

Prevalence and Patterns of Refractive Error among School children in Rural and Urban Khulna, Bangladesh: A Cross-sectional Study

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ABSTRACT

Background: Uncorrected refractive error is an important and readily treatable cause of visual impairment in school-age children. Evidence comparing rural and urban schoolchildren in Khulna, Bangladesh, is limited. **Objective:** To estimate the prevalence and describe the pattern of refractive error among schoolchildren in rural and urban settings of Khulna. **Methods:** This school-based cross-sectional study included 350 children aged 6–17 years, with 175 recruited from urban schools and 175 from rural schools. Distance visual acuity was measured with a Snellen chart, followed by pinhole testing and cycloplegic refraction using cyclopentolate 1%. Myopia was defined as spherical equivalent ≤ -0.50 dioptre (D), hyperopia as $\geq +0.5$, and astigmatism as cylinder power ≥ 0.75 D. Prevalence estimates are presented with 95% confidence intervals (CIs). Group differences were evaluated using Pearson's chi-square test; $p < 0.05$ was considered statistically significant. **Results:** Refractive error was identified in 29 of 350 children (8.3%; 95% CI, 5.8%–11.6%). Prevalence was 10.9% (19/175) in urban children and 5.7% (10/175) in rural children ($p = 0.081$). Prevalence increased substantially with age: 2.7% at 6–9 years, 4.4% at 10–13 years, and 23.3% at 14–17 years ($p < 0.001$). Prevalence was 10.2% in boys and 6.1% in girls ($p = 0.163$). Among affected children, myopia accounted for 65.5% (19/29), hyperopia for 27.6% (8/29), and astigmatism for 6.9% (2/29). **Conclusion:** Approximately one in 12 participating schoolchildren had refractive error. Myopia predominated, and refractive error was strongly concentrated in older students. Although the urban estimate was nearly twice the rural estimate, the study lacked sufficient precision to establish a statistically significant residence difference. Periodic school-based vision screening with referral and spectacle provision should include both rural and urban schools and should particularly ensure coverage of older students.

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INTRODUCTION

Uncorrected refractive error is a leading cause of vision impairment worldwide and affects children's educational participation, psychosocial well-being, and future opportunities.^[1,2] The global distribution of refractive error is changing, with childhood myopia increasing in many regions and particularly in urbanized Asian populations.^[3] Both inherited susceptibility and modifiable exposures—including near work and limited time outdoors—contribute to myopia development, although causal interpretation requires appropriately designed longitudinal or comparative studies.^[4,5]

Bangladesh has a large school-age population, but published estimates of refractive error vary because of differences in setting, age range, refraction technique, diagnostic thresholds, and sampling. A study from north-west Bangladesh reported refractive error in 9.2% of 500 schoolchildren, while investigations in southern

Bangladesh and Khulna have also demonstrated a clinically important burden.^[6–8] Rural–urban comparisons are particularly relevant because access to screening and optical services, schooling patterns, and environmental exposures differ between settings.

The present study aimed to estimate the prevalence and describe the types of refractive error among schoolchildren in rural and urban Khulna. Secondary objectives were to compare prevalence by residence, age, and sex and to describe family history and selected environmental exposures among children with refractive error.

METHODS

Study design and setting: This school-based cross-sectional study was conducted in urban and rural areas of Khulna, Bangladesh, during 1st July 2023 to 30th June 2024. Urban schools were located in Khulna city, and rural schools were located in Dumuria Upazilla].

Participants and sampling: Children aged 6–17 years who attended the selected schools were eligible. Children with ocular disease other than refractive error, a history of ocular surgery, or a systemic disorder known to affect vision were excluded. Schools were selected by random selectin method, followed by random selection of students from class registers. A total of 350 students were enrolled: 175 urban and 175 rural.

Eye examination: Presenting monocular distance visual acuity was measured using a ETDRS chart at the standard testing distance under uniform illumination. Children with reduced visual acuity underwent pinhole assessment and cycloplegic refraction with retinoscope after cyclopentolate 1%, following the study protocol.

Definitions: Refractive values were converted to spherical equivalent (sphere plus half the cylinder). Myopia was defined as spherical equivalent ≤ -0.50 D, hyperopia as spherical equivalent $\geq +0.5$ D, and astigmatism as cylinder power ≥ 0.75 D. Each affected child was assigned to one mutually exclusive refractive-error category according to the study dataset.

Statistical analysis: Data were analysed using SPSS version 26. Categorical variables are summarized as frequencies and percentages. Refractive-error prevalence is reported with Wilson 95% CIs. Pearson's chi-square test was used to compare prevalence by residence, age group, and. Analyses restricted to the 29 affected children are descriptive; they cannot establish determinants of refractive error because corresponding exposure data for unaffected children were unavailable. All tests were two-sided, and $p < 0.05$ was considered statistically significant.

Ethical considerations: Approval was obtained from the Institutional Review Committee of Khulna Medical College. Written informed consent was obtained from

parents or guardians, and age-appropriate assent was obtained from participating children. Children requiring refractive correction or further assessment were referred for appropriate care.

RESULTS

A total of 350 children were examined, equally divided between urban and rural schools. The age and sex distributions were similar between settings (Table 1).

Table 1. Demographic characteristics of participating schoolchildren by residence (n=350)

Characteristic	Urban, n (%) (n=175)	Rural, n (%) (n=175)	Total, n (%) (n=350)	p value
Age group, years				0.674
6–9	79 (45.1)	71 (40.6)	150 (42.9)	
10–13	54 (30.9)	60 (34.3)	114 (32.6)	
14–17	42 (24.0)	44 (25.1)	86 (24.6)	
Sex				0.668
Boy	91 (52.0)	95 (54.3)	186 (53.1)	
Girl	84 (48.0)	80 (45.7)	164 (46.9)	

p values are from Pearson's chi-square test.

Overall, 29 children had refractive error, corresponding to a prevalence of 8.3% (95% CI, 5.8%–11.6%). The urban prevalence was almost twice the rural estimate, but the difference was not statistically significant (10.9% vs 5.7%; $p = 0.081$). Prevalence increased markedly across age groups and was highest among children aged 14–17 years (23.3%; $p < 0.001$). The difference between boys and girls was not statistically significant (Table 2).

Table 2. Prevalence of refractive error by residence, age group, and sex

Characteristic	Refractive error, n/N	Prevalence, %	95% CI, %	p value
Overall	29/350	8.3	5.8–11.6	—
Residence				0.081
Urban	19/175	10.9	7.1–16.3	
Rural	10/175	5.7	3.1–10.2	
Age group, years				<0.001
6–9	4/150	2.7	1.0–6.7	
10–13	5/114	4.4	1.9–9.9	
14–17	20/86	23.3	15.6–33.2	
Sex				0.163
Boy	19/186	10.2	6.6–15.4	
Girl	10/164	6.1	3.3–10.9	

CIs are Wilson 95% confidence intervals.

p values are from Pearson's chi-square test.

Myopia was the most frequent category, comprising 65.5% of affected children, followed by hyperopia (27.6%) and astigmatism (6.9%).

Table 3. Pattern of refractive error among affected children (n=29) 28.0% had no comorbidity [Table II].

Refractive-error category	Urban, n (%) (n=19)	Rural, n (%) (n=10)	Total, n (%) (n=29)	95% CI for total, %
Myopia	12 (63.2)	7 (70.0)	19 (65.5)	47.3–80.1
Hyperopia	6 (31.6)	2 (20.0)	8 (27.6)	14.7–45.7
Astigmatism	1 (5.3)	1 (10.0)	2 (6.9)	1.9–22.0

Percentages use children with refractive error as the denominator. Categories are mutually exclusive as recorded in the study dataset.

Among the 29 affected children, 18 (62.1%) had a reported family history of eye problems. Family history was more frequent among urban than rural cases; however, this case-only comparison does not estimate an association between family history and refractive error (Table 4).

Table 4. Family history among children with refractive error (n=29)

Family history of eye problems	Urban, n (%) (n=19)	Rural, n (%) (n=10)	Total, n (%) (n=29)
Yes	14 (73.7)	4 (40.0)	18 (62.1)
No	5 (26.3)	6 (60.0)	11 (37.9)

These data are descriptive because family-history information for children without refractive error was not available in the manuscript dataset.

Television viewing, computer use, video-game use, and outdoor activity were recorded among affected children. These data describe the case group only and cannot be used to identify environmental risk factors without comparison with unaffected children (Table 5).

Table 5. Selected environmental exposures among children with refractive error (n=29)

Exposure	Urban, n (%) (n=19)	Rural, n (%) (n=10)	Total, n (%) (n=29)
Television viewing	13 (68.4)	4 (40.0)	17 (58.6)
Computer use	15 (78.9)	7 (70.0)	22 (75.9)
Video-game use	7 (36.8)	2 (20.0)	9 (31.0)
Outdoor activity	8 (42.1)	7 (70.0)	15 (51.7)

Multiple exposures could be reported by the same child. Duration and frequency were not available.

DISCUSSION

This study found refractive error in 8.3% of participating schoolchildren in Khulna. The estimate is close to the 9.2% reported among schoolchildren in north-west Bangladesh, although direct comparison is limited by differences in age, sampling, examination methods, and refractive definitions.^[6] The present estimate is also compatible with the broader South Asian literature showing that refractive error is a common, treatable cause of reduced vision in school-age children.^[9,10]

The urban prevalence (10.9%) was nearly twice the rural prevalence (5.7%), but the 95% CIs overlapped and the residence comparison did not reach conventional statistical significance ($p=0.081$). Therefore, the data suggest a possible urban–rural difference but do not establish one. A larger, adequately powered multisite study would be

required to estimate the residence effect with greater precision and to adjust for age, sex, school clustering, parental refraction, near work, outdoor time, and socioeconomic factors.

The clearest association was with age. Refractive-error prevalence rose from 2.7% among children aged 6–9 years to 23.3% among those aged 14–17 years. This pattern is biologically and epidemiologically plausible because myopia commonly develops and progresses during the school years.^[3,11] However, the cross-sectional design cannot distinguish incident myopia from cohort differences or duration of undetected refractive error.

Myopia comprised 65.5% of refractive errors, consistent with its increasing importance in school-age populations.^[3,6] Hyperopia accounted for 27.6%, and isolated astigmatism was uncommon in the mutually exclusive study categories. Comparison with other studies requires caution because some report eye-level rather than child-level prevalence, use non-cycloplegic refraction, employ different spherical-equivalent thresholds, or count astigmatism concurrently with spherical error.^[7,9,10]

The prevalence in boys (10.2%) was higher than in girls (6.1%), but the difference was not statistically significant. The original case-only percentages—65.5% boys and 34.5% girls among affected children—were influenced by the sex distribution of the full sample and should not be interpreted as sex-specific prevalence.

Family history and environmental exposures were available only for children with refractive error. Consequently, their frequencies cannot support claims of genetic predisposition, screen-related risk, or protection from outdoor activity in this dataset. Previous studies provide independent evidence that parental myopia and time outdoors are relevant to childhood myopia,^[4,5,12] but assessing those hypotheses in Khulna would require exposure data from all screened children and preferably multivariable modelling that accounts for age and school clustering.

STRENGTHS AND LIMITATIONS

Strengths include inclusion of both rural and urban schools, equal recruitment by residence, a broad school-age range, and cycloplegic refraction. Several limitations should be considered. First, the sample was relatively small, producing wide confidence intervals and limited power for residence and sex comparisons. Second, the number of schools, school-level clustering, response rate, sample-size was inadequate to use it as a national data.

CONCLUSION

Refractive error affected 8.3% of participating schoolchildren in Khulna, and myopia was the predominant type. Prevalence increased sharply with age and was highest among students aged 14–17 years. The urban estimate

exceeded the rural estimate, but this study did not demonstrate a statistically significant residence difference. School-based vision screening should cover both rural and urban settings, include older students, and be linked to cycloplegic assessment when indicated, affordable spectacles, and follow-up. Larger multisite studies should use complete exposure data and account for school clustering to determine independent demographic and environmental associations.

DECLARATIONS

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