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Assessment of refractive error and related ocular morbidities between school children: An analytical observational study

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Abstract
Aim: The aim of the present study was to compare the refractive error and related ocular morbidities between school children.
Methods: An analytical study design was adopted to screen school children from randomly selected schools in urban and rural areas and duration of the study was 2 years. All children aged 5–15 years that were present in the school on the day of examination were included in the study. Seven urban and eight rural schools were then randomly selected. A total of 1680 students were allocated for the evaluation. Either due to the non-availability of the consent form or the child itself, 1500 (89.9%) were included for the final evaluation.
Results: Out of 1500 students, 800 belong to urban school and 700 belong to rural areas. The gender distribution between groups was similar (P = 0.6). The proportion of preparatory and secondary students of rural and urban was significantly different (p<0.05). The coverage of RE services among urban students was significantly greater than rural students. 55% were urban boys and 60% rural boys. 70% urban students were and 35% rural students in preparatory. The prevalence of RE was significantly higher in urban as compared to rural students. The prevalence of hyperopia was significantly higher among rural students compared to urban school students (P = 0.001). The prevalence of myopia was significantly higher among urban students compared to rural students (p<0.001). The prevalence of anisometropia was significantly higher in urban students compared to rural students (P = 0.001). The prevalence of strabismus was significantly higher in urban students compared to rural students (p<0.001). The proportion of rural students with "functional normal vision" was significantly higher than urban students (93.42% vs. 65%).
Conclusion: This study revealed that the most common cause of ocular morbidity was refractive error. The majority of the causes were either treatable or preventable. A simple school screening was an effective and an easy method for early detection of ocular problems.

Keywords: Childhood blindness, eye screening, myopia, refractive error, spot screener

Introduction

Childhood blindness is the second largest cause of blind-person years, following cataract. Globally, approximately 70 million blind person years are caused by childhood blindness. There are an estimated 1.4 million blind children worldwide, 73% of whom live in low-income countries [2]. An additional 7 million suffer from low vision, and another 10 million children have a correctable refractive error causing visual impairment (refractive bilateral visual acuity [VA] of <6/18) [3].

India has an estimated 320,000 blind children, more than any other country in the world [4]. Estimated National Prevalence of Childhood Blindness/Low Vision is 0.80/1000 in India [5]. Most of the available studies demonstrate that corneal and lenticular conditions are the predominant causes of blindness, whereas among children outside blind schools, refractive errors are important causes of visual impairment and blindness [3]. In children of age range 5-15 years, the visual impairment is 6.4%, with refractive errors as the major cause [6].

The World Health Organization (WHO) estimates that 19 million children under 15 years of age are visually impaired. Uncorrected refractive error (RE) was the main cause of visual impairment (VI) in 12 million children [7]. RE includes myopia, hyperopia, and astigmatism [8]. The magnitude of RE is a factor and changes in refractive status as children grow warrant frequent reassessment and management [9]. Unfortunately, undetected VI in children can have a lifelong impact on learning ability, academic performance, personality, and quality of life [10].

Therefore, in children, early detection and treatment of RE is essential. The WHO also recommends vision screening of "12-13" and "15-16" years old schoolchildren and to provide refractive services [11]. The development of RE is influenced by both environmental and genetic factors [12]. The interplay between genes and environment may account for a substantial proportion of the phenotypic variance [13]. Among Indian children, there is a13% prevalence of myopia in Delhi [14]. In contrast, children in a southern region of rural India had a 2.2% prevalence of RE [15].
The aim of the present study was to compare the refractive error and related ocular morbidities between school children.

Materials and Methods
A cross-sectional analytical study design was adopted to screen school children from randomly selected schools in urban and rural areas and duration of the study was 2 years. All children aged 5–15 years that were present in the school on the day of examination were included in the study. Seven urban and eight rural schools were then randomly selected. A total of 1680 students were allocated for the evaluation. Either due to the non-availability of the consent form or the child itself, 1500 (89.9%) were included for the final evaluation. Before examination, permission and informed consent duly signed both in Hindi and English were taken from the principal of the school, and a date for screening was fixed.
Examination was done in the respective school campuses in clean, quiet and well-lit rooms. Only children present on the day of examination were screened. History taking was done from the children as well as the teachers. VA was measured using the Snellen's VA chart at 6 m. Children with VA <6/9 underwent a pinhole vision to differentiate refractive errors from pathological conditions. Refractive error was diagnosed when a VA worse than 6/9 improved on pinhole test. Undilated retinoscopy and subjective correction for children with uncorrected VA <6/6 were done. Cycloplegic refraction and post-mydriatic (PMT) were not done in the school. Ocular movements were checked, and convergence.
Distribution of children according to schools insufficiency testing was done. Anterior segment examination including lids, lacrimal sac, conjunctiva, cornea, anterior chamber, pupil, iris and lens was done using a torch light, and a handheld slit-lamp. Visual axis alignment was checked using cover-uncover, alternate cover and Hirschberg tests. Undilated fundus examination was done for every child using the small pupil aperture of a direct or an indirect ophthalmoscope depending on the examiner's preference.
Children not improving to 6/6 with a pinhole underwent a dilated fundus examination after tropicamide drops instillation. A pro forma was used for documentation. Children needing further assessment and management were referred to a higher center. VA assessment, cycloplegic refraction with cyclopentolate-tropicamide-cyclopentolate, PMT, orthoptics, a detailed anterior segment and posterior segment examination, relevant investigations, and the necessary management was done for the children who reported in the clinic. Interpretation and analysis of the data were done using Epi Info Software (developed by Centers for Disease Control and Prevention (CDC) in Atlanta, Georgia, USA) and t-test was used.

Results

Table 1: Table 1: Distribution of children in schools in rural and urban areas

School category	N%
Urban	800 (53.34)
Rural	700(46.66)
Total	1500 (100)

Out of 1500 students, 800 belong to urban school and 700 belong to rural areas.

Table 2: Demographic features of urban and rural school children with refractive error

	Urban (n=800), n (%)	Rural (n=700, n (%)	Validation OR (95% CI), P
Gender			
Boys	440 (55)	420 (60)	0.8 (0.6-1.3), 0.6
Girls	360 (45)	280 (40)	
Grade of school			
Preparatory	560 (70)	245 (35)	3.7 (2.7-5.0), <0.001
Secondary	240 (30)	455 (65)	
Spectacles prescribed in past			
Yes	384 (48)	224 (32)	1.9 (1.5-2.9), <0.001
No	416 (52)	476 (68)	
Using spectacles on day of screening			
Yes	640 (80)	525 (75)	1.2 (0.8-1.8), 0.2
No	160 (20)	175 (25)	
Family history of RE			
Yes	360 (45)	385 (55)	0.7 (0.5-0.8), <0.001
No	440 (55)	315 (45)	

The gender distribution between groups was similar (P = 0.6). The proportion of preparatory and secondary students of rural and urban was significantly different (p<0.05). The coverage of RE services among urban students was significantly greater than rural students. 55% were urban boys and 60% rural boys. 70% urban students were and 35% rural students in preparatory.

Table 3: Status of refractive error and related ocular morbidities based on the Spot Screener results

	Urban (n=800)		Rural (n=700)		Validation
	n (%)	95% CI	n (%)	95% CI	
RE					
Emmetropia	400 (50)	46.4-53.4	392 (56)	52.7-60.0	χ2=10, df=3, P=0.001
Hyperopia	36 (4.5)	3.0-6.0	56 (8)	5.8-9.7	
Myopia	360 (45)	42.1-49.1	245 (35)	32.3-39.4	
Mild	240 (30)	25.5-31.9	175 (25)	23.3-29.8	
Moderate	120 (15)	12.9-18.1	56 (8)	6.5-10.7	
Severe	12 (1.5)	0.6-2.2	5 (0.71)	0.1-1.3	
Anisometropia					
Present	48 (6)	4.8-8.4	21 (3)	1.7-4.2	OR=2.2 (95% CI: 1.3-3.8), P=0.001

Absent	652 (94)		679(97)		
Strabismus					
Present	88 (11)	8.8-13.2	28 (4)	2.6-5.5	OR=2.9 (95% CI: 1.9-4.5), $p<0.001$
Absent	712 (89)		672 (96)		
Uncorrected VA					
20/20-20/60	520 (65)	31.9-38.7	654 (93.42)	4.3-7.8	OR=8.4 (95% CI: 6.0-11.5), $p<0.001$
<20/60-20/200	278 (34.75)		42 (6)		
<20/200-20/400	1 (0.125)		0		
<20/400	0		0		
Missing	0		4 (0.57)		

The prevalence of RE was significantly higher in urban as compared to rural students. The prevalence of hyperopia was significantly higher among rural students compared to urban school students (P = 0.001). The prevalence of myopia was significantly higher among urban students compared to rural students ($p<0.001$). The prevalence of anisometropia was significantly higher in urban students compared to rural students (P = 0.001). The prevalence of strabismus was significantly higher in urban students compared to rural students ($p<0.001$). The proportion of rural students with “functional normal vision” was significantly higher than urban students (93.42% vs. 65%).

Table 4: Risk factors for myopia between urban and rural school children

	Adjusted OR	95% CI	P
Areas			
Urban	1.77	1.4-2.2	<0.001
Rural	1.0		
Gender			
Male	0.9	0.8-1.2	0.7
Female	1.0		
School level			
Preparatory	0.78	0.6-0.97	0.03
Secondary	1.0		
Family history of spectacle usage			
Present	0.56	0.45-0.69	<0.001
Absent	1.0		
Constant	0.8		0.05

Binominal regression analysis was performed to evaluate the interaction of different risk factors on the variation of myopia among students. Urban students and a family history of spectacles were significant risk factors.

Discussion

Worldwide, childhood blindness accounts for the second largest cause of blind-person years, after cataract [16]. Globally approximately 70 million blind-person years are caused by childhood blindness. Out of around 1.4 million blind children worldwide, 270,000 are estimated to be in India [17, 18]. Uncorrected refractive errors are a significant cause of avoidable visual disability, especially in developing countries [18].

Half of the participants had RE. The prevalence of RE was significantly higher in urban students compared to rural students. Hyperopia was more common in rural students, while myopia was more common in rural students. Gender was not associated to RE in either group. Secondary grade urban students had significantly higher rate of RE. Compliance with spectacle wear was equal in both groups. The association of family history of RE to the RE in a child was significantly higher in rural students than urban students. The existing ophthalmic/optical services cover only 1/3 of the rural students and nearly half of the urban students with RE. Anisometropia and strabismus were more prevalent in urban compared to rural students.

The findings of our study concur with these studies showing the wide variation in the prevalence of myopia. As the use of electronic gadgets increases among students, it reduces the amount of outdoor activities that children participate in. Outdoor activities are a known protective factor against myopia [9]. Sustained near work in low illumination is a risk factor for the development and rapid progression of myopia [14]. Strabismus was more prevalent among urban (11%) compared to rural (4%) students. Mittal *et al.* [19] reported strabismus was present in 6.1% of India children between 5 years and 15 years of age.

In the current study, mild VI was more prevalent in rural than in urban students. However, moderate VI was more prevalent in urban compared to rural students. This could be the result of different type of RE in these two groups; urban students having a higher rate of myopia and rural students had a higher rate of hyperopia. VI based on distant VA measurement will naturally be greater in urban students due to the higher rate of myopia. It should be noted that this grading of visual disabilities is based on uncorrected VA. Students with mild VI are less affected in their daily activities and thus are less likely to accept visual aids such as spectacles. This explains the low uptake of refractive services among rural students compared to urban students. Teachers and students should be counseled to note early signs of distant vision defects, including the inability to see writing the blackboard and should be referred for comprehensive eye examination.

A history of seeking assistance to eye professionals was much higher in urban students compared to rural students. This could also due to differing awareness of ocular conditions among parents of students in each group. Health education initiatives directed at the public should relay the asymptomatic nature of the early stages of RE. In addition, the need for proactive steps to identify RE in students should be targeted at rural students and their parents. Compliance with spectacle wear was high in both groups. In this age group (teenagers), the use of spectacle is somewhat undesirable. This could be due to the poor knowledge of the alternatives such as contact lens. In addition, the option of future (as an adult) refractive surgery should be discuss to reduce or eliminate spectacle wear [20].

This study has some limitations. The RE was based on the prescription generated by the Spot Screener and not the conventional method of cycloplegic refraction. The validity of this device as a vision screener compared to traditional cycloplegic vision screening has been established [21]. Therefore, the American Academy of Pediatric Ophthalmology and Strabismus and the American Academy of Pediatrics recommend the Spot Screener for instrument based vision screening. Strabismus evaluation was also based on the device report and not by clinical assessment. The Spot Screener is a valid device to use while diagnosing strabismus [22]. The prevalence of amblyopia could not be calculated in our study as we noted presenting vision only and not the best-corrected VA. Finally, the study was based on a cross-sectional study design, so the risk factors should be interpreted judiciously.

Conclusion

This study revealed that the most common cause of ocular morbidity was refractive error. The majority of the causes were either treatable or preventable. A simple school screening was an effective and an easy method for early detection of ocular problems. Early detection and management reduces the disease progression and can prevent visual disability. Schools form an effective media where mass communication can be done, and students can be taught about routine eye care and personal hygiene. Teachers of the schools should be briefed about common ocular problems and taught how to identify children with ocular problems, so that they can report the same to the child's guardian and necessary action can be taken in time.

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