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ORIGINAL ARTICLE

Vision Screening by Teachers in Southern Indian Schools: Testing a New "All Class Teacher" Model

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ABSTRACT

Aim: To study the effectiveness and cost of a new school vision screening program involving all class teachers (ACTs) compared with the standard program involving a limited number of selected teachers (STs) in Southern India.

Methods: A total of 12 schools were selected for intervention and 12 schools were matched as controls, from in and around Pondicherry, India. Teachers in both the intervention arm (ACTs) and the standard arm (STs) were trained to identify students between the ages of 6 and 17 years with visual acuity $\leq$20/30 in either eye or obvious ocular abnormalities and refer them to an ophthalmic team. The ophthalmic team, including an ophthalmologist, visited the schools to examine all children referred by teachers, provided medical treatment or a prescription for glasses, or referred them to the base hospital if required.

Results: ACTs (761 teachers) screened 39,357 children (97.7%) and STs (156 teachers) screened 38,469 children (95.7%). ACTs found significantly fewer screen-positive children ($n = 3806$, 9.7%) than the STs ($n = 6387$, 16.6%; $p < 0.001$), but had a significantly larger number of children with actual vision loss and other ocular pathology (2231, 5.7% and 1554, 4.0%, respectively, $p < 0.001$). More children from ACTs than STs reached the base hospital for further investigation within 3 months ($p < 0.001$). The cost of screening per child with actual ocular pathology was estimated to be US$1.91 for ACTs and US$4.83 for STs.

Conclusions: A school vision screening program involving ACTs resulted in more efficient screening than a program involving STs at about a third of the cost and also improved compliance with hospital referral.

Keywords: Class teachers, effectiveness and cost, India, school vision screening

INTRODUCTION

Population-based studies from India show that the prevalence of uncorrected visual acuity worse than 20/40 in the better seeing eye for children aged between 7 and 15 years ranges between 2.7% and 6.4%.[1,2] Recognizing the importance of proper vision for educational and behavioral development from an early age, Indian health care policy has strongly promoted school eye health programs.[3] Central to these eye health programs is school children eye screening (SCES) designed to detect refractive errors and other ocular defects. The SCES programs have become a central part of the mission to achieve the World Health Organization's Vision 2020 goals in most of the developing world.[4]

The SCES program is substantially more effective and less costly for delivering eye care to school-going children compared to other primary eye care models.[5] As a result, eye care providers throughout India (including the Aravind Eye Care System since 1980) have adopted SCES programs. It has been part of the National Program for the Prevention and Control of Blindness in India since 1994.[5,6]

Due to a scarcity of ophthalmic professionals, especially ophthalmologists and optometrists, in

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almost all settings, most SCES programs have been modeled around school teachers who are trained to screen students for defective visual acuity (hereafter referred to as selected teachers, STs).[3] Traditionally, one ST goes to a base hospital for training and then screens approximately 150 to 300 students.[5] The class teacher is the one responsible for monitoring and supporting the academic and social development of the students in his/her own class. In addition, class teachers have more interaction with students in their own class and probably have the best opportunity to identify students with visual impairments on a day-to-day basis. Hence, it seems prudent to actively involve all class teachers (ACTs) in SCES programs. In this study, we compared the effectiveness of SCES by the traditional approach employing STs to an alternative approach where an ophthalmic team trains ACTs at once to screen children only in their own classrooms.

MATERIALS AND METHODS

This was a prospective, non-randomized control study of alternative school screening methodologies. A survey of all the schools in and around Pondicherry, India, was undertaken as part of a routine school screening program and demographics of all schools, urban and rural, as well as large and small, were ascertained. To enable convenient screening of a large number of students, we selected 12 private schools with a minimum of 1500 students each and within 50 km of the base hospital for the program involving STs. They were matched to 12 demographically similar schools for the ACT program in terms of age and sex of children, type of school and distance from the base hospital. Children were screened during the academic year June 2012 to March 2013. Ethics committee approval was obtained from the Aravind Eye Hospital and Postgraduate Institute of Ophthalmology Institutional Review Board. All study procedures adhered to the recommendations of the Declaration of Helsinki.

Field workers who were employed by the base hospital, met with socially active individuals within the local community and heads of schools to discuss the details of the SCES programs. STs were selected based on the time that they could dedicate to the SCES program and one teacher was selected to screen a maximum of 250 children. Heads of schools typically selected teachers engaged in teaching subjects such as physical education or vocational studies, as these teachers would have the most time available for screening children at the school.

Training of the STs and ACTs was carried out in a uniform manner by the same personnel in two sessions. In the first session (2.5 hours for STs, 1 hour for ACTs) ophthalmologists lectured on recognition of eye problems, with an emphasis on pediatric diseases, and also provided the teachers with posters and pictures. In this session, teachers were also specifically given awareness about obvious ocular abnormalities like squint, nystagmus, corneal opacities, ptosis, conjunctivitis and external hordeolum so that they identified these children as defective even though their visual acuity was normal. Since the STs bore the costs and took the time to travel to the base hospital (Aravind Eye Hospital, Pondicherry) for training, they were given an extra lecture on additional ocular conditions including cataract and retinal and corneal diseases. In the second session (1.5 hours for STs, 1 hour for ACTs), optometrists instructed teachers on vision screening procedures using eye charts and provided them with basic tools for testing visual acuity.

Visual acuity was measured by teachers using full Snellen charts, asking students to occlude one eye at a time with the palm of their hand. To prevent students from memorizing and providing wrong interpretations, a tumbling E chart was used for one eye and a Snellen number chart was used for the second eye at a distance of 6 m. Additionally, only one student was examined at a time keeping others waiting in a line outside the classroom. During screening, students were asked to read from 20/200 (6/60 Snellen) downwards for both eyes. A line was considered as pass if all letters were read by the student accurately. If one letter in a particular line was not identified, then the previous Snellen equivalent was recorded as the visual acuity. If some children were wearing spectacles, then the teachers were instructed to record vision using the spectacles. An eye with visual acuity equal to 20/30 or lower was noted as ''defective''.

Field workers visited the schools and arranged a convenient date for a follow-up diagnostic visit by the ophthalmic team, which comprised a nurse, optometrist and ophthalmologist. All children referred by the teachers were examined. Spectacles were provided to these students free of cost. Those students requiring further medical or surgical intervention, for example for squint, amblyopia or cataract, were advised to visit the base hospital at Pondicherry. The complete teacher training, screening and diagnosis process is shown in Figure 1.

Data were collected on the total number of children screened, their visual acuity screening status and the diagnosis of those that were ''screen positive.'' The proportion of screen positive were calculated for the ST and ACT arms, as well as the proportion of students attending follow-up care within 3 months at the base hospital. Mean values were compared using student t and Wilcoxon rank sum tests, and proportions were compared between study groups using chi square statistics using STATA software (version 11.0; StataCorp, Texas, USA).

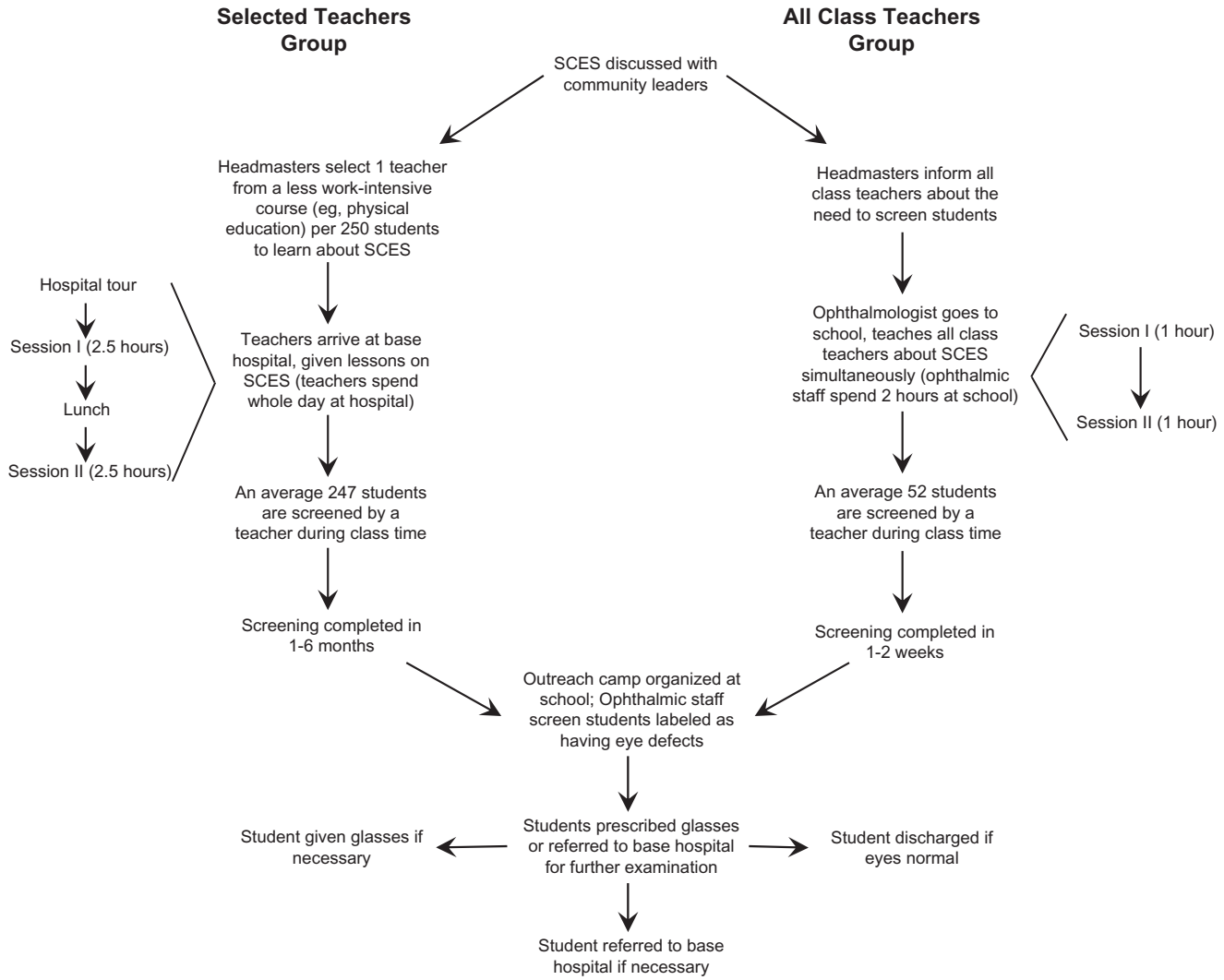

FIGURE 1. Training and screening process for selected teachers (STs) and all class teachers (ACTs) for school children eye screening (SCES), Southern India.

A detailed cost-estimate was made for the ACTs and STs, which included salaries, travel, accommodation and supplies for teachers' training, screening by teachers and examination by the ophthalmic team.

RESULTS

There were 40,197 students in the 12 ST schools and 40,266 in the 12 ACT schools included for screening. There were no significant differences in age ($p = 0.495$) or sex ($p = 0.237$) between the two samples (Table 1).

Teachers screened the children within 6 months of training in ST schools and within 1 month in ACT schools. STs (156 teachers) screened 38,469 students (95.7%) and ACTs (751 teachers) screened 39,357 (97.7%; $p < 0.001$). Almost all dropouts were due to absenteeism. The ACTs screened an average of 52 students each while the STs screened an average of 247 over the study period.

The ACTs found significantly fewer students with visual acuity worse than 20/30 than the STs (3806, 9.7% vs 6387, 16.6%, respectively, $p < 0.001$), but a significantly greater percentage of these were found to have actual vision loss or other ocular pathology (2231, 58.6% vs 1554, 24.3%, respectively, $p < 0.001$). Thus, of the entire population screened, ACTs found a larger number of children with vision loss and other ocular pathology compared to the STs (2231, 5.7% vs 1554, 4.0%, respectively, $p < 0.001$; Figure 2). Significantly more children from the ACT schools than the ST schools reached the base hospital for further investigations within 3 months (365/617, 59.2% vs 38/316, 12.0%, respectively, $p < 0.001$; Table 2).

The results of screening by the ophthalmic team showed that both ACTs and STs identified significantly more cases of refractive error than other pathologies (Table 3). The ACTs identified more children with other non-refractive conditions compared to STs, though most of these differences were not statistically significant.

The cost of screening a child was estimated to be US$0.11 and US$0.20 for ACTs and STs, respectively, resulting in a total cost of US$4,253 and US$7,507 for the two groups, respectively. This translates into US$1.91 (4253/2231) and US$4.83 (7507/1554) per child with actual ocular pathology in the ACTs and STs, respectively.

DISCUSSION

Of the children enrolled in the study, 95.7% and 97.7% were screened in the ST and ACT arms, respectively, indicating strong cooperation among teachers and students with the SCES program.

The proportion of screen-positive children with true ocular pathology in this study (STs 4.0% and ACTs 5.7%) was higher than other studies of SCES (between 1.8% and 2.2%) that used strategies similar to the ST group.[6] The higher proportion is likely an overestimation because our study used a lower visual acuity threshold (20/30) to categorize screen-positive children. Most other studies use the World Health Organization's recommended 20/40 for threshold screening.[7] Our study chose the lower threshold because of poor lighting and inconsistencies in room sizes in schools in Southern India. However, another reason for better detection of children needing ophthalmic interventions was that the teachers enrolled in our study were trained by ophthalmologists as well as optometrists. We believe that involving ophthalmologists in training provides impetus and motivates the teachers to do a better job while screening. Additionally, we encouraged screening with adequate time in hand to improve the accuracy of the teachers.

Uncorrected refractive error accounted for the highest proportion of children with ocular pathology (3.1% for STs and 4.1% for ACTs), similar to other studies in India.[7] The relatively high rate of uncorrected refractive error may be because the screened children attended private schools and myopia is known to be associated with urbanization and higher socioeconomic status, at least among Chinese and other Asian cultural groups.[8]

The ACTs found significantly more ocular conditions requiring intervention, other than refractive error (1.6% for ACTs vs 0.9% for STs). Achieving this diagnostic success with fewer screen-positive children shows greater accuracy of the ACTs compared to the STs, despite more intensive hospital-based training for the STs. A possible explanation is that ACTs had the maximum interaction with students in their own class and probably had the best opportunity to identify students with visual impairment.

TABLE 1. School vision screening sample by age and sex, for selected teachers and all class teachers, Southern India.

	All class teachers	Selected teachers	
Students	*n* (%)	*n* (%)	*p* Value
N	40,266	40,197	
Age group			
6–10 years	19,004 (47.20)	19,068 (47.40)	
11–17 years	21,262 (52.80)	21,129 (52.60)	0.495
Sex			
Male	20,801 (51.66)	20,598 (51.24)	
Female	19,465 (48.34)	19,599 (48.76)	0.237

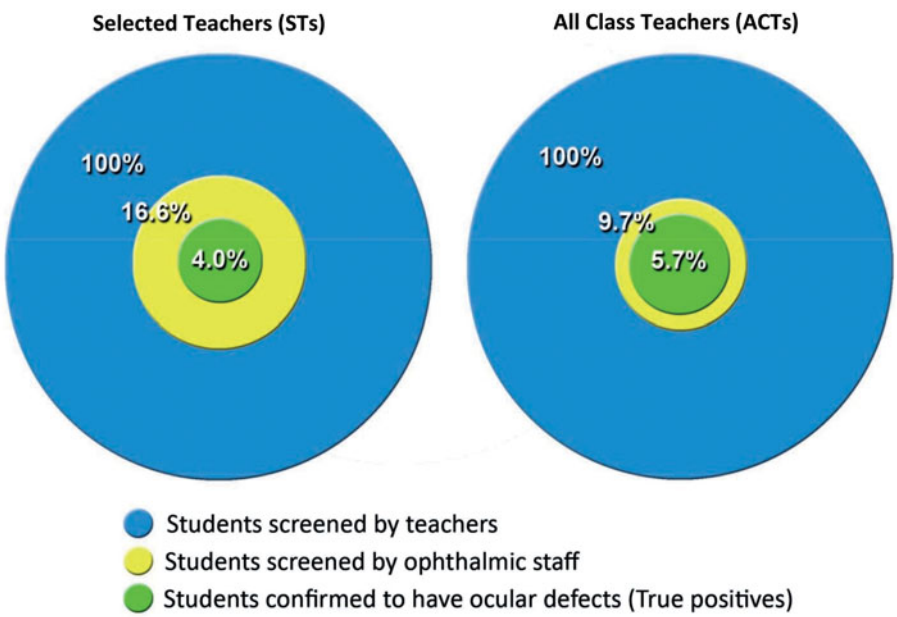

FIGURE 2. School vision screening sample for selected teachers (STs) and all class teachers (ACTs) groups, Southern India.

The proportion of students referred by teachers who were not found to have ocular pathology by the ophthalmic team is a major source of inefficiency because it adds unnecessary time and costs to the SCES program. Frick and colleagues estimated that the cost of the ophthalmic team examining each student during SCES in Delhi was about US$0.64[9] and in our study it was US$0.20, thus amounting to an overall excess cost of US$623 ($3117 \times 0.20$) using the ST model. Furthermore, falsely labeling children with vision loss may induce anxiety in children and their caretakers and decrease trust in the screening program.

The ACT program resulted in a much higher compliance rate (59.2%) to attend the base hospital within 3 months compared to the ST group (12.0%). This suggests ACTs were better than STs at promoting eye health to children and their parents. The ACTs likely spoke to individual parents more about their child's performance and had an opportunity to explain possible challenges such as vision problems and encourage them to use available eye care services.

The similar proportion of children obtaining spectacles in the ACT and ST arms may be explained by the fact that spectacles were provided free of cost, and were distributed immediately at the school. Therefore, little additional effort was necessary after a prescription was made.

Training ACTs in a school substantially reduced the workload on teachers, compared to the conventional ST model. The ACT group screened an average of 52 students while STs screened between 130 and 247 in our study and elsewhere.[6] Each ST would spend approximately 27–30 hours a year to screen all of their assigned students, compared to approximately 6–7 hours a year for ACTs. These estimates are based on an average of 5 minutes to screen a student, the average student-to-teacher ratios and the training time for a teacher in either group.

Higher student-to-teacher ratios in the ST program substantially prolonged the diagnostic process involving ophthalmic personnel, which did not take place until all children in a school were screened. STs took up to 6 months to finish screening assigned students, while schools with ACTs usually finished within a month. The longer delays may result in problems for children who need urgent attention.

The primary limitation of this study was the inability to determine the number and condition of children who falsely screened negative. It was not practical for the ophthalmic team to examine all children screened.

A number of individual factors likely affected the performance of the ACTs and STs, programs including training practices, teacher competence, and contact with individual students. A study of the multiple factors influencing school screening efficiency would

TABLE 2. Results of school visual acuity screening and ophthalmic diagnosis by selected teachers and all class teachers, Southern India.

Screening	All class teachers' referrals, *n* (%)	Select teachers' referrals, *n* (%)	*p* Value
Screen positive by teachers	3806 (9.70)	6387 (16.60)	<0.001
Eye exams performed by ophthalmic team	3785 (99.45)	6225 (97.46)	<0.001
True ocular pathology	2231 (58.62)	1554 (24.33)	<0.001
Referred to hospital for further examination	617 (16.21)	316 (4.95)	<0.001
Student compliance rate for hospital referrals	365 (59.20)	38 (12.03)	<0.001

TABLE 3. Ophthalmic diagnoses during school vision screening by selected teachers and all class teachers, Southern India.

	All class teachers	Select teachers	
Ophthalmic diagnosis	Children, *n* (%) *N* = 2231	Children, *n* (%) *N* = 1554	*p* Value
Refractive error	1594 (71.45)	1199 (77.16)	<0.001
Strabismus	228 (10.22)	133 (8.55)	0.087
Amblyopia	176 (7.88)	116 (7.46)	0.630
Ptosis	79 (3.54)	52 (3.35)	0.747
Corneal disorder	17 (0.76)	10 (0.64)	0.670
Cataract	5 (0.22)	2 (0.13)	0.707
Nystagmus	14 (0.63)	2 (0.13)	0.020
Other[a]	127 (5.69)	41 (2.64)	<0.001
Total	2231 (5.67)	1554 (4.04)	

[a]Other included transient conditions encountered by teachers during screening such as conjunctivitis and external hordeolum.

require a larger and more complex study of these factors. However, because the innovation is so simple, replicable, and effective we do not see any value in further study of its individual components in the future.

A school vision screening program involving ACTs found significantly greater screen-positive children than a program involving STs at about a third of the cost. In addition, the ACT program compared to the ST program resulted in significantly greater compliance to hospital referral. Other organizers of SCES programs would be well advised to consider teacher-training methods similar to our ACT model.

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DECLARATION OF INTEREST

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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