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Evaluation of Teacher's Performance of Vision Screening in Primary School Children in Al-Qassim, Saudi Arabia

Dr. Vishakh G. Nair

Department of Optometry ,Qassim University, Saudi Arabia
Email: *v.nair[at]qu.edu.sa*
optom.vish.nair[at]gmail.com

Abstract: ***Primary school teachers are often the first to observe signs of visual difficulties in students, as their close daily interactions provide a unique opportunity for early detection. Their involvement in school-based vision screening programs is particularly valuable, especially in rural areas where access to eye care services is limited. However, the effectiveness of their role depends significantly on the quality of training they receive and the level of collaboration with optometrists. This study employed a comparative, cross-sectional design to assess the accuracy of primary school teachers in conducting vision screenings compared to professional optometrists. The study was conducted among primary school children in Al-Qassim, Saudi Arabia. A total of 35 teachers and 346 students participated. Teachers underwent a structured training session and subsequently screened students' visual acuity using Snellen charts under unaided, aided, and pinhole conditions. The optometrists repeated the same assessments to serve as the reference standard. A total of 346 students were screened independently by both teachers and optometrists. The teacher-led screenings demonstrated a sensitivity of 78%, specificity of 96%, a positive predictive value (PPV) of 74%, and a negative predictive value (NPV) of 96%. The level of agreement between teachers and optometrists was substantial, with a Cohen's kappa coefficient of 0.72. With appropriate training and support, primary school teachers can effectively participate in school-based vision screening programs, particularly in underserved areas. Their involvement has the potential to improve early detection and referral of visual impairments in children, though ongoing collaboration with optometrists remains essential to ensure screening accuracy.***

Keywords: Vision screening, Primary school teachers, Visual acuity, Community eye care, Primary school children

1. Introduction

Good vision is crucial for children's learning and development. Early detection of vision problems can prevent learning difficulties, making schools an ideal setting for screenings [1]. In Saudi Arabia, the effectiveness of primary school teachers in conducting vision screenings compared to optometrists remains unclear.

This study investigates the ability of teachers in Al-Qassim to screen for vision problems accurately. It aims to determine if teachers can be trained to perform reliable screenings, providing insights for improving teacher training and shaping public health strategies for better vision care.

Several studies have explored the effectiveness of training schoolteachers to conduct vision screening among children, particularly in resource-limited settings.

In Ghana, a study conducted in the Bibiani-Ahwianso-Bekwai district demonstrated that teachers, following a one-day training session, were able to screen 978 pupils with a sensitivity of 76% and specificity of 96%. Although the positive predictive value (PPV) was modest at 47%, the high negative predictive value (NPV) of 99% indicated strong reliability in identifying children without vision problems. The study concluded that, with minimal yet targeted training, teachers can conduct vision screening with a high degree of accuracy. [2]

Similarly, a pilot study in Abakaliki, Nigeria, involved 20 trained primary school teachers screening 350 pupils. After a two-day training based on a modified WHO primary eye care manual, the teachers achieved a sensitivity of 73.3% and specificity of 92.8% in detecting visual impairments. The most common conditions identified were refractive errors and allergic conjunctivitis. The study emphasized the importance of continuous teacher training and collaboration with eye care professionals to enhance early detection and referral within school settings. [3]

In Port Harcourt, Nigeria, a larger study involved 130 teachers trained over a six-hour session, who subsequently screened 1,300 pupils. The findings showed a sensitivity of 53.3% and a notably high specificity of 98.4%, with a PPV of 79.3% and an NPV of 94.7%. While the teachers demonstrated moderate agreement with professional screeners (Cohen's Kappa = 0.604), the study emphasized that regular training and improved methodology could significantly enhance screening accuracy. [4]

Together, these studies provide strong evidence that trained teachers can play a vital role in early vision screening among schoolchildren, helping to reduce the burden on limited eye care systems and enabling timely interventions for preventable vision impairments.

The aim of the study was to evaluate the performance of primary school teachers in conducting vision screening for children in Al-Qassim, Saudi Arabia, and to compare their findings with those of professional optometrists. The objectives are

- To assess the accuracy (sensitivity and specificity) of teacher-conducted vision screenings compared to optometrist assessments.

- To determine the level of agreement (Cohen's Kappa) between vision screening outcomes performed by teachers and those by optometrists.
- To evaluate the potential of using trained teachers as a resource for school-based vision screening programs.
- To identify any statistically significant differences in screening performance between male and female teachers.
- To assess the need for further training or support to improve teacher-led screening accuracy.

This study employed a comparative cross-sectional design to assess the accuracy and effectiveness of primary school teachers in conducting visual acuity screenings, compared to trained optometrists, among primary school children in Al-Qassim, Saudi Arabia

2. Methodlology

Participants were primary school teachers and students selected from both urban and rural schools in Al-Qassim, Saudi Arabia.

The sample size was of approximately 35 teachers (20 males and 15 females) and 346 students aged between 6 and 12 years were randomly selected from three schools.

The following instruments were used for the vision screening procedures:
- Snellen visual acuity chart (10 feet)
- Occluder
- Pinhole device
- Measuring tape (3 meters)
- Trial frames (used when necessary)
- Structured recording sheets specifically designed for this study

A brief training session was conducted for the participating teachers on the use of visual acuity charts and the identification of common visual impairments in children. The training materials were reviewed (see Appendix A). and validated by three professors of optometry.

The training consisted of a two-hour hands-on workshop led by optometrists. Teachers were instructed on the use of Snellen's alphabetic chart and the tumbling 'E' chart in three testing conditions: unaided (without glasses), aided (with glasses), and with a pinhole lens. They were taught how to assess visual acuity for each eye separately by covering the non-tested eye and asking the child to read aloud the optotypes on the chart from a standardized distance of 3 meters. This distance was measured and marked on the floor using a measuring tape and tape markers.

Teachers were trained to classify a child's vision as "normal" if the child could correctly identify at least 4 out of 5 optotypes on the 20/32 line. Failure to do so (i.e., VA < 20/32) in either or both eyes was considered indicative of a vision problem, and the eye was labeled as a "bad eye." Practical demonstrations were provided, including examples of common errors such as incomplete eye occlusion or unclear instructions. Teachers then practiced on each other under supervision until competency was confirmed.

Following the training, each trained teacher independently conducted visual acuity screenings on 10 students from their own classrooms. The screenings were performed in well-lit environments, preferably with natural light, such as school halls or other available classrooms. Teachers used standardized Vision Recording Sheets to document their findings. (see Appendix B) No financial incentives were offered to the teachers in order to minimize potential bias.

In total, 346 students (approximately 10 per teacher) were screened by the participating teachers. Upon completion of the teachers' screenings, members of the research team independently repeated the visual acuity tests on the same students, using the same Snellen and tumbling 'E' charts. The optometrists' assessments served as the reference standard for evaluating the performance of the teachers' screenings.

The results obtained by the teachers were compared to those of the optometrists to determine the accuracy of the teachers' assessments. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated accordingly, using the following formulae:

$$\text{Sensitivity} = \frac{True\ positives(TP)}{True\ positive + False\ Negatives} \times 100\%$$

$$\text{Specificity} = \frac{True\ Negative(TN)}{True\ Negative + False\ Positive} \times 100\%$$

$$\text{Positive predictive value} = \frac{(TP) True\ Positives}{True\ Positives + False\ Positive} \times 100\%$$

$$\text{Negative predictive value} = \frac{True\ Negative(TN)}{True\ Negative + False\ Negative} \times 100\%$$

The agreement between the teachers' and optometrists' findings was measured using the Kappa statistic .

Additionally, mean differences in LogMAR visual acuity scores, along with standard deviations, were calculated and analyzed using the paired t-test for subgroup comparisons. Statistical significance was defined as $p < 0.05$.

Inclusion Criteria were
- Primary school students enrolled in the selected public schools.
- Students present on the day of screening.
- Teachers currently employed at the participating schools.

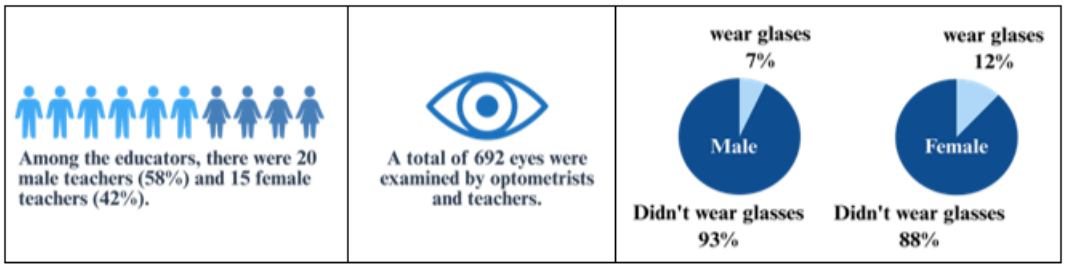
Exclusion Criteria were
- Sport teachers
- Private school teachers and students.
- Teachers who did not complete the training session.

Data were analyzed using Microsoft Excel software. The research team and teachers used the same instrument for screening. However, the results of the research team were used as the gold standard. The sensitivity, specificity, positive predictive value and negative predictive value of teacher's data was calculated after determining true positives, false positives, true negatives and false negatives.

3. Results and Analysis

Demographical Data :Among the educators, there were 20 male teachers, accounting for 58% of the total, and 15 female

teachers, representing 42%. Additionally, a total of 692 eyes were examined by both optometrists and teachers. The percentage of students wearing glasses was 7% for male students and 12% for female students.



Teachers' Visual Acuity Screening Versus the Research Team's Results

Table 1: Unaided VA

	TP	TN	FP	FN
Male	42	342	8	8
Female	24	242	15	11
Sum	66	584	32	19

Table 2: Aided VA

	TP	TN	FP	FN
Male	4	22	2	0
Female	1	33	2	0
Sum	5	55	4	0

Table 3: VA with Pinhole lens

	TP	TN	FP	FN
Male	27	352	14	7
Female	8	282	2	0
Sum	35	634	16	7

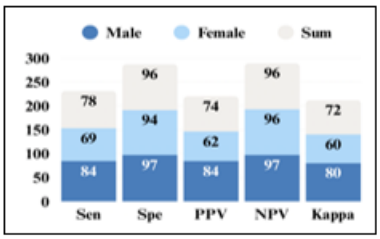


Figure 1: Unaided VA

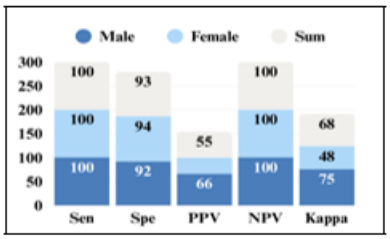


Figure 2: Aided VA

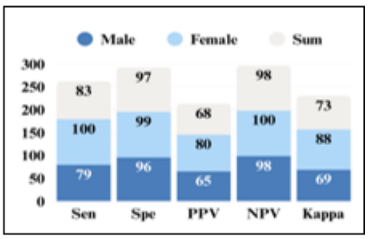


Figure 3: VA with Pinhole lens

The visual acuity results obtained by the teachers were compared to those of the research team (gold standard) across three testing conditions: unaided vision (table1), vision with glasses (aided VA) (table2), and vision with pinhole lens (table3). A total of 692 pupils were assessed across the various conditions.

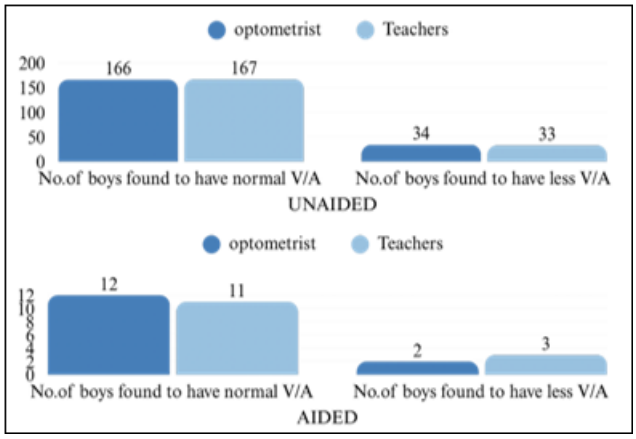
In the unaided visual acuity condition, among male students, 42 true positives (TP), 8 false positives (FP), 342 true negatives (TN), and 8 false negatives (FN) were observed. Among females, 24 TP, 15 FP, 242 TN, and 11 FN were recorded. In table1. Sensitivity was 84% for males and 69% for females, while specificity was 97% and 94%, respectively. The Cohen's Kappa scores indicated substantial agreement, with values of 0.80 for males and 0.60 for females (Fig1).

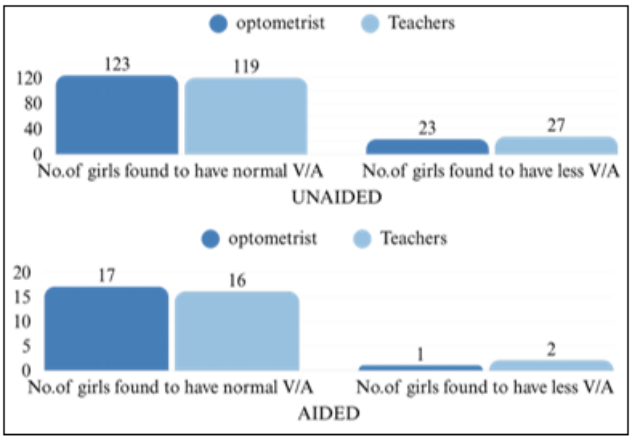
For the aided visual acuity (students wearing glasses), only 32 students were assessed due to the low percentage of glasses users (7% males, 12% females) (table 2).

Teachers showed perfect sensitivity (100%) for both males and females, with specificity values of 92% (males) and 94% (females). Kappa scores were 0.48 for females and 0.75 for males, reflecting moderate to substantial agreement (Fig 2).

In the pinhole lens condition, teachers screened the same 692 pupils. Among male students, 27 TP and 7 FN were recorded, with 352 TN and 14 FP. Among females, 8 TP and 0 FN were identified, with 282 TN and 0 FP. In table3. Sensitivity was 79% for males and 100% for females, and specificity was 100% for both groups. Notably, the Kappa score was higher among females (0.88) than males (0.69), suggesting a stronger agreement in the female subgroup (Fig3).

Positive predictive value (PPV) and negative predictive value (NPV) varied across groups and conditions but remained generally high, especially under the pinhole lens testing, which yielded the highest PPV and NPV across both genders (Fig1-3). These findings suggest that with appropriate training, teachers can achieve reasonably high accuracy in visual acuity screening, particularly in detecting normal vision (high specificity and NPV), though their sensitivity in detecting visual impairment was generally lower in females under the unaided condition.





Bar charts, presents a gender-based comparison of classification results for both unaided and aided vision. The teachers' results closely matched those of the optometrists, with only minor discrepancies in the number of students identified as having reduced or normal visual acuity across both genders and conditions. This suggests that despite small deviations in LogMAR scores, teachers were consistent in identifying visual impairments.

Table 4

	Mean difference in LogMar	Std. Dev	t.test	p-value
Unaided VA OD	-0.008	0.07	-2.122	0.035
Unaided VA OS	-0.009	0.06	-2.86	0.004
Aided VA OD	-0.001	0.01	-2.14	0.032
Aided VA OS	-0.004	0.04	-1.67	0.09
VA with Pinhole OD	-0.004	0.06	-1.32	0.18
VA with Pinhole OS	-0.01	0.06	-3.01	0.002

To evaluate the consistency between teachers' and optometrists' visual acuity measurements, the mean differences in LogMAR scores were analyzed under three conditions: unaided vision, aided vision, and vision with pinhole lens (Table 6).The results showed a statistically significant, mean difference in unaided visual acuity for both the right eye (OD: -0.008, p = 0.035) and the left eye (OS: -0.009, p = 0.004), indicating a slight but significant discrepancy between teachers' and optometrists' measurements. For aided visual acuity, a significant difference was also observed in the right eye (OD: -0.001, p = 0.032), while the left eye did not reach statistical significance (p = 0.09). In the pinhole lens condition, a significant difference was found only in the left eye (OS: -0.01, p = 0.002), while the right eye showed no significant difference (p = 0.18).

4. Discussion

In comparison with similar studies conducted in other regions, our study demonstrated strong diagnostic performance, with a sensitivity of 78%, specificity of 96%, positive predictive value (PPV) of 74%, negative predictive value (NPV) of 96%, and a Cohen's Kappa score of 0.72, indicating substantial agreement (Table 5).

These results are comparable to findings from Ghana (Bibiani-Ahwianso-Bekwai, 2017), which reported a sensitivity of 76%, specificity of 96%, PPV of 47%, NPV of 99%, and a Kappa score of 0.55. Similarly, a study conducted in Abakaliki, Nigeria (2023), showed slightly lower sensitivity (73%) and specificity (92%), with PPV and NPV of 60% and 95%, respectively, although the Kappa value was not reported.

In Port Harcourt, another study assessing teacher performance in vision screening reported a sensitivity of 53% and specificity of 94%, with PPV of 79%, NPV of 94%, and a Kappa score of 0.6.

These comparisons suggest that the vision screening performance of trained teachers in Al-Qassim is not only comparable to, but in some aspects exceeds, the outcomes observed in other low-resource or school-based screening settings. This high level of performance may be attributed to the structured training program provided, which included both theoretical instruction and supervised practical sessions led by optometrists. Additionally, the use of standardized tools- such as the Snellen chart and structured vision recording sheets- likely contributed to improved accuracy and student cooperation. Differences in training quality and screening conditions may explain the relatively lower performance reported in other studies.

Table 5: Shows a comparison with other studies

Study name	Sensitivity - specivity	PPV- NPV	Kappa score
Evaluation of Teacher's Performance of Vision Screening in Primary School Children in Al-Qassim, Saudi Arabia	78% - 96%	74% - 96%	0.72
1) Assessing the Quality of Vision Screening by Teachers among Schoolchildren, Bibiani-Ahwianso-Bekwai, Ghana (2017) [2]	76% - 96%	47% - 99%	0.55
2) Effectiveness of Teachers in the Detection of Eye Disorders among Primary School Children, Abakaliki, Nigeria (2023) [3]	73% - 92%	60%- 95%	Not reported
3) Evaluation of Teachers' Performance of Vision Screening in Primary School Children in Port Harcourt [4]	53% - 94%	79% - 94%	0.6

5. Conclusion

The results of this study indicate that trained primary school teachers in Al-Qassim can effectively conduct visual acuity screenings with high specificity and substantial agreement with optometrists' findings. With a sensitivity of 78% and a Kappa score of 0.72, the accuracy of teacher-led screenings demonstrates their potential as a valuable component in school-based vision screening programs.

No significant difference was found between male and female teachers in terms of screening performance, confirming that both can be equally effective following basic training. The statistical analysis showed minor differences in measured VA

values, but these are clinically acceptable for preliminary screening purposes.

Overall, this study supports the integration of trained teachers into vision screening initiatives, particularly in regions where access to professional eye care may be limited.

6. Area for Improvements

1) Wider Implementation: Extend the program to include a larger number of schools and teachers from different regions to improve generalizability of findings.
2) Training Enhancement: Develop a more detailed and structured training module for teachers, including follow-up refresher sessions and practical workshops.
3) Referral System Integration: Establish a streamlined referral pathway from schools to optometrists or eye clinics for children identified with vision problems.
4) Evaluation of Long-Term Impact: Future research should assess the long-term outcomes of teacher-led vision screening programs on children's academic performance and visual health.

Conflict of interest:
The author declares no conflict of interest.

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