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Prevalence of refractive error among school-aged children in Sylhet division of Bangladesh

Enayet Hussain[1] · Ava Hossain[2] · Saidur Rahman Mashreky[3,4] · Eija Viitasara[1] · Koustuv Dalal[1]

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Abstract

Background According to recent statistics from WHO, 150 million people globally have visual impairments caused by uncorrected refractive errors. This study aimed to estimate the prevalence rate of refractive error in Bangladesh's urban, rural, and marginalized populations (tea gardens).

Methods This was a cross-sectional study conducted among all school-going children (Class I-X) aged 5 to 18. The study adopted the stratified cluster sampling method to recruit study subjects. A pre-tested semi-structured questionnaire was used for face-to-face interviews. Trained optometrists carried out vision screening and refraction to identify children with vision impairment.

Results The prevalence of refractive error is 5.3 per 100 population in which myopia is the most common form of refractive error found in 125 (78.6%, 95% CI: 77.1–80.1), followed by astigmatism in 20 (12.6%, 95% CI: 11.4–13.8) and the rest of the cases are hyperopia among 14 (8.8%, 95% CI: 7.8–9.8) children. At the time of the vision screening, only 25 (15.7%) children using spectacles were found. The study findings also showed that urban areas had the highest percentage of refractive error (9.9%), and rural and tea gardens had 3.9% and 2.1% refractive error, respectively. Refractive error was relatively higher among girls' (AOR = 1.5, $p < 0.01$, 95%CI: 1.07–2.11) in comparison with boys' and the percentage of refractive error was three times higher within the secondary school-going children (AOR = 3.2, $p < 0.01$, 95%CI: 1.23–8.08) compared to primary school children.

Conclusion The prevalence of refractive error was higher in the above-ten-year-old age group and significantly lower in rural and tea garden populations. To resolve these challenges, an assortment of comprehensive strategies must be implemented.

Keywords Refractive error · Children · Eye health · LMICs · Bangladesh

1 Introduction

Visual impairment is referred to as a common public health problem, and refractive error is one of the leading causes of visual impairment [1]. The refractive error has four types: myopia, hyperopia, astigmatism, and presbyopia [2]. It cannot be prevented but can be corrected with corrective glasses, contact lenses, or refractive surgery. Refractive error correction may vary from person to person or according to age. According to recent statistics, globally, there

✉ Koustuv Dalal, koustuv.dalal@miun.se; koustuv2010@hotmail.com; Enayet Hussain, enayet.hussain@miun.se | [1]Division of Public Health Science, Department of Health Sciences, Mid Sweden University, Sundsvall, Sweden. [2]OSB Eye Hospital and Institute, Dhaka, Bangladesh. [3]Department of Public Health, North South University, Dhaka, Bangladesh. [4]North South University, Dhaka, Bangladesh.

were a projected 596 million people with distance vision impairment in 2020, 43 million of whom were blind [3]. The majority of persons impacted—90%—live in low- and middle-income nations (LMICs) [3].

At any stage of life, vision impairment may greatly affect a person's daily activities. If any children suffer vision impairment in their early stage of life, it significantly affects their progress as well as their education and quality of life [4]. According to Bangladesh's Pediatric Eye Care guideline in 2014, pediatric eye health is termed a major public health problem in Bangladesh. Based on their report, 67 percent of childhood blindness, including refractive error, is either preventable or treatable [5]. Literature indicated that there is a wide range of variations in the prevalence of myopia globally, such as the prevalence in Latin America at 28.1%. In contrast, in the Asia Pacific, high-income countries are at 53.4%, and in Central Africa, at 9.8% in the year 2020 [6]. Without proper prevention control programs, the prevalence rate of myopia will increase hugely globally. By 2050, it will affect nearly 5 billion people [7]. The highest prevalence rate of myopia may result from lifestyle changes, differences in ethnic groups, age groups, and correction methods. The distribution of refractive error is not the same in the world. The highest prevalence rate of myopia is in East Asian countries, but the highest prevalence rate of hyperopia is in Europe and Western countries [8].

As refractive error is a major cause of visual impairment among children[9], it affects the student's vision and ability to read and write; thus, the number of dropout school children is increasing rapidly [10], along with social problems. According to 2019 data in Bangladesh, the prevalence rate of childhood blindness is 6.3 per 10,000 children [11]. A recent study suggested that in China, among children, the prevalence of myopia is much higher at 38% and hyperopia at 2.8% [12]. As mentioned earlier, refractive error can be treated with corrective glass; one study in Nigeria states that by using spectacle, the quality of vision in children improves much more, and also, they suggested by this simple device that the burden of refractive error can be reduced [13].

As Vision 2020, "Right to Sight", aims to eliminate avoidable blindness worldwide by 2020, Bangladesh has worked to achieve this. One of the priority aims of Vision 2020 is to give eyeglasses to children with significant refractive errors through School Health Programs. The World Report on Vision noted that there is a dearth of information regarding children's visual impairment worldwide, particularly when it comes to indigenous, marginalized populations and ethnic minorities across the world [14]. As in Bangladesh, the recent prevalence rate of refractive error, including myopia, hyperopia, and astigmatism, was not well-known concerning socio-demographic character. Thus, our study aimed to estimate the prevalence rate of refractive error and their socio-demographic characteristics and to find out the difference in the prevalence rate of refractive error in urban, rural, and marginalized populations (tea gardens) in Bangladesh.

2 Methods

2.1 Study design

This cross-sectional study was conducted among all school-going children (Class I-X) aged 5 to 18 in the selected area from January 2023 to June 2023 to estimate the prevalence of refractive error in school-going children of the Sylhet division.

2.2 Sample size

The study's sample size was 3000, considering the refractive error prevalence of 6.3% at the target age population of 5–18 years, using $n = z^2pq/e^2$ where z = 1.96, p = 0.06, q (1-p) = 0.94 e = 0.15, n = 2674.891852. Considering a 10% non-response rate of 267.489 with a 95% confidence interval, then the total n 2942.381, thus we rounded up it to 3000.

The study adopted the stratified cluster sampling method to recruit study subjects. There were three strata: Urban, Rural, and Marginalized areas (tea gardens), where schools were considered clusters. All schools of the selected areas constituted the sampling frame of clusters. Using the sampling frame, four schools were selected randomly from each area. In the selected area, there were both primary and secondary schools. All students from each school were recruited from each class (I-X) for vision screening (Fig. 1).

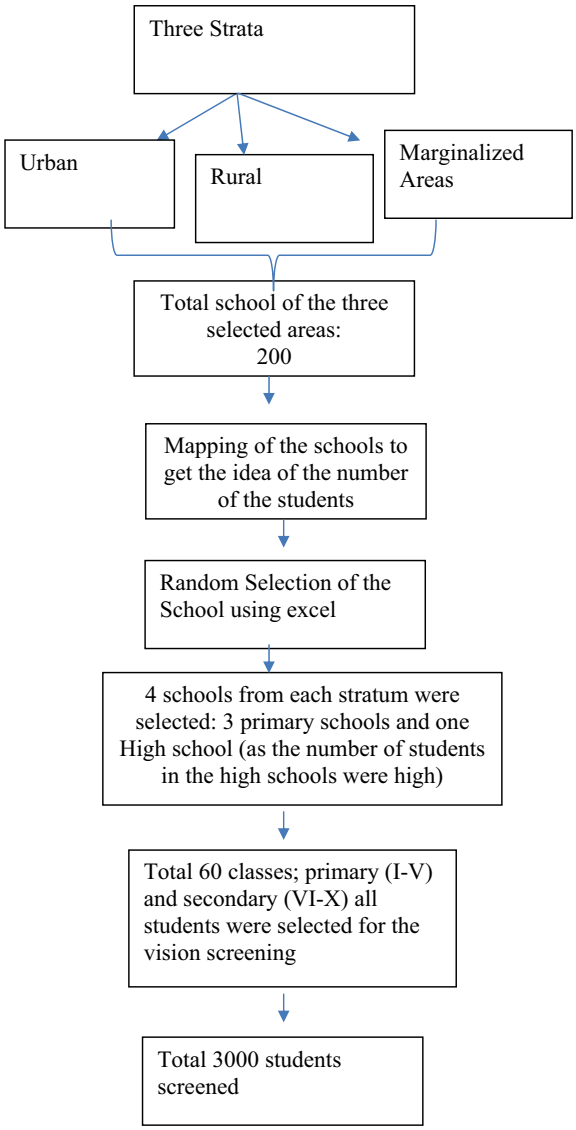

Fig. 1 Sampling methodology of the study

2.3 Data collection procedure

Before data collection, pre-testing of the questionnaire was carried out in one school situated (the school had I-X classes) in the rural area of Sylhet, which is different from what we selected for our study. As most of the data were clinical, not many changes were made after pre-testing. Three data collectors, three field managers, and two Optometrists were recruited for this study. As part of the data collection procedure, a semi-structured questionnaire was prepared for the face-to-face interview. After the pre-testing of the field, an interactive session was held with the principals of all selected schools. Researchers described the aim of the study, the procedures that would be done during the vision screening, and the possible side effect (cycloplegia), which is difficulty in near reading for a maximum of two days due to the procedure being done during the vision screening. The principals were responsible for informed consent on behalf of all the students, and he gathered all the students on the day of eye camping. Researchers and Ophthalmologists held a day-long comprehensive training session with data collectors.

The students were interviewed face-to-face. Socio-demographic characteristics like age, gender, parental education, parental/caregiver occupation, income, and school types were included in this study. A unique ID was created for each student according to their roll number and class.

2.4 Ophthalmic examination

A classroom with the desired light was selected for the eye examination. Data collectors took the socio-demographic information, and after that, each student, according to their unique ID number, went to an optometrist for the initial screening of their eye. In that room, there were two sitting places: one for optometrists and another one for data collectors. The optometrist tested the unaided visual acuity at the school with the Snellen chart placed at 6 m for children [15]. Students who wear eyeglasses were requested to remove their glasses before an eye examination. If any students failed to read 6/9 vision lines in either eye, cycloplegic refraction was done to them with 1% Cyclopentolate in the presence of the principal /other school teachers. Pupils were considered fully dilated if 6 mm or greater. The optometrist again did the refraction by placing the appropriate lenses in the trial frame. The optometrist referred these students for further evaluation and prescription of the spectacles to the base hospital after 48 h of examination to two weeks, where all facilities, including a pediatric ophthalmologist, were available.

2.5 Data analysis

Data ranges and frequency distribution among related variables were used. The confidence interval and p-value for prevalence estimation and regression were calculated. All data were analyzed using SPSS software version 29.

The prevalence of refractive error was calculated using uncorrected visual acuity. Using multiple logistic regression, the association between refractive error and age and class level, gender, and school location (urban vs. rural vs. tea garden) was explored.

2.6 Operational definition

Myopia is defined as a spherical equivalent (SE) refractive error of at least − 0.50 diopters (D) and hyperopia as + 2.00 D or more [7]. Visually impaired children were considered myopic if one or both eyes were myopic and hyperopic if one or both eyes were hyperopic so long as neither eye was myopic. Astigmatism was defined as cylinder values of 0.75 D or more [7].

2.6.1 Wealth index

The definition of the wealth index (poor, middle income, and rich) used for this study has already been published elsewhere [16].

3 Results

Distribution of age, gender, class, school location, parental education and occupation, and monthly family income and expenditure are described in Table 1. Among the study participants, the mean age of the school-going children was 11.4 ± 2.8 and more than half (56.0%) of students are girls, and secondary class students are prominent in this study (58.2%). As secondary classes are divided into more sections so, in these study settings, secondary classes are more than the primary class. In terms of father occupation, more than one-third (35.5%) are tea garden workers. (Table 1).

The prevalence of refractive error is 5.3 per 100 population, which is shown in Table 2. The main cause of the refractive error is myopia 78.6% (77.1–80.1), followed by astigmatism 12.5% (11.4–13.8) and hyperopia 8.8% (7.8–9.8). The study findings also showed that urban areas had the highest percentage of refractive error, 9.9% (8.8–10.9), and respectively rural and tea gardens had 3.9% (3.2–4.6) and 2.1% (1.6–2.6) refractive error. (Table 3).

Overall, 25 children (15.7%) were using spectacles during vision screening. In Table 4, it is shown that children in the above -10 years age group use more spectacles, and the findings are significant ($p < 0.05$) compared to the under

Table 1 Distribution of population characteristics (N = 3000)

Variable	Number (n)	Percentage (%)
Age, mean ± SD	11.4 ± 2.8	
Age		
Under-10	1076	35.9
Above-10	1924	64.1
5–8	510	17.0
9–12	1354	45.1
13–16	1090	36.3
17–18	46	1.5
Gender		
Boys	1321	44.0
Girls	1679	56.0
Class Level		
Primary	1254	41.8
Secondary	1746	58.2
Situation of School		
Urban	1000	33.3
Rural	1000	33.3
Tea Garden	1000	33.3
Education of Father		
No Formal Education	232	7.7
Primary	1034	34.5
Secondary	1038	34.6
Higher Secondary	363	12.1
Graduation and Above	333	11.1
Education of Mother		
No Formal Education	267	8.9
Primary	1086	36.2
Secondary	1249	41.6
Higher Secondary	231	7.7
Graduation and Above	167	5.6
Occupation of Father		
Service Holder	524	17.5
Tea Garden Worker	1066	35.5
Others	1410	47.0
Occupation of Mother		
Housewife	1945	64.8
Tea Garden worker	678	22.6
Others	377	12.6
Monthly Family Income		
Poor	922	30.7
Middle Income	1490	49.7
Rich	588	19.6
Monthly Family Expenditure		
Poor	1018	33.9
Middle Income	1711	57.0
Rich	271	9.0

-10 years age group. A significant relationship is found among the parents with graduation and above education group

Table 2 Overall Prevalence of Refractive error and its types per 100 population

Variables	Frequency	Prevalence (95%CI)
Refractive error	159	5.3 (4.5–6.1)
Refractive error without spectacle	134	4.5 (3.8–5.2)
Type of refractive error		
Myopia	125	78.6 (77.1–80.1)
Hyperopia	14	8.8 (7.8–9.8)
Astigmatism	20	12.6 (11.4–13.8)

Table 3 Prevalence of Refractive error according to age, gender, class level, situation of school

Variables	Frequency	Percentage (95%CI)
Age		
Under-10	29	2.7 (2.1–3.3)
Above-10	130	6.8 (5.9–7.7)
Gender		
Boys	60	4.5 (3.8–5.2)
Girls	99	5.9 (5.1–6.7)
Class Level		
Primary	31	2.5 (1.9–3.1)
Secondary	128	7.3 (6.4–8.2)
Situation of School		
Urban	99	9.9 (8.8–10.9)
Rural	39	3.9 (3.2–4.6)
Tea Garden	21	2.1 (1.6–2.6)

children were more spectacles than the other educational group ($p < 0.00$). (Table 4) In bivariate analysis, refractive error was more prominent in girls (AOR = 1.5, $p < 0.01$, 95% CI: 1.07–2.11) and among secondary school children (AOR = 3.2, $p < 0.01$, 95% CI: 1.23–8.08). (Table 5).

4 Discussion

The present study aimed to assess the prevalence of refractive error in Bangladesh by conducting a vision screening program at different schools. To the authors' best knowledge, this is the first study conducted in Bangladesh in which the prevalence of refractive error was assessed among marginalized children as well as urban and rural children. No studies in Bangladesh compared urban, rural, and marginalized populations (tea gardens). We addressed the tea garden population as marginalized because they lack proper health facilities as well as other facilities and live in very low socio-economic conditions [17].

The overall prevalence of refractive error in this study was 5.3%, which is relatively low compared to studies conducted in neighboring countries India and Bhutan [7, 18, 19]. However, a 4.5% prevalence of refractive error was found in Madhya Pradesh in India [20]. This may be due to the study setting, sample size, and geographical location.

In this study, Myopia was highly prevalent (78.8%), followed by astigmatism (12.5%), and the lowest prevalence was found in hyperopia (8.8%), which is supported by the existing literature for example in India the prevalence of Myopia was 31.1%, astigmatism 29.4% and hyperopia 2.6% and In China, Myopia 38.0%, astigmatism 16.5% and hyperopia 5.2% [7, 18, 19, 21–23].

The percentage of refractive error was more prevalent in female children (5.9%) than in male children, which was evident by the other studies [7, 18, 24], but a different result was found in the study of Yogesh, where males were predominantly affected by refractive error [20]. As children grow up, their likelihood of having refractive error increases[19]. The evidence showed that children over ten years of age are more likely to have refractive error than the five to nine years age group [18, 25], which is consistent with our study findings that 6.8%of children over ten years of age group had refractive error than the below 10 years of age group.

Table 4 Relationship of spectacle use with age, gender, class, situation of school

Variables	Not using spectacles n (%)	Spectacle use n (%)	Crude OR	p-value
Age				
Under-10	28 (96.6)	1 (3.4)	6.3	0.05
Above-10	106 (81.5)	24 (18.5)		
Gender				
Boys	46 (76.7)	14 (23.3)	0.41	0.04
Girls	88 (88.9)	11 (11.1)		
Class Level				
Primary	30 (96.8)	1 (3.2)	6.9	0.05
Secondary	104 (81.3)	24 (18.8)		
Situation of School				
Urban	75 (75.8)	24 (24.2)	0.1	0.001
Rural	39 (100.0)	0 (0.0)		
Tea Garden	20 (95.2)	1 (4.8)		
Education of Father				
No Formal Education	7 (100.0)	0 (0.0)	0.1	0.0
Primary	35 (92.1)	3 (7.9)		
Secondary	54 (94.7)	3 (5.3)		
Higher Secondary	17 (81.0)	4 (19.0)		
Graduation and Above	21 (58.3)	15 (41.7)		
Education of Mother				
No Formal Education	7 (77.8)	2 (22.7)	0.03	0.0
Primary	38 (97.4)	1 (2.6)		
Secondary	65 (94.2)	4 (5.8)		
Higher Secondary	22 (91.7)	2 (8.3)		
Graduation and Above	2 (11.1)	16 (88.9)		

Table 5 Binary regression analyses between refractive error and age, gender, class level, and situation of school

Variables		95%CI				95%CI	
	OR	Lower limit	Upper limit	AOR	*p*-value	Lower limit	Upper limit
Age							
Under-10	Ref.			Ref.			
Above-10	2.6	1.7	3.9	0.6	0.4	0.57	1.8
Gender							
Boys	Ref.			Ref.			
Girls	1.3	0.9	1.8	1.5*	0.017	1.07	2.11
Class Level							
Primary	Ref.			Ref.			
Secondary	3.1	2.1	4.7	3.2*	0.015	1.23	8.08
Situation of School							
Urban	Ref.			Ref.			
Rural	0.4	0.2	0.5	0.4	0.00	0.25	0.54
Tea Garden	0.2	0.1	0.3	0.3	0.00	0.16	0.44

*Adjusted odd ratios are significant at $p < 0.05$ considering 95% CI

Results also showed that the prevalence of refractive error was higher in urban (9.9%) school-going children than in rural (3.9%) and marginalized community children (2.1%), which is consistent with the study findings conducted in India [26].

At the time of the vision screening to assess the refractive error, out of 159 children, only 25 children (15.7%) were using spectacles. Different factors resulted in non-compliance with spectacles, such as broken glass, teasing of a friend, parents disliking of spectacles, etc. [27]. Results also showed that older age groups, such as those above 10 years age group are more non-compliant to spectacles due to various factors like teasing, discomfort, and aesthetics, etc. [28]. Public health benefits from knowing this knowledge, and comparable scenarios were observed in the research results, which were gathered from several nations [7, 29–31]. These findings might be the consequence of Bangladeshi parents' inadequate health-seeking practices when their children have ocular illness [32]. Among them, boys are more likely to wear spectacles than girls. Parental education showed a significant relationship in terms of children's spectacle use. School-going children with parents from higher education groups are more likely to use these spectacles.

5 Conclusion

The prevalence of refractive error was higher in the above-ten-year-old age group and significantly lower in rural and tea garden populations. A nationwide preschool vision screening program might be implemented to address vision impairment at an early stage and improve children's lives through early identification.

5.1 Strengths and limitations

To the author's knowledge, this is the first study conducted in marginalized populations and urban and rural areas. All school-going children from all classes at the selected school were screened to assess the prevalence of refractive error.

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Author contributions Enayet Hussain and Koustuv Dalal were mainly responsible for the study's design and supervision. Enayet Hussain and Ava Hossain were involved in the data collection. Enayet Hussain prepared the first draft. Enayet Hussain, Ava Hossain, Saidur Rahman Mashreky, EijaViitasara, and Koustuv Dalal wrote the manuscript. Koustuv Dalal critically reviewed and edited the article. Enayet Hussain, Ava Hossain, Saidur Rahman Mashreky, EijaViitasara, and Koustuv Dalal wrote, revised, and approved the final manuscript.

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Data availability Available upon reasonable request from Dr Enayet Hussain, Email: enayet.hussain@miun.se.

Declarations

Ethics approval and consent to participate Ethical clearance was obtained from CIPRB's (Centre for Injury Prevention and Research Bangladesh) ethical review board (CIPRB/ERC/2016/006). Signed informed consents were obtained from the principals of each school on behalf of the minor-aged respondents. As the parents were unavailable due to their work in tea gardens, the ethical committee approved the school principal's signing of the informed consent form. All research was conducted according to Ethical guidelines based on the Helsinki Declarations.

Consent for publication Not applicable.

Competing interests The authors declare no competing interests.

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