



IMPLEMENTATION OUTCOMES OF TEACHER-LED VISION SCREENING IN SCHOOL CHILDREN: A COMMUNITY-BASED CROSS-SECTIONAL STUDY

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ABSTRACT

Aim: To evaluate the outcomes of teacher-led vision screening in school children in a real world community setting.

Methods: This community-based cross-sectional study included 7,150 schoolchildren aged 6 - 18 years from three government schools, screened by 152 trained teachers using Snellen visual acuity charts. Children with visual acuity worse than 6/9 in either eye were referred for comprehensive ophthalmic evaluation. All screen-positive children and a randomly selected subset of screen-negative children underwent reference-standard examination by the ophthalmology team. Diagnostic performance was therefore assessed using complete evaluation of screen-positive children and sampled validation of screen-negative children. Refractive and spectacle-use-related visual findings were also analysed. **Results:** Of 7,150 children screened, 642 (8.98%) were referred for specialist evaluation. Among these, 300 children were confirmed to have visual abnormality, yielding a positive predictive value of 46.7%. A randomly selected subset of 200 screen-negative children underwent confirmatory examination, of whom 190 were true negatives and 10 were false negatives, corresponding to a sample-based negative predictive value of 95.0%. The sensitivity estimate of teacher-led screening was 96.8%. The program identified approximately one confirmed case per 24 children screened. Among the spectacle-analysis subgroup, non-users had significantly poorer visual acuity than spectacle users in both eyes. **Conclusion:** Teacher-led vision screening appears to be a feasible and sensitive first-level strategy for identifying school children who may require further ophthalmic evaluation in resource-limited settings.

KEYWORDS : Vision Screening; School Children; Refractive Errors; Visual Impairment; Teacher-Led Screening; Diagnostic Accuracy; Public Health

INTRODUCTION

Childhood visual impairment remains a significant public health concern, particularly in low- and middle-income countries.⁽¹⁻²⁾ Globally, an estimated 1.4 million children are blind, with a disproportionately higher burden in developing regions.⁽¹⁻²⁾ A large proportion of visual impairment in children is attributable to uncorrected refractive errors, which are easily detectable and avoidable visual morbidity among school-going children, but often remain unaddressed due to gaps in early detection and access to eye care services.⁽³⁾ Visual impairment during school years can adversely affect academic performance, classroom participation, psychosocial development, and overall quality of life.⁽⁴⁾

In India, school-based screening programs under the National Program for Control of Blindness play a crucial role in identifying visual impairment at an early stage.⁽⁵⁻⁶⁾ However, the effectiveness of these programs is often limited by the shortage and uneven distribution of trained eye care personnel, particularly in rural and semi-urban areas.

However, while earlier studies have demonstrated that teachers can participate effectively in preliminary vision screening, the available evidence has focused largely on basic referral accuracy, often under controlled or programmatic settings. Less attention has been paid to how teacher-led screening performs in routine, real-world school environments, particularly in government school systems where implementation challenges, referral burden, and follow-up gaps may differ substantially from ideal research conditions.⁽⁵⁻⁸⁾ Moreover, the practical value of such screening programs is determined not only by their ability to identify children with reduced vision, but also by how efficiently they channel specialist resources toward children who truly require further evaluation.⁽⁹⁻¹¹⁾

Therefore, the present study was undertaken to evaluate the effectiveness of teacher-led vision screening in a real-world community program involving schoolchildren from government school settings. Beyond estimating screening performance, the study also aimed to examine the diagnostic yield of referrals, quantify the burden of over-referral on specialist services, and describe spectacle-use-related residual visual deficit among screened children.

METHODS

Study Design and Setting

This cross-sectional, community-based study was conducted between July 2025 and December 2025 among school children aged 6- 18 years in three government schools in Gorakhpur, India.

The study was designed to assess the real-world performance of

teacher-led vision screening among school children, using ophthalmologist-led examination as the reference standard in all screen-positive children and in a randomly selected subset of screen-negative children.

Ethical approval for the study was obtained from the Institutional Ethics Committee. Written informed consent was obtained from the parents or guardians of all participating children prior to enrollment. The study was conducted in accordance with the principles outlined in the Declaration of Helsinki.

Participants

All enrolled schoolchildren aged 6-18 years who were present on the day of screening in the selected schools were eligible for inclusion. Children with known ocular pathology other than refractive error (such as congenital cataract, corneal opacity, or retinal disease), those with systemic or neurological conditions affecting cooperation, children absent during screening or follow-up, and those unable to complete visual acuity assessment despite repeated attempts were excluded from the study. Children with incomplete examination data were also excluded from the final analysis.

The study was carried out in three sequential phases: teacher training, vision screening by trained teachers, and validation of screening results by an ophthalmology team (Figure 1).

Phase 1: Teacher Training

Schools were selected in coordination with the District Education Office, and teachers were nominated by school principals based on availability and student load. A total of 152 teachers from classes 1 to 12 participated in the training program.

The training was conducted over a period of 1–2 days, with equal emphasis on theoretical instruction and practical hands-on sessions. The theoretical sessions included basic ocular anatomy, common causes of visual impairment in children, and the importance of early detection and timely referral. The practical component focused on standardized visual acuity assessment using a Snellen E chart at a distance of 6 meters under adequate illumination. Teachers were trained to conduct monocular testing and ensure proper occlusion of the non-tested eye. Demonstrations were followed by supervised hands-on practice sessions to ensure uniformity, accuracy, and competency in performing the screening procedure.

Phase 2: Vision Screening by Teachers

Following completion of training, teachers conducted vision screening

of all enrolled children in their respective government schools; catering predominantly to children from mixed socioeconomic backgrounds. As these schools draw students from both urban and peri-urban populations, the study population was considered reasonably representative of the community. All eligible children present on the day of screening were included to ensure comprehensive coverage and minimize selection bias.

Visual acuity was assessed for each eye separately using a Snellen E chart placed at a distance of 6 meters under daylight conditions. Children who were able to correctly identify all optotypes in each eye (visual acuity $\geq 6/9$)¹² were classified as screen-negative (normal).

Those who were unable to correctly identify one or more optotypes in either eye (visual acuity $< 6/9$) were classified as screen-positive and referred for further ophthalmic evaluation. All screen-positive children were referred for confirmatory ophthalmic evaluation by the ophthalmology team.

Phase 3: Validation by Ophthalmology Team

All children identified as screen-positive underwent comprehensive ophthalmic examination by a trained ophthalmology team, which served as the reference standard for diagnosis. The ophthalmology team consisted of a qualified ophthalmologist, optometrists, and trained ophthalmic assistants.

The comprehensive evaluation included assessment of uncorrected and best-corrected visual acuity, objective and subjective refraction, anterior segment examination, and ocular alignment assessment. In younger children and those unable to cooperate adequately, objective refraction using retinoscopy was performed, ensuring accurate estimation of refractive error.

Based on this evaluation, diagnostic outcomes were classified as follows: children who were identified as screen-positive and confirmed to have visual impairment were categorized as true positives (TP), while those who were screen-positive but found to have no abnormality were categorized as false positives (FP).

Because examination of all screen-negative children was not feasible, a randomly selected subset of screen-negative children underwent the same reference-standard evaluation. This sampled validation design was used to estimate missed cases among children classified as normal by teachers, while recognizing the potential for partial verification bias.

200 screen negative children were selected by simple random sampling without replacement using computer-generated randomisation (Excel randomization). Because the screen-negative group was only partially verified, estimates involving true negatives and false negatives were interpreted as derived from a sampled validation subset rather than from complete cohort verification.

Among this subgroup, children who were correctly identified as normal were classified as true negatives (TN), whereas those found to have visual impairment despite being classified as normal during screening were categorized as false negatives (FN).

Diagnostic Classification

Using teacher screening as the index test and ophthalmology examination as the reference standard, outcomes were classified at the child level as follows:

- True positive (TP): screen-positive child confirmed to have visual abnormality on reference-standard examination.
- False positive (FP): screen-positive child found not to have visual abnormality on reference-standard examination.
- True negative (TN): sampled screen-negative child confirmed normal on reference-standard examination.
- False negative (FN): sampled screen-negative child found to have visual abnormality on reference-standard examination.

Outcome Measures

The primary outcome of the study was the diagnostic accuracy of teacher-led vision screening. This was assessed using sensitivity, positive predictive value (PPV), sample based NPV. Specificity. Overall accuracy and likelihood ratio were exploratory outcomes.

Secondary outcomes included analysis of refractive error patterns, assessment of inter-eye differences in visual parameters, and

comparison of visual acuity between children using spectacles and those not using spectacles.

Statistical Analysis

Data were entered into Microsoft Excel and analysed using SPSS version. Continuous variables were expressed as mean $\pm$ standard deviation (SD), and categorical variables as frequencies and percentages.

The primary unit of analysis for screening performance was the child. Diagnostic performance of teacher-led vision screening was assessed using positive predictive value (PPV) calculated from all screen-positive children, sample-based negative predictive value (NPV) calculated from the randomly selected validated subset of screen-negative children, and sensitivity estimate derived from validated true-positive and false-negative children. Because only a randomly selected subset of screen-negative children underwent confirmatory examination, specificity, overall accuracy, false-positive rate, and likelihood ratios were not treated as definitive full-cohort measures and were therefore not emphasized in the primary analysis.

Ninety-five percent confidence intervals were calculated for the principal diagnostic performance measures using the binomial (Wilson) method. The false-negative proportion was calculated within the validated disease-positive subset.

Inter-eye comparisons of visual parameters were performed using paired t-tests, while comparisons between spectacle users and non-users were analysed using independent-samples t-tests. A p-value < 0.05 was considered statistically significant.

RESULTS

A total of 7,150 school children aged 6-18 years from three schools were screened by 152 trained teachers during the study period. Of these, 642 children (8.98%) were classified as screen-positive and referred for comprehensive ophthalmic evaluation, while 6,508 children (91.02%) were classified as screen-negative (Table 1). Thus, specialist evaluation was restricted to less than one-tenth of the screened population, indicating a substantial reduction in referral burden at the initial screening stage.

On validation by the ophthalmology team, 300/642 children were confirmed to have visual impairment and were classified as TP, while 342/642 children (53.3%) were found to be normal and classified as FP (Table 2). This yielded a PPV of 46.7%.

To assess accuracy among screen-negative children, a randomly selected subset of 200 screen-negative children underwent the same confirmatory evaluation. Among these, 190 were TN and 10 were FN, resulting in a sample-based NPV of 95%.

Based on the validated subset, the sensitivity of teacher-led screening was 96.8%. The false-negative proportion within the validated disease-positive subset was 3.2% (Table 3).

Given that only a sampled subset of screen-negative children underwent confirmatory examination, specificity, overall accuracy, false-positive rate, and likelihood ratios were not treated as definitive full-cohort diagnostic measures and were therefore not emphasized in the primary analysis. Instead, the screening model was interpreted as having high case-detection sensitivity among validated children, with a relatively modest referral yield, as fewer than half of screen-positive referrals were confirmed to have visual abnormality.

The screening program detected 300 confirmed cases from 7,150 children screened, corresponding to a crude screening yield of approximately 1 confirmed case per 24 children screened. In addition, only 8.98% of the screened population required referral for specialist evaluation, supporting the feasibility of teacher-led screening as a first-level triage strategy in school eye health programs.

Among the children who failed screening, 71.3% were already using spectacles, while 28.7% were not using any corrective lenses (Table 4). Children not using spectacles had significantly poorer best-corrected visual acuity compared to those using spectacles ($p < 0.01$), indicating suboptimal visual outcomes in this group.

Significant inter-eye differences were observed for uncorrected visual acuity and spherical refractive error ($p < 0.001$), suggesting

asymmetry in refractive status within affected children.

The overall refractive profile indicated a predominance of myopic refractive error, with mild-to-moderate astigmatism observed in a subset of children.

DISCUSSION

The present study successfully achieved its objective of evaluating the real-world performance of teacher-led vision screening in a government-school setting. Overall, the findings suggest that trained teachers can function as effective first-level screeners for identifying children who may require further ophthalmic evaluation, particularly in resource-limited settings where access to specialized eye care services is limited.

The principal strength of the model was its high sensitivity estimate within the validated subset, indicating that relatively few children with visual abnormality were missed by the screening process. At the same time, the study also demonstrated that a substantial proportion of referred children were not confirmed to have abnormality on specialist examination, highlighting an important trade-off between case detection and referral efficiency.

From a public health perspective, this balance is important. In school screening programs, particularly in children, missing true cases is generally considered more problematic than over-referral, because undetected visual impairment may adversely affect learning, classroom participation, psychosocial development, and, in some cases, amblyopia management. In that context, the high sensitivity estimate observed in the present study supports the use of teacher-led screening as a pragmatic triage strategy in resource-constrained settings. However, because only a randomly selected subset of screen-negative children underwent confirmatory examination, the diagnostic performance measures derived from this design must be interpreted with caution. Accordingly, the findings are best understood as demonstrating strong case-detection ability among validated children, rather than definitive full-cohort diagnostic accuracy across all measures.

An important operational finding of this study was that only 8.98% of the screened population required referral for specialist evaluation. This does not directly quantify formal workload reduction in a health-systems sense, but it does indicate that the program substantially restricted the number of children needing ophthalmologist-led assessment at the first stage. In large school-based programs, such triaging can be valuable because it allows limited specialist resources to be directed toward a smaller subset of children most likely to benefit from further examination. The crude screening yield of approximately one confirmed case per 24 children screened also provides a useful programmatic measure of field utility, even though it should not be interpreted as a formal diagnostic-performance index.

The findings of this study are consistent with previous literature on teacher-based vision screening.⁽⁶⁻⁸⁾ Studies have demonstrated similar trends, showed that teachers can identify most children with reduced vision, although false-positive referrals remain common.⁽⁵⁻⁶⁾ Kaur et al. also supported the feasibility of teachers as first-level screeners in school eye health programs.⁽⁷⁾ However, direct comparison across studies requires caution because these programs differ in several important respects, including visual acuity cut-offs used for referral, teacher training protocols, school setting, validation methods, and whether all screen-negative children underwent reference-standard examination.⁽¹¹⁻¹³⁾ In particular, the present study used a sampled validation design for screen-negative children, whereas some prior studies may have used different verification strategies.

One of the more informative findings of this study was the high proportion of spectacle users among children with persistent visual deficit in the analysis subgroup. This represents one of the most important findings of the present study and highlights a critical gap in the continuum of eye care. While school screening programs traditionally focus on detection, the persistence of visual impairment despite spectacle use suggests issues such as inaccurate prescriptions, poor compliance, progression of refractive error, and lack of regular follow-up.^(9,12-14) This finding emphasizes the need to shift from a detection-only approach toward a comprehensive care model that ensures appropriate correction, monitoring, and long-term visual rehabilitation.⁽⁴⁻⁵⁾

From a clinical perspective, these findings support teacher-led screening as an effective first step in identifying children requiring further evaluation. However, the relatively low specificity indicates the need to improve referral accuracy. A tiered screening approach, incorporating optometrists or trained vision technicians as an intermediate step, may help reduce unnecessary referrals. Additionally, the integration of digital or artificial intelligence-based screening tools may further enhance diagnostic precision and standardization.

From a public health standpoint, teacher-led screening enables large-scale coverage with minimal additional resources, making it particularly suitable for low- and middle-income settings. By limiting referrals to less than 10% of the screened population, this model significantly reduces the burden on ophthalmologists and improves the efficiency of service delivery. Integration of such programs into national school health initiatives, along with structured follow-up systems, can further enhance effectiveness and sustainability. These findings emphasize the need to strengthen continuity of care in school eye health programs.

The strengths of this study include its large sample size, real-world community-based design, and standardized teacher training. The use of comprehensive ophthalmic examination as the reference standard ensures diagnostic validity. Additionally, the study provides valuable insights into refractive error patterns and spectacle use, highlighting gaps beyond detection.

Nevertheless, several limitations should be acknowledged. First, because only a randomly selected subset of screen-negative children underwent confirmatory examination, the study is subject to partial verification bias, and specificity-related measures cannot be interpreted as definitive full-cohort estimates. Second, the cross-sectional design precludes assessment of longitudinal outcomes such as spectacle adherence, prescription updating, or change in refractive status over time. Third, the study was conducted in a single geographic region, which may limit generalizability to other school systems and program settings. Future studies should incorporate complete or weighted verification strategies, longitudinal follow-up, and direct assessment of spectacle compliance and refractive service quality.

What is Already Known:

Prior studies have demonstrated that teachers can achieve reasonably high sensitivity in detecting reduced visual acuity, although concerns regarding referral accuracy and false-positive rates remain.

What is New in this Study:

The present study extends existing evidence by evaluating teacher-led vision screening in a real-world government school setting using a large cohort and a pragmatic validation design. It demonstrates that such screening achieves high sensitivity (96.8%) while restricting referrals to less than 10% of the screened population, thereby optimizing specialist workload. Importantly, the study introduces programmatic metrics such as crude screening yield (approximately 1 confirmed case per 24 children screened), providing a practical measure of field utility.

CONCLUSION

Teacher-led vision screening is a feasible and sensitive first-level strategy for early detection of visual impairment in school children, esp in resource-limited settings. Its public health value lies in its ability to triage large numbers of children through the school system while limiting specialist referral to a smaller subgroup. Equally importantly, the study highlights that detection alone is not sufficient: school eye health programs must also strengthen the continuity and quality of refractive care, particularly for children who already use spectacles but continue to have suboptimal vision.

Table 1: Overall Screening Profile of the Study Population

Variable	Value
Total children screened	7,150
Age (years), mean $\pm$ SD	13.66 $\pm$ 3.91
Age range (years)	6 - 18
Screen-Positive	642 (8.98%)
Screen-Negative	6,508 (91.02%)

Table 2: Validation Outcomes of Teacher-Led Vision Screening

Parameter	Number	Percentage (%)
Total children screened	7,150	100

Screen-positive (referred)	642	8.98
Screen-negative	6,508	91.02
Screen-positive children validated (642)		
True positives (TP)	300	46.7
False positives (FP)	342	53.3
Screen-negative children sampled for validation (200)		
True negatives (TN)	190	95.0
False negatives (FN)	10	5.0

Table 3. Primary Diagnostic Performance Estimates of Teacher-Led Vision Screening

Parameter	Value
Sensitivity	96.8%
Positive predictive value (PPV)	46.7%
Sample-based negative predictive value (NPV)	95.0%
False-negative proportion	3.2%
Crude screening yield	1 confirmed case per 23.8 children screened

Because only a randomly sampled subset of screen-negative children underwent confirmatory examination, specificity, overall accuracy, and false-positive rate, are not presented here as definitive full-cohort estimates.

Table 4: Comparison of Best-Corrected Visual Acuity Based on Spectacle Use

Parameter	Spectacle Users (Mean ± SD)	Non-Users (Mean ± SD)	p-value
BCVA (Right Eye)	6.43 ± 1.64	6.92 ± 2.46	0.003
BCVA (Left Eye)	6.30 ± 1.72	7.12 ± 2.95	<0.001

BCVA: Best-corrected visual acuity; SD: Standard deviation

Figure 1. Flow Diagram of Study Methodology

Flow diagram depicting the three-phase teacher-led vision screening model among 7,150 school children. Teachers screened children using Snellen charts, classifying 642 as screen-positive and 6,508 as screen-negative. All screen-positive and a random subset of screen-negative children (n=200) underwent ophthalmologist validation, yielding true positives (300), false positives (342), true negatives (190), and false negatives (10).

Acknowledgement: NIL

Conflict of Interest: NIL

Data Availability Statement: The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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