Original Article

Prevalence of ocular morbidities among school children in Raipur district, India

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Purpose: To estimate the prevalence of various ocular morbidities in school children (5–15 years) utilizing a comprehensive mobile eye unit in Central India. **Methods:** A prospective, cross-sectional, school-based observational study was carried out in Raipur, Chhattisgarh, India between December 2017 and September 2018. A total of 1557 eligible school-going children in the age group 5–15 years were evaluated. Random sampling was done to allocate schools (n = 29) and children from various urban and rural (836 vs 721) schools. The primary objective was to estimate the prevalence of ocular morbidities in school-going children in Raipur district, India. The secondary objective was to analyze whether geographical location (rural vs urban), age group, and gender led to any differences in ocular morbidity patterns. **Results:** The mean age of the study population was 10.3 ± 2.4 years. There were 691 (44.4%) boys and 866 (55.6%) girls. Ocular morbidity was present in a total of 331 (21.2%) children. Vitamin A deficiency was the most common cause of ocular morbidity, noted in 156 (10%) children, followed by refractive error (81, 5.2%). Myopia was significantly higher in urban school children (4.3%) compared to rural children (1.9%) (P = 0.002). The older age group had a higher prevalence (7.6%) of refractive error, especially myopia, compared to the younger age group (2.2%) (P < 0.001). **Conclusion:** Vitamin A deficiency prevalence was much higher indicating missed opportunities for vitamin A supplementation at a younger age. Refractive error was more prevalent in the urban population as well in the older age group (11–15 years), indicating a need for frequent eye screening.

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Worldwide, childhood blindness accounts for the second largest cause of blind-person years, after cataract.[1] 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.[2,3] Uncorrected refractive errors are a significant cause of avoidable visual disability, especially in developing countries.[3] Holding the book up close to face, squeezing the eyes, or even not doing the work requiring visual attentiveness are a few signs which tell us about the adjustment of a child to poor eyesight. Vision 2020: The Right to Sight has included the correction of refractive errors as a priority component within the planned areas of action. Factors other than refractive errors such as amblyopia, strabismus, vitamin A deficiency, cataract, corneal opacity, lid disorders, and retinal disorder are largely unaccounted causes for ocular morbidity in children. The presence of any of these morbidities, not only affects the learning ability of a child but also has an impact on adjustment in the school and personality development as a whole.

Population-based studies for the age group 5–15 years have estimated the prevalence of blindness as 1.25/1000 and 0.53/1000 children in rural and urban areas, respectively.[4,5] A comprehensive data on causes and prevalence of ocular morbidity in children is essential for planning and evaluating, preventive and curative services for children in a given region.

The prevalence of childhood blindness is very difficult to ascertain, and there is not enough reliable data from developing countries. In India, there have been few published studies from northern, southern, eastern, and western parts of India. But there has been a lack of comprehensive data on ocular comorbidities from central India, especially, in school-going children. The previous studies have found that there have been dismally low referral rates after school screening, leading to attrition bias.[6] Keeping all these points in mind, this study was designed to determine the prevalence of ocular morbidity among the school-going children in Raipur, Chhattisgarh. In this study, we examined school children in a mobile van, where we were able to evaluate a child comprehensively, obviating the need for referral to the base hospital.

Methods

This cross-sectional study was designed to estimate the prevalence of ocular morbidities among school children in and around Raipur, between December 2017 and September 2018. Institutional Ethics Committee approval was obtained and the study was conducted in full accord with the tenets of the Declaration of Helsinki. Data related to urban and rural schools in all four divisions of Raipur district were collected from the local education office. Children in the age group 5–15 years

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from urban and rural schools were included for the evaluation. To achieve a confidence interval of 95% with a precision of 2%, the sample size calculated was 1537 from 29 randomly selected primary and middle schools, based on a prevalence of ocular morbidity of 20%. The estimated population size gave us a ratio of 1:1.14 for rural:urban. Following stratified random sampling, evaluation of 715 rural and 822 urban children was planned, based on the ratio. The school principal was approached 2 days prior to the day of screening and written permission was obtained. Consent forms were distributed to a total of 60 boys and girls from primary and middle schools ensuring equal distribution between different standards. Children who were not able to bring back the signed consent form from parents or were absent on the day of screening were excluded from the study. For the analysis, children were divided into 2 groups, Group 1 (5-10 years) and Group 2 (11-15 years), based on age.

A well-equipped and well-lit mobile eye unit was utilized for comprehensive evaluation. The mobile eye unit comprised of vision drum, trial box, retinoscope, slit-lamp bio-microscope, applanation tonometer and also has a non-mydriatic fundus camera installed in it. The study field staff included 1 ophthalmologist (Principal investigator), 2 optometrists, and 1 outreach coordinator. Optometrists were guided about the assessment pattern and initial evaluation was done by them. History was noted in the study proforma. Any relevant point mentioned by the class in charge regarding the ocular health of the child was also noted. Visual acuity (VA), both aided and unaided, was assessed by Snellen's chart available in both English and Hindi. Distance VA was measured with a pinhole to assess possible refractive error. Near vision was assessed by reduced Snellen's chart for near. All children with VA <6/9 had undergone dry retinoscopy and subjective correction. Cycloplegic refraction was not done at the school level. Color vision was tested using the Ishihara Plates in children with visual acuity better than 20/200 in broad-daylight. Further evaluation was performed by an ophthalmologist. Extra-ocular movements, Hirschberg corneal reflex test, and cover-uncover tests were done for squint assessment. Slit-lamp biomicroscopy was used to evaluate the anterior segment including lids, lacrimal sac, conjunctiva, cornea, anterior chamber, pupil, iris, and lens. Un-dilated fundus evaluation for a child not improving on refractive correction was done by Non-Mydriatic Fundus Camera. Whenever required, a dilated fundus examination with indirect ophthalmoscopy was done following the instillation of tropicamide (0.8%) + phenylephrine (5%) eye drops by the ophthalmologist.

Operational definitions

Ocular morbidity was defined as the spectrum of eye diseases which includes both visually impairing and non-visual impairing ocular conditions. Clinical conditions were diagnosed based on standard diagnostic criteria. A diagnosis of myopia was made if spherical equivalent (SE) refraction was ≥–0.50 diopter sphere (DS). Hyperopia was diagnosed when SE was ≥+2.00 DS and astigmatism when cylindrical power was ≥±1.00 diopter cylinder (DC) in either eye. A child was considered myopic if at least one eye was myopic and hyperopic if at least one eye was hyperopic but neither was myopic. Vitamin A deficiency in our study was diagnosed in the presence of conjunctival xerosis with Bitot's spot (X1B) or Keratomalacia (X3B) as per the WHO grading system. A diagnosis of red-green color vision deficiency was made if a co-operative child on Ishihara plates made five or more errors on the first 21 plates of Ishihara.

Statistical analysis

After checking the questionnaire for errors, the data was entered into Microsoft Excel® Spreadsheet for statistical analysis. The data was analyzed using SPSS version 16.0 for Windows (IBM® SPSS). The Chi-square and Mann–Whitney U tests were used to test the association of factors and differences in proportions, respectively. A P value of less than 0.05 was considered to be statistically significant.

Results

A total of 1740 students were allocated for the evaluation. Either due to the non-availability of the consent form or the child itself, 1557 (89.5%) were included for the final evaluation. The mean age of the study population was 10.3 ± 2.4 years. The number of children from urban schools were 836 (53.7%), while 721 (46.3%) children were from rural schools. There were 691 (44.4%) boys and 866 (55.6%) girls. In the study population, ocular morbidity was present in a total of 331 (21.2%) children [Fig. 1].

Vitamin A deficiency was found to be the most common cause of ocular morbidity, noted in 156 (10%) children. All diagnosed cases had Bitot's spots, none had keratomalacia. Refractive error was present in 81 (5.2%) children out of which myopia was the most common, noted in 50 (3.2%) children followed by astigmatism in 22 (1.4%) children and the least common was hyperopia seen in only 9 (0.6%) children. Color blindness was present in 52 (3.3%) children. Eyelid disorders such as blepharitis, external hordeolum, congenital ptosis, and chalazion in decreasing order of frequency were noted in 25 (1.6%) children. Other morbidities which were less in number includes conjunctival disorders such as adenoviral conjunctivitis, vernal keratoconjunctivitis, allergic conjunctivitis, and subconjunctival hemorrhage noted in 15 (0.9%) children. Corneal disorders like the presence of corneal scar (post-trauma/exposure to foreign body), retinal disorders like choroidal coloboma and retinitis pigmentosa, and amblyopia were noted in 6 (0.4%) children each. Squint was noted in 3 (0.2%) children and all the cases were of intermittent exotropia.

Ocular morbidity was noted more in urban children (22.2%) as compared to rural children (20.1%) although this difference was statistically insignificant ($P = 0.249$) [Table 1]. However, the difference in refractive error was statistically significant between both the groups ($P = 0.002$). Myopia was the major contributor, as it was higher in children from urban school 36 (4.3%) compared to the ones studying in rural setting 14 (1.9%) ($P = 0.002$). On the gender-based assessment of ocular morbidity patterns, a statistically significant difference ($P < 0.001$) was noted in boys (25.3%) as compared to girls (18%) [Table 2]. The

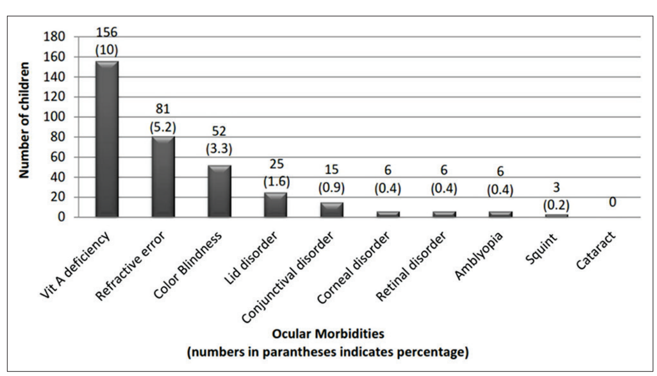

Figure 1: Prevalence of various ocular morbidities in the study population

statistical difference was mainly contributed by red-green color deficiency ($P = 0.025$) and conjunctival disorders ($P = 0.023$). When ocular morbidity was analyzed in the aforementioned two age groups, group 2 (22.4%) had a higher prevalence of ocular morbidity as compared to group 1 (19.7%) but this difference was statistically insignificant ($P = 0.192$) [Table 3]. Refractive error was the only factor that attained a statistically significant difference ($P < 0.001$). Myopia was noted to be higher in group 2, 42 (4.8%), compared to group 1, 8 (1.1%), ($P = 0.006$).

Discussion

The prevalence of ocular morbidity in the present study was found to be 21.2%. Prevalence has varied from region to region among previous studies. A study from Kathmandu by Shrestha and Shrestha[7] has reported a similar and comparable prevalence of ocular morbidity (21.4%). In Indian studies by Gupta *et al*.[8] and Singh *et al*.[9] a higher prevalence of 31.6% and 29.35%, respectively, has been reported. This was most likely due to the significant contribution towards morbidity by the higher prevalence of refractive errors in their study, which was comparatively low in the present study.

The prevalence of refractive error was found to be 5.2% in the present study, which was comparable with the prevalence reported by Padhye *et al*.[10] (4.04%). Similar results were reported by Rahman *et al*. (8.8%).[11] However, a higher prevalence of refractive error, from studies outside India, has been reported by He *et al*.[12] (21.1%), Aldebasi[13] (18.6%), and Shrestha and Shrestha.[7] (10%). This could be due to the inclusion of cycloplegic refraction in the methodology in all these studies and also the fact that Shrestha and Shrestha.[7] had included children from class 1 to 10 in their study, hence a higher prevalence. Although cycloplegic refraction is considered the gold standard for pediatric refraction, studies have shown that non-cycloplegic refraction, when combined with subjective refractive, is fairly accurate compared to cycloplegic refraction in children above 6 years of age.[14] Hence, in the absence of parents, we decided to forego cycloplegic refraction at the school level. There have been various studies from different zones of India [Table 4]. In a study by Biswas *et al*.,[15] a higher prevalence (23.67%) was reported which was non-comparable, this could be due to the fact that it was a hospital-based study. Gupta *et al*.[8] reported the prevalence of refractive error as high as 22% and this could be attributed to the fact that the entire study population was from an urban setting. In the present study also, we have noted a trend of higher prevalence of refractive errors in the urban setting. Singh *et al*.[9] obtained a higher prevalence of 17.36% of refractive errors. As cut off visual acuity was taken as 6/6 to subject a child for subjective refraction, whereas in the present study, it was 6/9; this is the most likely explanation for the difference between both the studies. Kalikivayi *et al*.[16] also reported a higher prevalence (13.8%) but this could be due to the greater age range (3–18 years) of the study population. In the present study, we also observed an increase in the prevalence of refractive errors with an increase in age. Hashia and Slathia[17] (11.6%) have also reported a higher and non-comparable prevalence, as this was a hospital-based study in an urban setting. Bigyabati *et al*.[18] also reported a higher and non-comparable prevalence of 16.4%.

Myopia was the most common refractive error with a prevalence of 3.2%. The prevalence of hyperopia noted was 0.6% and that of astigmatism was found to be 1.4%. Aldebasi[13] reported a similar prevalence of myopia (5.8%) and hyperopia (0.7%). Padhye *et al*.[10] reported a 4.61% prevalence of myopia which was comparable with the present study; however, the prevalence of hyperopia and astigmatism reported was 1.45% and 0.37%, which was higher than the present study. Hashia and Slathia[17] reported the prevalence of myopia to be 4.36%, hyperopia to be 0.93% which was

Table 1: Prevalence of various ocular morbidities based on area

Ocular morbidity	Area		*P*
	Urban (*n*=836)	Rural (*n*=721)	
Ocular Morbidity	186 (22.2%)	145 (20.1%)	0.249
Refractive error	56 (6.6%)	25 (3.4%)	0.002
Squint	2 (0.2%)	1 (0.1%)	0.652
Vit A deficiency	76 (9%)	80 (11.1%)	0.189
Conjunctival disorder	10 (1.1%)	5 (0.7%)	0.311
Corneal disorder	5 (0.6%)	1 (0.1%)	0.145
Cataract	0 (0)	0 (0)	1
Lid disorder	16 (1.9%)	9 (1.2%)	0.298
Retinal disorder	4 (0.5%)	2 (0.3%)	0.523
Amblyopia	5 (0.6%)	1 (0.1%)	0.145
Red green color deficiency	25 (3%)	27 (3.7%)	0.409

Table 2: Prevalence of ocular morbidity based on gender

Ocular morbidity	Gender		*P*
	Boys (*n*=691)	Girls (*n*=866)	
Ocular Morbidity	175 (25.3%)	156 (18%)	<0.001
Refractive error	29 (4.1%)	52 (6%)	0.111
Squint	3 (0.4%)	0 (0%)	0.052
Vit A deficiency	78 (11.2%)	78 (9%)	0.137
Conjunctival disorder	11 (1.6%)	4 (0.4%)	0.023
Corneal disorder	4 (0.6%)	2 (0.2%)	0.271
Cataract	0 (0)	0 (0)	1
Lid disorder	9 (1.3%)	16 (1.8%)	0.395
Retinal disorder	3 (0.4%)	3 (0.3%)	0.781
Amblyopia	4 (0.6%)	2 (0.2%)	0.271
Red green color deficiency	46 (6.6%)	6 (0.7%)	0.025

Table 3: Various ocular morbidities based on age groups

Ocular morbidity	Age group		*P*
	Group 1 (*n*=689)	Group 2 (*n*=868)	
Ocular Morbidity	136 (19.7%)	195 (22.4%)	0.192
Refractive error	15 (2.2%)	66 (7.6%)	<0.001
Squint	2 (0.3%)	1 (0.1%)	0.434
Vit A deficiency	69 (10%)	87 (10%)	0.996
Conjunctival disorder	10 (1.4%)	5 (0.6%)	0.079
Corneal disorder	3 (0.4%)	3 (0.3%)	0.776
Cataract	0 (0)	0 (0)	1
Lid disorder	13 (1.8%)	12 (1.4%)	0.432
Retinal disorder	1 (0.1%)	5 (0.6%)	0.173
Amblyopia	4 (0.5%)	2 (0.2%)	0.173
Red green color deficiency	26 (3.7%)	26 (3%)	0.396

Table 4: Representative comparison of prevalence of refractive error from different zones of India

Region	Study	Participants (*n*); age group (y)	Prevalence (%)
North	Gupta *et al.*	1561; 6-16	22
East	Bigyabati *et al.*	1700; 5-15	23.67
West	Padhye *et al.*	12422; 6-15	8.09
South	Kalikivayi *et al.*	3669; 3-18	13.8
Central India (present study)	Agrawal *et al.*	1557; 5-15	5.2

comparable, however, astigmatism was reported to be 6.38%, which was non-comparable. Krishnan *et al*.[19] reported the prevalence of myopia, hyperopia, and astigmatism as 6.81%, 0.61%, and 1.64%, respectively. The prevalence of myopia was higher but the prevalence of hyperopia and astigmatism were similar and comparable. In another study by Rahman *et al*.,[11] a higher and non-comparable prevalence of myopia (7.17%), hyperopia (1.50%), and astigmatism (2.17%) was reported. Myopia was the most common refractive error. It was noted to be significantly higher in urban children and also in older age group children (11–15 years). Previously published studies have shown that with an increase in literacy rate, duration of study hours and age of the child, all these factors are associated with a higher prevalence of myopia in the urban group.[10,20,21] A child in the urban area spends more time reading and writing outside of school compared to a child in the rural area.[21,22]

Prevalence of Vitamin A deficiency was noted to be as high as 10%. This was comparable with a study done by Chaturvedi *et al*.[23] who reported a prevalence of 10.6%. However, Rahi *et al*.[24] reported prevalence as high as 19% and this was possibly due to the fact that the study was conducted across 9 states of India (7.5%–26.7%). Among the 9 states analyzed by Rahi *et al*.,[24] Madhya Pradesh contributed the most towards visual disability due to vitamin A deficiency and Chhattisgarh was part of Madhya Pradesh before 2000; hence, we can expect a higher prevalence of vitamin A deficiency in central states of India. Data from national family health survey-3 (NFHS-3) (2005-06) showed that Chhattisgarh falls in the last 3 states, accounting for up to 80% missed opportunities for vitamin A supplementation.[25,26] However, data from NFHS-4 shows improvement in the immunization coverage in the age group 12-23 months. The age group we analyzed was not part of the NFHS-4 survey but would have been a part of the NFHS-3 survey which could be the reason for the higher prevalence of vitamin A deficiency in the present study.[26,27] Although these studies are from the 1990s and if we compare it with studies recently published, Gupta *et al*.[8] reported the prevalence to be 1.8%. The lower prevalence in this study could be attributed to the fact that the study was conducted in an urban setting. However, in our study, the prevalence of vitamin A deficiency was comparable in both rural and urban settings (9% vs 11.1%; $P = 0.189$). Singh *et al*.[9] also reported a lower prevalence of 2.09%. Conjunctival xerosis/Bitot's spot (X1B) is considered as a public health problem if prevalence in a population aged up to 71 months of age is >0.5%.[28] In older age groups, it serves as a reminder of a period of malnutrition/missed opportunities for supplementation. In fact, our data corroborate the findings of NFHS-3. Recent studies done elsewhere in India had not reported such high rates of vitamin A deficiency and hence we did not aim for a detailed history or serum retinol level, which would have been difficult at the school level. We agree that it is a limitation of our study.

In the current study, the prevalence of red-green color deficiency was found to be 3.3% and this was similar to results reported by Gupta *et al*.[8] (2.3%). Prevalence was more in boys (6.6%) compared to girls (0.7%), which was similar and comparable with the prevalence reported by Mahajan and Gogna[29] in males (3.85%) and females (0.38%). Male children tend to have higher color vision defects frequency which supports the genetic fact that color vision is of X-linked recessive nature.[30] As there is a significant difference in red-green color deficiency between boys and girls, this could be a possible explanation for a significant difference in the overall ocular morbidity between both genders. Eyelid disorders accounted for the prevalence of 1.6%. Hashemi *et al*.[31] reported the prevalence of ptosis to be 1.41%. Singh *et al*.[9] found the prevalence of blepharitis to be 2.11% and stye to be 0.31%. However, Bigyabati *et al*.[18] found the prevalence of eyelid disorders to be 0.4%. The prevalence of conjunctivitis in the present study was found to be 0.9% and this was similar and comparable with the prevalence reported by Gupta *et al*.[8] (0.8%) and Bigyabati *et al*.[18] (0.3%). Singh *et al*.[9] in their study reported the prevalence of allergic conjunctivitis as 1.92% and bacterial conjunctivitis as 0.95%. Shrestha and Shrestha[7] reported a prevalence of 4.3% of conjunctivitis. However, a higher prevalence of 17.23% was reported by Biswas *et al*.[15] which was non-comparable with the present study, this could be due to regional variation. In the present study, prevalence of squint was found to be 0.1%. Comparable prevalence of 0.1% and 0.27% were reported by Bigyabati *et al*.[18] and Singh *et al*.[9] respectively. However, Gupta *et al*.[8] reported a 2.5% prevalence of squint which was not comparable with the present study.

The prevalence of corneal opacity in the present study was 0.4% which was similar to the prevalence of 0.1% reported by Bigyabati *et al*.[18] but was higher than reported by Singh *et al*.[9] (0.04%). The prevalence of amblyopia was found to be 0.4% which was comparable with the prevalence reported by Singh *et al*.[9] (0.41%). Ganekal *et al*.[32] reported a similar prevalence of 1.1% of amblyopia. However, a higher prevalence of 8.6% was reported by Gupta *et al*.[33] which was non-comparable with the present study. Retinal disorders which usually go undiagnosed and unreported were found to be 0.4% prevalent which mainly included morbidities like choroidal coloboma (0.32%) and optic atrophy (0.08%). In one of the previous studies,[9] comparatively less percentage (0.1%) of cases of the posterior segment have been reported.

Conclusion

In this population-based study, we were able to collect data related to eye disorders in a comprehensive manner with the help of a mobile eye unit. Vitamin A deficiency was the most common morbid condition in the present study and it was prevalent in both urban and rural populations. This indicates missed opportunities for vitamin A supplementation at a younger age. This can be corrected by nutritional supplementation and more effective immunization coverage. Overall ocular morbidity was noted more in the urban population.

Refractive error, especially myopia, was more prevalent in the urban population as well in the older age group (11–15 years). Measures to assess uncorrected refractive errors, provision of refractive services, and meeting health needs should be monitored at the national level to identify communities in need and evaluate the most cost-effective ways to screen and treat. State department of health and welfare can take help of consolidated data from a study like ours to be better prepared medically and infrastructurally, to run more efficient and regular screening as well as treatment programs. As this was a population-based study, the inability to perform cycloplegic refraction and serum analysis of Vitamin A levels were the limitations of this study.

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Conflicts of interest

There are no conflicts of interest.

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