Prevalence and determinants of refractive status and related ocular morbidity among Indian school children in Riyadh, Saudi Arabia

ZiaulHaq Yasir, Rajiv Khandekar, Malek A. Balous , Abdulrahman S. Banaeem, Ahmad K. Al-Shangiti, Fatimah A. Basakran, Nora A. Alhumaid, Hassan A. Al-Dhibi

Access this article online

Quick Response Code:

Website: www.saudijophthalmol.org

DOI: 10.4103/1319-4534.337848

Abstract:

PURPOSE: We present the magnitude and determinants of refractive status of Indian school children in Riyadh, Saudi Arabia.

METHODS: This cross-sectional study was conducted in 2017–18 at a preparatory and secondary Indian school in Riyadh. A "Spot Screener" was used to determine if the child passed or failed a refraction test. Data were collected on refractive status in each eye, amblyopia, and strabismus. The type of refractive error (RE) was estimated and association to the gender, age group, and higher education was analyzed.

RESULTS: We examined 770 students. The prevalence of RE in Indian school children was 50.3% (95% confidence interval [CI]: 51.3; 58.3). There were 51.1% of boys and 49.3% of girls. The prevalence of RE in preparatory and secondary grade students was 47.9% and 56.8%, respectively. The proportion of myopia and hyperopia among children with RE was 48% and 5%, respectively. Family history of RE was positively associated to RE in school children (odds ratio: 1.5 [95% CI: 1.1; 2.0]). The existing refractive services provided 47.4% coverage for children with RE. The current screening initiative could identify 22 (2.9%) new cases of RE who required visual aids and 38 (4.9%) students who needed a new prescription for RE. The compliance rate for using visual aid among students with RE was 78.9%. The prevalence of amblyopia and strabismus was 1.2% and 11%, respectively.

CONCLUSION: A high proportion of Indian school students in Riyadh have RE. Periodic ocular assessment and refractive services are recommended for this group of school children.

Keywords:

Children, compliance, myopia, refractive error, screening

Introduction

The World Health Organization (WHO) estimated 19 million children under 15 years of age were visually impaired. Uncorrected refractive error (RE) was the main cause among 12 million children with visual impairment (VI).[1] RE included myopia, hyperopia, and astigmatism among children.[2] In addition to the magnitude, the refractive status changes as children grow, resulting in frequent reassessment and management of RE.[3] Unfortunately, unattended VI in children can have a lifelong impact on their learning ability, academic performance, and personality.[4] Its essential to detect and address eye disorders in children as early as possible and then monitor them periodically. The WHO recommends vision screening of school children and provides them refractive services.[5]

Refractive development is influenced by both environmental and genetic factors.[6] The interplay between genes and environment may account for a substantial proportion of the phenotypic variance.[7] The RE is the leading cause of VI in Saudi children of Riyadh.[8] The pattern of ocular disease varies from country to

Department of Research, King Khaled Eye Specialist Hospital, Riyadh, Kingdom of Saudi Arabia

Address for correspondence:
Dr. ZiaulHaq Yasir, Department of Research, King Khaled Eye Specialist Hospital, 2775 AlUrubah Road, Umm AlHamam AlGharbi, Unit 2, Ar Riyadh, Kingdom of Saudi Arabia.
E-mail: yasir0075@yahoo.co.in

Submitted: 12-Feb-2019
Revised: 03-Oct-2019
Accepted: 07-Jul-2020
Published: 18-Feb-2022

How to cite this article: Yasir Z, Khandekar R, Balous MA, Banaeem AS, Al-Shangiti AK, Basakran FA, *et al*. Prevalence and determinants of refractive status and related ocular morbidity among Indian school children in Riyadh, Saudi Arabia. Saudi J Ophthalmol 2021;35:97-101.

country and even from region to region in the same country.[9] The RE ranged from 26.4% in <8-year-old children of southern Saudi Arabia to 34.9% among 3–10-year-old children in west Saudi Arabia.[10,11] Indian children in Delhi had 13% prevalence of myopia.[12] In contrast, children in a southern region of rural India had a 2.2% prevalence of RE.[13]

Methods

In this cross-sectional study, we included children from Indian schools in Riyadh, Saudi Arabia. This study was conducted between Dec 2017and June 2018. The institutional research and ethics board approved this study (1633-P). Written informed consent was obtained from the school authorities. Students of preparatory (12–14 years old) and secondary grades (aged 15–18 years) were included. Students who were absent on the day of screening or did not want to participate were excluded.

We assume that prevalence of RE among school children would be 13.7%.[14] To achieve 95% CI, acceptable error margin of 3% and clustering effect of 1.5 for a population of 1 million, we need to evaluate the refractive status of 757 children.

Our team consists of an ophthalmologist, an epidemiologist, and medical students. Medical students were trained in using the "Spot Screener" (WelchAllyn, USA). An ophthalmologist supervised the field activities. A separate room was provided by the school authorities to undertake vision screening. Demographic data such as age and gender were collected from the school records. Data were collected on spectacle wear, contact lens usage, history of eye surgery, ophthalmic/optical consultation in the past, family history of RE. The contact lens users were further inquired if they were using contact regularly or occasionally.

The Spot Screener was used in this study as it is easy to handle, user friendly, both eyes can be tested simultaneously, and the results are available in seconds The "Spot Screener" was calibrated every day to minimize measurement bias. During measurements, it was held at a distance of 1 m from the child. The distance was then adjusted based on the message displayed on the monitor. If the message was "too far," the Spot Screener was moved closer to the child. If it was "too close," the Spot Screener was slowly moved away from the child without losing the focus from the child's eyes. The device produces a noise to attract the student's attention and keep the child fixating. In approximately 5–10 s, a "Pass" or "Fail" message is displayed on the monitor. A "Pass" indicated that the participant had no defects or marginal RE. A "fail" indicates that the eye has a visual defect. In addition to the test result, the refractive status of each eye is also displayed in the sphere, cylinder, and axis. The student was labeled with "failed test" based on the "spot screener" measured RE of > ±0.75D in either eye. We also assessed the visual acuity (VA) with the help of the Lea symbol chart placed in the lightbox that was held at 3 m away from the student and recorded his/her distance VA in LogMAR notation. The finding of spot screener was matched with the distance VA. If the WHO grade of VI matched with the severity of RE, we considered VI due to RE. These students were advised to consult an optometrist and/or an ophthalmologist for further eye care. If a message indicated that the pupils were constricted, ambient room lighting was reduced, and the test was repeated.

The spherical equivalent (SE) was calculated using the standard formula:

SE = sphere + (cylinder/2). The higher value of RE between eyes of an individual defined his/her RE status. Emetropia was defined as RE between <−0.5D and <+0.5D. Myopia was defined as ≥−0.5 D (Diopter). Myopia was further graded into: low myopia (≥−0.5 to <−3D), moderate myopia (≥ −3D to ≤ −6D), and high myopia (>-6D).[15] Hyperopia was defined as RE ≥+0.5D. Hyperopia was further graded as: low hyperopia (≥ +0.5D to ≤+2D), Moderate hyperopia (≥+2.25D to ≤+5D), and high hyperopia (>+5D). Astigmatism was defined as eye with RE ≥ 1D cylinder. Anisometropia was defined as RE difference greater 2.5 D between eyes.[16] The functionally normal vision was ≥20/20 to ≤20/60 with pinhole correction. Moderate VI was defined as presenting VA of ≥20/70 to ≤20/160 in better eye. Severe VI (SVI) was define as presenting VA of ≥20/200 to ≤20/400 in better eye.[17]

The data were collected on a pretested collection form and subsequently entered into an Excel® spreadsheet (Microsoft Corp., Redmond, WA, USA). The data were reviewed for errors and then transferred to the Statistical Package for the Social Studies (SPSS-22; IBM Corp., Armonk, NY, USA). For qualitative data, the frequencies and the percentage proportions were calculated. For quantitative data, normality was tested, and the mean and standard deviations were calculated if the variable was distributed normally. To associate the outcome to the determinants like age, gender, grade of school and history of RE in family, the odds ratio, and the 95% confidence interval (CI) and a two-sided "*P*" value was calculated. A value of $P < 0.05$ was considered statistically significant.

Results

Of 786 students enrolled, 770 were examined (6 male students of grade 9 refused and 10 students were absent). The median age of the study sample was 13.4 years. The mean age was 13.7 (minimum 7 and maximum 19). Among them, 413 (53.6%) were boys. There were 543 (70.5%) preparatory grade students and 227 (29.5%) secondary school students.

The refraction test by using the spot screener was passed by 383 (49.7%) students and 387 (50.3%) failed the test. The prevalence of RE in Indian school children that required spectacle prescription at the time screening was (348) 45.2% (95% Cl: 41.7; 48.7). The prevalence of RE in subgroups is presented in Table 1.

The proportion of different types of RE is presented in Figure 1.

Uncorrected VA (UCVA) based on VI grades among Indian school children at Saudi Arabia is presented in Figure 2.

The details of visual aid-related history and health behavior regarding the use of visual aid are presented in Table 2. The compliance of spectacle ware was 78.9% (95% CI 74.7; 83.1)

There were 60 (7.8%) new cases of RE or children with changed prescription who required spectacles during the study (Yield of screening). The existing refractive services (eye department + optical shops) did not reach these cases.

The subtypes of RE among boys and girls are presented in Table 3.

The subtypes of RE among preparatory and secondary school students are presented in Table 4.

Discussion

This study focused on preparatory and secondary school children in Indian schools in Riyadh, Saudi Arabia. The outcomes of this study indicate that half of the children had RE and needed visual aids. Only 2.9% of these were detected with RE for the first time. One in five had a change in prescription and required revised visual aids. The noncompliance rate for using visual aids was 21.1% on the day of examination. Age and higher education were positively associated with RE, especially myopia.

The prevalence of RE among Indian school children in Saudi Arabia was 50.3%. It was similar to the rate (59.5%) noted in urban school children (6–17-year-old) in Eastern India.[9] Prema reported a 30.5% prevalence of RE among children who were 12-year-old in a community in south India.[18] This variation in RE rate could be due to differences in age groups, location of assessment, and methodology. The parents of the study participants are educated and more vigilant on their study performance. Perhaps, this could have resulted in the high rate of timely assessment of vision and visual aid provision for RE.

The prevalence of RE in boys and girls in our study was similar. This does not match with the gender proportion of RE noted in previous studies. In North Indian students, RE rate was higher in males compared to females. However, it was a hospital-based study.[19] In another population-based study in South India, girls had a higher prevalence of RE compared to boys.[18] It seems that the utilization of RE services vary by gender in different parts of India. Gender equality among children of educated parents in our study could have resulted in similar access to visual aids and RE services.

The prevalence of RE was higher among secondary grade students than preparatory students. RE is positively associated

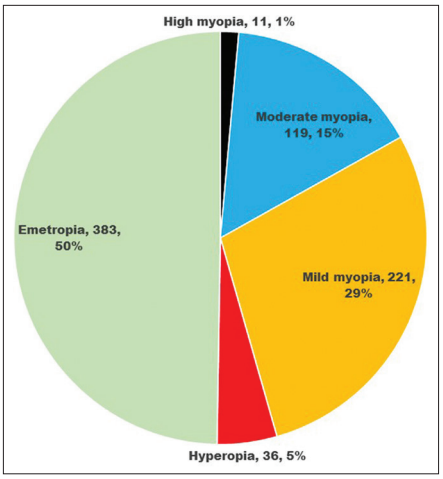

Figure 1: The proportion of different types of refractive error among Indian school children at Saudi Arabia

Table 1: Prevalence of refractive error and related eye conditions in Indian school children in Riyadh

	Examined	Refractive error+	Prevalence	95% CI	Validation, OR (95% CI), *P*
RE in Indian students	770	387	50.3	46.7-53.8	
Gender					
Male	413	211	51.1	46.3-55.9	1.1 (0.8-1.5), 0.6
Female	357	176	49.3	44.1-54.5	
School grade					
Preparatory	543	258	47.5	43.3-51.7	0.7 (0.5-0.9), 02
Secondary	227	129	56.8	50.4-63.3	
Age-group					
12-14	579	278	48.0	43.9-52.1	0.7 (0.5-0.95), 0.03
15-18	191	109	57.1	50.0-64.1	
Family history of RE					
None	426	191	44.8	40.1-49.5	1.6 (1.2-2.2), <0.001
Siblings	344	196	57.0	51.8-62.2	
Type of RE					
Myopia	770	351	45.6	42.1-49.1	
Hyperopia	770	36	4.7	3.2-6.2	
RE in Indian students that need visual aid as per spot screener	770	348	45.2	41.7-48.7	
Amblyopia in Indian students	770	9	1.2	0.4-1.9	
Strabismus in Indian students	770	85	11.0	8.8-13.3	
Anisometropia (difference of >2.5 D)	770	51	6.6	4.9-8.4	

RE=Refractive error; CI=Confidence interval

Table 2: Risk factors of refractive error and health behavior regarding use of visual aid among Indian school children in Riyadh

	n (%)
Advised use of spectacles in past	
Yes	365 (47.4)
No	405 (52.3)
Contact lens usage	
Regular	8 (1.0)
Occasional	6 (0.8)
Not using	756 (98.2)
Past history of ocular surgery	
No	765 (99.4)
Yes	5 (0.6)
Retinal hole sealing	1 (0.1)
Refractive surgery	1 (0.1)
Ocular trauma	1 (0.1)
Unknown	2 (0.1)
Using spectacles at time of screening	
Yes	288 (78.9)
No	77 (21.1)

Table 3: Refractive error subtypes among Indian school children at Saudi Arabia by gender

	Male, *n* (%)	Female, *n* (%)	Validity (χ^2, df, *P*)
High myopia	8 (4.2)	3 (1.9)	3.9, 2, 0.06
Moderate myopia	70 (36.8)	49 (30.4)	
Mild myopia	112 (59.0)	109 (67.7)	
All myopia	190 (46.0)	161 (45.1)	0.1, 2, 0.95
Emmetropia	202 (48.9)	181 (50.7)	
Hyperopia	21 (5.1)	15 (4.2)	

Fisher's extract $P<0.05$ is statistically significant

Table 4: Refractive error subtypes among Indian school children at Saudi Arabia by school grade

	Preparatory, *n* (%)	Secondary, *n* (%)	Validity (χ^2, df, *P*)
High myopia	5 (0.9)	6 (2.6)	0.1, 2, 0.8
Moderate myopia	85 (15.7)	33 (14.6)	
Mild myopia	145 (26.7)	77 (33.9)	
All myopia	235 (43.3)	116 (51.1)	5.7, 2, 0.058
Emmetropia	285 (52.5)	98 (43.2)	
Hyperopia	23 (4.2)	13 (5.7)	

Fisher's extract $P<0.05$ is statistically significant

with the age of school children.[20,21] Even in community-based study, this association of age to RE was noted among children.[22]

The compliance rate for visual aid among Indian students in our study at a gulf country was 78.9%. Compliance was 21.7% and 7.3% in studies of children in India.[18,19] Our study was hospital based while the India studies were community based.[18,19] Studies from other gulf countries reported compliance rates ranging from 42.3% to 71.6%.[23,24] A number of causes have been noted for noncompliance among Indian students.[19,25] The reasons for high compliance among Indian school children in Saudi Arabia should be further evaluated.

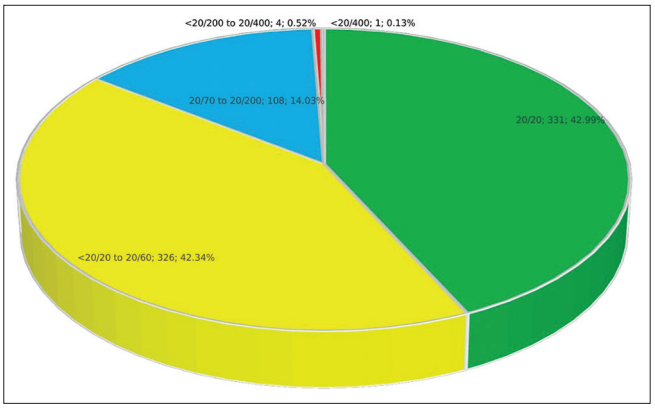

Figure 2: Uncorrected visual acuity -based visual impairment grades among Indian school children at Saudi Arabia

RE in students was positively associated with family history of RE among parents and siblings. This observation is consistent with Mittal *et al*.'s and Pavithra *et al*.'s findings.[19,21] Counseling and motivational activities for early detection of RE is recommended if a positive family history of RE is present.

The prevalence of amblyopia among school children in our study was 1.2%. This was lower than 7.1% noted by Mittal *et al*., but higher than 0.62% noted by Xiao *et al*.[19,26] Amblyopia in these children could have been detected and addressed early if preschool screening was introduced as recommended internationally.[27]

The prevalence of strabismus in our study was 11%. This was higher compared to 2.7% reported in a school based study using the cover/uncover test in north India.[28] In a hospital-based study using similar method, the rate of strabismus was 6.1%.[19] However, torchlight examination to define strabismus reported a prevalence of strabismus of 5.7%.[20] It should be noted that in our study, the misalignment was labeled by the Spot screener finding. The variation of methods to assess strabismus should be noted while comparing the rates of strabismus in these studies. Further evaluation of cases with strabismus is warranted and if found correct needs to be addressed. All these studies favor eye screening at an earlier age to detect this ailment and for management.

The difference in the prevalence of myopia among males and females in our study was not significant. Saxena *et al*. found a higher rate of myopia among female children and concluded it to be due to more time spent by females indoors.[12] Indian students of both genders studying in Saudi Arabia are equally exposed to indoor and outdoor activities but spend more time reading, writing, playing video games, and watching television (TV) at home instead of spending time on outdoor sports. Sustained near work and reduced outdoor activity have be associated with early onset and rapid progression of myopia in children.[12]

The prevalence of myopia among secondary students was higher compared to preparatory students. More near work,

studying/reading >5 h a day, watching TV >2 h a day, and playing computer/video/mobile games for long periods have been associated with the development of myopia.[12]

UCVA based on VI grades among Indian school children reports moderate and SVI without visual aid among 15% of children [Figure 2].

There were some limitations to our study. Strabismus evaluation was based on the Spot screener's report and not verified by a cover/uncover test. The RE was also based on the prescription generated by the Spot screener and was not verified by cycloplegic refraction. This could have resulted in underestimation of RE, especially of hyperopia. The selection of one school from three Indian schools with higher education was not random. Hence, extrapolation of results to all Indian school students should be done with caution.

The high rate of RE among preparatory and secondary Indian school students in Riyadh is concerning. Family history of RE was a significant indicator of RE in school children and it could be used to label high risk group of school students who could be focused more frequently on RE screening. Periodic ocular assessment and providing refractive services to school students as recommended by the WHO is once again established. This rates should be compared to Saudi school students of similar grades through further studies to understand phenotype/environmental factors affecting RE.

Conclusion

The expatriate children share the same environment as Saudi children but are a different genotype. This could result in variation in the magnitude and determinants of RE even if they reside in the same region of the Kingdom. Therefore, we evaluated the magnitude and determinants of RE, other ocular morbidities, and compliance of visual aids among Indian children studying in schools in the Riyadh region of Saudi Arabia.

References

1. Rono HK, Bastawrous A, Macleod D, Wanjala E, Di Tanna GL, Weiss HA, *et al.* Smartphone-based screening for visual impairment in Kenyan school children: A cluster randomised controlled trial. Lancet Glob Health 2018;6:e924-32.
2. Aldebasi YH. Prevalence of correctable visual impairment in primary school children in qassim province, Saudi Arabia. J Optom 2014;7:168-76.
3. Rose KA, Morgan IG, Ip J, Kifley A, Huynh S, Smith W, *et al.* Outdoor activity reduces the prevalence of myopia in children. Ophthalmology 2008;115:1279-85.
4. Schneider J, Leeder SR, Gopinath B, Wang JJ, Mitchell P. Frequency, course, and impact of correctable visual impairment (uncorrected refractive error). Surv Ophthalmol 2010;55:539-60.
5. Guidelines for School Eye Health for the Eastern Mediterranean Region (EMR). Available from: https://www.iapb.org/wp-content/uploads/Guidelines-for-School-Eye-Health-for-the-EMR_2009_0.pdf. [Last accessed on 2019 May 19].
6. Wojciechowski R. Nature and nurture: The complex genetics of myopia and refractive error. Clin Genet 2011;79:301-20.
7. Fan Q, Verhoeven VJ, Wojciechowski R, Barathi VA, Hysi PG, Guggenheim JA, *et al.* Meta-analysis of gene–environment-wide association scans accounting for education level identifies additional loci for refractive error. Nat Commun 2016;7:11008.
8. Al Rowaily M, Alanizi BM. Prevalence of uncorrected refractive errors among adolescents at King Abdul-Aziz Medical City, Riyadh, Saudi Arabia. J Clinic Experiment Ophthalmol 2010;1:114.
9. Warkad VU, Panda L, Behera P, Das T, Mohanta BC, Khanna R, *et al.* The tribal odisha eye disease study (TOES) 1: Prevalence and causes of visual impairment among tribal children in an urban school in eastern India. J AAPOS 2018;22:145.e1-00000.
10. Darraj A, Barakat W, Kenani M, Shajry R, Khawaji A, Bakri S, *et al.* Common eye diseases in children in saudi arabia (Jazan). Ophthalmol Eye Dis 2016;8:33-9.
11. Al-Tamimi ER, Shakeel A, Yassin SA, Ali SI, Khan UA. A clinic-based study of refractive errors, strabismus, and amblyopia in pediatric age-group. J Family Community Med 2015;22:158-62.
12. Saxena R, Vashist P, Tandon R, Pandey RM, Bhardawaj A, Menon V, *et al.* Prevalence of myopia and its risk factors in urban school children in Delhi: The north India myopia study (NIM study). PLoS One 2015;10:e0117349.
13. John DD, Paul P, Kujur ES, David S, Jasper S, Muliyil J, *et al.* Prevalence of refractive errors and number needed to screen among rural high school children in southern India: A Cross-sectional study. J Clin Diagn Res 2017;11:NC16-9.
14. Al Wadaani FA, Amin TT, Ali A, Khan AR. Prevalence and pattern of refractive errors among primary school children in al Hassa, Saudi Arabia. Glob J Health Sci 2012;5:125-34.
15. Optometric Clinical Practice Guideline, American optometric Association. Available from: https://www.aoa.org/documents/optometrists/CPG-15.pdf. [Last accessed on 2019 May 19].
16. Optometric Clinical Practice Guideline, American optometric Association. Available from: https://www.aoa.org/documents/optometrists/CPG-16.pdf 19. [Last accessed on 2019 May 19].
17. Optometric Clinical Practice Guideline, American optometric Association. Visual Impairment. Available from: https://www.aoa.org/documents/optometrists/CPG-14.pdf. [Last accessed on 2019 May 19].
18. Prema N. Prevalence of refractive error in school children. Indian J Sci Technol 2011;4:1160-1.
19. Mittal S, Maitreya A, Dhasmana R. Clinical profile of refractive errors in children in a tertiary care hospital of Northern India. Int J Community Med Public Health 2017;3:1189.
20. Vinay BS, Shruthi BN. Prevalence of refractive error and other ocular morbidities among school going children aged 9-16 yrs in rural area of Mandya, Karnataka, India. Int J Contemp Pediatr 2016;3:509-13.
21. Pavithra MB, Maheshwaran R, Sujatha RM. A study on the prevalence of refractive errors among school children of 7-15 years age group in the field practice areas of a medical college in Bangalore. Int J Med Sci Public Health 2013;2:641-6.
22. Murthy GV, Gupta SK, Ellwein LB, Muñoz SR, Pokharel GP, Sanga L, *et al.* Refractive error in children in an urban population in new Delhi. Invest Ophthalmol Vis Sci 2002;43:623-31.
23. Al Faisal W. Visual impairment screening and early interventions among schooling kids in Dubai, Dubai-UAE-2016. Int J Ped Neo Heal 2017;1:2-33.
24. Khandekar R, Mohammed AJ, Al Raisi A. Compliance of spectacle wear and its determinants among schoolchildren of dhakhiliya region of Oman: A descriptive study. J Sci Res Med Sci 2002;4:39-43.
25. Gogate P, Mukhopadhyaya D, Mahadik A, Naduvilath TJ, Sane S, Shinde A, *et al.* Spectacle compliance amongst rural secondary school children in Pune district, India. Indian J Ophthalmol 2013;61:8-12.
26. Xiao O, Morgan IG, Ellwein LB, He M, Refractive Error Study in Children Study Group. Prevalence of amblyopia in school-aged children and variations by age, gender, and ethnicity in a multi-country refractive error study. Ophthalmology 2015;122:1924-31.
27. Donahue SP, Arthur B, Neely DE, Arnold RW, Silbert D, Ruben JB, *et al.* Guidelines for automated preschool vision screening: A 10-year, evidence-based update. J AAPOS 2013;17:4-8.
28. Sharma DJ, Agrawal DD, Vyas DM, Hans DP, Garg DJ. Prevalence of refractive error, squint and colour vision defects among school children in Rajiv international school, Mathura. Int J Curr Res 2017;9:61595-8.