susceptible children.

The demographic distribution indicated that refractive errors were not limited to older children; younger participants also demonstrated early onset, suggesting that

environmental influences may be exerting their effects earlier than previously anticipated. This early detection emphasizes the need for screening to begin in the early primary school years to prevent delays in visual correction and academic impact.

Collectively, the findings highlight the importance of integrating preventive strategies within school systems, including regulated digital exposure, structured outdoor playtime, and routine vision assessments. Understanding the convergence of genetic, behavioral, and environmental factors provides a foundation for targeted interventions aimed at slowing the trajectory of refractive errors in Pakistani children.

CONCLUSION: Refractive errors were highly prevalent among school-aged children, with myopia emerging as the dominant pattern. Significant associations with prolonged screen time, reduced outdoor activity, and family history highlight critical modifiable and hereditary risk factors. The findings underscore the need for early screening and preventive strategies to mitigate the increasing burden of childhood visual impairment.

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