
ORIGINAL ARTICLE**Comparison of smartphone based WHOeyes app and Snellan Chart for visual acuity among students of a Medical College, Bengaluru, India***Lakshmi Hulugappa^{1*}, Shaik Nazia Nazneen¹, Sunil Kumar D R¹, Kalpana S², Manjula S¹**¹Department of Community Medicine, ²Department of Ophthalmology, Akash Institute of Medical Sciences & Research Centre, Bengaluru-562110 (Karnataka) India*

Abstract

Background: Vision plays a vital role in our life. As the technology is advancing, tools such as smartphone-based assessment have been identified to screen visual impairment at the earliest. **Aim and Objectives:** To compare the Visual Acuity (VA) by WHOeyes- a smartphone-based applications and the standard Snellen chart to explore the possibility of screening test. **Material and Methods:** A descriptive cross-sectional study with purposive sampling method was conducted on 208 eyes of 104 undergraduate medical students. Participants with VA < 6/60 and gross ocular pathology were excluded from the study. Visual acuity was assessed using the standard Snellen chart and the WHOeyes smartphone application. Distance and near visual acuity were recorded and expressed in logarithm of the minimum angle of resolution (logMAR) and SPSS 26 was used for statistical analysis. **Results:** Among 104 participants, the mean Distance VA was 0.02 ± 0.05 logMAR with the Snellen chart and 0.04 ± 0.06 logMAR with WHOeyes for the right eye, and 0.02 ± 0.06 and 0.04 ± 0.06 logMAR, respectively, for the left eye. For near vision, the corresponding means were 0.00 ± 0.00 and 0.03 ± 0.056 logMAR. A strong positive correlation was observed between Snellen and WHOeyes for the right eye ($r = 0.821, p < 0.001$), while moderate correlations were observed for both eyes ($r = 0.606, p < 0.001$) and the left eye ($r = 0.464, p < 0.001$). Bland–Altman analysis showed mean biases of +0.021 and +0.017 logMAR for the right and left eyes, respectively, with ICCs of 0.691 and 0.651. **Conclusion:** WHOeyes showed moderate agreement with the Snellen chart for distance visual acuity, with a small tendency to record poorer visual acuity. The findings suggest that WHOeyes may be a useful and convenient tool for visual acuity screening.

Keywords: WHOeyes, Smartphone, Visual acuity, Snellen chart, Vision screening

Introduction

Vision, is the crucial part of our life. Vision Impairment (VI) is a major public health issue that has the potential to affect economic and educational opportunities, reduce quality of life and increase the risk of premature mortality [1-3]. Worldwide around 2.2 billion people have a near or distant VI and low-and middle-income regions prevalence of distant VI is estimated to be 4 times higher than in high income regions. In all the countries, uncorrected refractive error is the main cause of VI specially in adults and children. A person who wears spectacles or contact lenses to compensate for their vision impairment, still has a VI [4].

In ophthalmic clinical practice, Visual Acuity (VA) testing is the preferred examination as it measures how well the eye can distinguish shapes and details at a given distance. Its accurate assessment is crucial in helping clinicians to identify if further investigations are necessary and quantify changes to vision over time [5]. The assessment of both distance and near VA is fundamental to defining visual function. In addition, the two measurements correlate to a certain degree, but they are not interchangeable [6-8]. Traditionally, VA testing requires people to physically attend a clinic, and a

nurse, technician, or eye health care professional is required to perform the test.

Advancement in recent technology has made availability of numerous smartphone-based application assessment. It identifies VI at the earliest [2,3]. In the year 2023, the World Health Organization (WHO) Vision and Eye Care Programme launched “WHOeyes” on October 12th. An automated, accurate and user-friendly approach app for vision screening or self-monitoring. It's a free app to check VA. It is based on how an eye care professional would assess your vision using a conventional chart in a clinical setting [9]. Medical students represent a young, educated population with frequent exposure to digital devices, but data on the performance and applicability of smartphone-based VA assessment among medical students in the Indian context are limited.

Though it has been validated, evidence regarding medical students is limited. There is a need to determine whether VA measurements obtained by WHOeyes are comparable to Snellen chart which is widely used in routine clinical practice [10]. This is one of the few studies conducted among the medical students on VI in the Indian context and its applicability on smartphone-based screening assessments. This study was conducted at a medical college to evaluate the students' socio-demographic backgrounds. It aimed to compare their near and distance vision using both the Snellen and WHOeyes charts, and to measure how well the results of these two methods agree.

Material and Methods

A cross-sectional study was conducted from June 2024 to March 2025 in a medical college. A total of 104 students were included in the study by purposive sampling method. Participants included only MBBS Phase III Part -1 students of a batch of 140 students. Inclusion criteria included all the eligible students willing to participate and co-operate for the

study procedure and examination. Exclusion criteria were participants with VA worse than 6/60 in either eye, or gross ocular pathology. Finally 104 students voluntarily agreed and participated in the study.

Institutional ethics committee approved the study with the reference no. AIMSRC/01/2023-24. The details were collected using a Google Form, and two vision tests, one with WHOeyes app and the other with the Snellen chart were performed on the same day in the standard clinical conditions. In this study OnePlus Nord CE5 Android phone was used with a 6.77inch AMOLED display with a resolution of 2392 × 1080 pixels based on Android 15 using the same smartphone throughout the study. The testers included postgraduate doctors from ophthalmology and medical interns. The testing distance for Snellen chart and WHOeyes testing were precisely measured by the tester prior to each examination. The principal investigator first demonstrated the testing procedure. Firstly, vision test using Snellen chart was performed by the postgraduate ophthalmology doctors followed by WHOeyes by medical interns.

WHOeyes app and Snellen chart distant vision testing was tested monocularly for each eye separately by covering the non-tested eye with an opaque occluder. On opening the WHOeyes application, instructions were loaded to visually instruct testers to perform the test correctly. Instructions included a guide on the requirement of two individuals for distant vision and one individual for near vision, to hold the device at 2m from the participant, maximize the brightness in the mobile settings, put the distance glasses on, and to correctly point in the direction the letter E was facing. The tester would swipe the screen in the same direction as the participant pointing, if unable to see the direction E is facing the participant had to try the best until the

test stops and to hold the mobile at chest height with the screen facing the participant. The tester was masked to the screen, which reduces the risk of bias. A brief break of 10 min was given in between the two tests. Near VA testing instructions included a testing distance of 40 cm and to keep both eyes open and the tester should swipe the screen in the direction the letter E was facing. At the end of the screening, participants with impaired VA were referred to the ophthalmologist.

The WHOeyes app provides a score between 0 to 100% and fraction when you finish testing. VI is diagnosed and classified based on the VA. Distance VI: –Mild – VA worse than 6/12 to 6/18, Moderate – VA worse than 6/18 to 6/60, Severe – VA worse than 6/60 to 3/60, Blindness – VA worse than 3/60. Near VI: Near VA worse than N6 or M.08 at 40cm. In addition, a basic demographic profile of participants was obtained.

All VA measurements were converted to logMAR units. The data collected was entered in MS excel and the Statistical Package for the Social Sciences software version 26 was used. Categorical data was expressed in the form of frequency, percentage. The association between VA measurements obtained using WHOeyes and the Snellen chart was assessed using Spearman's correlation. Bland and Altman (B&A) plots were examined for limits of agreement. P-value < 0.05 was considered statistically significant.

Results

Socio-demographic profile of participants

A total of 104 participants were included in the study. Majority (62.6%) were in the age group of 21–22 years and three-fourth (76%) were females. Around 33.6% reported having previously self-screened for VI, 32.7% had a family history of VI. Current history

of VI was reported in 52.9% participants. Around 22% used spectacles or contact lenses for near vision and 51.0% used spectacles or contact lenses for distance vision as indicated in Table 1.

Distribution of participants according to VA

Distance VA was expressed in logarithm of the minimum angle of resolution (logMAR). VA distribution ranged from 20/20 to 20/32 (0.00 to 0.20 logMAR) as shown in Table 2. For near vision, all participants (104, 100%) had a VA of 0.00 logMAR on the Snellen chart.

VA measured by Snellen chart and WHOeyes

The mean difference was 0.02 logMAR (approximately 0.2 visual-acuity line) for distance vision in both eyes and 0.03 logMAR (approximately 0.3 line) for near vision. The mean VA measured by WHOeyes was marginally poorer than that measured by the Snellen chart for both distance and near vision. The median VA was 0.00 logMAR for both methods across all measurements and was comparable. The results are presented in Table 3.

Correlation of VA between Snellen chart and WHOeyes

There was a statistically significant positive correlation between VA measured by the Snellen chart and WHOeyes. The correlation was strongest for the right eye (Spearman's $p = 0.821, p < 0.001$), followed by the combined analysis of both eyes ($p = 0.606, p < 0.001$) and the left eye ($p = 0.464, p < 0.001$) as in Table 4.

Agreement between WHOeyes and Snellen

Bland–Altman analysis demonstrated a small positive mean bias for WHOeyes compared with the Snellen chart. The mean bias for right eye was + 0.021 logMAR, with 95% Limits of Agreement (LoA) of between –0.063 to + 0.105 logMAR between the two methods. The mean bias for left

eye was + 0.017 logMAR, with 95% LoA between -0.075 to + 0.109 logMAR between the two methods as indicated in Figures 1 & 2. The Intraclass Correlation Coefficient (ICC) was 0.691 for the right eye and 0.651 for the left eye, indicating moderate agreement between WHOeyes and the Snellen chart. The small positive bias indicates that

WHOeyes tended to record slightly higher logMAR values, corresponding to marginally poorer VA, compared with the Snellen chart. However, the mean differences were small and the paired comparisons did not demonstrate statistically significant differences for either eye for distance vision as in Table 5.

Table 1: Social demographic profile of participants

Characteristics		N = 104
Age (years)	18-20	33 (31.7%)
	21-22	65 (62.6%)
	23-24	6 (5.7%)
Sex	Male	25 (24.0%)
	Female	79 (76.0%)
History of self-screening for visual impairment	Yes	35 (33.6%)
	No	69 (66.4%)
Family history of visual impairment	Yes	34 (32.7%)
	No	70 (67.3%)
Current history of visual impairment	Yes	55 (52.9%)
	No	49 (47.1%)
Use of spectacles/contact lens for near vision	Yes	23 (22.1%)
	No	81 (77.9%)
Use of spectacles/contact lens for distance vision	Yes	53 (51.0%)
	No	51 (49.0%)

Table 2: Distribution of participants according to visual acuity

Visual Acuity logMAR	Snellen	WHOeyes	
	N = 104	N = 104	
Distance Right Eye	0.00	93 (89.4 %)	70 (67.3 %)
	0.10	0 (0%)	24 (23.1%)
	0.18	11 (10.6 %)	10 (9.6%)
Distance Left Eye	0.00	91 (87.5%)	71 (68.3%)
	0.10	2 (1.9%)	25 (24.0%)
	0.18	11 (10.6%)	7 (6.7%)
	0.20	0 (0%)	1 (1.0%)
Near Vision	0.00	104 (100%)	78 (75%)
	0.10	-	21 (20.2%)
	0.20	-	5 (4.8%)

Table 3: Mean, standard deviation and median of the participants

Visual Acuity logMAR (N = 104)		Mean $\pm$ Standard Deviation	Median (Q1-Q3)
Distance Right Eye	Snellens	0.02 $\pm$ 0.05	0.00 (0.00-0.00)
	WHOeyes	0.04 $\pm$ 0.06	0.00 (0.00-0.00)
Distance Left Eye	Snellens	0.02 $\pm$ 0.06	0.00 (0.00-0.00)
	WHOeyes	0.04 $\pm$ 0.06	0.00 (0.00-0.00)
Near Vision	Snellens	0.00 $\pm$ 0.00	0.00 (0.00-0.00)
	WHOeyes	0.03 $\pm$ 0.056	0.00 (0.00-0.08)

Table 4: Correlation between visual acuity distance visions with Snellen's vs WHOeyes app

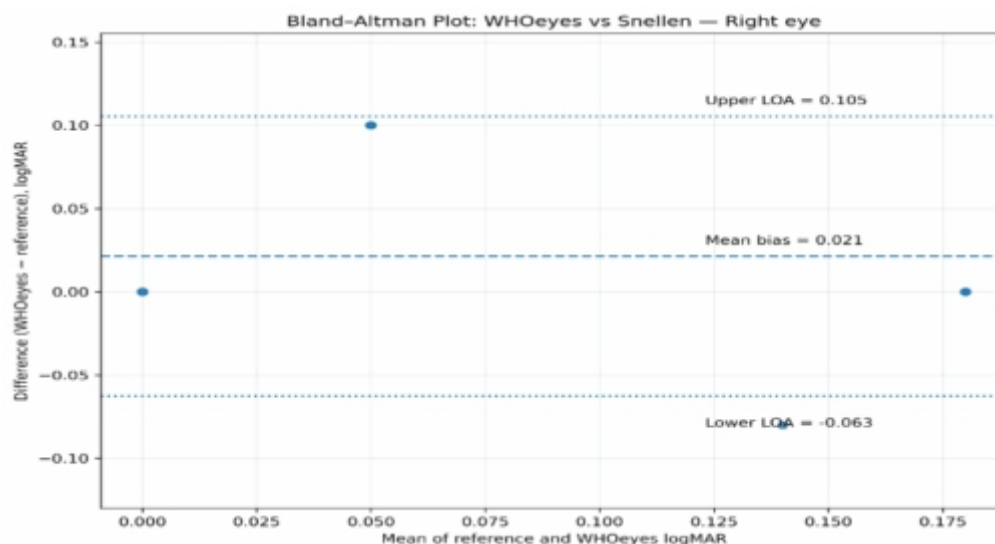
Distance Visual Acuity (N = 104)	Correlation	
	Correlation coefficient (r)	p
Snellen's v/s WHOeyes both eyes	0.606	< 0.001
Right eye: Snellen's v/s WHOeyes	0.821	< 0.001
Left eye: Snellen's v/s WHOeyes	0.464	< 0.001

$P < 0.05$. Sperman's correlation test.

Table 5: Agreement between WHOeyes and Snellen chart (N = 104)

Measurement	Mean bias (WHOeyes-Snellen)	95% Lower LoA	95% Upper LoA	Intraclass correlation co-efficient
Right eye	+0.021	-0.063	+0.105	0.691
Left eye	+0.017	-0.075	+0.109	0.651

LoA – Limits of agreement

**Figure 1: Mean of WHOeyes and Snellen chart Right eye (logMAR)**

LoA – Limits of agreement

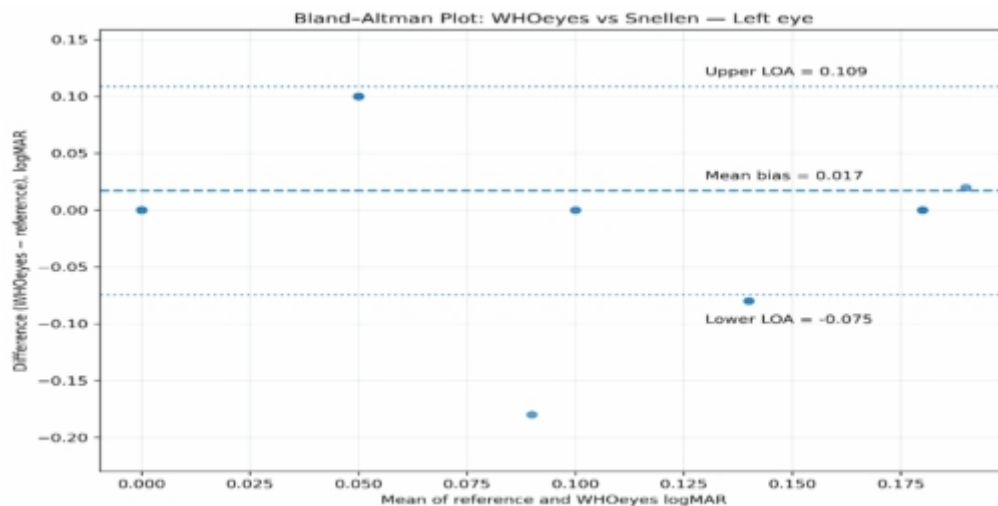


Figure 2: Mean of WHOeyes and Snellen chart left eye (logMAR)

LoA – Limits of agreement

Discussion

VA assessment is a crucial aspect of ophthalmic examination in identification of VI. Smartphone based technology to measure VA has increased among health professionals to identify the VI at the earliest residing in rural or remote areas [10-11]. One such app from WHO is WHOeyes. The principle of WHOeyes is based on how an eye care professional would assess VA using a conventional chart in a clinical setting. The accuracy and usability of the app were tested in three separate research studies. WHOeyes is suitable for anyone aged over 8 years[1].

This study included 104 participants and 208 eyes. Most participants had normal distant VA with both methods. However, WHOeyes identified a slightly higher proportion of participants with mild reductions in VA compared with the Snellen chart. This suggests that WHOeyes may tend to record slightly poorer VA than the Snellen chart, although the differences were small.

In the present study, WHOeyes suggested comparable results for distance VA measurements with the

Snellen chart in this young adult population. WHOeyes tended to record slightly poorer VA than Snellen, with mean differences of approximately 0.02 logMAR for both eyes. The median VA was 0.00 logMAR with both methods, indicating that the observed difference was small and occurred predominantly around the normal-vision range. For NV, WHOeyes also showed a slightly higher mean logMAR value than Snellen's chart (0.03 vs 0.00), with some variability in the WHOeyes measurements. Overall, WHOeyes tended to record slightly poorer VA than Snellen's chart, particularly for near vision. This was similar to the study conducted by Wu *et al.* (2024) revealed WHOeyes showed good agreement with the ETDRS chart [13]. Similarly, Han *et al.* (2019), Bastawrous *et al.* (2015), and Bhaskaran *et al.* (2022) found that smartphone-based VA tests showed good agreement with conventional visual acuity charts [14-16]. However, these studies differed from the present study in terms of participants, reference charts, smartphone applications, testing distances, and statistical method. In contrast

mixed results found in other studies could be due to different participant groups [17-19].

The correlation analysis between distance VA measurements obtained using Snellen chart and the WHOeyes application revealed a moderately strong positive correlation ($r = 0.606$, $p < 0.001$) for both eyes. This finding indicates that as VA measured by one method improved, a corresponding improvement was observed with the other method. The statistically significant p -value ($p < 0.001$) confirms that this relationship was unlikely due to chance.

The Bland–Altman analysis showed good agreement between WHOeyes and Snellen's chart. WHOeyes recorded slightly poorer VA, with a mean difference of 0.021 logMAR in the right eye and 0.017 logMAR in the left eye. The ICC values showed moderate agreement between the two methods (0.691 for the right eye and 0.651 for the left eye).

Overall, the differences between WHOeyes and Snellen's chart were small, suggesting that WHOeyes can provide comparable distance VA measurements. Some studies have demonstrated the use of Snellen chart VA assessment in young adults [20-21]. Further studies involving different population groups and larger size are recommended to establish the diagnostic accuracy and applicability of WHOeyes for community screening. This

study had few limitations: purposive sampling method could have introduced selection bias and generalization of result findings for broader population is not possible. The relatively small sample size may have affected the reliability of observed associations.

Conclusion

The present study demonstrated moderate agreement between the WHOeyes application and the Snellen chart for the assessment of distance visual acuity among MBBS students. Visual acuity measurements obtained using WHOeyes were slightly poorer than those recorded using the Snellen chart for both eyes. However, the measurements were comparable between the two methods in the majority of participants. Overall, WHOeyes demonstrated comparable distance visual acuity measurements with the Snellen chart, with only a small tendency to record poorer visual acuity. These findings suggest that WHOeyes may be a useful and convenient tool for visual acuity screening, particularly in settings where conventional visual acuity charts may not be readily available.

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***Author for Correspondence:**

Dr. Lakshmi Hulugappa, Department of Community Medicine, Akash Institute of Medical Sciences & Research Centre, Bengaluru, Karnataka, India
Email: lakshmi.hulugappa11@gmail.com
Cell: 7892313325

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