Original Article

Vision Screening of Younger School Children by School Teachers: A Pilot Study in Udaipur City, Western India

Parveen Rewri[1,2], MS; Chandra Kant Nagar[2,3], MS; Vijay Gupta[2], MS

[1]*Department of Ophthalmology, Maharaja Agrasen Medical College, Hisar, Haryana, India*
[2]*Department of Ophthalmology, Ravinder Nath Tagore Medical College, Udaipur, Rajasthan, India*
[3]*Department of Ophthalmology, Geetanjali Medical College, Udaipur, Rajasthan, India*

Abstract

Purpose: To assess the reliability of school teachers for vision screening of younger school children and to study the pattern of vision problems.
Methods: In this cross-sectional study, trained school teachers screened 5,938 school children aged 3 to 8 years for vision and ocular disorders. Children were cross screened by professionals to assess the reliability of the teachers in vision screening and detecting ocular disorders in these children. The pattern of visual acuity, ametropia and ocular disorders was studied.
Results: Sensitivity and specificity of the vision screening by school teachers was 69.2% (95% CI: 66.8-71.5%) and 95.3% (95% CI: 94.5-95.8%), respectively. The positive predictive value was 83.5% (95% CI: 81.4-85.6%) and negative predictive value was 89.8% (95% CI: 88.8-90.6%). The kappa statistic was 0.68 (95% CI: 0.66-0.7).
Conclusion: School teachers could effectively screen younger school children for vision assessment and ocular disorders.

Keywords: Ametropia; Vision Screening; Visual Acuity; Younger School Children

J Ophthalmic Vis Res 2016; 11 (2): 198-203.

INTRODUCTION

Early childhood is a sensitive period for the development of the visual system, and ocular disorders are among the most common disabilities in this age group.[1,2] Visual impairment in early childhood may affect learning ability and adjustments at school[3] or later lead to adverse consequences on the professional, socio-economic and personal life of the individual.[4-7] Pre-primary school screenings are intended to assist in identifying such undetected vision disorders, mainly amblyopia, strabismus and refractive errors.[8,9] However, several real and perceived barriers often prevent the conduction of screening programs for preschool age children.[10] Cost-effectiveness of vision screening in preschool school children is also a debatable issue.[11,12] The present study investigated whether teachers could successfully provide the first component of school eye screening services. Moreover, the pattern of ametropia and other ocular disorders in this younger school age group was assessed.

Correspondence to:
Parveen Rewri, MS. Department of Ophthalmology, Maharaja Agrasen Medical College, Agroha, Hisar - 125 047, Haryana, India.
E-mail: drparveenrewri@gmail.com

Received: 01-04-2015 Accepted: 16-01-2016

Access this article online

Quick Response Code:

Website: www.jovr.org

DOI: 10.4103/2008-322X.183920

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How to cite this article: Rewri P, Nagar CK, Gupta V. Vision screening of younger school children by school teachers: A pilot study in Udaipur City, Western India. J Ophthalmic Vis Res 2016;11:198-203.

METHODS

The study involved younger school children, aged 3 to 8 years, from schools situated within the municipal corporation limits of Udaipur city (Rajasthan) in Western India. The study was approved by the institutional review board and adhered to the guidelines of the Declaration of Helsinki. A list of schools situated within the city limits was obtained from the district education office, and schools with pre-primary (aged 3 to 5 years) and primary (aged 5 to 8 years) children were selected. Udaipur city was divided into six zones, and schools were mapped in the respective zones [Figure 1]. Schools were grouped based on functioning (government run versus private) and pattern of education (co-education versus boys or girls exclusive) to bridge socio-economic and gender gaps. The sample size was calculated, and schools were surveyed to collect data on eligible pre-primary school children. The schools were randomly drawn from a sampling frame of schools in each zone, until the desired number of children was included.

A multistage technique was planned to screen children [Figure 2]. Stage one involved a pilot study in 10% of schools to evaluate its feasibility using Snellen chart for vision screening in these age groups. At the same time, a training module was developed and validated to train teachers regarding screening for ocular disorders. Stage two involved selecting two class teachers per school by voluntary agreement and training them for vision screening. Teachers were provided with explanations and demonstrations of the procedure of gross ocular examination and vision screening.

For gross ocular examination, teachers were trained to detect a deviated eye (squint), lusterless eyes or Bitot's spot, white opacity (corneal or lenticular) and signs and symptoms of ocular allergy, using teaching modules.

Vision screening was performed using Snellen charts at six meters distance in outdoor illumination. Different types of the Snellen chart were utilized considering to age range [Pictorial Snellen chart, Snellen E chart, Snellen chart with Hindi alphabets and Snellen chart with English alphabets]. The importance of proper distance, lighting condition and placing a hand over the other eye during vision screening was emphasized. Written guidelines summarizing the testing conditions, procedures and common pitfalls were provided to teachers and they were given three weeks to complete vision screening and to prepare a class-wise list of children with visual acuity less than or equal to 6/9 in either eye, or the presence of any ocular disorder noticed during screening.

At stage three, cross screening of children was done by a team of professionals including ophthalmology residents assisted by trained medical students. The team screened all the children listed as "abnormal" by teachers to detect true positives. A random sample of 25% was selected from the children screened as normal (vision >6/9 or no ocular disorder) on screening by teachers. These children were screened to detect false negative (those with vision ≤6/9). Stage four involved issuing referral slips to all children with significantly reduced visual acuity (≤6/12 in either eye) or the presence of any ocular disorder. Referral slips were sent to parents via the school authorities. Children who presented to us underwent ocular examination, cycloplegic refraction and subsequent management at the department of ophthalmology of the institute. In fifth and last stage, the data from children who underwent refraction at other centers was also collected. The refraction slips were sought from children through schools. This was done to include them in the analysis.

Ametropia was defined as uncorrected distant visual acuity of less than 6/9 which improved with a pinhole at least by two lines on the Snellen chart. The operational definition of myopia, hyperopia and astigmatism was correction equivalent to or more than -0.50 diopter (D), +0.50 D and ±0.5 D, respectively in children with

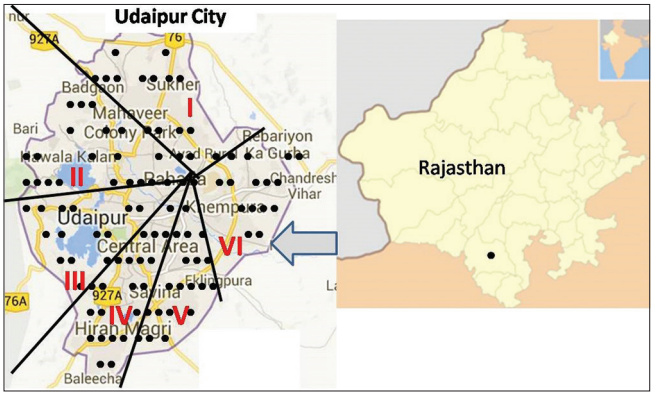

Figure 1. Maps showing the location of Udaipur city in Rajasthan state in Western India. Udaipur city was divided into six zones and schools were randomly selected from each zone.

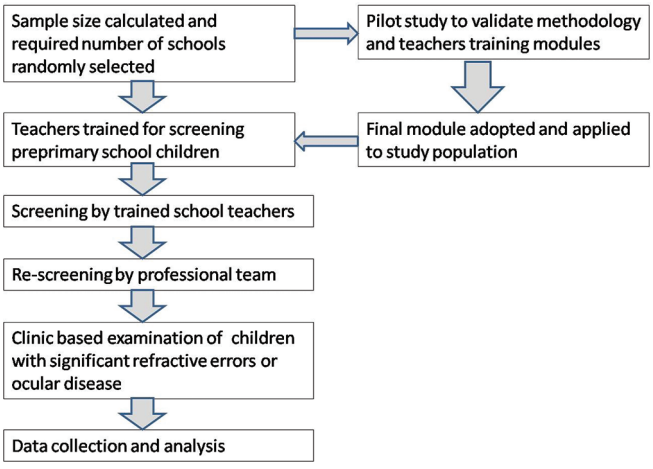

Figure 2. Flow chart depicting the scheme and study methodology.

significantly reduced visual acuity. Amblyopia was defined as non-improvement of reduced visual acuity (<6/9) with optical correction in the absence of any organic cause.

Data was collected using a pre-designed form and then was entered into excel sheets. For analysis, enrolled children were divided into three groups. Group I comprised of children aged 3 and 4 years, Group II included those aged 5 and 6 years and group III consisted of children 7 and 8 years of age. Each group was further subgrouped on the basis of gender. Descriptive statistical analysis was done to calculate sensitivity and specificity of screening by teachers and to calculate the prevalence of refractive errors and ocular disorders. Statistical tests of significance were conducted using x^2 tests, and the level of significance was set at 0.05%.

RESULTS

A total of 6,122 children, aged 3 to 8 years, enrolled in 66 schools were included in the study. Of these 6,004 children underwent primary vision screening by school teachers; and 5,938 [Figure 3] were available for professional screening (response rate, 97%; 95% Confidence interval (CI): 96.5-97.4%); these subjects included 3,393 (57%) boys and 2545 (43%) girls. On primary screening, school teachers detected 1,280 (21.5%; 95% CI: 20.4-22.5%) children as having vision ≤6/9, and 42 (0.7%; 95 CI: 0.49-0.91%) children with some ocular disorder [Table 1]. During the third stage, our professional team examined a total of 2,447 (41%) children, consisting of the 1,280 children who had failed primary screening and a random sample of 1,167 (25%) children who were reported to be normal (vision >6/9 and no ocular disorder) on primary screening.

Out of 1,280 children detected with subnormal vision on primary screening, 9 (0.7%) subjects were absent for screening by the professional team. A total of 1,271 children were re-screened; 1,070 (84%) cases had vision ≤6/9 (true positive), while 201 (16%) children had vision >6/9 (false positive). Out of 1,167 (25%) randomly selected "normal" children, 119 (10.1%; 95% CI: 8.3-11.8%) subjects had vision ≤6/9 in either eye (false negative). The projected false negative number for the sample population (n = 4,658 with vision > 6/9) was 475 (10.7%). In the study population, 4,393 (73.8%; 95% CI: 72.8-75.1) children had vision better than 6/9. A total of 364 children had significantly reduced visual acuity after the professional cross screening. The prevalence of significantly reduced visual acuity was 8.04% (95% CI: 7.35-8.73%), of whom children with visual acuity of ≤6/18-6/60 comprised the majority (4.05%) [Figure 4]. Ametropia in both eyes was found in 247 (68%; 95% CI: 63.2-72.9%) subjects, and 41 (11%; 95% CI: 8.2-14.7) children were already wearing glasses.

All children with significantly reduced visual acuity were given referral slips for cycloplegic refraction and ocular examination. Out of 364 referred children, 258 (71%) subjects underwent refraction at our institute while 83 (23%) were examined at other eye care centers, with an overall response rate of 93.6%. All 41 children wearing glasses were referred to eye care centers for refraction, of whom 7 (17%; 95% CI: 5-28%) needed a change of glasses. The level of visual impairment was significantly higher in children with glasses as compared to those with uncorrected refractive errors [Table 2]. Hyperopia

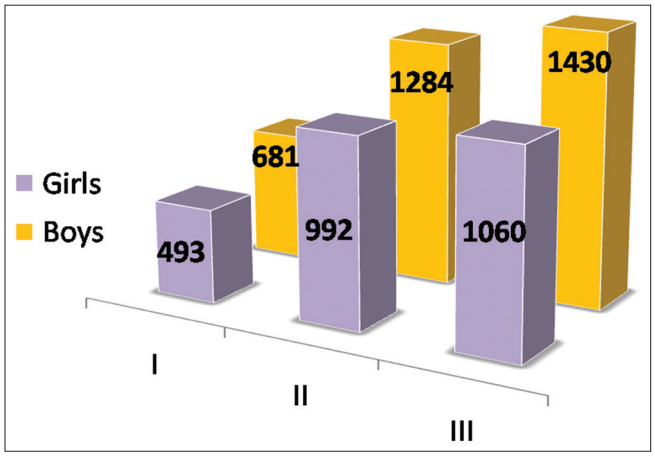

Figure 3. Histogram showing the distribution of children in different age groups based on gender. Age groups I: 3 to 4 years, II: 5 to 6 years, and III: 7 to 8 years.

Table 1. Distribution of children at different age groups in relation to gender and the frequency of children with vision ≤6/9 on primary screening by school teachers (age groups - I: 3-4 years; II: 5-6 years; III: 7-8 years; *n*=5938)

Age groups	Enrolled children			Children with vision ≤6/9 on primary screening			Ocular disorders
	Total	Boy	Girl	Total (%)	Boy	Girl	Total
I	1174	681	493	269 (22.9)	159	110	06
II	2274	1282	992	523 (22.9)	296	227	19
III	2490	1430	1060	488 (19.5)	270	218	17
All	5938	3393	2545	1280 (21.5)	725	555	42

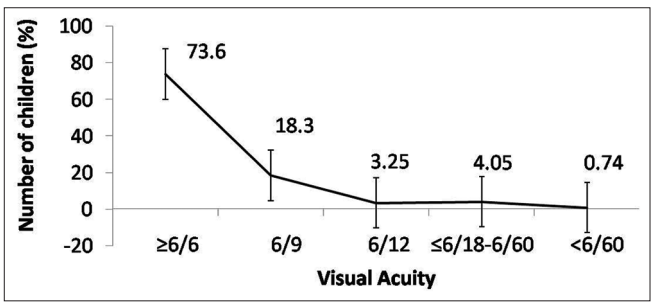

Figure 4. Frequency distribution of visual acuity.

dominated as the most common type of refractive error among all age groups [Table 3]. There was no gender-based significant difference in the frequency and pattern of ametropia (p, 0.732). All 42 children detected with ocular disorders underwent a comprehensive eye examination at our institute.

Sensitivity and specificity of vision screening by school teachers in younger age children was 69.2% (95% CI: 66.8-71.5%) and 95.3% (95% CI: 94.5-95.8%), respectively. The positive predictive value was 83.5% (95% CI: 81.4-85.6%) and negative predictive value was 89.8% (95% CI: 88.8-90.6%). The kappa statistic was 0.68 (95%CI: 0.66-0.7). These indicators were significantly better ($P < 0.01$) for children aged above five years [Table 4].

Ocular disorders were confirmed in all 42 children on professional screening. None of the children in the randomly selected cross-screening sample had any obvious ocular disorder. Ocular disorders such as refractive amblyopia were found in 53 (0.89%; 95% CI: 0.65-1.13%) children [Table 5].

Table 2. Comparison of presenting visual acuity among children wearing glasses and those with uncorrected visual acuities (*n*=341)

Un-corrected visual acuity*	Number of children wearing glasses (%) (*n*=41)	Number of children with uncorrected refractive errors (%) (*n*=299)
6/12	9 (21)	129 (43)
≤6/18-6/60	27 (66)	144 (48)
<6/60	5 (12)	26 (9)

Table 3. Distribution of ametropia among children with vision <6/12 in either eye (age groups - I: 3-4 years, II: 5-6 years, and III: 7-8 years; *n*=341)

Age groups	Total	Hyperopia (%)	Myopia (%)	Astigmatism (%)
I	43	39 (90)	2 (5)	2 (5)
II	125	84 (67)	13 (10)	28 (23)
III	173	119 (69)	15 (9)	39 (22)
All	341	242 (71)	30 (9)	69 (20)

Table 4. Reliability indicators of teachers screening for children in different age groups (age groups - I: 3-4 years, II: 5-6 years, and III: 7-8 years; *n*=5938)

Age groups	95% CI (%)			
	True positive	False negative	Sensitivity	Specificity
I	70 (68-73)	19.5 (18-21)	53 (43-58)	90 (88-92)
II	85 (69-72.5)	9 (8-10)	74 (70-77)	95 (94-96)
III	89.5 (69-72)	8 (7-9)	75 (71-78)	97 (96-98)

CI, confidence interval

Table 5. Prevalence of ocular disorder in children based on professional screening

Ocular disorder	Prevalence, *n* (%)	95% CI (%)
Amblyopia	11 (0.18)	0.08-0.29
Bitot's spot	5 (0.08)	0.01-0.16
Cataract	2 (0.0003)	0-0.1
Corneal opacity	7 (0.11)	0.03-0.2
Ocular allergy	16 (0.26)	0.14-0.4
Strabismus	12 (0.20)	0.09-0.32

CI, confidence interval

DISCUSSION

School vision testing is considered as an effective program for early detection and intervention against childhood blindness.[13-15] In India, it is a part of the national program for control of blindness, executed by school teachers, targeting school children aged 8-15 years.[16] To the best of our knowledge, no study in India has evaluated the validity of school teachers in screening younger school age children.

The presence of significant refractive errors and strabismus are potential risk factors for amblyopia in preschool children.[17] The primary aim of early age vision screening and eye examination strategies is to detect and treat amblyogenic conditions.[18] Cost-effectiveness of screening in this age group of children is debatable.[8,19] Usefulness of vision screening in preschool children has been demonstrated, and implementation of the program is recommended.[20-23]

Several types of charts have been validated for screening preschool children.[20,21,24,25] We chose the Snellen charts due to their wider availability, simplicity of use and teacher's experience in screening. Similarly, the training module for detecting ocular disease was kept simple as the purpose was to detect children with any abnormal ocular sign and symptom, but not a correct diagnosis, by the screening teachers. In our study, teachers correctly identified all children with ocular disorders as per module. We selected the cut off visual acuity for referral to be 6/12, as it is considered more cost- and compliance effective for spectacle use.[16,26]

In the current study, we found that trained school teachers were effective in detecting refractive errors and ocular disorders in younger school children. Overall agreement for the validity of vision screening in younger school children was good in our study, although the performance was better in children aged more than five years. This probably resulted from lack of cooperation, hesitation, shyness or difficulty in comprehending the teachers' instructions. However, the results are comparable to studies on screening older school children by teachers.[27,28] Previous studies have noted variable validity in school vision screening by school teachers.[13,18,27-30] In the other study conducted in Iran,

sensitivity and positive predictive values of screening by teachers were low.[29] Agreement for vision screening by school teachers and profession was moderate in a study from Nigeria.[27] Training school teachers for screening school children have been shown to improve outcomes.[31]

The prevalence of refractive errors among younger school children in the present study was 8%, which lies in the mid-range (1.8-23%) reported in previous studies.[32] The prevalence of refractive errors varies among different studies due to the age of target population, the definition of refractive errors and sampling techniques. The pattern of refractive errors also depends on the age of the population. Hyperopia tends to predominate in the early years, and myopia is the refractive error which most likely develops during primary school presenting typically between 8 and 12 years of age.[18,32] In our study, we found hyperopia as the predominant refractive error in all age groups; however, myopia and astigmatism tend to increase with older age. Jamali et al also reported a predominance of hyperopia in their study on preschool children.[33] The presence and amplitude of hyperopia have been shown to be associated with amblyopia.[34]

Uncorrected or undetected refractive errors were significant in the study, and only 11% of children were wearing glasses. This issue endorses the necessity for regular screening procedures in school children. Among those wearing glasses, a proportion of children did not have regular follow-up for their refractive errors and required a change of glasses.

While studying the prevalence of ocular disorders among children, we included amblyopia, which was not part of primary screening by school teachers. The prevalence of amblyopia in our study was lower as compared to other studies.[32,33,35] Possible reasons for this issue could be that children with greater refractive errors were already using glasses. Racial differences also have been noted, and Asians tend to have a lower prevalence.[36] The prevalence of other disorders was comparable to other studies.[32,37] There was a relatively higher prevalence of ocular allergy in our study population, which may be explained by the dry and windy climate in Western India.

The present study does have some limitations. We studied only one aspect of screening, the i.e., reliability of school teachers in screening children and did not address problems associated with screening this age group. Secondly, we did not study the reasons why some children did not turn up for refraction. Studying this aspect may be beneficial in formulating study designs with more accuracy and feasibility. However, the results of this study indicate that the scope of school vision screening may be broadened to include younger age children and trained teachers can effectively detect and refer these age group children. There is currently no existing school health program for pre-primary school children in India, and this study may provide data for effective planning for such program.

Acknowledgements

The authors would like to thank Dr. Shalini Virani, Dr. Sohan Lal Yadav and Dr. Kirti for their help in collection and processing of data. We also thank all school teachers, children and their parents for their participation; and acknowledge the valuable support from the medical interns; ophthalmic department staff and department colleagues: Dr. Dinesh Bhardwaj, Dr. Meera Tirpathi, Dr. Arvind Morya, Dr. Sharva Sharma and Dr. Jaquline for coordinating the refraction and eye examination services.

Financial Support and Sponsorship

Nil.

Conflicts of Interest

There are no conflicts of interest.

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