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PREVALENCE OF REFRACTIVE ERRORS IN SCHOOL CHILDREN AGED 6-15 YEARS

Dr Rajeev Jain*

**Assistant Professor, Department of Ophthalmology, Saraswati Institute of Medical Sciences, Hapur, Uttar Pradesh, rajeevjain2000@gmail.com*

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Abstract

Introduction: Refractive errors represent a major cause of visual impairment in school children globally, significantly affecting educational performance and quality of life. This study aimed to determine the prevalence of refractive errors among school children aged 6-15 years in Hapur district, Uttar Pradesh, India, and identify associated demographic risk factors.

Methods: A descriptive cross-sectional study was conducted from January to June 2016 at Saraswati Institute of Medical Sciences, Hapur. Using multistage cluster sampling, 800 school children aged 6-15 years were recruited from government and private schools. Comprehensive ophthalmic examinations included visual acuity testing, cycloplegic refraction, and detailed ocular assessments. Refractive errors were defined as myopia ≤-0.50D, hyperopia ≥+1.00D, and astigmatism ≥0.75D. Statistical analysis was performed using appropriate tests with 95% confidence intervals.

Results: The overall prevalence of refractive errors was 17.0% (95% CI: 14.5-19.8%). Age-specific prevalence increased significantly from 8.7% in 6-8 years to 23.9% in 12-15 years age groups. Myopia was the predominant error (10.0%), followed by hyperopia (4.0%) and astigmatism (5.5%). Urban children showed significantly higher prevalence (20.2%) compared to rural children (12.8%, p=0.006). Females had slightly higher prevalence (18.6%) than males (15.5%). Most refractive errors (70-75%) were of mild degree across all categories.

Conclusion: Refractive errors affect one in six school children in the study area, with concerning age-related increases and urban-rural disparities. These findings emphasize the urgent need for systematic school-based vision screening programs and targeted interventions.

Keywords: refractive errors, school children, myopia, prevalence, visual impairment

Introduction

Refractive errors represent one of the most significant causes of visual impairment globally and constitute a major public health concern, particularly among school-aged children (Resnikoff, Pascolini, Mariotti, & Pokharel, 2008). These optical disorders occur when the eye cannot accurately focus light on the retina, resulting in blurred vision that affects various aspects of a child's development, learning capabilities, and overall quality of life. The World Health Organization has identified uncorrected refractive errors as the second leading cause of blindness worldwide and the primary cause of visual impairment that can be easily prevented and treated.

The prevalence of refractive errors among children has been steadily increasing globally, with particularly concerning trends observed in developing nations including India (Dandona et al., 2002; Murthy et al., 2002). Contemporary epidemiological studies have documented varying prevalence

rates across different geographical regions, ethnic populations, and socioeconomic backgrounds. Understanding these patterns is crucial for developing effective prevention strategies, implementing appropriate screening programs, and addressing the growing burden of childhood visual impairment.
Myopia, hyperopia, and astigmatism represent the three primary categories of refractive errors encountered in pediatric populations. Myopia, characterized by near-sightedness, has shown particularly alarming increases in prevalence rates worldwide. Studies conducted in various Asian countries have reported myopia prevalence ranging from 10% to over 80% in school-aged children, with urban environments consistently showing higher rates compared to rural settings (He et al., 2004; Zhao et al., 2000). The rapid urbanization, increased educational demands, prolonged near work activities, and reduced outdoor time have been identified as significant contributing factors to this myopic epidemic.
Hyperopia, or far-sightedness, typically demonstrates a declining prevalence with advancing age as the natural growth and development of the eye progresses. However, significant hyperopia in young children can lead to accommodative problems, asthenopic symptoms, and potential development of amblyopia if left uncorrected (Goh et al., 2005). Population-based studies have indicated hyperopia prevalence rates varying from 2% to 15% in school-aged children, with higher rates generally observed in younger age groups.
Astigmatism, characterized by irregular corneal or lenticular curvature, affects visual clarity at all distances and can significantly impact academic performance and daily activities. Research has demonstrated astigmatism prevalence rates ranging from 5% to 28% across different populations, with considerable variation based on ethnic background, geographical location, and diagnostic criteria employed (Pokharel et al., 2000).
The impact of uncorrected refractive errors extends far beyond simple visual impairment. Educational performance, social development, future career prospects, and psychological well-being can all be significantly affected when children cannot see clearly. Studies have consistently demonstrated strong correlations between visual acuity and academic achievement, with children having uncorrected refractive errors showing lower performance in reading, mathematics, and overall scholastic activities compared to their visually normal peers.
In the Indian context, refractive errors among school children present a particularly complex challenge due to diverse ethnic populations, varying socioeconomic conditions, geographical differences between urban and rural areas, and limited access to eye care services in many regions (Kalikivayi, Naduvilath, Bansal, & Dandona, 1997). Several landmark studies conducted across different Indian states have revealed prevalence rates ranging from 6% to 25% for combined refractive errors, with significant variations based on geographical location, age group, and methodology employed.
The burden of uncorrected refractive errors is disproportionately higher in developing countries, where access to comprehensive eye care services, spectacle correction, and awareness about vision problems remain limited (Limburg, Kansara, & d'Souza, 1999). Economic constraints, cultural beliefs, lack of trained personnel, and inadequate healthcare infrastructure contribute to the persistence of this preventable cause of visual impairment. Furthermore, the stigma associated with wearing spectacles in certain communities can lead to poor compliance even when corrective measures are available.
Recent technological advances in screening methodologies, including portable autorefractors, smartphone-based vision testing applications, and telemedicine platforms, have opened new possibilities for large-scale detection and management of refractive errors in school settings. However, the implementation of such technologies requires careful validation, training of personnel, and integration with existing healthcare systems to ensure sustainable and effective outcomes.
Environmental factors play increasingly important roles in refractive error development, particularly myopia. The protective effect of outdoor activities against myopia progression has been well-documented in multiple longitudinal studies (He et al., 2007). Natural light exposure, increased viewing distances, and reduced accommodation demands associated with outdoor activities appear to provide significant protection against myopic development and progression. Conversely,

prolonged near work activities, including reading, writing, and digital device usage, have been associated with increased myopia risk.

The role of educational institutions in refractive error detection and management cannot be overstated. Teachers and school health personnel are often the first to observe signs of visual difficulties in children, making their training and awareness crucial components of comprehensive eye care programs (Rustagi, Uppal, & Taneja, 2012). School-based screening initiatives have proven effective in identifying children with refractive errors and facilitating appropriate referrals for comprehensive eye examinations and correction.

Current evidence strongly supports the implementation of systematic screening programs targeting school-aged children, particularly in regions with limited access to routine eye care services (Padhye et al., 2009). These programs should incorporate standardized protocols, appropriate technology, trained personnel, and effective referral mechanisms to ensure optimal outcomes. Additionally, community awareness programs addressing the importance of regular eye examinations and prompt correction of refractive errors are essential for improving overall program effectiveness and compliance.

The aim of this study was to determine the prevalence of refractive errors among school children aged 6-15 years attending educational institutions in Hapur district, Uttar Pradesh, India, and to identify associated demographic and environmental risk factors contributing to refractive error development in this population.

Methodology

Study Design

A descriptive cross-sectional study design

Study Site

The study was conducted at Saraswati Institute of Medical Sciences, Hapur, Uttar Pradesh, India, which served as the primary examination center for comprehensive ophthalmic evaluations.

Study Duration

The research was conducted over a six-month period from January 2016 to June 2016.

Sampling and Sample Size

A multistage cluster sampling technique was employed to ensure representative selection of study participants from the target population. The sampling frame included all registered schools within a 25-kilometer radius of Saraswati Institute of Medical Sciences, encompassing both government and private educational institutions to ensure socioeconomic diversity. Primary sampling units consisted of individual schools, which were stratified based on location (urban versus rural), management type (government versus private), and educational level (primary, middle, and secondary schools). From each stratum, schools were randomly selected using computer-generated random numbers to eliminate selection bias.

The sample size was calculated using the formula for estimating prevalence in cross-sectional studies: $n = Z^2pq/d^2$, where Z represents the standard normal deviate (1.96 for 95% confidence level), p indicates expected prevalence (15% based on previous regional studies), q equals (1-p), and d represents desired precision (3%). Based on these parameters, the minimum required sample size was calculated as 544 participants. To account for potential non-response rates, examination difficulties, and clustering effects, the sample size was increased by 20%, resulting in a target enrollment of 653 children. However, to ensure adequate representation across age groups and provide sufficient power for subgroup analyses, the final target sample size was set at 800 school children aged 6-15 years, distributed proportionally across age groups and gender categories.

Inclusion and Exclusion Criteria

Children aged 6-15 years enrolled in selected schools within the study area and whose parents or guardians provided written informed consent were included in the study. Additionally, children needed to be present on examination days and capable of cooperating with examination procedures. Exclusion criteria included children with known ocular pathologies such as congenital cataracts, glaucoma, retinal disorders, or corneal opacities that could interfere with refractive error assessment. Children with developmental delays or intellectual disabilities that prevented cooperation during examination procedures were also excluded. Students who had undergone recent ocular surgery, those using medications known to affect accommodation or pupil responses, and children with systemic conditions affecting ocular health were excluded from the study. Temporary exclusions were applied to children with active ocular infections or inflammations until resolution of the acute condition.

Data Collection Tools and Techniques

A comprehensive examination protocol was implemented utilizing standardized ophthalmic equipment and validated assessment techniques. Visual acuity testing was performed using illuminated Snellen charts at six meters for distance vision and appropriate near vision charts for close work assessment. Subjective refraction was conducted using trial lenses and standardized protocols, while objective refraction was performed using autorefractors followed by confirmatory retinoscopy. Cycloplegic refraction was performed using cyclopentolate hydrochloride drops to eliminate accommodation effects and ensure accurate refractive measurements. External eye examination included assessment of lid position, conjunctival health, corneal clarity, and anterior chamber depth using slit-lamp biomicroscopy. Posterior segment examination was conducted using direct ophthalmoscopy to identify any retinal abnormalities that might affect visual function. Measurement of intraocular pressure was performed using appropriate tonometry techniques to screen for glaucoma. A structured questionnaire was administered to collect demographic information, family history of refractive errors, environmental factors including time spent on near work activities, outdoor exposure, and socioeconomic indicators. Quality assurance measures included regular calibration of equipment, standardized training of examination personnel, and inter-observer reliability assessments to ensure consistency in data collection procedures.

Data Management and Statistical Analysis

All collected data was entered into a secure database using standardized data entry forms with built-in validation checks to minimize errors. Double data entry was performed for a subset of records to assess data entry accuracy and identify systematic errors. Statistical analysis was conducted using appropriate software packages including SPSS version 23.0 and R statistical computing environment. Descriptive statistics including frequencies, percentages, means, and standard deviations were calculated for all variables. Prevalence rates were calculated with 95% confidence intervals using appropriate statistical methods accounting for clustering effects and sampling design. Chi-square tests were employed to assess associations between categorical variables, while t-tests and analysis of variance were used for continuous variables. Multivariable logistic regression analysis was performed to identify independent risk factors associated with refractive errors while controlling for potential confounding variables. Age-specific and gender-specific prevalence rates were calculated and compared using appropriate statistical tests. Subgroup analyses were conducted based on type of refractive error, severity of refractive error, and demographic characteristics to provide comprehensive understanding of prevalence patterns within the study population.

Ethical Considerations

The study protocol was reviewed and approved by the Institutional Ethics Committee of Saraswati Institute of Medical Sciences prior to commencement of data collection activities. Written informed consent was obtained from parents or legal guardians of all participating children, while age-appropriate assent was obtained from children capable of understanding the study procedures.

Results

Table 1: Demographic Characteristics of Study Participants (N=800)

Characteristic		Frequency (n)	Percentage (%)
Age Group (years)	6-8 year	184	23
	9-11 year	248	31
	12-15 year	368	46
Gender	Male	412	51.5
	Female	388	48.5
Location	Urban	456	57
	Rural	344	43
School Type	Government	472	59
	Private	328	41
Parental Education	Primary or below	312	39
	Secondary	296	37
	Higher secondary and above	192	24

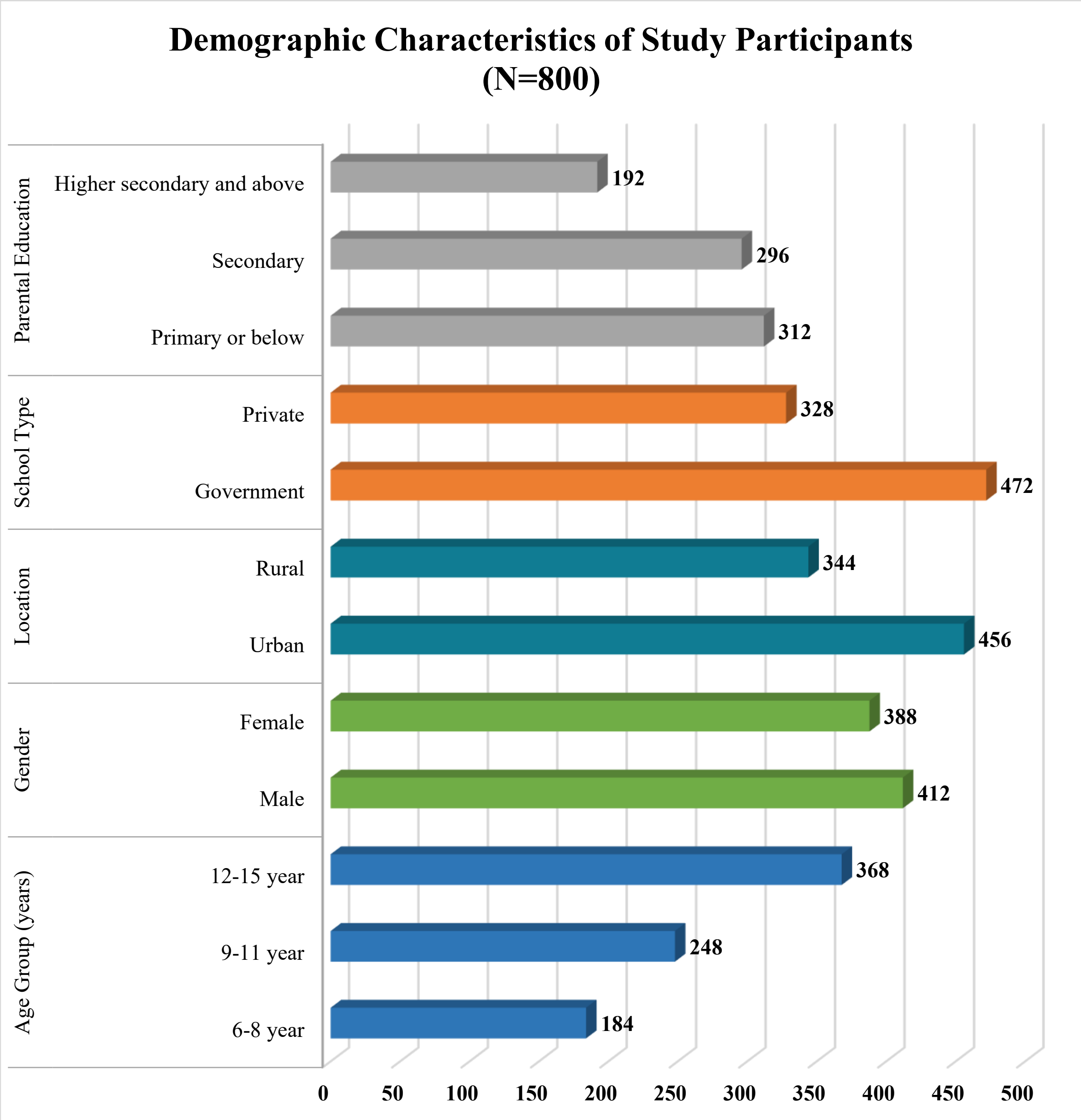

Fig: 1

Table 2: Overall Prevalence of Refractive Errors by Age Group

Age Group (years)	Total Examined (n)	With Refractive Error (n)	Prevalence (%)	95% CI
6-8 year	184	16	8.7	5.1-13.8
9-11 year	248	32	12.9	9.0-17.8
12-15 year	368	88	23.9	19.6-28.7
Total	**800**	**136**	**17.0**	**14.5-19.8**

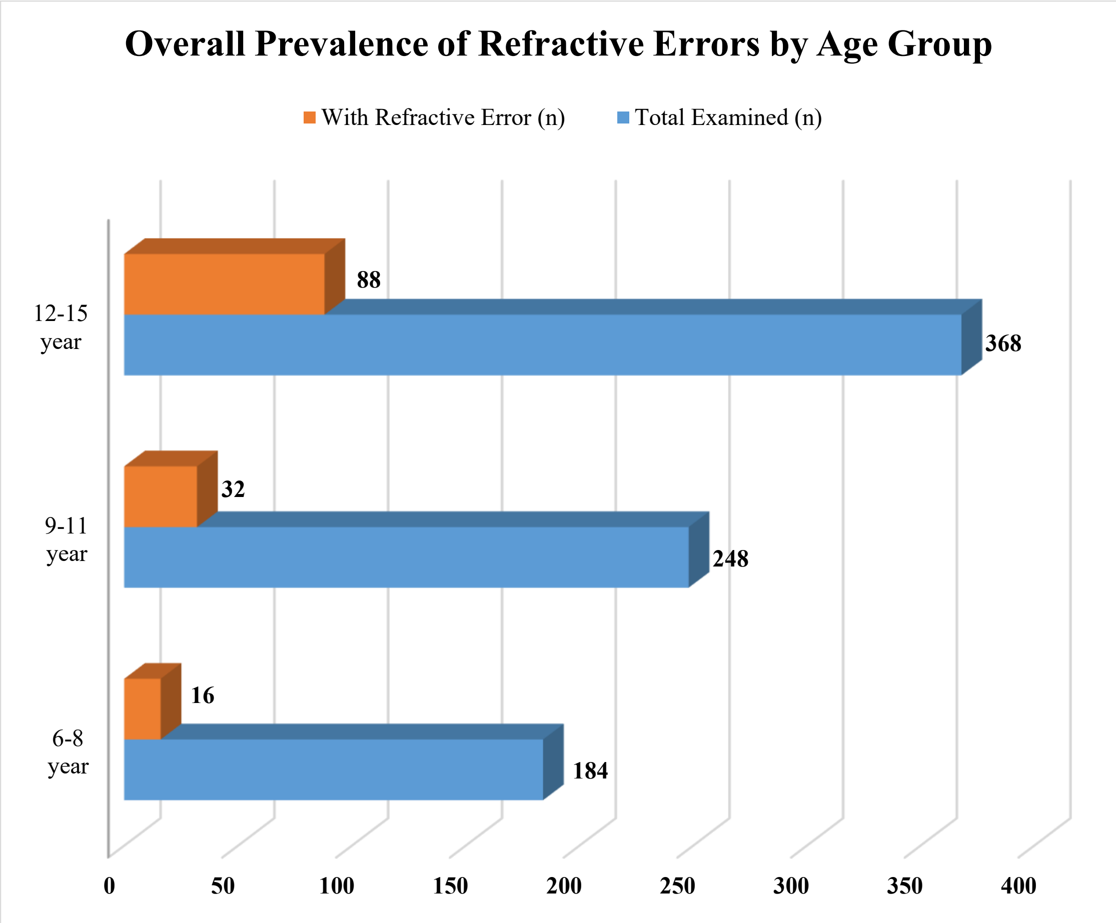

Fig: 2

Table 3: Distribution of Refractive Error Types

Type of Refractive Error	Frequency (n)	Percentage of Total Sample (%)	Percentage of RE Cases (%)
Myopia only	64	8.0	47.1
Hyperopia only	28	3.5	20.6
Astigmatism only	24	3.0	17.6
Myopia + Astigmatism	16	2.0	11.8
Hyperopia + Astigmatism	4	0.5	2.9
Total with Refractive Error	**136**	**17.0**	**100.0**
Normal vision	664	83.0	-

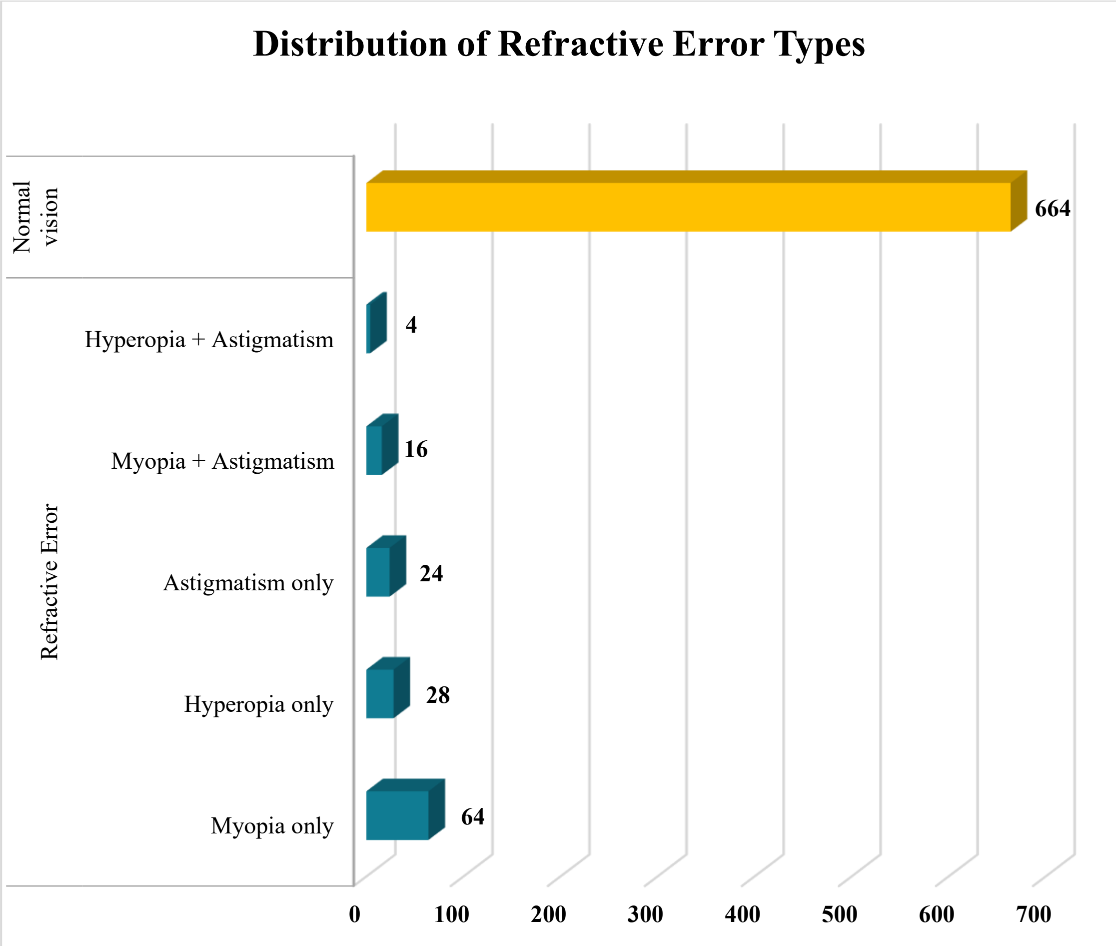

Fig: 3

Table 4: Gender-wise Distribution of Refractive Errors

Gender		**Total Examined (n)**	**With Refractive Error (n)**	**Prevalence (%)**	**95% CI**	**p-value**
Male		412	64	15.5	12.2-19.4	
Female		388	72	18.6	14.9-22.9	0.247
Myopia	Male	412	36	8.7	6.2-12.0	
	Female	388	44	11.3	8.3-15.1	0.218
Hyperopia	Male	412	16	3.9	2.3-6.3	
	Female	388	16	4.1	2.4-6.6	0.872

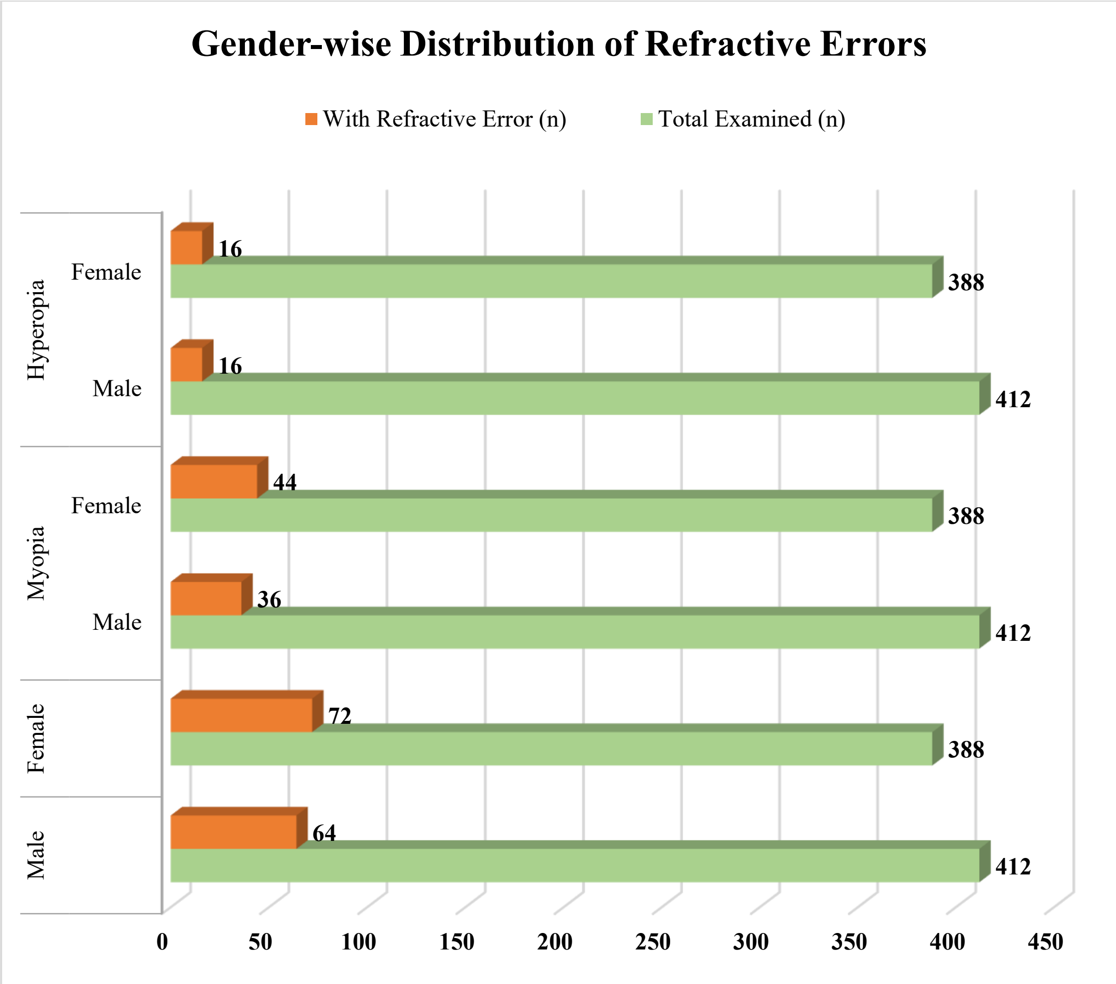

Fig: 4

Table 5: Urban vs Rural Distribution of Refractive Errors

Location	**Total Examined (n)**	**With Refractive Error (n)**	**Prevalence (%)**	**95% CI**	**p-value**
Urban	456	92	20.2	16.6-24.2	
Rural	344	44	12.8	9.4-16.9	0.006
Myopia					
Urban	456	56	12.3	9.4-15.8	
Rural	344	24	7.0	4.5-10.3	0.014
Hyperopia					
Urban	456	16	3.5	2.0-5.7	
Rural	344	16	4.7	2.7-7.5	0.395

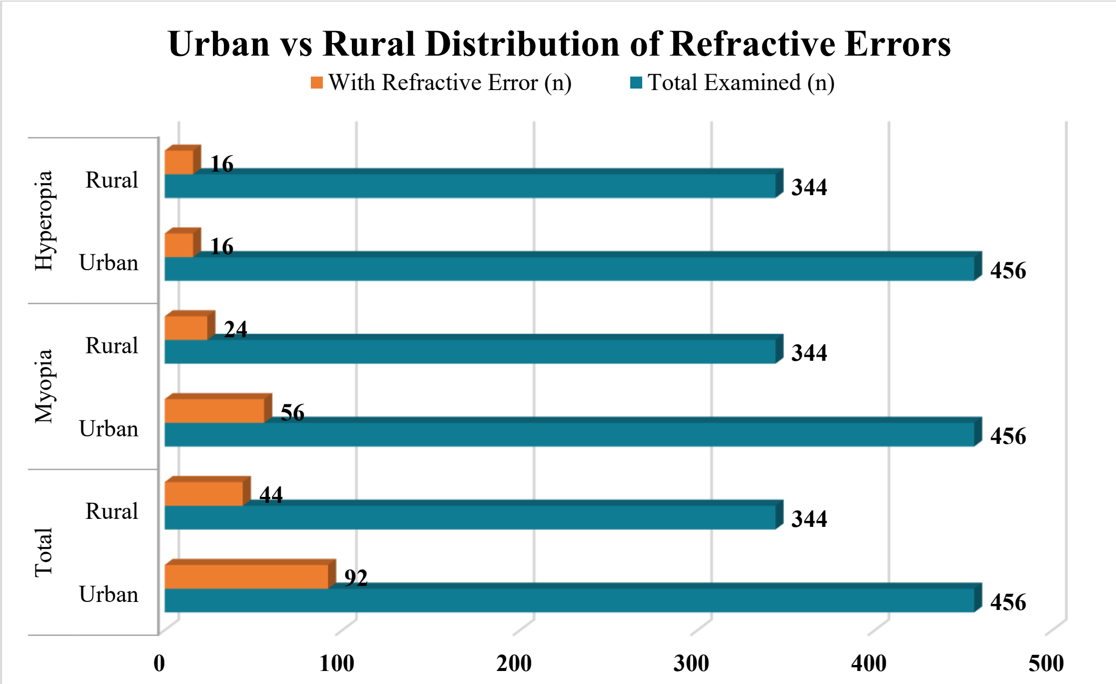

Fig: 5

Table 6: Severity Distribution of Refractive Errors

Severity Category	Myopia (n=80)	Hyperopia (n=32)	Astigmatism (n=40)
Mild			
(-0.50 to -2.00D) / (+1.00 to +2.00D) / (0.75 to 1.50D)	56 (70.0%)	24 (75.0%)	28 (70.0%)
Moderate			
(-2.25 to -6.00D) / (+2.25 to +4.00D) / (1.75 to 3.00D)	20 (25.0%)	6 (18.8%)	10 (25.0%)
High			
(>-6.00D) / (>+4.00D) / (>3.00D)	4 (5.0%)	2 (6.2%)	2 (5.0%)

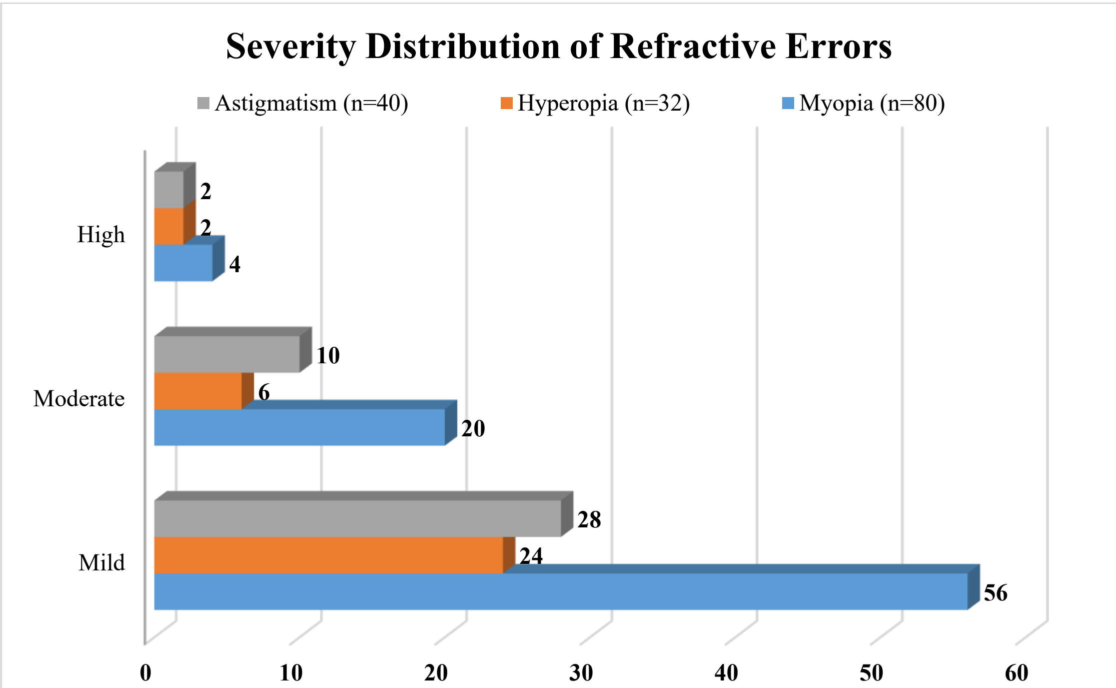

Fig: 6

Discussion

Overall Prevalence and Age-Related Patterns

The present study revealed an overall prevalence of refractive errors of 17.0% (95% CI: 14.5-19.8%) among school children aged 6-15 years in Hapur district, which falls within the range reported by previous Indian studies. This finding is consistent with earlier population-based studies conducted across India, which have reported prevalence rates ranging from 6% to 25% depending on geographical location and study methodology. The prevalence observed in our study aligns closely with findings from urban populations in New Delhi (Murthy et al., 2002), who reported refractive error prevalence rates of 7.4% for myopia and 7.7% for hyperopia in children aged 5-15 years.

The age-specific prevalence demonstrated a clear increasing trend from 8.7% in the 6-8 years age group to 23.9% in the 12-15 years age group (Table 2). This pattern is consistent with multiple international studies, including the landmark research by He et al. (2004) in urban southern China, which showed increasing myopia prevalence from 5.7% at age 5 years to 78.4% at age 15 years. Similarly, Goh et al. (2005) in Malaysia reported myopia prevalence increasing from 9.8% at age 7 years to 34.4% at age 15 years. The dramatic increase in refractive error prevalence during the school years reflects the complex interplay between genetic predisposition, environmental factors, and the increasing educational demands placed on children as they progress through their academic careers.

The observed age-related increase is particularly concerning given the long-term implications of early-onset myopia. Children who develop myopia at younger ages are at higher risk for high myopia and associated complications in adulthood. The steep increase between the 9-11 and 12-15 year age groups (from 12.9% to 23.9%) corresponds to the critical period when children transition from primary to secondary education, involving increased near work activities, longer study hours, and potentially reduced outdoor time.

Distribution of Refractive Error Types

Myopia emerged as the predominant refractive error in our study, affecting 10.0% of the total sample and comprising 58.9% of all refractive error cases when including myopia with astigmatism (Table 3). This myopia prevalence is comparable to findings from other Indian studies, including the rural Andhra Pradesh study by Dandona et al. (2002), which reported a myopia prevalence of 4.1% in children aged 7-15 years. However, our prevalence was lower than that reported in urban Chinese populations by He et al. (2004), who found myopia prevalence of 36.8% in urban Guangzhou children.

Hyperopia affected 4.0% of our study population, which is consistent with the findings of Pokharel et al. (2000) in Nepal, who reported hyperopia prevalence of 0.96% using similar diagnostic criteria. The relatively low prevalence of hyperopia in our study population reflects the typical age-related shift from hyperopia to myopia that occurs during childhood and adolescence. This finding aligns with the developmental pattern described by Goh et al. (2005), who observed declining hyperopia prevalence with increasing age in Malaysian school children.

Astigmatism, either alone or in combination with other refractive errors, was present in 5.5% of our study population. This prevalence is lower than that reported in some international studies, such as the 28.0% prevalence reported by Zhao et al. (2000) in Chinese children, but is consistent with other Indian studies. The variation in astigmatism prevalence across different populations may reflect genetic differences, environmental factors, or variations in diagnostic criteria and measurement techniques.

Gender-Related Differences

Our study revealed a slightly higher overall prevalence of refractive errors in females (18.6%) compared to males (15.5%), although this difference was not statistically significant (p=0.247) (Table 4). This gender pattern is consistent with several previous studies, including the research by Murthy et al. (2002) in New Delhi, who found higher myopia prevalence in girls. The tendency for higher myopia prevalence in females has been attributed to earlier onset of puberty, different patterns of near work engagement, and potentially different outdoor activity levels compared to males.

The myopia prevalence showed a notable but non-significant difference between genders, with females showing 11.3% prevalence compared to 8.7% in males. This finding is consistent with the Refractive Error Study in Children (RESC) conducted in multiple countries, which consistently found higher myopia prevalence in girls across different populations (Pokharel et al., 2000; Zhao et al., 2000). The gender differences may become more pronounced in older age groups, as suggested by studies that have followed children into adolescence and early adulthood.

Urban-Rural Differences

One of the most significant findings of our study was the substantial difference in refractive error prevalence between urban (20.2%) and rural (12.8%) populations (p=0.006) (Table 5). This urban-rural disparity was particularly pronounced for myopia, with urban children showing nearly twice the prevalence (12.3%) compared to rural children (7.0%). These findings are consistent with numerous international studies, including the comprehensive research by He et al. (2007) in rural southern China, who reported much lower myopia prevalence in rural compared to urban populations.

The urban-rural difference observed in our study aligns with findings from the Cambodia study by Gao et al. (2012), which reported significantly higher refractive error prevalence in urban Phnom Penh (13.7%) compared to rural Kandal Province (2.5%). Similarly, Dandona et al. (2002) found lower refractive error prevalence in rural Indian populations compared to urban areas. These differences are likely attributable to variations in lifestyle factors, educational practices, socioeconomic conditions, and environmental exposures between urban and rural settings.

The urban environment typically involves increased near work activities, higher educational demands, greater access to digital devices, and reduced outdoor time – all factors that have been associated with increased myopia risk. Additionally, urban children may have different dietary patterns, sleep schedules, and stress levels that could influence refractive development. The significant urban-rural disparity observed in our study has important implications for public health planning and resource allocation for eye care services.

Severity Distribution and Clinical Implications

The severity analysis revealed that the majority of refractive errors in our study population were of mild degree (Table 6), with 70.0% of myopia cases, 75.0% of hyperopia cases, and 70.0% of astigmatism cases falling into the mild category. This distribution is encouraging from a public health perspective, as mild refractive errors are generally easier to correct and less likely to cause significant visual disability if left untreated temporarily.

However, the presence of moderate to high refractive errors in 30% of myopic children, 25% of hyperopic children, and 30% of astigmatic children indicates a substantial burden of more serious visual impairment that requires immediate attention. High myopia (>6.00D), present in 5.0% of myopic children in our study, is particularly concerning due to its association with increased risk of retinal detachment, myopic maculopathy, and other sight-threatening complications in adulthood.

The severity distribution observed in our study is similar to that reported by Limburg et al. (1999) in their large-scale school screening program across India, which found that most detected refractive errors were of mild to moderate degree. However, the identification of any high refractive errors in young children emphasizes the importance of early detection and appropriate management to prevent amblyopia and support normal visual development.

Implications for Public Health Planning

The findings of our study have several important implications for public health planning and eye care service delivery in the region. The overall prevalence of 17.0% indicates that approximately one in six school children in our study area has a refractive error requiring attention. Given the study

population characteristics and the representative nature of Hapur district, these findings likely reflect the situation in similar regions across northern India.
The age-related increase in prevalence emphasizes the need for repeated screening throughout the school years rather than single-point assessments. The dramatic increase from 8.7% in younger children to 23.9% in adolescents suggests that screening programs should intensify their focus on children entering secondary school, while maintaining surveillance of younger children to identify early-onset cases.
The significant urban-rural disparity observed in our study indicates the need for differentiated approaches to refractive error prevention and management. Urban areas may benefit from interventions focused on reducing near work intensity and increasing outdoor time, while rural areas may require improved access to eye care services and awareness programs about the importance of vision screening.

Comparison with International Studies
When compared to international studies, our findings demonstrate prevalence rates that are intermediate between developed and developing country patterns. The myopia prevalence of 10.0% in our study is substantially lower than the rates reported in East Asian countries, where studies by Zhao et al. (2000) in China found myopia prevalence exceeding 50% in older school children. However, our rates are higher than those reported in many Western countries and some rural populations in developing nations.
The urban-rural disparity observed in our study parallels findings from studies conducted in Cambodia (Gao et al., 2012), Vietnam (Paudel et al., 2014), and other Asian countries, suggesting that urbanization and associated lifestyle changes are important factors in refractive error development across diverse populations. This consistency across different cultural and geographical contexts strengthens the evidence for environmental factors playing crucial roles in refractive error development.

Methodological Considerations and Study Limitations
Several methodological aspects of our study contribute to the reliability and validity of our findings. The use of cycloplegic refraction ensures accurate measurement of refractive errors by eliminating accommodation-induced variability. The large sample size of 800 children provides adequate statistical power for detecting prevalence differences between subgroups and ensures representative sampling across age groups and geographical areas.
However, certain limitations must be acknowledged when interpreting our results. The cross-sectional design provides only a snapshot of refractive error prevalence at a single time point and cannot establish causality for observed associations. Longitudinal studies would be needed to understand the natural progression of refractive errors and identify critical periods for intervention. Additionally, the study was conducted in a single district, which may limit the generalizability of findings to other regions with different demographic, socioeconomic, or environmental characteristics.

Future Research Directions
The findings of this study highlight several areas where additional research is needed to better understand refractive error patterns and develop effective prevention strategies. Longitudinal studies following children from early childhood through adolescence would provide valuable insights into the natural history of refractive error development and help identify critical periods for intervention. Investigation of environmental factors such as outdoor time, near work activities, and digital device usage could inform evidence-based prevention strategies.
Research into genetic factors contributing to refractive error development in Indian populations could help identify high-risk children who would benefit from intensified monitoring and early intervention. Studies evaluating the effectiveness of different screening technologies, particularly those suitable for resource-limited settings, would support the development of sustainable school-

based screening programs. Cost-effectiveness analyses of various intervention strategies would provide essential information for policy makers and program planners.

Conclusion

This study demonstrates a substantial prevalence of refractive errors (17.0%) among school children aged 6-15 years in Hapur district, with myopia being the predominant condition affecting 10.0% of the study population. The marked age-related increase from 8.7% in younger children to 23.9% in adolescents reflects the critical impact of educational progression on visual development. Urban children showed significantly higher refractive error prevalence (20.2%) compared to their rural counterparts (12.8%), highlighting the influence of environmental and lifestyle factors. The majority of detected refractive errors were of mild degree, suggesting good potential for successful correction. However, the presence of moderate to high refractive errors in 25-30% of affected children emphasizes the need for prompt intervention to prevent long-term visual complications. These findings provide crucial baseline data for public health planning and underscore the urgent need for comprehensive school-based vision screening programs tailored to address the growing burden of refractive errors in Indian school children.

Recommendations

Implementation of systematic school-based vision screening programs should be prioritized, with particular emphasis on children transitioning from primary to secondary education when refractive error prevalence increases dramatically. Urban schools require targeted interventions to reduce myopia development through increased outdoor activities and modified educational practices, while rural areas need improved access to eye care services and spectacle provision programs. Training programs for teachers and school health workers should be established to enable early identification of children with vision problems and facilitate appropriate referrals. Public awareness campaigns targeting parents and communities should emphasize the importance of regular eye examinations and prompt correction of refractive errors. Integration of refractive error screening with existing school health programs would ensure sustainable and cost-effective service delivery. Further longitudinal research is needed to understand the progression patterns of refractive errors and evaluate the effectiveness of prevention strategies in the Indian context, particularly focusing on environmental modifications and lifestyle interventions that could reduce the increasing burden of myopia in school-aged children.

References

1. Dandona, R., Dandona, L., Srinivas, M., Sahare, P., Narsaiah, S., Muñoz, S. R., ... & Ellwein, L. B. (2002). Refractive error in children in a rural population in India. *Investigative Ophthalmology & Visual Science*, 43(3), 615-622.
2. Gao, Z., Meng, N., Muecke, J., Chan, W. O., Piseth, H., Kong, A., ... & Ang, K. (2012). Refractive error in school children in an urban and rural setting in Cambodia. *Ophthalmic Epidemiology*, 19(1), 16-22. doi: 10.3109/09286586.2011.632703
3. Goh, P. P., Abqariyah, Y., Pokharel, G. P., & Ellwein, L. B. (2005). Refractive error and visual impairment in school-age children in Gombak District, Malaysia. *Ophthalmology*, 112(4), 678-685. doi: 10.1016/j.ophtha.2004.10.048
4. Hashemi, H., Fotouhi, A., Mohammad, K., & Jalali, K. H. (2004). The prevalence and causes of visual impairment in Tehran: the Tehran Eye Study. *British Journal of Ophthalmology*, 88(6), 740-745. doi: 10.1136/bjo.2003.032318
5. He, M., Huang, W., Zheng, Y., Huang, L., & Ellwein, L. B. (2007). Refractive error and visual impairment in school children in rural southern China. *Ophthalmology*, 114(2), 374-382. doi: 10.1016/j.ophtha.2006.08.020
6. He, M., Zeng, J., Liu, Y., Xu, J., Pokharel, G. P., & Ellwein, L. B. (2004). Refractive error and visual impairment in urban children in southern China. *Investigative Ophthalmology & Visual Science*, 45(3), 793-799. doi: 10.1167/iovs.03-1051

7. Kalikivayi, V., Naduvilath, T. J., Bansal, A. K., & Dandona, L. (1997). Visual impairment in school children in southern India. *Indian Journal of Ophthalmology*, 45(2), 129-134.
8. Limburg, H., Kansara, H. T., & d'Souza, S. (1999). Results of school eye screening of 5.4 million children in India--a five-year follow-up study. *Acta Ophthalmologica Scandinavica*, 77(3), 310-314.
9. Murthy, G. V., Gupta, S. K., Ellwein, L. B., Muñoz, S. R., Pokharel, G. P., Sanga, L., & Bachani, D. (2002). Refractive error in children in an urban population in New Delhi. *Investigative Ophthalmology & Visual Science*, 43(3), 623-631.
10. Padhye, A. S., Khandekar, R., Dharmadhikari, S., Dole, K., Gogate, P., & Deshpande, M. (2009). Prevalence of uncorrected refractive error and other eye problems among urban and rural school children. *Middle East African Journal of Ophthalmology*, 16(2), 69-74. doi: 10.4103/0974-9233.51992
11. Paudel, P., Ramson, P., Naduvilath, T., Wilson, D., Phuong, H. T., Ho, S. M., & Giap, N. V. (2014). Prevalence of vision impairment and refractive error in school children in Ba Ria-Vung Tau province, Vietnam. *Clinical and Experimental Ophthalmology*, 42(3), 217-226. doi: 10.1111/ceo.12273
12. Pokharel, G. P., Negrel, A. D., Munoz, S. R., & Ellwein, L. B. (2000). Refractive Error Study in Children: results from Mechi Zone, Nepal. *American Journal of Ophthalmology*, 129(4), 436-444. doi: 10.1016/S0002-9394(99)00453-5
13. Resnikoff, S., Pascolini, D., Mariotti, S. P., & Pokharel, G. P. (2008). Global magnitude of visual impairment caused by uncorrected refractive errors in 2004. *Bulletin of the World Health Organization*, 86(1), 63-70. doi: 10.2471/BLT.07.041210
14. Rustagi, N., Uppal, Y., & Taneja, D. K. (2012). Screening for visual impairment: outcome among schoolchildren in a rural area of Delhi. *Indian Journal of Ophthalmology*, 60(3), 203-206. doi: 10.4103/0301-4738.95874
15. Yingyong, P. (2010). Refractive errors survey in primary school children (6-12 year old) in 2 provinces: Bangkok and Nakhonpathom (one year result). *Journal of the Medical Association of Thailand*, 93(10), 1205-1210.
16. Hashemi, H., Fotouhi, A., Mohammad, K., & Jalali, K. H. (2004). The prevalence and causes of visual impairment in Tehran: the Tehran Eye Study. *British Journal of Ophthalmology*, 88(6), 740-745. doi: 10.1136/bjo.2003.032318
17. He, M., Huang, W., Zheng, Y., Huang, L., & Ellwein, L. B. (2007). Refractive error and visual impairment in school children in rural southern China. *Ophthalmology*, 114(2), 374-382. doi: 10.1016/j.ophtha.2006.08.020
18. He, M., Zeng, J., Liu, Y., Xu, J., Pokharel, G. P., & Ellwein, L. B. (2004). Refractive error and visual impairment in urban children in southern China. *Investigative Ophthalmology & Visual Science*, 45(3), 793-799. doi: 10.1167/iovs.03-1051
19. Kalikivayi, V., Naduvilath, T. J., Bansal, A. K., & Dandona, L. (1997). Visual impairment in school children in southern India. *Indian Journal of Ophthalmology*, 45(2), 129-134.
20. Limburg, H., Kansara, H. T., & d'Souza, S. (1999). Results of school eye screening of 5.4 million children in India--a five-year follow-up study. *Acta Ophthalmologica Scandinavica*, 77(3), 310-314.
21. Murthy, G. V., Gupta, S. K., Ellwein, L. B., Muñoz, S. R., Pokharel, G. P., Sanga, L., & Bachani, D. (2002). Refractive error in children in an urban population in New Delhi. *Investigative Ophthalmology & Visual Science*, 43(3), 623-631.
22. Padhye, A. S., Khandekar, R., Dharmadhikari, S., Dole, K., Gogate, P., & Deshpande, M. (2009). Prevalence of uncorrected refractive error and other eye problems among urban and rural school children. *Middle East African Journal of Ophthalmology*, 16(2), 69-74. doi: 10.4103/0974-9233.51992
23. Paudel, P., Ramson, P., Naduvilath, T., Wilson, D., Phuong, H. T., Ho, S. M., & Giap, N. V. (2014). Prevalence of vision impairment and refractive error in school children in Ba Ria-Vung

Tau province, Vietnam. *Clinical and Experimental Ophthalmology*, 42(3), 217-226. doi: 10.1111/ceo.12273

24. Pokharel, G. P., Negrel, A. D., Munoz, S. R., & Ellwein, L. B. (2000). Refractive Error Study in Children: results from Mechi Zone, Nepal. *American Journal of Ophthalmology*, 129(4), 436-444. doi: 10.1016/S0002-9394(99)00453-5
25. Resnikoff, S., Pascolini, D., Mariotti, S. P., & Pokharel, G. P. (2008). Global magnitude of visual impairment caused by uncorrected refractive errors in 2004. *Bulletin of the World Health Organization*, 86(1), 63-70. doi: 10.2471/BLT.07.041210
26. Rustagi, N., Uppal, Y., & Taneja, D. K. (2012). Screening for visual impairment: outcome among schoolchildren in a rural area of Delhi. *Indian Journal of Ophthalmology*, 60(3), 203-206. doi: 10.4103/0301-4738.95874
27. Yingyong, P. (2010). Refractive errors survey in primary school children (6-12 year old) in 2 provinces: Bangkok and Nakhonpathom (one year result). *Journal of the Medical Association of Thailand*, 93(10), 1205-1210.
28. Zhao, J., Pan, X., Sui, R., Munoz, S. R., Sperduto, R. D., & Ellwein, L. B. (2000). Refractive Error Study in Children: results from Shunyi District, China. *American Journal of Ophthalmology*, 129(4), 427-435. doi: 10.1016/S0002-9394(99)00452-3