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Validating teachers for Visual Acuity Screening in rural South African schools

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Background: Early detection of a reduction in visual acuity (VA) in children is crucial for their education, job prospects, and overall well-being. In many regions, this is deficient because of limited access to eye-care services, adversely affecting the well-being of visually impaired children. There is, therefore, a need for alternative vision screening methods.

Aim: This study assessed teachers' efficacy in VA screenings for rural primary school students.

Setting: The study was conducted in a rural primary school in the Pinetown Education District, KwaZulu-Natal, South Africa.

Methods: The same group of children was tested by both teachers and final-year optometry students for comparison. The methodology adhered to the Standard School Eye Health Guidelines for low- to middle-income countries. Screening tools involved a 6/60 tumbling E optotype and a line of five 6/12 optotypes.

Results: Teachers screened 256 children between ages 6 and 12 years. Their results showed a sensitivity of 100%, a specificity of 99.2%, a positive predictive value of 33%, and a negative predictive value of 100%. All teachers acknowledged the importance of vision screening and committed to integrating it into their skill set.

Conclusion: The findings reveal that teachers can match eye-care professionals' efficacy in visual screenings. Training them can facilitate early detection and referrals, mitigating vision impairment's negative impacts on a child's education and overall well-being.

Contribution: This original research study highlights the success of task shifting as a strategy to address human resource challenges for eye care in South Africa.

Keywords: validation; sensitivity; specificity; vision screening; teachers; negative predictive value; positive predictive value.

Introduction

Vision is an essential prerequisite to learning, and its impairment significantly impacts a child's developmental, educational, and social outcomes.[1] Vision loss is associated with a higher risk of mortality,[2] depression,[3] difficulty performing activities of daily living,[4] and quality of life[5] among others. Furthermore, the health burden of distance visual acuity (VA) impairment in children is far more significant than that of adults because of the early age of onset and potential lifespan of children.[6] With the rising prevalence of paediatric vision disorders globally, early detection and intervention for these conditions have become increasingly important.[7] Vision screening in young children is advisable because children, unlike adults, may be unable to articulate their distance VA impairment. Vision screening, particularly in schools, has been suggested as an effective method to identify distance VA impairments in children, considering its relative accessibility and the potential for high-impact outcomes.[8] However, trained personnel for these screenings are often limited, especially in developing contexts where resources are significantly constrained.[9,10] Vision screening by non-healthcare personnel has been adopted in some scenarios to bridge the gap to access if training addresses proper screening settings, recording, interpretation and referrals.[10]

In South Africa, the Integrated School Health Programme (ISHP) was initiated to improve the health of school-age children and their communities by providing a comprehensive array of services aimed at addressing barriers to learning and conditions contributing to childhood morbidity and mortality.[11] School health nurses provide services; however, in their absence, health personnel or allied health personnel are recruited. While school health services are expected to address the need for vision screening in schools, anecdotal evidence suggests that these efforts are provided sporadically and inequitably.[12] An innovative approach to train and utilise teachers as vision screeners has been suggested as a cost-effective and convenient strategy to address this challenge of limited access to screening services.[9] It leverages teachers' daily interaction with students and their potential to detect vision problems early on. This strategy has been investigated in various developing countries such as Vietnam,[13] India,[14,15] China[16] and Tanzania.[17] As South Africa shares similar human resource challenges as many other developing countries, this study aimed to validate teachers as vision screeners in rural primary schools. By bridging the gap between need and service provision, this study's findings can help reduce the burden of childhood distance VA impairment in resource-limited settings.

Research methods and design

Study design and setting

The study was part of a larger prospective study investigating the impact of spectacle correction on the well-being of children with distance VA impairment because of uncorrected refractive error (URE), the Healthy Eyes, Happy Child (HEHC) project. This school-based validation study was conducted in 2022 in one rural primary school in the Pinetown Education District, KwaZulu-Natal province, South Africa.

Sample selection

Volunteer teachers, one from each grade (one to seven), were recruited to be part of the study. Each teacher conducted the screening of the learners from their class. The population-based Refractive Error Study in Children in Africa (RESC) reported a 2% prevalence of URE in children.[18] A 5% prevalence rate was postulated for this school-based study, based on a greater likelihood of encountering children with distance VA impairment because of URE. Schools are primary venues for health screenings and serve as critical points for identifying distance VA impairment that affects academic performance. Additionally, the structured environment of schools allows for closer observation and reporting of vision-related issues, making it more likely to identify children with URE than in a broader population-based setting.[17] With an estimated prevalence of 5%, a minimum sample of 240 learners was required to achieve a minimum power of 90% (Actual power = 88.9%) for detecting a change in the percentage value of sensitivity of a screening test from 0.50 to 0.90, based on a target significance level of 0.05 (actual $P = 0.039$). The learners, aged 6–12 years, were selected by convenience sampling because only children with parental consent were included in the sample. This research formed a component of a broader study investigating the impact of spectacle correction on the well-being of children with vision impairment because of URE. For this aspect of the study, no specific exclusion criteria were applied. Children were included in the study based on parental consent and child assent.

Training of teachers on the visual acuity screening protocol

Teachers were trained in an on-site 2 h programme on the VA screening methodology adopted from the Standard Guidelines for Comprehensive School Eye Health Programmes for low- and middle-income countries.[10] The training provided to teachers included instruction on the following aspects: correct placement of the VA chart, maintenance of the appropriate testing distance and lighting conditions, instructions on VA testing communication protocols, accurate recording of screening data, and referral protocols for children who failed the screening.

Testing equipment and set-up

The VA chart was adapted from the Standard School Eye Health Guidelines and was specifically constructed for this project.[10] As such, no manufacturer's permission was required for its use or publication in this study. The chart comprised a single 6/60 'E' optotype followed by a line of five 6/12 optotypes (Figure 1) oriented in four directions. A chart with a single line of letters enables a quick screening of vision loss, especially in resource-limited settings. The 6/12 VA threshold was selected based on the WHO's classification of distance VA impairment, which documents VA less than 6/12 as distance VA impairment.[7] The test distance was maintained at 3 m. The screening was conducted outdoors in daytime illumination. To ensure optimal conditions, the chart was positioned to prevent any glare, with children standing with their backs to the sun and the chart held perpendicular to the ground. This setup prevented glare because of bright light from shining directly into the children's eyes or onto the chart's surface. Learners were instructed to demonstrate the orientation of the 'legs' of the E by pointing their hands in the same direction. This optotype enabled a response to be recorded even in children who could not read the alphabet.

Data collection

The data collection process was divided into two sections: VA data and teachers' feedback.

Visual acuity data

To ensure that linguistic limitations did not affect the screening outcome, especially for younger learners, instructions and screening were carried out by first-language isiZulu speakers among the optometry students and teachers. The data capture form included fields for recording the child's demographic details (age, gender, grade level), the outcome of the VA screening (pass or fail), and any additional notes. These data were then tabulated for analysis.

Unaided VA was screened first in the right eye and then in the left eye. To adhere to coronavirus disease 2019 (COVID-19) protocols and reduce the risk of transmission, children were instructed to use their hands to cover the eye not being tested, instead of using an occluder. A 'pass' was recorded when the

Note: Testing distance 3 meters.

FIGURE 1: Screenshot of the visual acuity screening chart.

orientation of four or five of the optotypes was correctly identified on the 6/12 line, and a 'fail' was recorded if three or fewer optotypes were correctly identified. Children who failed the screening were regarded as having distance VA impairment and were referred for further assessment to the optometrist who conducted a pinhole examination to determine the cause of distance VA impairment. Children who passed the pinhole screening were subjected to refraction and spectacles were provided to those learners with URE as the cause of distance VA impairment. Children who failed pinhole screening were assessed for other causes of distance VA impairment, such as ocular diseases and were referred to the local eye hospital for further investigation and management. Each learner was randomly allocated to be screened first either by a teacher or by a final-year optometry student, with the second screening conducted by the other. The final-year optometry students served as the gold standard in the validation process. The randomisation was adopted to minimise the learning effect impacting the test results.

Duplicate recording forms were created for each participant. The first screener retained the recording form to ensure the second screener was blinded from the first screening result. The second screener completed a screening report and provided it to the class teacher for feedback to the parents.

Teacher's feedback

After completing the VA screenings for their class, each teacher participated in a one-on-one post-screening interview. These interviews were conducted by a fourth-year optometry student not involved in the VA screening. During the interviews, teachers were asked a series of structured questions to gather their opinions and perceptions of the screening process, any challenges they encountered, their confidence in identifying vision problems, and their willingness to continue conducting screenings in the future. The responses were recorded and analysed descriptively.

TABLE 1: Definition of validity metrics.

Screening performed by teachers	Gold standard Screening performed by fourth-year optometry students		
	Failed VA	**Passed VA**	**Total**
Failed VA (> 6/12)	A	B	A+B
Passed VA ≤ 6/12	C	D	C+D
Total	**A+C**	**B+D**	**N**

Note: Failed VA: > 6/12; passed VA: ≤ 6/12. Sensitivity: A/A+C. Specificity: D/B+D. Positive predictive value: A/A+B. Negative predictive value: D/C+D.
VA, visual acuity.

Following the interview, all participating teachers were provided with a vision screening kit comprising a vision screening chart and a 3 m piece of string, along with guidance on adhering to the steps outlined in the initial training on how to use the kit in future screenings.

Data analysis

Data were captured on a Microsoft Excel spreadsheet and analysed using the Statistical Package for Social Sciences (SPSS) version 19. Frequencies and distributions were computed for the demographic variables. The results of the teacher VA screening were tabulated against the gold standard (screening by final-year optometry students) in a two-by-two table to calculate the various validity metrics, namely sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) with 95% confidence intervals (Table 1).

Sensitivity referred to the ability of the screening method to correctly identify individuals who had distance VA impairment (true positives). In this study, sensitivity measured the proportion of children with distance VA impairment who were correctly identified as such by the teachers' screening, compared to the gold standard (optometry students' screening). A high sensitivity indicated that the teachers were effective in detecting nearly all cases of distance VA impairment, minimising the risk of false negatives (i.e. cases where distance VA impairment goes undetected). Specificity referred to the ability of the screening method to correctly identify children who did not have distance VA impairment (non-cases). In the context of this study, it measured the proportion of children who were correctly identified as not having distance VA impairment by the teachers' screening, compared to the gold standard (optometry students' screening). A high specificity indicated that the teachers were effective in minimising false-positive results, meaning that most children who passed the screening truly did not have distance VA impairment. The PPV indicated the likelihood that a child who was identified as having distance VA impairment by the teachers' screening had distance VA impairment when assessed by the gold standard. In this study, PPV reflected the proportion of true positives (children who had distance VA impairment) among all those who were identified as impaired by the teachers. A higher PPV indicated that the screening by teachers was reliable in predicting actual cases of distance VA impairment, which was crucial for ensuring that those referred for further evaluation needed it.

The NPV represented the likelihood that a child who was identified as not having distance VA impairment by the teachers' screening did not have distance VA impairment when assessed by the gold standard. In this study, NPV reflected the proportion of true negatives (children who did not have distance VA impairment) among all those who were identified as not impaired by the teachers. A high NPV was particularly important in a screening context as it reassures that children who pass the screening are unlikely to have an undetected distance VA impairment, reducing the risk of missed diagnoses. A chi-square analysis was performed to identify demographic factors associated with the accuracy of the teacher vision screening.

Ethical considerations

Ethical clearance to conduct this study was obtained from the University of Kwazulu-Natal Biomedical Research Ethics Committee (No. BREC/00004217/2022) and the Department of Basic Education granted gatekeeper permission. Parents or guardians provided written informed consent, and children provided oral assent before screening. Children participating in the study were issued a participant number to maintain confidentiality. Ethical considerations also extended to the participating teachers who provided informed consent. All participants had the right to withdraw from the study at any time. Children could withdraw their participation at any point, either verbally or through behaviours indicating discomfort. The security of the data was ensured by storing all collected information in a secure, password-protected computer, where it will be kept for 5 years following the conclusion of the study, after which it will be securely removed.

Results

A total of 256 learners of African ethnicity, comprising 52.7% females and 47.3% males, were screened. The mean age of the learners was 8.86 ± 2.12 years (range: 6–12 years), and most were in Grade 1 (19.5%) (Table 2).

Seven female teachers were involved in the VA screening. They could correctly identify all cases of reduced VA (Table 3) and in almost all cases who did not have reduced VA with 100% sensitivity and 99.22% specificity, respectively (Table 3).

No statistically significant associations were found between teacher vision screening accuracy and the demographic characteristics explored (P = 0.498 for gender, P = 0.208 for age, and P = 0.766 for grade level) (Table 4). Multivariate regression outputs were not calculated as the number of inaccurate teacher vision screenings was very small.

In the post-screening interview, all seven participating teachers reported that vision screening was essential, and they had no difficulties performing the procedure. They also found that VA screening was a skill that they would be interested in continuing to use.

TABLE 2: Demographic characteristics of learners in visual acuity screening (N = 256).

Demographic characteristics	*n*	%
Gender		
Female	135	52.7
Male	121	47.3
Age (years)		
6	50	19.5
7	33	12.9
8	39	15.2
9	27	10.5
10	31	12.1
11	38	14.8
12	38	14.8
Grade		
1	63	24.6
2	39	15.2
3	31	12.1
4	34	13.3
5	37	14.5
6	35	13.7
7	17	6.6
Is the child wearing spectacles?		
No	255	99.6
Yes	1	0.4

TABLE 3: Validity indices of visual acuity screening of teacher versus optometry student.

Screening test (Teacher)	Gold standard (fourth-year optometry student)			%	95% CI
	Failed VA	Passed VA	Total		
Failed VA (Worse than 6/12 acuity)	1	2	3	-	-
Passed VA (6/12 or better acuity)	0	253	253	-	-
Total	**1**	**255**	**256**	**-**	**-**
Prevalence of vision impairment	-	-	-	0.4	-
Sensitivity	-	-	-	100.0	0.00–100.0
Specificity	-	-	-	99.2	98.1–100.0
Positive predictive value	-	-	-	33.3	27.6–39.1
Negative predictive value	-	-	-	100.0	100.0–100.0

VA, visual acuity; CI, confidence interval.

Discussion

This study evaluated the effectiveness of teachers in performing VA screening of learners in a rural primary school. The results showed high sensitivity (100%) and specificity (99.2%), indicating that teachers could successfully identify learners with distance VA impairment while minimising false negatives and positives. The findings of this study are discussed in reference to other studies, which investigated teacher screening, summarised in Table 5. This study showed the highest sensitivity and specificity compared to similar earlier studies (Table 5).

The high sensitivity (100%) in this study implies that teachers could always detect all true positives, in learners with distance VA impairment. This aspect is crucial for vision screening of children because early detection of vision problems in children is critical for initiating timely interventions to prevent potential learning difficulties and academic setbacks.[19] Implementing a vision screening protocol that yields high sensitivity, as in this case, suggests that teachers will effectively identify and refer learners who require further evaluation and professional care. The specificity of 99.2% indicates that the vision screening conducted by teachers has successfully minimised the number of false-positive results. This is crucial in reducing unnecessary referrals for further diagnostic assessments or interventions, thus optimising the allocation of healthcare resources. However, it is worth observing that the remaining 0.8% false-positive rate suggests that a small proportion of students may be referred for further evaluation despite not having any distance VA impairments. Further investigation could focus on identifying potential factors contributing to these false positives and developing strategies to minimise them.

TABLE 4: Association of demographic variables with accuracy of teacher vision screening.

Factors	Inaccurate		Accurate		Chi-square *P*-value
	Count	%	Count	%	
Gender					0.498*
Female	1	33.3	134	53.0	-
Male	2	66.7	119	47.0	-
Age (years)					0.208*
6	0	0.0	50	19.8	-
7	1	33.3	32	12.6	-
8	2	66.7	37	14.6	-
9	0	0.0	27	10.7	-
10	0	0.0	31	12.3	-
11	0	0.0	38	15.0	-
12	0	0.0	38	15.0	-
Grade level					0.766*
1	1	33.3	62	24.5	-
2	1	33.3	38	15.0	-
3	1	33.3	30	11.9	-
4	0	0.0	34	13.4	-
5	0	0.0	37	14.6	-
6	0	0.0	35	13.8	-
7	0	0.0	17	6.7	-

*, Results were insignificant ($P > 0.05$).

While sensitivity and specificity are essential measures of screening accuracy, the PPV and NPV provide additional insights into the predictive values of the screening process. The PPV of 33% suggests that approximately one-third of students with positive screening results will truly have vision problems upon further evaluation. This indicates that while the screening process effectively identifies a significant number of true positives, there is room for improvement to reduce the number of false positives. Additional training for teachers, implementing standardised screening protocols, or incorporating additional screening measures may help to enhance the PPV.[20] Higher PPVs were observed in studies by Paudel et al.,[13] Shukla et al.,[14] OstadiMoghaddam et al.,[21] Sharma et al.,[16] Wedner et al.[17] and Rewri et al.[15] The NPV of 100% on the other hand, represents the proportion of negative screening results that were true negatives, indicating the probability of not having a vision problem given a negative screening result. This finding highlights the screening process's ability to accurately rule out distance VA impairments among students who receive negative screening results, reassuring both students and their families. The variability of the PPV and NPV in relation to earlier studies can be attributed to disease prevalence.[22] For this reason, a test can have good sensitivity and specificity and a low PPV when applied in a population where the likelihood of the disease or condition is low, as seen in this study.

Most studies using a 6/12 VA cut-off also presented with high sensitivity and specificity[13,14,16,17]; however, studies using a 6/9 and 6/7.5 VA cut-off showed poor sensitivity.[17,21,23] This finding suggests that a lower VA threshold is likely to yield higher false positives where everyone with any vision loss will be referred, irrespective of the magnitude of the problem. These findings also suggest that teachers, as non-

TABLE 5: Studies validating vision screening in other countries.

Country	Author	Year	VA cut-off	Age (years)	Sample size	Chart used	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
South Africa	Govender-Poonsamy et al.†	2025	6/12	6–12	256	LogMar Tumbling-E	100.0	99.2	33.3	100.0
China	Sharma et al.[16]	2008	6/12	12–17	1892	Snellen Tumbling-E	93.5	91.2	92.0	92.8
Peru	Latorre-Arteaga et al.[24]	2014	≤ 6/9	3–11	364	Tumbling-E	Was not calculated	93.0	47.8	Not available
India	Shukla et al.[14]	2018	6/12	7–10	6056	Snellen	92.3‡	72.6§	Not available	Not available
Vietnam	Paudel et al.[13]	2016	6/12	12–15	555	LogMAR Tumbling-E	86.7	95.7	86.7	95.7
Tanzania	Wedner et al.[17]	2000	6/12	7–19	1483	Snellen Tumbling-E	80.0	91.0	14.9	99.8
India	Adhikari and Shestra[25]	2011	< 6/12	3–7	528	HOTV test	80.0	99.0	30.4	98.8
Iran	Khandekar et al.[26]	2009	6/12	3–6	4838	Alphabet chart	74.5	97.2	Not available	Not available
India	Rewri et al., 2016[15]	2016	6/9	3–8	5938	Different Snellen chart	69.2	95.3	83.5	89.8
Thailand	Teerawattananon et al.[20]	2014	≤ 6/12	7–12	5885	Lea symbols, Tumbling-E and Snellen charts	59.0	98.0	Not available	Not available
Nigeria	Tabansi et al.[23]	2009	≤ 6/18	6–11	1300	Snellen letter chart	53.3	94.6	79.3	94.7
Iran	OstadiMoghaddam et al.[21]	2012	6/7.5	7–15	847	Tumbling-E	37.5	92.0	25.0	95.4

Note: Please see the full reference list of this article https://doi.org/10.4102/aveh.v84i1.906 for more information.

VA, visual acuity; PPV, positive predictive value; NPV, negative predictive value.

†, this reference refers to the current study: Govender-Poonsamy P, Mashige KP, Bhawanibik A, et al. Validating teachers for Visual Acuity Screening in rural South African schools. Afr Vision Eye Health. 2025;84(1), a906. https://doi.org/10.4102/aveh.v84i1.906; ‡, 95% confidence interval: 88.6–95.0; §, 95% confidence interval: 68.2–76.6.

healthcare professionals, may be more effective in detecting gross errors in VA, which are more apparent and easier to identify with limited training. However, they may lack the skill set required to accurately measure VA at more detailed cut-off points, which could explain the discrepancy in sensitivity and specificity observed. Using a VA cut-off of 6/12 results in higher sensitivity, thereby reducing the false-positive rate, further reducing the burden on the eye-care system, and ensuring only necessary referrals are made. The inclusion of a +1.00 D or +2.00 D lens test would also assist in ruling out false-positive findings.

The choice of a 6/12 cut-off is significant in the context of classroom visual demands. While a child with VA of 6/12 may be able to participate in classroom activities, such as seeing the board, this level of acuity might still impede optimal performance and social participation without correction. Numerous guidelines recommend that a VA of 6/12 warrants a referral for full refraction and potential prescription of corrective lenses or further ocular health investigations to ensure the child's visual needs are fully met.[10,27] Additionally, given that this study was conducted within a larger study aimed at determining the impact of spectacle correction on children's well-being, the 6/12 threshold was chosen to identify children with significant refractive error who would be more likely to comply with spectacle wear and experience noticeable improvements in well-being. While local anecdotal evidence[28] suggests that teachers are resistant to performing vision screening in schools, all teachers who participated in this study reported that vision screening was important, they experienced no difficulties with the procedure and that they would conduct it in the future. Teachers also reported similar perspectives in studies undertaken in China[16] and Vietnam.[13]

The results of this study must be interpreted within the context of certain limitations. The study was conducted in only one school in a rural setting and included a relatively small sample size compared with other similar studies. The use of a 6/12 threshold may not have captured all children struggling in school due to milder refractive errors that could still affect academic performance. However, the threshold was chosen in alignment with the objectives of the larger study, which focused on assessing the impact of spectacle correction on children with significant refractive errors. Several studies[10,27] have employed the 6/9 VA threshold, as recommended by the International Agency for the Prevention of Blindness (IAPB).

However, this approach may result in an increased rate of false positives. The IAPB also acknowledges that a 6/12 cut-off is an acceptable alternative for school-based vision screening, particularly in resource-limited settings,[29] such as the context of this study. Another limitation is that the screening was only limited to distance vision, and therefore, no considerations of the complexity of near viewing, which affects eye muscles and focussing systems, impacting visual comfort and visual performance, subsequently leading to children struggling at school and possibly disengaging from the work. Future investigations should explore the effectiveness of different training approaches and their cost-effectiveness, the feasibility of incorporating advanced or novel screening technologies, augmentation of vision screening to include near vision screening or the impact of repeated screenings on the accuracy of teacher-conducted vision assessments.

Conclusion

This study showed high sensitivity and specificity of vision screening conducted by teachers, thus indicating their potential as valuable screeners in identifying students with vision problems. However, efforts should be directed towards improving the PPV to minimise false positives and enhance the efficacy of the screening process.

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Competing interests

The authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

Authors' contributions

P.G.-P. and K.P.M. designed the study. P.G.-P. coordinated the data collection. V.F.C. provided critical feedback on the article. P.G.-P., K.P.M., A.B., N.A.M., N.M., S.N., N.T.N., N.F.S. and V.F.C. contributed to the first draft, and read and approved the final article.

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Data availability

The data that support the findings of this study are available on reasonable request from the corresponding author, P.G.-P.

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