Burden of ocular morbidities and color blindness among school-attending children in a foothill town of Uttarakhand State

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Purpose: To estimate prevalence of common ocular morbidities including color blindness among school-attending children of an urban foothill town of Uttarakhand State in Northern India. **Methods:** A cross-sectional study was conducted among school-going children of age group 6–16 years of standard I–XII. Schools were selected using population proportionate to the size sampling technique. Detailed ocular examination including color vision and unaided or aided visual acuity for various ocular morbidities was done. Data was entered into MS excel with statistical analysis using SPSS version 23 with significant *P* value <0.05. **Results:** In total, 13,492 students (mean age 10.9 ± 2.7 years) with almost equal male to female ratio were screened. Overall prevalence of ocular morbidity was 23.2%, with refractive error (18.5%) on top, followed by color blindness (2.2%). The later was observed more among males (3.0%) as compared to females (1.4%) with significantly higher odds, OR = 2.3 (1.7–2.9) (*P* < 0.001). **Conclusion:** Refractive error has been the most common ocular morbidity, followed by color blindness. Earliest detection can prevent permanent disability and disappointment among youngsters when rejected from entering certain professions due to color vision defect.

Key words: Childhood ocular morbidity, color blindness, prevalence, refractive error, school eye screening

Worldwide there is an estimated 1.4 million blind children among which approximately 73% live in lower income countries.[1] In addition to this, nearly seven million suffer from low vision, and another 10 million have visual impairment with correctable refractive error (refractive bilateral visual acuity of less than 6 by 18.[2] In the pediatric age group, the estimated national prevalence of blindness/low vision is 0.8 per 1000.[3]

In India, 0–15 year's age group represents approximately 25% of the total population. Schools are the best forum for imparting health education to the children, screening for ocular morbidities, and are also effective in implementing comprehensive eye healthcare programs.[4] Due to wide geographic variability in prevalence and distribution of ocular diseases among school children, there is paucity of reliable population survey-based data on prevalence and distribution of eye diseases among school children especially from developing nations like India. Among the studies conducted in northern India, only a few are from hilly states documenting the prevalence of ocular diseases among school-going children.[5,6]

A survey among school-going children for color blindness will help us to know its true prevalence and shall be useful for the parents in the counselling of their affected children regarding future career planning. Besides this, several treatable and preventable eye disorders remain undetected till late either due to ignorance or carelessness on part of parents or teachers. Hence, this large, school-based cross-sectional descriptive study was conducted with the aim of estimating the prevalence and distribution of ocular morbidities including color vision among school-going children of age group 6–16 years in foothills of Himalaya. Another objective of this study was to create awareness among the students and their teachers for eye care.

Methods

Demography of study area

As per provisional data of 2011 census of India, Rishikesh town had a population of 1,02,138 with 54,466 males and 47,672 females, while in 2021 Aadhar estimates, it is 322,825. The literacy rate was 86.86% compared to the national average of 74.04%.[7] As per Department of School Education, Doiwala block is subdivided into 13 clusters including Rishikesh. In cluster Rishikesh, there were 87 schools [18 (20.68%) government, 69 (79.31%) private] out of which 83 (95.4%) were coeducational school. In India, difference exists between private and government schools in terms of infrastructure, fees, education level and socioeconomic status, teaching curriculum, and performance pressure. This could lead to

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variation in the pattern and distribution of ocular morbidities. Since, coeducational schools had nearly equal representation from both sexes and represented 95% of student population, only these were included in the study.

The study was conducted among school-going children of class 1–12 (age group 6–16 years) from selected coeducational government and private schools in the city of Rishikesh over a period of 22 months from April 2018 to February 2020.

For calculating the sample size, we utilized reported prevalence of ocular morbidity 20% (0.20),[8] with 95% confidence level, and absolute precision as 2%. We calculated the minimum sample size required for the study as 1536 school children.

Schools were selected by the cluster sampling technique from varied geographical locations, among the list of all the coeducational government and private schools in Rishikesh. Sixteen private and four government coeducational schools were selected randomly utilizing population proportionate to size methodology.

The approval of Institutional ethical committee was taken. Heads of the selected schools were informed about the study and official written permissions were taken. Parents were also informed about the study by respective school teachers.

All the students studying in class 1–12 (age group 6–16 years) present in the school on the day of examination and willing to participate were included. Those who were either absent or were not willing to participate at the time of survey were excluded.

The study field staff included one ophthalmologist and one optometrist. Interview methods in Hindi, English, or local vernacular language were adopted for recording of data from class teachers or students. Pretested, predesigned semistructured questionnaires were used to collect information on sociodemographic factors like age, sex, class or standard, Chief or specific ocular complaints (single/multiple), and past history of any ocular disease. Ocular examinations were performed in the respective school campus in a clean, quiet, well-lit room with adequate length, preferably longer than 20 feet. All children present in the class on the day of examination were screened following a standard wise pattern in ascending order with the help of an attendance register. Visual acuity (unaided and aided) was assessed using Snellen's chart available in both English and Hindi including animal optotypes kept at a distance of 6 m. Possible refractive error was assessed by measurement of distant VA using pinhole. Color vision was tested using Ishihara-colored plates in children with visual acuity better than 20/200 in broad-daylight. Assessment of strabismus was done by Hirschberg corneal reflex test for manifest squint, uniocular or binocular extraocular movements, and cover–uncover test for latent and manifest strabismus. Gross anterior segment examination including the lids, lacrimal sac, conjunctiva, cornea, anterior chamber, pupil, iris, lens, and convergence was done using a torch light to rule out any abnormality. The presence of any congenital ocular disorders such as ptosis, nasolacrimal duct obstruction, and congenital cataract was also noted. Other ocular conditions like conjunctivitis, stye, chalazion, corneal scars/opacities, etc., were also looked for. Undilated fundus examination of every child was done using small pupil aperture of a direct ophthalmoscope. Those students requiring dilated fundus examination, cycloplegic refraction, postmydriatic test, or any

further detailed evaluation were referred to our tertiary care hospital or to nearby Government hospitals. Teachers and parents, if available were also counselled for the children with any detectable ocular abnormality.

Both visually impairing and nonvisually impairing ocular pathologic conditions were defined as ocular morbidities. Refractive error was diagnosed for unaided VA worse than 6/9 in any one eye, which improved on pin hole testing. Convergence insufficiency was tested using a pen tip and noting a near point of convergence. A diagnosis of defective color vision was made if a cooperative child made five or more errors in reading first 21 plates of 38 plates Ishihara chart. Allergic conjunctivitis was diagnosed on the basis of symptoms of itching, redness, and seasonal variation together with conjunctival and limbal signs. Amblyopia was diagnosed as any diminution of vision VA <6/12 that cannot be explained with ocular media or visual pathway itself and two lines difference on Snellens chart between two eyes was considered. Diagnosis of vitamin A deficiency or Xerophthalmia was made if there was history of night blindness, or on examination, there were signs of conjunctival xerosis, bitot spots, corneal xerosis, or keratomalacia as per clinical grading by WHO.

Appropriate statistical tests were applied and P value < 0.05 was considered significant. For analysis, statistical software SPSS version 23 was utilized.

Table 1: Summary of basic demographic details

Basic Details	Mean±SD || Median (IQR) || Min-Max || Frequency (%)
Age (Years)	10.99±2.71 || 11.00 (9.00-13.00) || 6.00-16.00
Age Group	
6-10 Years	5466 (40.5%)
11-16 Years	8026 (59.5%)
Gender	
Male	6750 (50.0%)
Female	6742 (50.0%)
Class	
Class 1	828 (6.1%)
Class 2	1113 (8.3%)
Class 3	1051 (7.8%)
Class 4	1363 (10.1%)
Class 5	1452 (10.8%)
Class 6	1695 (12.6%)
Class 7	1530 (11.3%)
Class 8	1325 (9.8%)
Class 9	1549 (11.5%)
Class 10	1418 (10.5%)
Class 11	76 (0.6%)
Class 12	90 (0.7%)
Class/Standard	
Primary	5807 (43.0%)
Middle	6099 (45.2%)
High School	1418 (10.5%)
Intermediate	166 (1.2%)
Type of School	
Government	3428 (25.4%)
Private	10064 (74.6%)

Table 2: Association between any ocular morbidity and demographic variables

Variables	Any Ocular Morbidity		P
	Present (n=3130)	Absent (n=10362)	
Age Group			0.646[1]
6-10 Years	1257 (23.0%)	4209 (77.0%)	
11-16 Years	1873 (23.3%)	6153 (76.7%)	
Gender***			0.011[1]
Male	1628 (24.1%)	5122 (75.9%)	
Female	1502 (22.3%)	5240 (77.7%)	
Class/Standard			0.114[1]
Primary	1328 (22.9%)	4479 (77.1%)	
Middle	1460 (23.9%)	4639 (76.1%)	
High School	300 (21.2%)	1118 (78.8%)	
Intermediate	42 (25.3%)	124 (74.7%)	
Type of School***			<0.001[1]
Government	671 (19.6%)	2757 (80.4%)	
Private	2459 (24.4%)	7605 (75.6%)	

***Significant at P<0.05, [1]Chi-squared test

Table 3: Association between refractive errors and demographic parameters

Parameters	Refractive errors		P
	Present (n=2502)	Absent (n=10,990)	
Age (Years)	10.99±2.73	10.99±2.71	0.744[1]
Age Group			0.141[1]
6-10 Years (n=5466)	981 (17.9%)	4485 (82.1%)	
11-16 Years (n=8026)	1521 (19.0%)	6505 (81.0%)	
Gender			0.603[1]
Male (n=6750)	1240 (18.4%)	5510 (81.6%)	
Female (n=6742)	1262 (18.7%)	5480 (81.3%)	
Class/Standard***			0.034[1]
Primary (n=5807)	1047 (18.0%)	4760 (82.0%)	
Middle (n=6099)	1177 (19.3%)	4922 (80.7%)	
High School (n=1418)	239 (16.9%)	1179 (83.1%)	
Intermediate (n=166)	39 (23.5%)	127 (76.5%)	
Type of School***			0.015[1]
Government (n=3428)	588 (17.2%)	2840 (82.8%)	
Private (n=10064)	1914 (19.0%)	8150 (81.0%)	

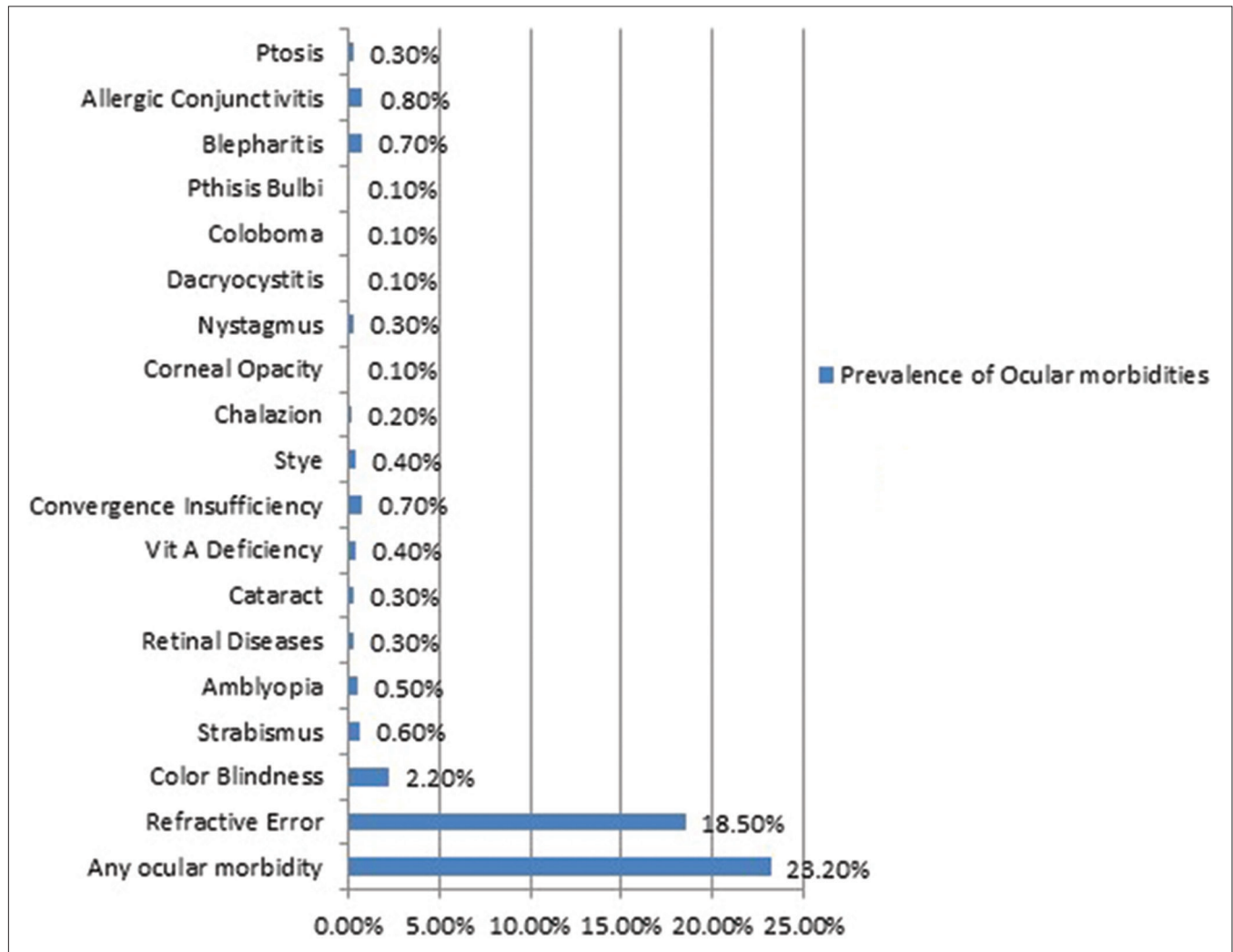***Significant at P<0.05, [1]Chi-squared test

Figure 1: Summary of prevalence of ocular morbidities

Table 4: Association between the gender and prevalence of different types of ocular morbidities

Ocular Morbidity	Gender		P
	Male (*n*=6750)	Female (*n*=6742)	
Refractive Error (Present)	1240 (18.4%)	1262 (18.7%)	0.603[1]
Color Blindness (Present)***	205 (3.0%)	92 (1.4%)	<0.001[1]
Strabismus (Present)	43 (0.6%)	33 (0.5%)	0.252[1]
Amblyopia (Present)	44 (0.7%)	28 (0.4%)	0.059[1]
Retinal Diseases (Present)	28 (0.4%)	19 (0.3%)	0.190[1]
Cataract (Present)	28 (0.4%)	17 (0.3%)	0.101[1]
Vit A Deficiency (Present)	29 (0.4%)	22 (0.3%)	0.328[1]
Convergence Insufficiency (Present)	55 (0.8%)	42 (0.6%)	0.187[1]
Stye (Present)***	35 (0.5%)	19 (0.3%)	0.029[1]
Chalazion (Present)	14 (0.2%)	11 (0.2%)	0.550[1]
Corneal Opacity (Present)	11 (0.2%)	8 (0.1%)	0.493[1]
Nystagmus (Present)***	32 (0.5%)	14 (0.2%)	0.008[1]
Dacryocystitis (Present)	10 (0.1%)	8 (0.1%)	0.639[1]
Coloboma (Present)	5 (0.1%)	4 (0.1%)	1.000[2]
PthisisBulbi (Present)	6 (0.1%)	4 (0.1%)	0.754[2]
Blepharitis (Present)	45 (0.7%)	44 (0.7%)	0.920[1]
Allergic Conjunctivitis (Present)	63 (0.9%)	45 (0.7%)	0.083[1]
Ptosis (Present)	21 (0.3%)	16 (0.2%)	0.412[1]

***Significant at *P*<0.05, [1]Chi-squared test, [2]Fisher's exact test

Table 5: Association between the type of school and prevalence of different types of ocular morbidities

Ocular Morbidity	Type of School		P
	Government (*n*=3428)	Private (*n*=10064)	
Refractive Error (Present)***	588 (17.2%)	1914 (19.0%)	0.015[1]
Color Blindness (Present)***	58 (1.7%)	239 (2.4%)	0.019[1]
Strabismus (Present)***	11 (0.3%)	65 (0.6%)	0.028[1]
Amblyopia (Present)***	6 (0.2%)	66 (0.7%)	<0.001[1]
Retinal Diseases (Present)***	4 (0.1%)	43 (0.4%)	0.008[1]
Cataract (Present)***	2 (0.1%)	43 (0.4%)	0.001[1]
Vit A Deficiency (Present)	7 (0.2%)	44 (0.4%)	0.055[1]
Convergence Insufficiency (Present)***	15 (0.4%)	82 (0.8%)	0.024[1]
Stye (Present)***	4 (0.1%)	50 (0.5%)	0.002[1]
Chalazion (Present)	3 (0.1%)	22 (0.2%)	0.123[1]
Corneal Opacity (Present)	2 (0.1%)	17 (0.2%)	0.188[2]
Nystagmus (Present)***	3 (0.1%)	43 (0.4%)	0.003[1]
Dacryocystitis (Present)	2 (0.1%)	16 (0.2%)	0.275[2]
Coloboma (Present)	1 (0.0%)	8 (0.1%)	0.464[2]
PthisisBulbi (Present)	1 (0.0%)	9 (0.1%)	0.469[2]
Blepharitis (Present)***	7 (0.2%)	82 (0.8%)	<0.001[1]
Allergic Conjunctivitis (Present)***	16 (0.5%)	92 (0.9%)	0.011[1]
Ptosis (Present)***	2 (0.1%)	35 (0.3%)	0.005[1]

***Significant at *P*<0.05, [1]Chi-squared test, [2]Fisher's exact test

Results

A total of 13,492 students, (25.4% in government school and 74.6% in private school) of age group 6–16 years studying in standard I–XII were evaluated. There were 6,750 males and 6,742 females in study population. The students were divided into two broad age groups; Group 1 (6–10 years) of 5466 (40.5%) students and Group 2 (11–16 years) of 8026 (59.5%) students. The mean age of the students was 10.9 ± 2.7 years [Table 1].

In the study population, the overall prevalence of ocular morbidity of any form in either eye among children of age group 6–16 years was 23.2%. The estimated prevalence of ocular morbidities in private school was 24.4%, which was significantly (Statistical *P* value <0.001) higher than in

Table 6: Association between the age group and prevalence of different types of ocular morbidities

Parameters	Age Group		P
	6-10 Years (*n*=5466)	11-16 Years (*n*=8026)	
Refractive Error (Present)	981 (17.9%)	1521 (19.0%)	0.141[1]
Color Blindness (Present)	105 (1.9%)	192 (2.4%)	0.067[1]
Strabismus (Present)	27 (0.5%)	49 (0.6%)	0.375[1]
Amblyopia (Present)	33 (0.6%)	39 (0.5%)	0.356[1]
Retinal Diseases (Present)	25 (0.5%)	22 (0.3%)	0.076[1]
Cataract (Present)	22 (0.4%)	23 (0.3%)	0.252[1]
Vit A Deficiency (Present)	22 (0.4%)	29 (0.4%)	0.702[1]
Convergence Insufficiency (Present)	48 (0.9%)	49 (0.6%)	0.071[1]
Stye (Present)***	29 (0.5%)	25 (0.3%)	0.048[1]
Chalazion (Present)	7 (0.1%)	18 (0.2%)	0.202[1]
Corneal Opacity (Present)	7 (0.1%)	12 (0.1%)	0.744[1]
Nystagmus (Present)***	30 (0.5%)	16 (0.2%)	<0.001[1]
Dacryocystitis (Present)	10 (0.2%)	8 (0.1%)	0.193[1]
Coloboma (Present)	4 (0.1%)	5 (0.1%)	1.000[2]
PthisisBulbi (Present)	6 (0.1%)	4 (0.0%)	0.334[2]
Blepharitis (Present)	43 (0.8%)	46 (0.6%)	0.133[1]
Allergic Conjunctivitis (Present)***	56 (1.0%)	52 (0.6%)	0.016[1]
Ptosis (Present)***	21 (0.4%)	16 (0.2%)	0.044[1]

***Significant at *P*<0.05, [1]Chi-Squared Test, [2]Fisher's Exact Test

government schools (19.6%). The overall prevalence of ocular morbidity was found to be more among males (24.1%) as compared to females (22.3%) with significant *P* value = 0.011. Both age groups (i.e. 6–10 and 11–16 years) had almost similar prevalence of ocular morbidity of any kind. There was no statistically significant relationship found between the prevalence of ocular morbidity and the age group or the class/standard of a student (*P* value > 0.05) [Table 2].

The most common cause of ocular morbidity found was refractive error (18.5%), followed by color blindness (2.2%). The prevalence of total ocular disorders that were existent among study population is depicted in Fig. 1.

On individual disease comparison, refractive error constitutes the predominant cause of ocular morbidity seen in 1240 (18.4%) males and 1262 (18.7%) females. However, this difference was statistically insignificant with *P* value >0.05 and OR = 0.98 (0.9–1.07) with 95% CI. Various types of refractive errors were not subanalyzed further. Refractive error was present more in students studying in private schools (19.0%) as compared to those in government schools (17.2%). This difference was statistically significant with *P* value <0.05 and OR = 1.13 (1.02–1.26) with 95% CI [Table 3].

On comparing the prevalence of individual ocular morbidity with gender distribution, a statistically significant difference was noted for color blindness (*P* < 0.001, OR = 2.26 with 95% CI 2.886–5.306), stye (*P* = 0.029, OR = 1.84 with 95% CI 1.054–3.227), and nystagmus (*P* = 0.008, OR = 2.29 with 95% CI 1.22–4.293) with increased prevalence of ocular morbidity among males as compared to females. The rest of the ocular morbidities' prevalence did not vary significantly with gender [Table 4].

Similarly, Table 5 shows the prevalence of ocular morbidities that were found to be more in private school as compared to government schools with statistically significant values (*P* < 0.05).

The occurrence of stye (*P* value = 0.048, OR = 1.71 with 95% CI 0.9988–2.918), nystagmus (*P* value < 0.001, OR = 2.76 with 95% CI 1.505–5.073), allergic conjunctivitis (*P* value = 0.016, OR = 1.59 with 95% CI 1.087–2.319), and ptosis (*P* value = 0.044, OR = 1.93 with 95% CI 1.007–3.703) were observed more in children in the age group 6–10 years when compared to the age group 11–16 years, with statistically significant difference (*P* < 0.05). All other ocular morbidities were also compared, but differences were statistically insignificant [Table 6].

The prevalence of color blindness was observed more among males (3.0%) as compared to females (1.4%) with *P* value < 0.001 and OR = 2.26 (1.77–2.9) with 95% CI [Table 7]. It was also higher among students studying in private school (2.4%) against those in government schools (1.7%) with *P* value = 0.019 and OR = 1.41 (1.06–1.89) with 95% CI. Also, the students with color blindness presented with statistically significant more complaints related to eye disorders like refractive error (*P* value = 0.004, OR = 1.47 with 95% CI), chalazion (*P*- value <0.001, OR = 59.29 with 95% CI), and allergic conjunctivitis (*P* value <0.001, OR = 6.89 with 95% CI) [Table 7].

Discussion

This study screens 13492 students in order to gather data on current prevalence of various ocular morbidities among school-going children in the age group of 6–16 years.

The estimated prevalence of ocular morbidity in the present study was found to be 23.2%. The reported prevalence of ocular morbidities is variable among different geographical regions of study, which may be due to difference in race or ethnicity, age group studied, sample size, and methodologies adopted for screening, lifestyle, and living condition of population under consideration. The results of our study were almost comparable with another population-based study involving a similar age group conducted by Gupta *et al.*[6] in region of

Table 7: Association between color blindness and all parameters

All Parameters	Color Blindness		P
	Present	Absent	
Age (Years)	11.18±2.62	10.98±2.72	0.262[1]
Age Group			0.067[2]
6-10 Years (*n*=5466)	105 (1.9%)	5361 (98.1%)	
11-16 Years (*n*=8026)	192 (2.4%)	7834 (97.6%)	
Gender***			<0.001[2]
Male (*n*=6750)	205 (3.0%)	6545 (97.0%)	
Female (*n*=6742)	92 (1.4%)	6650 (98.6%)	
Class/Standard			0.052[2]
Primary (*n*=5807)	113 (1.9%)	5694 (98.1%)	
Middle (*n*=6099)	157 (2.6%)	5942 (97.4%)	
High School (*n*=1418)	25 (1.8%)	1393 (98.2%)	
Intermediate (*n*=166)	2 (1.2%)	164 (98.8%)	
Type of School***			0.019[2]
Government (*n*=3428)	58 (1.7%)	3370 (98.3.%)	
Private (*n*=10064)	239 (2.4%)	9825 (97.6%)	
Refractive Error (Present)***	74 (24.9%)	2428 (18.4%)	0.004[2]
Strabismus (Present)	0 (0.0%)	76 (0.6%)	0.418[3]
Amblyopia (Present)	0 (0.0%)	72 (0.5%)	0.412[3]
Retinal Diseases (Present)	0 (0.0%)	47 (0.4%)	0.628[3]
Cataract (Present)	0 (0.0%)	45 (0.3%)	0.627[3]
Vit A Deficiency (Present)	0 (0.0%)	51 (0.4%)	0.630[3]
Convergence Insufficiency (Present)	0 (0.0%)	97 (0.7%)	0.280[3]
Stye (Present)	0 (0.0%)	54 (0.4%)	0.634[3]
Chalazion (Present)***	14 (4.7%)	11 (0.1%)	<0.001[3]
Corneal Opacity (Present)	0 (0.0%)	19 (0.1%)	1.000[3]
Nystagmus (Present)	1 (0.3%)	45 (0.3%)	1.000[3]
Dacryocystitis (Present)	0 (0.0%)	18 (0.1%)	1.000[3]
Coloboma (Present)	0 (0.0%)	9 (0.1%)	1.000[3]
PthisisBulbi (Present)	0 (0.0%)	10 (0.1%)	1.000[3]
Blepharitis (Present)	0 (0.0%)	89 (0.7%)	0.270[3]
Allergic Conjunctivitis (Present)***	14 (4.7%)	94 (0.7%)	<0.001[3]
Ptosis (Present)	0 (0.0%)	37 (0.3%)	1.000[3]

***Significant at *P*<0.05, [1]Chi-squared test, [2]Fisher's exact test, [3]Mann-Whitney U Test

Table 8: Comparison of prevalence of any ocular morbidity, refractive error, and color blindness from representative population of different regions of India

Study	Participants (*n*); Age group (years)	Prevalence of any ocular morbidity (%)	Prevalence of refractive error (%)	Prevalence of color blindness (%)	Region of study
Gupta *et al.*[6]	1561; 6-16	31.6%	22%	2.3%	Shimla, North India
Agrawal *et al.*[9]	1557; 5-15	21.2%	5.2%	3.3%	Raipur, Central India
Sarkar *et al.*[11]	540; 11-17	76.3%	57.4%	3.1%	Meghalaya, East India
Akarkar *et al.*[12]	817; 6-10	13.22%	9.55%	0.12%	Goa, Southern India
Hashmi *et al.*[10]	705; 5-16	23.3%	13.19%	0.009%	Aligarh, North-western India
Mittal *et al.* (Current Study)	13492; 6-16	23.2%	18.5%	2.2%	Rishikesh, North India

North India, who reported a slightly higher 31.6% prevalence of ocular morbidity. Possible reason for this was the significant contribution of refractive errors (22%) toward prevalence of ocular morbidity in their study. Both our study and by Gupta *et al.*,[6] reported nearly similar prevalence of color blindness (2.2 and 2.3%, respectively) in the study population. The studies

from different regions of India, conducted by Agrawal *et al.*,[9] and Hashmi *et al.*,[10] also reported similar prevalence of ocular morbidities comparable with our results. However, both the studies reported lower prevalence of refractive error (5.2 and 13.19%, respectively) in comparison to our study. A study by Sarkar *et al.*,[11] conducted in city of Shillong (Eastern part of

India) reported higher prevalence of ocular morbidity (76.3%) with refractive error as predominant cause (57.4%). Most of the studies conducted in various regions of India found refractive error as most common cause of ocular morbidity, which is in concurrence with our study [Table 8]. In our study, there was slight increase in prevalence of ocular morbidity in the older age group (11–16 years) compared to the younger age group (6–10 years). However, difference was statistically insignificant (*P* value > 0.05) [Table 2]. The similar trend was also observed in a study conducted by Singh *et al*.[5] The possible reason could have been that the children of older age group had more exposure to environmental insults and were more aware of their ocular problems in comparison with younger children. We also found that the students studying in private schools had higher prevalence (24.4%) of ocular morbidities as compared to those in government schools (19.6%). This can possibly be due to the fact that better socioeconomic strata in the former made them accessible to more use of mobile phone gadgets and second the large sample size in this group [Table 2]. However, a study by Gupta *et al*.[6] reported almost comparable prevalence of ocular morbidity among both government and private public schools, which is in contrast to our study.

In the current study, the prevalence of color blindness was reported to be 2.2% with males affected predominantly. Agrawal *et al*.[13] and Mahajan and Gogna reported similar male preponderance of color blindness. This could be explained by the genetic fact that hereditary transmission of color blindness is X-linked recessive, where males are affected and females are usually carriers.

Our study showed the prevalence of corneal opacity in study population to be 0.1%, which was similar to those reported by Bigyabati *et al*.[14]

The prevalence of vitamin A deficiency was found to be 0.4%, which was much lower as reported by Agrawal *et al*. (9–11.1%)[9] due to urban setting and improvement in immunization coverage nowadays. Such high prevalence of vitamin A deficiency reported by Agrawal *et al*.[9] could be explained by data from national family health survey-3, which showed that state Chhattisgarh was among the last three states who missed opportunities for vitamin A supplementation in almost 80% cases.[15]

In our current study, the prevalence of strabismus was found to be 0.6%, which is lesser than reported in the study by Sarkar *et al*.[11] Our study reported allergic conjunctivitis as an important type of conjunctivitis with estimated prevalence of 0.8%, which was in accordance with the results reported by the International Study of Asthma and Allergies in Childhood (0.8–14.9%).[16]

Limitation of study

As our study was an urban setting-based screening study; hence, results may not be comparable to the rural setting-based school study. Also, due to time constraint and logistical issues, we could not be able to analyze refractive errors into further subtypes. There is gross difference in the sample size between Government and private schools. Testing of color vision by Ishihara chart can miss detection of milder version.

Conclusion

The results of such a large-scale school-based eye screening study may reflect the current true prevalence of ocular morbidities among school-going children in the region of North India. Refractive error was found to be the most common ocular morbidity followed by color blindness. Hence, data from this study could be utilized in devising and implementation of cost effective, school level, health facility-based appropriate eye care strategies targeting the school-going age group to reduce burden of visual impairment among vulnerable population in the country, especially in Northern India.

Conflicts of interest

There are no conflicts of interest.

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