ORIGINAL ARTICLE

# Accuracy of Vision Screening for Elementary School Students by Teachers in School-Based Setting

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## ABSTRACT

**Introduction:** Due to limitations in healthcare resources, teachers are hoped to conduct vision screening effectively at school. **Objective:** To determine the accuracy of vision screening conducted by teachers compared to those conducted by practitioners. **Methodology:** Seventy five teachers from two elementary schools in East Java Province, Indonesia, were trained to screen their fourth to sixth grade students. They were trained to use six tumbling E-letters arranged in a row, self-printed in different orientations, and held three meters away. Identifying of at least four optotypes correctly was considered as "pass", and the letter size was set represent 6/9 Snellen visual acuity. The practitioners then repeated the examination using a standardized Snellen chart. The results from both groups were then compared and analyzed statistically. **Results:** A total of 918 eyes from 459 students were evaluated in this study. Although there was a statistically significant difference between the results of the teachers' screening and the practitioners' ($p<0.05$), the teachers still demonstrated good clinical accuracy. Specifically, the teachers' screening showed an accuracy of 84.85% per eye and 84.05% per student compared to the practitioner's assessment. **Discussion:** The results were not 100% accurate, which may be due to inadequate training, a lack of proficiency among the teachers, and unsuitable environmental conditions during the screenings. Nevertheless, an accuracy rate of 84% is still considered good. **Conclusion:** Vision screening conducted by teachers is an accurate method for the early detection of vision disorders and could be considered a national strategy to prevent avoidable blindness.

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## INTRODUCTION

Refractive error is a common eye disorder in children and the second leading cause of visual impairment. If left uncorrected, it can lead to serious problems affecting the children's future. For young children, vision is crucial for growth and development. Uncorrected refractive error can hinder academic performance, lower self-esteem, impact social life, and limit educational and job opportunities (1-4).

About 45.5 million people worldwide are visually impaired due to uncorrected refractive errors, including 12.8 million children aged 5 to 15, with a global prevalence of 0.96-12%. Studies in eight countries indicate that uncorrected refractive errors impact 62% to over 90% of children in this age group (2,3). Thus, early detection through school-based vision screening is essential to prevent serious issues. One example is school eye health programs, which focus on identifying uncorrected refractive errors.

Currently, the implementation of eye health screening in Indonesia, including in East Java, is incorporated in the School Health Efforts (Usaha Kesehatan Sekolah, UKS), where schools collaborate with Community Health Centers to conduct eye health examinations alongside

other health screenings (school immunization activities). The activities are carried out by health personnel from the Community Health Centers, or at least with their assistance. Unfortunately, the Community Health Centers often deal with limited resources since they must conduct numerous other public health services. Hence, the implementation of eye health screening has not been fully effective. Given these challenges, it is necessary to consider alternative methods to ensure that the screening can continue, such as involving teachers, who spend more time with students to observe their academic and social performance. Involving teachers in vision screenings is a sensible strategy for early detection of refractive errors before having children undergo medical examinations. In 2023, the WHO released the Vision and Eye Screening Implementation Handbook, which recommends training teachers to conduct screenings in schools. Since this examination is conducted by school teachers or non-medical practitioners, this study finds it necessary to assess the accuracy of vision screenings at school. The assessment employs a simple vision screening chart, comparing the results of teachers' vision examinations with the standard medical equipment conducted by practitioners, such as optometrists or ophthalmologists.

## MATERIALS AND METHODS

### Subjects

This was a cross-sectional retrospective study, using secondary data from medical records. The data were obtained from a community service activity organized by Indonesian Ophthalmologists Association, which provide free glasses for students who need of refractive correction. The study involved fourth to sixth grade students and their teachers from two school in East Java Province, Indonesia.

Ethical clearance for this study was obtained from the issued by the Health Research Ethical Clearance Commission, Faculty of Dental Medicine, Universitas Airlangga, with the number 1056/HRECC. FODM/X/2024.

### Methods

The community service activities were conducted for two days. On the first day, two activities took place. Activity 1 focused on theoretical session on refractive errors, their harmful, the importance of early detection, and the role of teachers in identifying cases. Then Activity 2 provided training on how to conduct screenings using the Tumbling E-chart. On the second day, other two activities were carried out. First, teachers practiced screening students based on the training material. Then the ophthalmologist team conducted vision examinations, performed refraction, and provided glasses if the best corrected visual acuity less than 6/9.

To ensure consistency in vision screening, a standardized procedure was implemented by teachers using a simplified tumbling E-chart. The screening used a a self-printed white sheet of paper containing a single line consisting of six tumbling 'E' letters, each oriented in a different direction. The size of the letters corresponded to a 6/9 optotype when viewed from a distance of three meters. This set up is shown in Fig.1.

**Figure 1: Tumbling E used in this study**

This simple visual chart is a modification of the chart proposed by the International Agency for the Prevention of Blindness (IAPB) (2). The distance between the teacher and the student was maintain at three meters, measured using a pre-measured plastic string marked to indicate the correct length. The teacher pointed to each letter "E," and the student was asked to identify the direction in which the letter opened. If the students correctly identified the direction of at least four out of the six letters, they were classified as "pass," indicating that their visual acuity were 6/9 or better. Therefore, they did not require a referral for eyeglass correction. If the students only could identify fewer than four optotypes, they are classified as "fail".

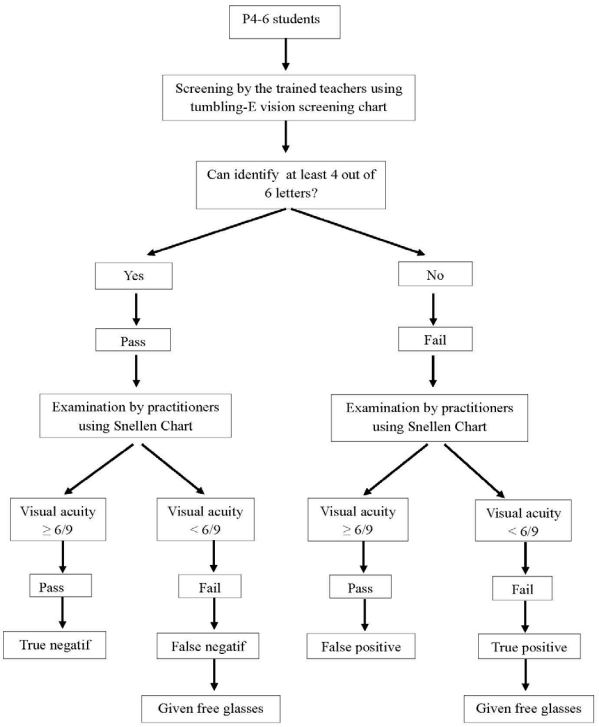


**Figure 2: Flow Chart of the study**

Students were re-examined by the ophthalmologists' team using a standardized Snellen Chart (OneMed®) at distance of six meters. If the visual acuity was 6/9 or better, it was considered as "pass", while worse than 6/9, considered as "fail", followed by refraction examinations and other eye health assessments. If a refractive error

was detected in at least one eye, the student will receive a free pair of glasses. The results from teachers were then compared with those of the practitioners, analyzed both per eye and student. The flow chart of the study is shown in Fig 2.

### Statistical analysis

The statistical analysis was performed using SPSS software version 29.0. McNemar correlation analysis was used to compare variables. In this study, a value of $p<0.05$ was considered statistically significant.

## RESULTS

This section presents the baseline characteristics of participants and the outcomes of the vision screening. It includes a comparison between the screening results conducted by trained teachers and those verified by ophthalmology practitioners.

### Baseline characteristics

In this study, total of 75 teachers participated, with a gender distribution of 53% male (n=40) and 47% female (n=35). Age analysis revealed that the majority of participants were aged between 46-50 years (21%), followed by those aged 36-40 years (20%) and 41-45 years (19%). In terms of education, a significant majority held a Bachelor's degree (83%), while 15% had a Master's degree. and 2% had completed only high school. In total, 459 students were screened (918 eyes). Comparison and statistical analysis

A statistical comparison was conducted to evaluate the agreement between the vision screenings conducted by teachers and those by practitioners. Table II showed comparison of the examination results by teachers and practitioners.

**Table I: Basic Characteristic of the Teachers**

| | Characteristics Frequencies (%) |
|---|---|
| **Gender** | |
| Male | 40 (53) |
| Female | 35 (47) |
| **Age** | |
| 25-30 years | 4 (5) |
| 31-35 years | 11 (15) |
| 36-40 years | 15 (20) |
| 41-45 tahun | 14 (19) |
| 46-50 tahun | 16 (21) |
| 51-55 tahun | 12 (16) |
| 56-60 tahun | 3 (4) |
| **Education level** | |
| High school | 2 (2) |
| Bachelor's degree | 62 (83) |
| Master's degree | 11 (15) |
| Total | 75 |

**Table II: Comparison examination results by teacher and practitioner**

| Eyes | | | | | Student | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Practitioners' results | | | | | Practitioners' results | | | |
| Teachers' results | Pass | Fail | Total | p-value | Teachers' results | Pass | Fail | Total | p-value |
| Pass | 688 | 120 | 808 | <0.001 | Pass | 330 | 59 | 389 | <0.001 |
| Fail | 19 | 91 | 110 | | Fail | 14 | 56 | 70 | |
| Total | 707 | 211 | 918 | | Total | 344 | 115 | 459 | |
| Sensitivity | 80,00% | | | | Sensitivity | 82,73% | | | |
| Specificity | 84,83% | | | | Specificity | 85,15% | | | |
| Accuracy | 84,09% | | | | Accuracy | 84,85 % | | | |

The analysis showed a statistically significant difference between teachers' and practitioners' results with a p-value of <0.001. The true positive rate was 9.9% per eye and 12.2% for students. Meanwhile, the true negative rate was 74.9% per eye and 71.9% for students. False positives were 2.1% per eye and 3.1% for students, and false negatives were 13.1% for eyes and 12.9% for students. Accuracy was measured by calculating the number of true positives plus true negatives divided by the total. The overall screening accuracy was 84.09% per eye and 84.85% per student. Sensitivity was found at 80% per eye and 82.73% per student, while specificity was 84.83% per eye and 85.15% per student. These values indicate a significant difference in screening results between teachers and practitioners, with an overall accuracy of approximately 84% for both eyes and students. Meanwhile, the sensitivity and specificity rates suggest that the screenings are effective, although there are notable rates of false negatives and false positives.

## DISCUSSION

This study analyzes vision screenings performed by school teachers using a self-printed single-row Tumbling E-chart modified from the chart recommended by the IAPB. The goal was to develop a screening method that is simple, quick, and easy to administer. By using only one row of six optotypes, this method is efficient for large-scale evaluation and cost-effective. The optotype used was the Tumbling E, not the alphabet like in the Snellen Chart, making it accessible to everyone, including those who cannot read or have communication difficulties, who might struggle with examination using the Snellen chart. Additionally, this screening was conducted at a distance of only three meters. This range is more practical than the Snellen chart, which requires a distance of 5–6 meters, which might not be feasible for some schools. Furthermore, the screening card was designed to be simple and could be printed repeatedly by each school, making it more cost-effective and efficient.

Although a different chart was used, this study still followed the same cutoff point at 6/9 in accordance with IAPB recommendations. With a visual acuity of 6/9 in one eye, which is likely to improve when using both eyes, the students can see well for both near and distant

activities. A refractive error with a visual acuity of 6/9 is minimal and does not require correction with glasses, even in a clinical examination setting by an eye doctor. The analysis was conducted for both per eye and per student because one eye may pass or meet the screening threshold while the other does not. This distinction helps teachers identify students who need a referral to healthcare. Although a statistically significant difference was found between teachers' and practitioners' screening results, the error rates were not excessively high. The false positive and false negative rates were slightly better than in Siddiqui et al.'s study, which reported 17.9% false positives and 15.79% false negatives (5).

The errors found in the screening results may be influenced by several factors, including limited time for training and the lack of follow-up practice sessions. According to Bechange et al., issues affecting screening quality included rushed training, unclear procedures, and insufficient practice time. To ensure accurate screenings, training should include both theoretical knowledge and practical skills to familiarize with screening equipment and standard procedures, including documentation and referrals (6).

Environmental conditions during the screening may also have affected the accuracy of the results. In this study, the lighting and atmosphere in the classroom during the examination were noisy and distracting, which may have confused the students. Ideal conditions for screenings include adequate lighting without glare, minimal distractions, and ensuring that students waiting to be screened cannot see the vision chart (1).

Despite these challenges, the accuracy of the teachers' assessments exceeded 84% compared to practitioners, both for individual eyes and together. Sensitivity and specificity were all within a good range of 80-90%. These results were similar to studies by Marmamula et al. in India, Tabansi et al. and Aribaba et al. in Nigeria, Govender-Poonsamy et al. in South Africa, and Paudel et al. in Vietnam (7-11). In our study, despite the short duration of the training, the teachers were quite proficient in understanding the methodology and interpreting screening results. This may be attributed to their high level of education (as almost all had at least a bachelor's degree) and the fact that the students being screened were from higher grades (we conducted the screening on grades 4-6). Therefore, the students can follow the instructions very well.

Limited medical staff, especially in ophthalmology, is still a major hamper for early detection of vision problems. However, findings from this study and others show that teachers can accurately conduct vision screenings, provided they receive adequate training, demonstrations, and practical experience. These practices and experiences enable them to make well-informed referral choices and promptly direct patients to eye care professionals when necessary. For this reason, collaboration between the Ministry of Health and the Ministry of Education is highly encouraged to accelerate program approval and prioritization. Rapid screenings can cost-effectively identify vision issues, alleviating financial pressure on families and healthcare systems while promoting a comprehensive school eye care policy (1, 7-11).

## CONCLUSION

Screening by teachers is an accurate method for early detection of vision disorders and could be considered a national strategy for preventing avoidable blindness. Adequate training is essential to achieve higher-quality screening results.

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