Original Article

Comparative evaluation of qualitative performance of technical human resource in school eye health program

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Purpose: To measure sensitivity and specificity of vision screeners in identifying children with visual impairment and positive signs and symptoms and assess association of effectiveness with individual characteristics of screeners and type of schools screened. **Methods:** A total of 1096 children from age 5 to 15 years of age were screened. A total of 396 children were screened from a municipal school, 200 children from a government-aided school, and 500 children from a private school were screened. Four persons with basic 12th standard science qualification willing to be a part of school eye health program were selected who carried out screening in school children after receiving appropriate training. **Results:** The two vision screeners who had a background of conducting community eye health programs and worked in eye hospital had 100% sensitivity and specificity for presenting visual acuity, squint detection, and blurring. The screening by these screeners was done in private and semi-private schools, respectively. The other two screeners with no such background conducting screening in government schools had 60% and 75% sensitivity in detecting presenting visual acuity, respectively. **Conclusion:** People with a background of organizing community eye health programs and those working in eye hospitals are the best candidates for being trained as new cadre of vision screeners with best results being obtained in private and government-aided schools.

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The impact in terms of disability adjusted life years (DALY) puts childhood blindness second only to cataract on the global burden of eye disease and one of the five priority areas of the World Health Organization's "Vision 2020—the right to sight" program.[1] Study done by Holden BA *et al*. in 2016 says that in 2050 estimated 4758 million people in the world will have myopia.[2] The prevalence of refractive errors among younger school children in the study conducted by Rewari *et al*. in Udaipur, India was 8%.[3] In a study conducted by Dr Padhye, Dr Dole *et al*. it was noted that prevalence of uncorrected refractive error especially myopia was higher in urban children (3.16%).[4] All these studies point to increasing prevalence of myopia in the world especially in urbanized locations. The major causes of moderate and severe visual impairment in 2010 in order, were uncorrected refractive error, cataract, and macular degeneration.[5] Vision screening for school-age children is important to detect uncorrected refractive errors,[5-8] which remains the most common cause of childhood visual impairment. Impaired vision from birth or in early childhood can have a major effect on an infant's or child's development, hampering participation in social, physical and educational and, later, employment opportunities. Follow up with parents can ascertain if referrals were accepted and acted on.

A WHO study titled "Global Magnitude of visual impairment caused by uncorrected refractive errors" recommends that the screening of children for refractive errors should be integrated into school health programs.[9] School screening programs are carried out by government and non-governmental organizations as well. Screening conducted by NGOs is mainly conducted by optometrists. Under NPCB (National Program for Prevention and Control of Blindness), one schoolteacher is selected from every school and given one day training course. During the training, the teachers are provided with a kit containing 6 m measuring tape, standard vision screening E card, referral card for children with suspected poor vision, and educational material. The school eye health programs are a part of NPCB since 1994.[10] In 2002 Orbis launched the India Childhood Blindness Initiative. REACH (Refractive Error Among Children, a joint program of Orbis and Qatar Fund for Development) covers 300,000 children enrolled in government schools for refractive errors, which is the most common cause of visual impairment in children. Free spectacles would be provided to children screened under this project.[11] Study in Iran by Ostadimoghaddam *et al*. inferred that teachers lacked sensitivity required for case detection (37% at cutoff of visual acuity of 20/25) and attributed this to lack of sufficient repeated training to teachers in detecting visual acuity.[12] One study in Thailand by Kanlaya Teeerawattananon *et al*. inferred that sensitivity for visual impairment case detection was around 60%(cut off visual acuity 20/40).[13] Study by Gurvinder Kaur,

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Koshy *et al.* in Ludhiana shows that vision screening by teachers resulted in high false positive rates wherein they tended to over diagnose, increasing the time and cost of the screening program and also increasing the workload of the ophthalmology team.[14] Khandekar *et al*. conducted a study in Oman wherein they did vision screening in seven regions of Oman using nurses where sensitivity of 68.34% (95% CI: 67.30–69.38) and specificity of 99.23% (95% CI: 99.19–99.27) was found when the results of screening by nurses was compared against results of practicing optometrists.[15] In this study, we wished to identify a different cadre which will maintain good sensitivity and specificity for vision screening.

Methods

A total of 1096 children from age 5 to 15 years of age from standard first to tenth were screened. 396 children were screened from a municipal school, 200 children from a government-aided school and 500 children from a private school were screened from September 2017 to August 2018. This was done to enable representation of all socio-economic groups in the sample also enabling calculation of effectiveness of screening for each socio-economic group. Consent for screening was obtained from the school headmasters by due process. Permission for carrying out school eye screening program had been obtained from appropriate authorities. A cross sectional, study was undertaken to assess the efficacy of vision screeners as compared to a gold standard (post MBBS personnel with one-year training in ophthalmology), after adequate permissions were obtained. The Ethics Committee members of the hospital were briefed about the study and their permission was sought and obtained.

Information sheet about nature of study was designed for guardians (schoolteachers and headmasters) in local language and written consent was taken from the school headmaster of the child. Children with medical eye problems were treated free of cost with help from the eye institute carrying out this research. Those who needed surgical treatment were referred to this eye hospital where after parental consent they were treated free of cost.

Sample size

A systematic review article on prevalence of refractive error in children in India by Sheeladevi S *et al*., quotes the prevalence of refractive error in school children at 10.8%.[16]

Using the formula

Sample size n = [DEFF*Np (1-p)]/[(d2/Z21-a/2*(N-1)+p*(1-p)]

DEFF = 2, p = 0.08, z = 1.96, d = 3, absolute error 3%

Minimum sample size calculated was 823.

Screening of 1096 students was done in this study.

Selection of vision screeners

Four persons with basic 12th standard science qualification willing to be a part of school eye health program were selected. The training methodology was described as below. Henceforth they will be referred to as screener one, two, three, and four.

Screener one had worked in the research department doing clerical work in this eye hospital for duration of 1.5 months prior to being recruited as vision screener in this study. This vision screener carried out screening of children of first, second, seventh, and eighth standard from a private school. A total of 200 children were screened by this screener. Screener two had worked in organizing community eye screening programs prior to being recruited as a vision screener in this study. This vision screener carried out screening of children of fifth, sixth, seventh, and eighth standard from a semi-private school. A total of 200 children were screened by this screener. Screener three and four were fresh high school graduates with no previous exposure to community work or research. Screener three carried out screening of 300 children from first to sixth standard from a private school and of 273 children from fifth to tenth standard from a government run school. Screener 4 carried out screening of 123 children from first to third standard from a government school. The vision screeners were allotted schools for vision screening after randomization by chit method wherein chits containing names of the schools were randomly selected by the screeners. This was done in order to minimize introduction of bias.

Training of vision screeners

One day training in finding presenting visual acuity (PVA) using a pocket screener, doing + 1.50D lens test and checking for blurring and squinting by gold standard (post MBBS one-year training in ophthalmology) using appropriate PowerPoint presentations and training videos showing types of squint was done and a practical examination for the vision screeners was taken at the end of training. Screening took place within one month of their training to avoid knowledge attrition. The pocket screener is designed in such a way that a person with 6/12 Snellen visual acuity is able to read it when placed at a distance of three meters. The room in which acuity is to be tested should be well lit with the pocket screener being kept at the eye level. If the student is successfully able to read the middle line with other eye closed his/her vision is better than 6/12 in that eye. Tumbling E optotypes are preferred as children are not able to memorize them. Students who were identified as ones with vision better than 6/12 were asked to read the same pocket screener with +1.50D lens in front of either eye (separately tested). The students who were still able to read the pocket screener accurately were considered as failed as they were able to read the pocket screener with excessive accommodation in absence of the lens and were referred. The students who were no longer able to read the pocket screener accurately were considered to have passed the test. The vision screeners were trained in pediatric ophthalmology department of the hospital to orient themselves around children and were made to screen children registered in outpatient department for the day after taking appropriate consent of the guardians before being taken on field for school screening program. The vision screeners were shown how to communicate with children during the screening and they carried out the screening under supervision of trainee ophthalmologist and any difficulties during the screening were addressed and mistakes made were corrected.

Statistical analysis

The data were collected in the data forms during school screening and was tabulated in Microsoft Excel and coded appropriately. The data analysis was done with SPSS software (Statistical package for social science for Windows). The parameters assessed were sensitivity, specificity, positive predictive value (PPV), negative predictive value (PPV), false positive rate (FPR), false negative rate (FNR). The findings of trainee ophthalmologist were treated as gold standard and the findings of vision screener were compared against his findings and above-mentioned parameters were assessed.

Results

Screener wise separate analysis of PVA, blurring, and squinting was done as these are particularly important findings with < 100% results in one or more parameters assessed and their misdiagnosis could potentially hamper visual development of children in long term. The parameters which could not be assessed are assigned as N/A. The findings were entered separately for right (OD) and left (OS) eye.

Screener one had 100% sensitivity, specificity, PPV, and NPV for presenting visual acuity and squint detection and 100% specificity and NPV for blurring. Screener two also had a 100% sensitivity, specificity, PPV, and NPV for presenting visual acuity, squint detection, and blurring.

Analysis of screening of 300 children from 1st to 6th standard from a private school by screener three given in Table 1 and analysis of screening of 273 children from fifth to tenth standard from government school by screener three given in Table 2. Analysis of screening of 123 children from first to third standard from a government school by screener four given in Table 3. The sensitivity and PPV in analysis of all above screeners could not be calculated in the instances where the children did not present with that sign/symptom.

Discussion

The study had the aim to find out whether locally trained community volunteers were competent enough in identifying children with visual impairment, blurring of vision, and squinting. All the children screened by the vision screeners were reexamined by the gold standard. The study was conducted with the aim to develop a cadre which can be easily trained even in villages where there is acute shortage of clinically trained personnel. The cutoff of vision <6/12 was selected as children with visual acuity less than that had difficulty in reading from the board in classroom. Separate screener wise analysis of PVA, blurring, and squinting was done to analyze the possible deficiencies in this program.

Screener one and two had a remarkable 100% sensitivity, specificity, PPV, and NPV for presenting visual acuity, squint detection, and blurring (sensitivity and PPV for blurring could not be calculated for screener one as children did not present with these symptoms). The screening by these screeners was done in private and semi-private schools, respectively. The high-quality outcomes by these vision screeners could be attributed to their background of work in eye hospital/community work and to the simplified methods of vision screening used.

Screener three and four had absolutely no exposure to eye hospital environment or community work before. Also, it should be noted that screener three and four carried out screening in government school which had comparatively suboptimal results as compared to private schools. Screener four had conducted screening in standards first to third in government school and had the worst outcome of all screeners. This could possibly point towards lack of effective communication between screeners and children due to differences in cultural background and social factors which needs to be analyzed further.

Table 1: Analysis of screening of 300 children from 1st to 6th standard from a private school by screener three

	Sensitivity	Specificity	PPV	NPV
PVA: OD	100	100	100	100
PVA: OS	100	100	100	100
Blurring: OD	100	100	100	100
Blurring: OS	100	100	100	100
Squinting: OD	N/A	100	N/A	100
Squinting: OS	N/A	100	N/A	100

PVA: Presenting visual acuity, OD: Right eye, OS: Left eye, N/A: Not applicable, PPV: Positive predictive value, NPV: Negative predictive value

Table 2: Analysis of screening of 273 children from fifth to tenth standard from government school by screener three

	Sensitivity	Specificity	PPV	NPV	FPR	FNR
PVA: OD	60	99.3	60	99.3	0.7	40
PVA: OS	100	100	100	100	N/A	N/A
Blurring: OD	N/A	100	N/A	100	N/A	N/A
Blurring: OS	100	100	100	100	N/A	N/A
Squinting: OD	N/A	100	N/A	100	N/A	N/A
Squinting: OS	N/A	100	N/A	100	N/A	N/A

PVA: Presenting visual acuity, OD: Right eye, OS: Left eye, N/A: Not applicable, PPV: Positive predictive value, NPV: Negative predictive value, FPR: False positive rate, FNR: False negative rate

Table 3: Analysis of screening of 123 children from first to third standard from a government school by screener four

	Sensitivity	Specificity	PPV	NPV	FPR	FNR
PVA: OD	75	100	100	99.2	0	25
PVA: OS	75	100	100	99.2	0	25
Blurring: OD	33.3	100	100	98.4	0	66.7
Blurring: OS	33.3	100	100	98.4	0	66.7
Squinting: OD	N/A	100	N/A	100	N/A	N/A
Squinting: OS	N/A	100	N/A	100	N/A	N/A

PVA: Presenting visual acuity, OD: Right eye, OS: Left eye, N/A: Not applicable, PPV: Positive predictive value, NPV: Negative predictive value, FPR: False positive rate, FNR: False negative rate

Hadi Ostadimoghaddam, *et al*. did a study in Mashhad, Iran to check the validity of screening tests by teachers among school children.[12] In Iran there is a cadre of teachers who have provided screening services for over 10 years after a single training session at the very beginning of screening program. This cadre was tested against optometrists who were considered as gold standard. Visual acuity of less than 20/25 was taken as cutoff for reference to secondary screening. On statistical analysis it was noted that sensitivity and specificity of the teachers for testing visual acuity was 37.5% and 92%, respectively. The study showed that one time training of the cadre is not sufficient and highlights the need for periodical retraining and reevaluation of the cadre used in screening from time to time so as to prevent knowledge attrition thus fall in sensitivity of testing. Parveen Rewari *et al*. did a study in Udaipur, India where they tried to assess the reliability of schoolteachers in screening younger children and to study the pattern of vision problems.[3] The children were initially screened by teachers. Then the children listed as abnormal according to visual acuity cutoff criteria of < 6/9 by the teachers were rescreened by professionals including ophthalmologists and trained medical students. After statistical analysis it was found that specificity and sensitivity was 95.3% and 69.2%, respectively for screening of visual acuity. Overall agreement for the validity of vision screening in younger school children in this study was good, but the performance improved in children aged more than five years. This was probably a result of lack of cooperation, hesitation, shyness, or difficulty in comprehending the teachers' instructions. However, the results are comparable to studies of screening of older children by teachers. Kanlaya Teerawattananon *et al*. did a cross-sectional descriptive and analytical study in 17 schools in four provinces representing four geographic regions in Thailand to assess the accuracy and feasibility of screening by teachers wherein they found out that the detection rate of refractive error screening by teachers among pre-primary school children is relatively low (21%) for mild visual impairment but higher for moderate visual impairment (44%).[13] The detection rate is high for primary school children for both levels of visual impairment (52% for mild and 74% for moderate). Refractive error screening by health professionals in pre-primary and primary school children is not being currently implemented in Thailand due limited resources but the findings suggest that a program for screening refractive error conducted in schools by teachers in the country is reasonable and feasible.

Conclusion

From our study it could be concluded that people from a social work background with more sensitization towards community eye work are the best candidates for being trained as new cadre of vision screeners. Alternatively, those people working for any duration of time in an eye hospital environment with basic educational background are also good candidates for being trained as new cadre of vision screeners. People with no background in community work or eye hospital as mentioned above are comparatively less ideal candidates and may be used for vision screening only after more training and sensitization towards needs of children and when importance of work being done has been understood by them. Children from younger age group and those from government schools had less optimal results when screened by vision screeners. This may be remedied with improving communication methods and vision screener sensitization towards the needs of this group of children along with prescreening counseling of children about the importance of vision screening and its benefits. More duration of training and observation in vision screening camps may be done to improve the outcomes by the vision screeners. A follow-up study with more number of this cadre of human personnel can be done to define optimum training program and improve screening outcomes in non-experienced screeners.

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Conflicts of interest

There are no conflicts of interest.

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