ABENHA MEDICAL JOURNAL bmj

Print ISSN 1110-208X.

Online ISSN 2357-0016

Original article

Diagnostic Accuracy of the Peek Acuity Smartphone App versus Conventional Snellen Charts in Young Adults: A Cross-Sectional Study

Sudesan J.[a], Sowmya E.[a], Rajalaksmi S.[a], Muralitharan N.[a], Annie A. Solomon[b], Ponmozhi N.[b], Devlin E. F. David[a], Ajith K. Pushpanathan[a], Priyadharshini D.[a], Vidhyashree P.[a]

[a] Department of Optometry, Faculty of Allied Health Sciences, Dr. M.G.R. Educational and Research Institute, ACS Medical College, Chennai, Tamil Nadu, India

[b] Department of Clinical Nutrition, Faculty of Allied Health Sciences, Dr. M.G.R. Educational and Research Institute, ACS Medical College, Chennai, Tamil Nadu, India

Corresponding to:

Sudesan Jothi, M. Optom..
Department of Optometry, Faculty of Allied Health Sciences, Dr. M.G.R. Educational and Research Institute, ACS Medical College, Chennai, Tamil Nadu, India

Email:
sudesan.opto@drmgrdu.ac.in

Received:23 June 2025

Accepted:12 August 2025

Abstract:

Background: Mobile health technologies offer promising solutions to vision screening gaps, especially in resource-limited environments. This study evaluates the diagnostic accuracy of the Peek Acuity smartphone application in comparison with the conventional Snellen chart for assessing visual acuity (VA) among young adults. **Methods:** One hundred undergraduate students, ages 18 to 23, participated in a cross-sectional study at a postsecondary educational institution. Monocular VA was assessed using both the Snellen chart and the Peek Acuity app. Sex and age distributions were analysed using Chi-square goodness-of-fit tests. Pearson correlation coefficients were used to determine the relationship between Snellen and Peek VA scores for each eye. **Results:** This study included 100 participants, 69% were female (95% CI: 58.8%–77.7%) and 31% male (95% CI: 22.3%–41.2%), with a significant sex distribution difference ($p < 0.001$). The mean age was 21.0 ± 0.33 years, with 92% of students aged 21. Age distribution was significantly skewed ($\chi^2 = 239.6$, $df = 3$, $p < 0.001$). Peek and Snellen VA scores matched in 65% of right eyes and 69% of left eyes. A strong correlation was found between Snellen and Peek results in the right eye ($r = 0.79$, $p < 0.001$) and an even stronger correlation in the left eye ($r = 0.85$, $p < 0.001$), indicating close agreement between the tools. **Conclusion:** Peek Acuity demonstrates strong concordance with the Snellen chart and serves as a dependable, accessible, and low-cost alternative for VA screening in young adult populations.

Keywords: Peek Acuity, Visual Acuity, Smartphone Application, Mobile Health (mHealth), Teleophthalmology.

Introduction

The most widely used technique in general and ophthalmic practice for measuring VA is the Snellen chart. The gold standard for assessing visual acuity in primary care facilities in about 42 U.S. states is the Snellen chart [(1)].

Snellen charts and the Early Treatment Diabetic Retinopathy Study (ETDRS) charts are two well-known approaches for measuring VA. Because to its ease of use, familiarity, and low cost, the Snellen chart is frequently employed in routine clinical practise, efficient in terms of both time and cost-effective [(11)]. However, Snellen is not much satisfactory because of its non-geometric progression in the size of the letters or optotypes (standardized symbols for testing vision) and the inconsistent number of optotypes in each line [(2)].

In remote and underprivileged areas, smart phones are being used more frequently to reduce health care inequities. Mobile health technologies, which are more affordable and effective than traditional ocular screening methods, have changed global eye care [(3)]. People could be helpful from a diagnostic aspect for the ophthalmologist or optometrist, but more crucially for the patient with a chronic eye condition who wants to monitor their eyesight or wishes to be seen remotely during a telehealth appointment [(4)].

In recent years mobile technology has evolved rapidly. In 2019, around 1.52 billion smartphones were sold worldwide and is expected to increase in the coming years, in an affordable price particularly in developing countries [(5)].

Keeping this in account, a logMAR styled smart phone based visual acuity test app called Portable Eye Examination Kit (PEEK Acuity) was developed with a fast algorithm which allows to measure with accuracy and clinically acceptable time. The app was developed, evaluated, and compared with Snellen chart and an ETDRS based Tumbling E logMAR chart in rural Kenya among adults aged 55 [(6)].

A cohort study conducted in Paraguay evaluated the validity of the Peek Acuity application among a paediatric population and demonstrated its potential for use in school-based vision screening programs, citing its low cost and high specificity[(7)]. Building on this evidence, the present population-based study aims to assess the feasibility and clinical applicability of the Peek Acuity app among young adults in a clinical setting.

Another study was done in validating the effectiveness of the PeekSim (A feature of the Peek acuity app which mimics the level of vision lost by the patient) which was helpful in explaining to the concerned guardian / parent / patient about the visual loss they have. PeekSim was validated a was studied in Hyderabad, India amo school going children [(8)] in which high proportion of parents (71.4%) have understood their child's visual problem.

Vision screening was also made with the same population in Hyderabad, India using Peek [(9)]. Validation of various visual acuity test apps for tele-ophthalmology during COVID 19 was studied and PEEK acuity was also one of the apps validated in the study and revealed that the app was comparable to COMPlog (software used in computers to measure VA) [(10)].

The integration of mobile technology into healthcare delivery has significantly transformed medical practice, particularly in resource-limited settings. Mobile health (mHealth) tools are increasingly being utilized for disseminating health information, enabling real-time patient monitoring, supporting clinical research, and facilitating remote consultations. One such innovation is Peek Acuity, a component of the Portable Eye Examination Kit (Peek) developed by Peek Vision. This application provides a simple, smartphone-based method for assessing visual acuity, making eye care more accessible in both clinical and community-based settings. This smartphone-based tool has been evaluated for its effectiveness in assisting with eye examinations, especially

in assessing visual acuity. Its portability, ease of use, and potential for deployment in resource-limited settings make it a promising alternative to conventional eye examination methods. [17]

Taking the previously mentioned literatures into consideration, there is a paucity of research and understanding regarding the use of the Peek acuity app, particularly among university students in the southern portion of India. This chapter explains the methodology for measuring VA with PEEK.

Methodology:

This cross-sectional study was performed out at Chennai's A.C.S. Medical College and Hospital from March to September of 2021.Undergraduate students (young adults aged 18–25 years) from the institution were recruited for the study. All participants provided informed consent prior to participation.

This study received ethical clearance from the Institutional Ethics Committee of A.C.S. Medical College and Hospital (Approval No. 192/2021/IEC/ACSMCH, dated 02/03/2021), and all procedures were conducted in compliance with institutional ethical standards.

Participants were randomly assigned to undergo visual acuity (VA) screening using either the PEEK Acuity smartphone application or the traditional Snellen Tumbling E chart. Visual acuity assessment commenced with the Snellen chart. Each participant was comfortably seated at a distance of 6 meters. Monocular vision testing was conducted, starting with the right eye (OD) while the left eye (OS) was occluded. Participants were instructed to read the chart down to the smallest line they could discern. Visual acuity was recorded accordingly (e.g., OD: 6/9), and the procedure was then repeated for the left eye.

Following Snellen chart testing, PEEK Acuity—a mobile-based visual acuity testing application—was employed using a smartphone with the app pre-installed. Monocular testing followed the same sequence as with the traditional chart. The application uses a standardized ETDRS layout, presenting the optotype letter "E" in a 5×5 grid, displayed in four orientations (0°, 90°, 180°, 270°). Participants were instructed to indicate the direction of the optotype arms, and the examiner responded by swiping the smartphone screen in the same direction.

Ensure objectivity, the examiner was masked to the correct orientation of the optotype and thus unaware of the accuracy of the participant's responses. In cases where the participant was unable to perceive the optotype, the examiner shook the device, which was recorded as a non-recognition response. All results were systematically documented.

After completion of both testing methods, the visual acuity outcomes obtained from the traditional Snellen chart, and the PEEK Acuity app were compared to evaluate their agreement and assess the reliability of the smartphone-based method.

Results

Demographics:

A total of one hundred participants were enrolled in the study, comprising 30% males and 70% females (Table 1; Fig. 1). All participants were undergraduate students from a university setting.

The mean age of the participants was 21.03 ± 0.33 years, where 92% of participants were in the 21-year age group (Table 2).

Table 1. Sex of the participants

Sex	Frequency (n)	Percentage (%)	95% Confidence Interval	p-value
Male	31	31	22.3% – 41.2%	**< 0.001**
Female	69	69	58.8% – 77.7%	

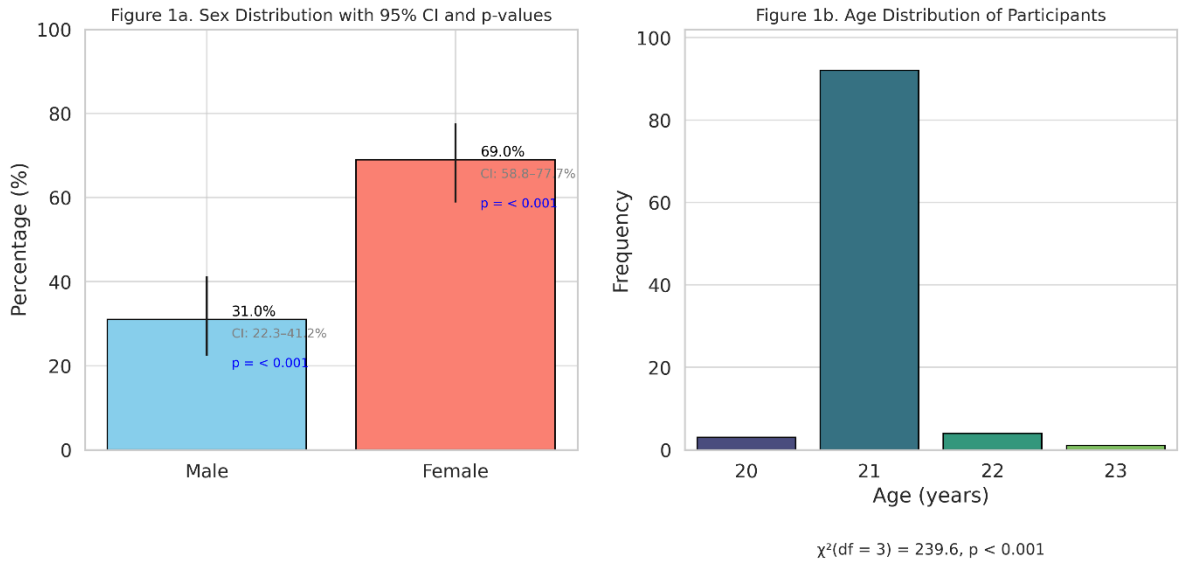

Figure 1. Demographic characteristics of study participants showing (a) sex distribution with 95% confidence intervals and p-values, and (b) age distribution with χ^2 (df = 3) = 239.6, p < 0.001.

Table 2. Age Distribution and Descriptive Statistics of Study Participants (n = 100)

Age (years)	**Frequency (n)**	**Percentage (%)**	**Cumulative Percentage (%)**	**Descriptive Statistics**	**Value**
20	3	3	3	Mean age ± SD (years)	**21.0 ± 0.33**
21	92	92	95	Median (IQR)	**21 (21 – 21)**
22	4	4	99	Mode	**21**
23	1	1	100	Minimum – Maximum (Range)	**20 – 23 (3)**
Total	**100**	**100**	–	χ^2 (df = 3) †	**239.6**
				p-value †	**< 0.001**[+]

+ Chi-square goodness-of-fit test was used to compare observed age frequencies against a uniform distribution to assess whether the age distribution occurred by chance.

Visual Acuity Of the one hundred participants, when evaluated using Snellen in the right eye 73% of the participants had VA of 1.0 and in the left eye 75% of the participants had VA of 1.0. When the same participants were assessed using Peek Acuity 59% of the participants had VA of 1.0 and in the left eye 61% of the participants had VA of 1.0.

The statistical method known as the "Correlation coefficient" was employed to examine the connection between Snellen and Peek Acuity. The degree to which two variables are related is determined by correlation coefficients. The typical range of correlation coefficient values is +1, which indicates a strong positive association, to -1, which indicates a strong negative relationship.

Right eye

For this study, 65% had the same VA score in both the charts. The VA scores, 6/6, 6/9 are expressed statistically as 1.00 and 0.67. The same applies to the corresponding scores as well. (Table 3)

The correlation coefficients for the right eye, comparing Snellen and Peek Acuity were 0.79. The scatter plot below shows the pictorial representation of the same. (Fig 2) The positive correlation was statistically significant. (p<0.001)

Table 3. Visual Acuity score for right eye for Snellen and Peek Acuity

Visual acuity		Peek Acuity									
		.13	.17	.25	.33	.40	.50	.67	6	1.00	1.20	1.50
Snellen	.10	1	1	0	0	0	0	0	0	0	0	0
	.17	0	1	1	1	1	0	0	0	0	0	0
	.25	0	0	0	0	1	1	0	0	0	0	0
	.50	0	0	0	0	0	3	3	4	0	0	0
	.67	0	0	0	0	0	0	3	4	1	0	1
	1.00	0	0	0	0	0	0	0	0	58	4	11

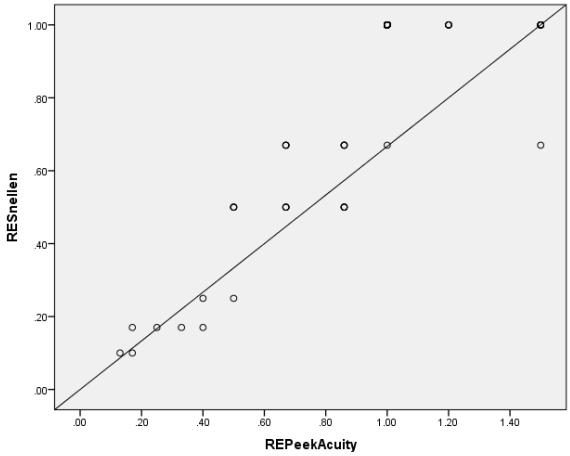

Figure 2. Scatter plot of visual acuity scores for right eye (Snellen vs Peek Acuity) (RE-Right Eye)

Left eye:

For this study, 69% had the same VA score in both the charts. (Table 4)

The correlation coefficients for the left eye, comparing Snellen and Peek Acuity were 0.85. The scatter plot below shows the pictorial representation of the same. The positive correlation was statistically significant ($p<0.001$). (Fig 3)

Table 4 Visual Acuity score for left eye for Snellen and Peek Acuity

Visual acuity		**Peek Acuity**										
		.10	.13	.17	.25	.40	.50	.67	.86	1.00	1.20	1.50
Snellen	.10	1	1	0	0	0	0	0	0	0	0	0
	.17	0	0	1	1	2	0	1	0	0	0	0
	.33	0	0	0	0	1	1	0	0	0	0	0
	.50	0	0	0	0	0	3	2	4	0	0	0
	.67	0	0	0	0	0	0	5	0	2	0	0
	1.00	0	0	0	0	0	0	0	0	59	8	8

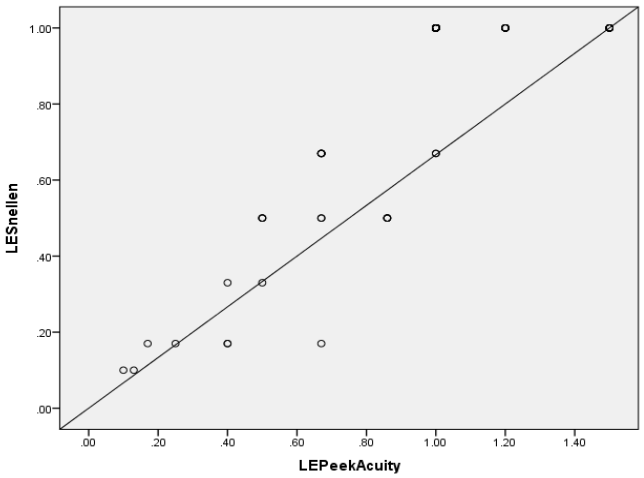

Figure 3. Scatter plot of visual acuity scores for Left eye (Snellen vs Peek Acuity) (LE- Left eye)

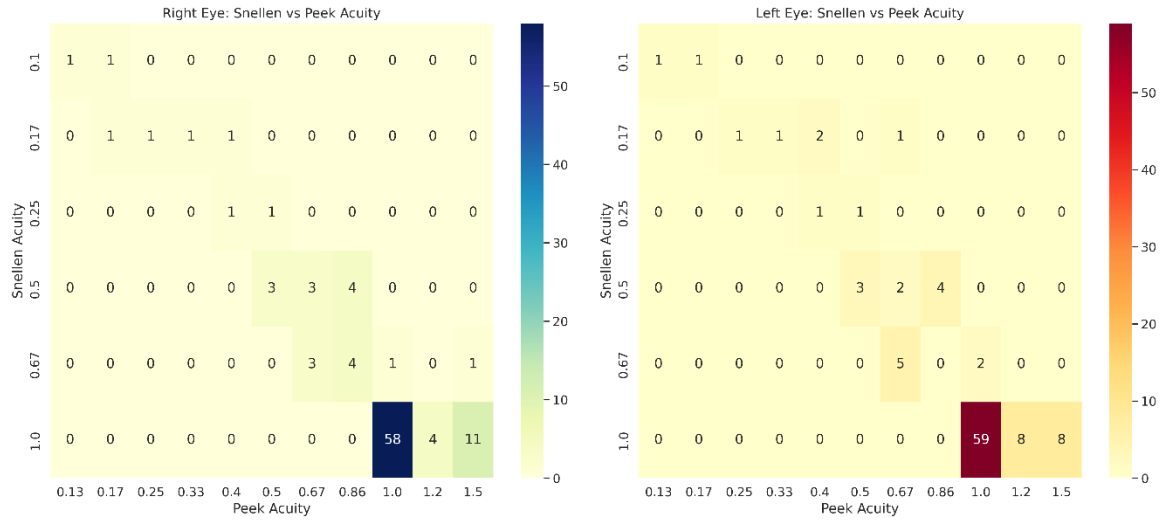

Figure 4. Heatmap Comparison of Snellen and Peek Visual Acuity Scores in Right and Left Eyes

Table 5: Correlation & P-value Table: Peek Acuity vs Snellen Chart

Eye	Comparison Type	Mean±SD	Correlation Coefficient (r)	P-value*
Right Eye	Peek Acuity	0.822±0.272	0.79	0.001
	vs	vs		
	Snellen	0.801±0.260		
Left Eye	Peek Acuity	0.829 ±0.268	0.85	0.001
	vs	vs		
	Snellen	0.810±0.255		

*The linear association between the Snellen chart scores and peek acuity for both eyes was evaluated using the Pearson correlation coefficient. The statistical significance of the association is indicated by the associated p-values.

Table 5 presents the correlation between visual acuity measurements obtained using Peek Acuity and the conventional Snellen chart for both eyes. The Pearson correlation coefficients indicate a strong (r = 0.79) and strong (r = 0.85) positive relationship for the right and left eyes, respectively. The p-values (< 0.001) demonstrate that these correlations are statistically significant, confirming that the observed agreement is unlikely to be due to chance.

A correlation coefficient of 0.85 does suggest a good relationship between Snellen and Peek Acuity in the right eye and similar is the scenario with correlation coefficient of 0.79. A correlation of 1.0 would be the best but, given a scenario where a participant is not able to visit the clinic, Peek Acuity would be able to help participant to have clarity about their queries related to their visual health.

Given the 65% of accuracy, this would serve as a cost-effective technique to help the participants be sure of the need to have an ophthalmologic check-up.

These findings support Peek Acuity as a reliable and cost-effective alternative for vision screening, especially in community or remote settings where Snellen charts or eye care professionals may not be readily available.

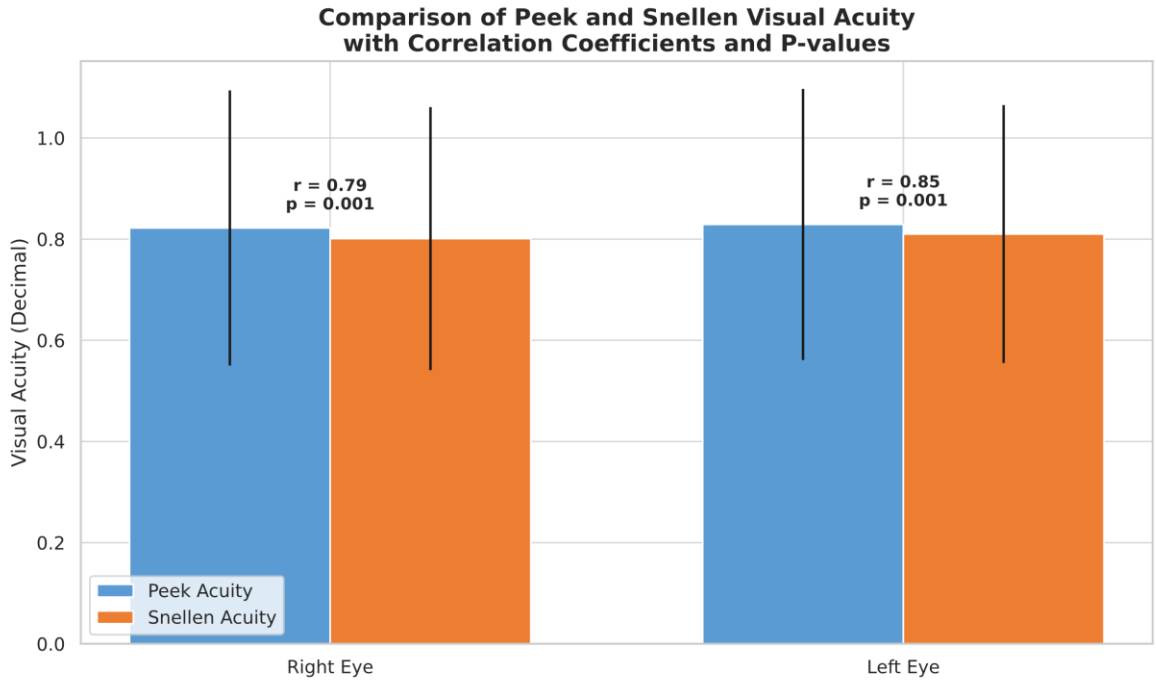

Figure 5 Inter-method Agreement Between Peek and Snellen Visual Acuity Tests

Discussion:

Discover uncorrected refractive problems and improve the subject's education, a cost-effective and scalable screening technique must be implemented in low-income settings. This study assessed this technology with current screening methods to ascertain the usefulness of peek acuity in university screenings. Peek Acuity was created to give groups with limited access to an ophthalmologist or optometrist affordable screening.

This screening gadget is appealing because to the increasing prevalence of cell phone use. Peek acuity has been validated among adult [(6)] and paediatric population [(7)] but not among young adults and University population. The continuing coronavirus outbreak highlights the necessity for telemedicine (COVID-19) [(12)].

This epidemic is very contagious and has almost spread to every country in the world. Stop the spread of this infection, social separation, quarantine, and little in-person contact between individuals were essential. Because an eye examination necessitates direct touch with the patient, this has made it difficult to provide eye treatment. This resulted in a rise in phone consultations for recent problems as well as follow-up guidance in all disciplines, including ophthalmology [13]. Telemedicine also saves the patient money, time, and travel. Telemedicine adds a layer of safety for both the patient and the practitioner in the COVID-19 era. With the help of the Peek Acuity application, non-experts may accurately assess visual acuity using a straightforward portable gadget. [7,14]

Technology has considerable promise for integrating communication amongst the participating countries, enabling non-experts to screen, and producing quantifiable results. [15.16]

For healthcare practitioners, the integration of smartphone applications into ophthalmological examinations has significantly improved time efficiency, accessibility, and the practical utility of subjective clinical data. These digital tools streamline the assessment process, enabling quicker and more consistent analysis of patient findings, particularly in settings with limited resources. [18]

Earlier research demonstrated strong correlations between Peek Acuity and the LogMAR chart, supporting its accuracy and reliability for visual testing. Similarly, our study compared Peek Acuity with the conventional Snellen chart and found comparable results. [19]

Peek Acuity and comparable mobile phone ideas continue to be a crucial tool for broadening screening capabilities in a sustainable way for areas with a shortage of eye care practitioners.

When trained instructors in India used a Snellen Chart to analyse visual acuity faults, Peek Acuity fared better than the data. In 24.33% of the participants referred by eye care practitioners, these teachers successfully recognized genuine ocular disease, with most subjects testing positive for refractive error. [20]

In this scenario, where the patients are unable to visit the clinic, Peek acuity would help the patient to have a gross opinion about their visual health. In universities, Peek acuity can be implemented to have screenings in classrooms and other locations with suitable illumination. Patients with defective vision can be encouraged to consult an optometrist or an ophthalmologist to rule out their ophthalmologic issue.

Conclusion:

This study revealed a statistically significant correlation between the Peek and the traditional Snellen chart for measuring visual acuity. Given its high specificity, low cost, and ease of use, Peek Acuity demonstrates strong potential as a viable alternative to traditional logMAR charts for vision screening. It is especially well-suited for large-scale university screenings and other public health initiatives targeting the young adult population.

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To cite this article: Sudesan J., Sowmya E., Rajalaksmi S., Muralitharan N., Annie A. Solomon, Ponmozhi N., Devlin E. F. David, Ajith K. Pushpanathan, Priyadharshini D., Vidhyashree P. Diagnostic Accuracy of the Peek Acuity Smartphone App versus Conventional Snellen Charts in Young Adults: A Cross-Sectional Study. BMFJ 2025;42(10):27-35.