Original Article

Assessing the inclusion of primary school children in vision screening for refractive error program of India

Pallavi Shukla, Praveen Vashist, Suraj Senjam Singh, Vivek Gupta, Noopur Gupta, Meenakshi Wadhwani, Amit Bharadwaj, Lakshya Arora

Purpose: In India, teachers screen middle school children using the 6/9 Snellen's optotype. Recently, the National Program for Control of Blindness included primary school students also. The present cross-sectional study was planned to assess the inclusion of primary school students. Compliance to spectacles was ascertained after 6 months follow-up. **Methods:** Randomly selected 23 Government primary schools. A total of 30 teachers were nominated and given hands-on training in vision screening and recording formats. Teachers conducted vision screening of primary school students of their respective schools using the 6/12 Snellen's chart and referred students with subnormal vision to optometrist. Optometrist also validated the screening done by teachers. Optometrist screened the vision of 5% randomly selected children screened by teachers as having normal vision. Descriptive statistics used STATA version 13.0. **Results:** A total of 6056 students screened by the teachers. Sensitivity and specificity of teacher screening were 92.3% (confidence interval [CI] 88.6–95.0) and 72.6% (CI 68.2–76.6)), respectively. About 277 students underwent refraction and 186 prescribed spectacles. The prevalence of myopia, hypermetropia, and astigmatism is 2.5% (2.1–2.9), 0.6% (0.4–0.8), and 1.3% (1.0–1.6), respectively. Compliance to spectacles usage is 36%. **Conclusion:** Burden of refractive error in primary school is very low. Trained teachers can identify children with subnormal vision, but the false-positive rate is very high. Compliance to spectacle use among primary school children is also less. Vision screening by teachers prioritized in secondary schools and preschool screening should be done by more skilled eye care workers preferably optometrist.

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Universal Eye Health: Global Action Plan-2014–2019 targets to reduce the prevalence of avoidable visual impairment (VI) by 25% by 2019 from the baseline established by the WHO in 2010.[1] Main cause of VI in India is refractive error (RE) contributing 61% VI in the eyes of rural and 81.7% VI in the eyes of urban children.[2,3] RE is easily diagnosed and treated by an optometrist.

Per two lakh population, there is nearly one optometrist as against the norms of vision 2020 of one optometrist/50,000 population.[4] To reduce time spent examining eyes of children with normal vision, school eye screening program was started in 1994, in which teachers screen vision of middle school children using the 6/9 Snellen's optotype.[5] Recently, Government added primary school students also as beneficiary.[6]

There are studies on vision screening of middle school children. The present study was planned to provide a comprehensive picture of school vision screening program for RE in primary class students including the prevalence of RE, validation of vision screening done by the teachers, and spectacles compliance among the primary school students.

Methods

The Ethical Approval for the study was obtained from the Institute's Ethics Committee as a part of a major project related to primary eye care services in Delhi. The study was from November 2015 to September 2016.

Permission was obtained from the Director of South Delhi Municipal Corporation. List of all the Municipal Corporation Primary Schools in South Delhi district was procured from them.

Twenty-three primary schools were randomly selected from the list. Teacher selection was as per the National Program for Control of Blindness (NPCB) guidelines.[7] Thirty motivated science teachers were nominated by the principal from the respective schools one from each school and two from those schools in which enrollment was >250. Preference was given to female teachers wearing spectacles.

Training of teachers

One-day training session was held for the teachers. They were sensitized about the various childhood eye diseases which led to blindness and VI, especially those which are treatable or preventable. They were given hands-on training in vision screening and recording formats. Teachers were

Dr R. P. Centre for Ophthalmic Sciences, AIIMS, New Delhi, India

Correspondence to: Prof. Praveen Vashist, Room No. 788, Community Ophthalmology, Dr R. P. Centre for Ophthalmic Sciences, AIIMS, New Delhi - 110 029, India. E-mail: praveenvashist@yahoo.com

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provided with a screening kit comprising of 6 meter long tape, some information, education, and communication material, and vision screening "E" card equivalent to 6/12 Snellen's optotype. The cutoff was selected to reduce the false positive rates. In one of the studies conducted in the Delhi schools earlier, it was seen that using 6/12 cutoff than 6/9 reduced the false-positive rates to a large extent.[8] Apart from the screening card, the kit also had consent form to be filled and duly signed by the respective guardian/parent of the students for the cycloplegic refraction since the children were young.

Vision screening by the teachers

Teachers were given 2–3 weeks to screen vision of all students in classes 3rd–5th (primary school in India is from class 1 to 5). Students were asked to identify the direction of "E" four times, with each eye separately. If in any eye he/she is unable to correctly identify the direction at least three out of four times, then he/she was considered to have subnormal vision, and was referred to the optometrist for further examination.

Optometrist conducted refractions in the school itself, to ensure minimum dropout. The spectacles with acetate frame and white English lenses were provided to the students. Frame was selected according to his/her head size and power of corrective lenses. The spectacles were provided in the school itself.

Validation of the vision screening

Teachers were given 2–3 weeks to conduct vision screening in their respective schools. Once the list was prepared, the very next day visit of optometrist was planned in that school, and cross-validation was done.

To find out false negatives and true negatives, 5% sample was randomly selected from among students who were identified as "Normal" by the teachers, followed by validation by an optometrist. The 5% of students were selected with the help of computer-generated random number from the cumulative dataset. Validation by an optometrist was performed using the same "E" chart as the one used by the teacher. A uniform standard procedure was followed for assessing the participants in the same setting.

Refraction

All students identified with subnormal vision either by optometrist or teacher were subjected to cycloplegic refraction.

Refraction was done in two stages, first, objective by streak retinoscope under cycloplegia with 2% of homatropine drop twice at an interval of 10 min. Cycloplegia was considered complete if pupil dilated to 6 mm or more and pupillary reaction was absent. In the second stage, postmydriatic subjective acceptance of the child was assessed after 3–5 days of cycloplegic refraction.

If students had problem other than RE, they were referred to specialty clinics of the base hospital.

Magnitude of refractive error

Myopia was defined as the spherical equivalent of RE of at least-0.5D and hyperopia as + 1.0D or more. Children were considered myopic if one or both eyes were myopic; hyperopic if one or both eyes were hyperopic, so long as neither eye was myopic; and emmetropic if neither eye was myopic or hyperopic. Spherical equivalent of RE for any eye is calculated by doing an arithmetic summation of spherical power and half of the cylindrical power in that eye.

Astigmatism was defined as any eye having cylindrical power >|0.5D|

Compliance to spectacles

After 6-7 months of spectacles distribution, compliance to spectacle use was checked in all the schools without prior information to the schools or students. Compliance is defined as "a student who correctly follows the advice to wear spectacles". An interview was held with the students regarding the regular use of spectacles, the facilitating factors, and barriers to spectacles usage.

Students were considered compliant if they were found to wear spectacles on follow-up visit. Students who were absent on the day of verification were telephonically contacted, and were enquired whether they regularly wore spectacles and what were the facilitating factors. Those who were noncompliant were asked about the barriers of spectacle use.

Double data entry was done and errors were rectified. Certain consistency checks were kept through software to minimize data entry errors. Data were analyzed using STATA 13.0 software (StataCorp LP, College Station, Texas, USA). Descriptive statistics using frequency and percentages were used for data analysis.

Results

Vision screening was done by the teachers for the 6056 students, of which 56 (0.9%) students were already wearing spectacles. A total of 442 (7.3%) students were identified to have subnormal vision by the teacher. Out of the 442 children referred by the teacher, 399 (90.3%) of them were examined by the optometrist and among them 186 (46.6%) were prescribed spectacles, and all of them 186 (100%) were provided with the spectacles free of cost [Fig. 1]. Refraction could not be conducted for 43 students whose consent forms signed by their parents were not available.

The spectacle provision was within 1 month of examination by the optometrist. There were 56 children whose vision did not improve even with best correction, and they were referred to tertiary care center for further management.

Among 186 students identified to have any form of uncorrected RE, there were 152 (2.5% and 2.12–2.90) myopes, 34 (0.56% and 0.37–0.75) hypermetropes, and 79 (1.3% and 1.01–1.59) pure astigmatic [Table 1].

Out of 399 students who were rescreened by the optometrist after being referred by the teacher, it was found that 275 actually had "subnormal" vision and 124 were false positives. Nearly 5% of children who were labeled by the teacher as "normal" were randomly screened by an optometrist. Thus, out of 351 such students, 328 were found to be truly "normal" by optometrist [Table 2]. Sensitivity, specificity, positive predictive value, and negative predictive value of the screening done by teachers is 92.3% (95% confidence interval [CI]; 88.6–95.0), 72.6% (95% CI; 68.2–76.6), 68.9% (95% CI; 64.1–73.4), and 93.4 (95% CI; 90.3–95.8), respectively.

Out of the 186 students prescribed spectacles, compliance details could be obtained for 158 (84.9%) students because

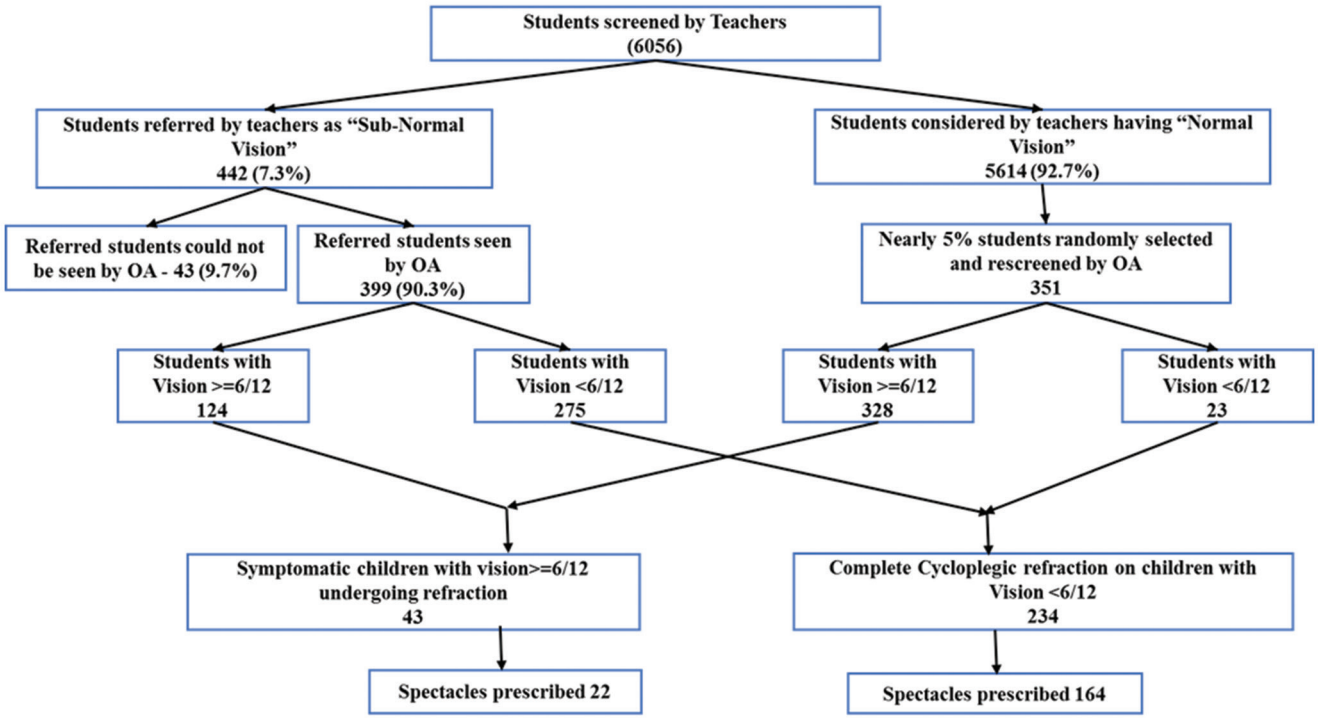

Figure 1: Flowchart depicting the flow of screening by the teachers and ophthalmic assistant (optometrist)

Table 1: Gender-wise distribution of children enrolled, identified as having vision <6/12, and prevalence of different refractive errors

	Total children screened (%)	Children with vision <6/12 identified by teachers (%)	Prevalence of refractive error, (*n*=186)		Astigmatism prevalence (CI) (*n*=79)
			Myopia prevalence (CI) (*n*=152)	Hypermetropia prevalence (CI) (*n*=34)	
Male	2269 (37.5)	139 (31.4)	2.0 (1.5-2.7)	0.5 (0.2-0.8)	1.1 (0.7-1.5)
Female	3787 (62.5)	303 (68.6)	2.8 (2.2-3.3)	0.6 (0.4-0.9)	1.4 (1.0-1.8)
Total	6056	442	2.5 (2.1-2.9)	0.56 (0.4-0.8)	1.3 (1.0-1.6)

CI: Confidence interval

the visit was unannounced after 6–7 months of spectacle distribution. All those found to be wearing spectacles were considered to be compliant. Out of 158 students observed for compliance, 57 (36%) were compliant in wearing spectacles.

Students who wore spectacles regularly were interviewed about the factors which facilitated them in wearing spectacles. The most common reasons were blackboard appeared clearer, spectacle design made them look good, motivation from parents and teachers, protection from dust and injury and also because through the entire process they developed trust on the optometrist that it was done for their own good.

Students who were not wearing spectacles were enquired about barriers in spectacle usage.

Many hesitated because they were teased by their pals. Some felt that there was no need for them to wear spectacles. Few students complained of discomfort and symptoms such as headache and watering. Spectacles of 13 of them were either lost or broken. Few girl students also stated that their spectacles were handed over to their brothers by their parents since they had lost their own spectacles.

Discussion

RE being the second most important cause of blindness attracts much of the NPCB's attention after cataract. School eye screening program for RE was launched in the year 1994 and ever since has earned lot of credit. It is seen that involving teachers in this program would reduce the screening workload of optometrist to 5% of all school children.[9]

Another advantage of utilizing teachers was that since they were the ones who were in regular touch with the students, and hence, it would be easier for them to identify the children with subnormal vision at the earliest. Many times, young children were not able to know themselves that they were having problem with the vision. They tend to overcome the problem by various maneuvers such as sitting close to the blackboard and squeezing the eyes. Training the teachers in this regard would sensitize them and guide them to be more observant.

Apart from identification, teachers are likely to influence children and motivate them to be more compliant in wearing

Table 2: Sensitivity and specificity of vision screening done by the teachers compared to ophthalmic assistant

	Ophthalmic assistant screened		Total	
	Children identified with "subnormal" vision	Children identified with "normal" vision		
Teacher screened				
Children identified with "subnormal" vision	275	124	399	PPV=68.9% (95% CI is 64.1-73.4)
Children identified with "normal" vision	23	328	351	NPV= 93.4% (95% CI=90.3-95.8)
Total	298	452	750	
	Sensitivity=92.3% (95% CI is 88.6-95.0)	Specificity=72.6% (95% CI is 68.2-76.6)		

PPV: Positive predictive value, NPV: Negative predictive value, CI: Confidence interval

spectacles. The literal meaning of the word compliant is "obedience to a request or command"; students are most obedient toward none other than their teachers.

School eye screening programs for RE used to be done for middle school children only because public health specialists used to opine that conducting vision screening in primary schools is not very productive due to three reasons as follows; first, the prevalence of RE in this age-group would be very low. Second, teachers would not be able to screen the primary school students effectively. Finally, spectacles compliance in this young age-group would be very low.

In a recent Government policy modification, even primary school students were included in school vision screening program.[6] The present study was planned to assess the school screening program for RE among the primary school children.

RE was the main cause of moderate VI in children and a public health problem as seen in a study conducted in South India.[10] However, the total prevalence of uncorrected RE in the current study was 3%. The reason could be that we had covered only the Government schools from urban area and also because the study was selectively done on the primary school students. Similar prevalence is being reported from rural settings.[2] A study from urban Delhi conducted in 2012 shows higher prevalence, but the prevalence among Government schools was one-third that of the private schools.[11] The Government policy does not usually cater to private schools. In the same study, the prevalence of myopia was much lesser in <10 years age group compared to >10 years students.

The study did not include children younger than 7 years because development of myopia generally occurs at 8–12 years of age and this problem can be screened by the teachers and managed simply by providing spectacles. However, in the younger age-groups (5–6 years), the aim of screening is detection and treatment of conditions leading to amblyopia, which can neither be screened nor treated by teachers.[12]

Coming from nonmedical background, it is difficult for the teachers to screen young children. In the present study, it was found that school teachers are correctly able to identify 7–10 years children with subnormal vision when they were trained by the experts from the field. Sensitivity and specificity of teacher screening as compared to the ophthalmic technician screening using the same "E" chart and in the same examination conditions was 92.28% and 72.57%, respectively. There were 124 children falsely reported as having "subnormal" vision by the teachers. Such false positive cases not only increased the time and cost lost at the level of optometrist but also are a deterrent to the credibility of the teachers. A study conducted on children aged 3–8 years in Udaipur shows sensitivity, specificity, PPV, and NPV of 69.2%, 95.3%, 83.5%, and 89.8%, respectively.[13] Probably the difference is due to the fact that children in this study, were mostly in the age-group of 7–10 years while those in Udaipur study were much younger. There is one more study conducted in Ludhiana on children <16 years has true positive rate of 47.25% and true negative rate of 96%.[4]

The present study was conducted in ideal conditions, but the ground realities might differ. Hence, further studies should be planned in rural settings, remote areas, and also in private schools to evaluate the reliability of vision screening by the primary school teachers.

This primary school screening study was comparable with all respects to earlier school vision screening studies conducted in the middle schools. Coverage was good, 85% of the students enrolled in the sampled schools were screened by the teachers. From each school at least one teacher was trained. In the present study, teachers referred around 7.3% of children screened by them, this figure is more than a study conducted in Satna where it was 4.91%.[14] A study from Ludhiana reports that teacher referred 14.9% of children, but later on, it was found that only 47% of them were correctly identified.[4] While in the present study conducted on primary school students, the teacher referred 7.3% of the students but almost 68% of them were correctly identified. Even 93.4% of students were correctly identified as "normal" by the teachers as seen through the 5% random sample screened by the optometrist in the present study. Thus, it can be said, that school vision screening of primary school students is technically reliable.

Primary school students in this study were not very compliant in wearing spectacles. The present study has a compliance rate of 36% which is better than the study from Pune (29.5%) and worse than the study from South India (57.8%).[15,16] Howsoever, all the spectacles compliance studies adopted different techniques to assess compliance, and hence, it is tough to compare them. The Pune study has been conducted on secondary school children and has compliance of 29.5% which is even lesser than the compliance rate of primary school students of the present study (36%). The South India study has seen compliance among 7–15-year-old children. Even in the study from Central India, overall compliance is better than

the present study may be because compliance was checked after 3 months.[17] In the present study, cost is not the most important barrier for compliance since the spectacles were distributed free of cost. If spectacles are prescribed at subsidized rate, parents may avoid procuring spectacles at this age.

Screening the primary school students will help in identification of the ever-increasing problem of RE at the earliest. However, the major challenge then would be the requirement of optometrist all over the country and the provision of free spectacles for the students. On an average, there is one optometrist per 2,00,000 population in India.[18] The problem of RE is more prevalent in secondary schools than primary school children; hence, the optometrist should first be utilized in conducting refraction for secondary schools. However, the teachers should be trained and sensitized toward screening of primary school children as well. Those primary school children identified to have decreased vision should be referred to a health-care facility where an optometrist is available. This way, all the children with VI would be benefitted, and there would not be any extra burden on the existing system.

As regarding spectacle requirement, presuming the prevalence of RE as 5% in the school going children, nearly 12.5 million spectacles are required per year for school children. However, the current targets of NPCB is 9 lakh spectacles per year all over India.[19] Even in the present study, it was found that there were 186 children who actually required spectacles, while at the start of study only 56 children wore spectacles. It is also seen that prescription changes quite frequently for myopic children, they should be reevaluated every 1–2 years.[20] Thus, if Primary Schools are to be included in the program, there is a need to revise targets for spectacle provision through Government.

Conclusion

Government of India took decision for conducting screening at primary level. However, targets are kept very low for this purpose. Keeping this in mind, the secondary schools should be given priority as the problem of RE is more prevalent in this age-group and if possible the frequency of screening should be annual, only then primary school screening by teachers should be attempted. However, there are certain diseases which if identified earlier and managed earlier may result in better visual potential for the children. Such screening need to be done even before school entry (preschool) by a skilled eye-care-worker preferably an optometrist.

Limitations of the present study were that only Government primary schools were assessed. In the future, similar studies should be planned in other settings such as rural and in private schools to give a more comprehensive picture.

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Conflicts of interest

There are no conflicts of interest.

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