A Comparative Study on Smartphone Based Visual Acuity Test and Conventional age-matched vision testing charts in GEN alpha and Z

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Aimen Munir[1], Asra Fayyaz[2], Moin Yaqin[3].
Noor International University[1], College of Ophthalmology & Allied Vision Sciences[2,3].

ABSTRACT

Purpose: To determine the accuracy of visual acuity measurements using smartphone application in comparison to traditional visual acuity tests in the Generation Z and Generation Alpha.

Methodology: The research was approved by National Eye Centre Lahore. The study took place on patients visiting National Eye Centre Lahore. Sample size consisted of total 132 participants which were grouped into two; 66 in generation z (1995-2009) and 66 in gen alpha (2010-2024). Distance visual acuity and near visual acuity was recorded using ETDRS chart, near logMAR chart (traditional charts) and "Snellen chart" (smartphone-based chart) at standard distance. All dependent and independent variables were kept in mind. Data was entered and analyzed using SPSS version 25. Mann Whitney test was applied to analyze the data. P value ≤ 0.005 was considered significant.

Result: Mean age of the participants was 16.73 ± 6.45 in which 54.5% were female and 45.5% was male. After comparing visual acuity recorded by both methods; conventional charts and smartphone-based charts, the p value of distance visual acuity was 0.143 for both eyes and near VA had p value of 0.00. The results showed significant difference in near visual acuity and no significant difference in distance visual acuity.

Conclusion: It is concluded that smartphone-based distance visual acuity test represents an easy and reliable alternative to conventional age-matched vision charts for Gen Z and Gen Alpha. Smartphone-based charts prove better for near visual acuity in both generations.

Keywords: Visual acuity, Snellen chart, Generation.

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Correspondence: Aimen Munir,
Noor International University, Lahore.
Email: aimen1830@gmail.com

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INTRODUCTION

Visual impairment has become one of the greatest public health challenges globally. Blindness and moderate to severe vision impairment have numerous socioeconomic impacts, including employment status, health care requirements, social life, independence, quality of life, education opportunities, and hazards of injury, and mortality.

In the ophthalmological examination, VA plays a critical role. The level of sharpness and clarity of vision, or more specifically, the ability to perceive fine details, is called visual acuity. Visual acuity has four components which are; Minimum visible, Resolution, Recognition and Minimum discriminable acuity or hyper acuity. In clinical practice, Snellen chart and ETDRS charts are commonly used to evaluate visual acuity. The disadvantages of the Snellen chart are; the number of symbols in rows varies unevenly and the size of the symbols and the crowding effect increases linearly from row to row. While each row of the ETDRS visual acuity charts contains five letters, with a consistent gap between each letter and each row. Many researchers now consider ETDRS as the gold standard for visual acuity assessment in research. It is necessary to evaluate near vision as a part of complete ophthalmic examination. For near vision evaluation, logMAR near vision chart is commonly used.

With the advancement and widespread use of digital technology, modern smartphones provide strong internet access in addition to texting, calling and video chatting. Smartphone AI and digital technology influence the daily interactions and lives of Generation Z and Generation Alpha. Overuse of screens can result in headaches and neck pain, as well as problems like digital eye strain which is characterized by dryness, irritation, and blurred vision. Furthermore, the blue light that screens emit can interfere with sleep cycles.

Smartphones have also revolutionized healthcare delivery systems specifically in rural areas through telemedicine by removing the barrier of travelling as patients can reach the medical professionals through video calls and messaging. The assessment of visual acuity has become different with the use of smartphones and associated apps as improves accessibility and convenience. These applications provide a variety of configurable visual acuity charts, including Snellen and LogMAR. Mobile technology allows for smartphone visual acuity tests to be taken from the comfort of a consumer's own home. Applications will often appear like standard charts optotypes, but screen size, resolution and ambient lighting may compromise accuracy. By integrating the comfort of mobile testing with the reliability of traditional testing, the integration of both methods would therefore maximize care in vision.

There is hardly any comprehensive research comparing accuracy of smartphone-based visual acuity tests using Snellen chart application with conventional age-matched vision testing charts in relation to the assessment of the visual acuity of Generation Alpha and Z. This study is aimed to evaluate the effectiveness and feasibility of smartphone-based visual acuity tests by using a Snellen chart application vs the conventional vision charts, and it could give insights on modern ways for vision screening in Generation Alpha and Z.

METHODOLOGY

The research protocols was approved by Ethical Review Board of National Eye Centre Lahore. A proforma based comparative cross-sectional study was conducted in National Eye Centre Lahore from March 2024 to August 2024. The size of obtained sample was 132 which was equally divided into two groups;gen Z and gen Alpha.

$$n = \frac{z^2_{1-\alpha/2}[P_1(1-P_1)+P_2(1-P_2)]}{d^2}$$

Confidence level (1-α) was 95%, precision level (d) was 10%, P1 was 0.917 and P2 was 0.893. Desired sample was selected by non-probability convenient sampling. Individuals with severe visual impairments and diagnosed ocular diseases such as cataract, glaucoma and participants who had undergone eye surgery were excluded. After taking informed consent, Visual acuity measurements for distance and near was recorded of each participant for each eye separately on both conventional charts (ETDRS and near charts) and smartphone application (Snellen chart) under standard distance and brightness settings for both tests. Data was analyzed using SPSS version 25. P value was calculated by using Mann Whitney Test. P value <0.005 was considered significant.

RESULTS

In this study, there were 132 participants; 66 in each group. In which 72 of the participants were female and 60 of the participants were male.

Table No. 01: Gender Distribution

	Frequency	Percentage
Female	72	54.5%
Male	60	45.5%

Majority of the participants were female.

Table No: 02: Descriptive Statistics Of Visual Acuity Recorded On Conventional Charts

Eye	Visual Acuity (Mean ±SD)	
	Near	Distance
Right	-0.01 ± 0.09	0.12 ± 0.15
Left	-0.02 ± 0.12	0.12 ± 0.15

The table shows mean ± standard deviation of distance and near visual acuity recorded by conventional method.

Table No: 03: Descriptive Statistics Of Time Taken In Recording Visual Acuity On Conventional Charts

Eye	Time taken in recording Visual Acuity (Mean ± SD)	
	Near	Distance
Right	10.87 ± 5.10	12.27 ± 5.54
Left	10.99 ± 5.12	12.21 ± 5.88

The table shows mean ± standard deviation of time taken in recording distance visual acuity and near visual acuity by conventional methods.

Table No: 04 Descriptive Statistics Of Visual Acuity Recored On Smartphone-based Charts

Eye	Time taken in recording Visual Acuity (Mean ± SD)	
	Near	Distance
Right	10.93 ± 4.38	11.44 ± 4.15
Left	10.86 ± 4.50	11.60 ± 4.35

This table shows mean ± standard deviation of time taken in recording distance visual acuity and near visual acuity by smartphone-based charts

Table No: 06 Comparison Of Mean ± Sd Of Conventional And Smartphone Based Charts

	Conventional charts Mean VA ± SD	Smartphone based charts Mean VA ± SD	p-value
DVA Right Eye	0.12 ± 0.15	0.09 ± 0.14	0.143
DVA left Eye	0.12 ± 0.15	0.09 ± 0.14	0.143
NVA Right Eye	-0.01 ± 0.09	-0.14 ± 0.11	0.00
NVA Left Eye	-0.02 ± 0.12	-0.14 ± 0.11	0.00

This table shows mean ± SD VA, and p-values. It describes that the distance visual acuity recorded by conventional and smartphone-based was comparable but near visual acuity shows better results on smartphone-based charts than that of conventional charts.

DISCUSSION

In the current study, there were two groups; generation Z (1995-2009) and generation Alpha (2010-2024); each consists of 66 individuals. Individuals having any ocular pathology other than refractive error were excluded. Distance and near visual acuity of each participant was recorded on both conventional age matched visual acuity charts and smartphone-based visual acuity charts.

A cross-sectional study conducted by N Tiraset, in Thailand in 2021 in evaluated the visual acuity of participants aged ≥18 years, using the ETDRS chart, Near Chart, and a smartphone-based Eye Chart application. Sample size was 151 participants. Good positive correlations occurred between VA measurements of the Near Chart vs ETDRS chart and the Eye Chart application vs ETDRS chart, all with $p < 0.001$. The results suggest that both the Near Chart and smartphone-based Eye Chart application can potentially be used as a reliable substitute for the ETDRS chart in determining VA. The results of this study strongly agree with the current study for distance visual acuity (p-value=0.143) but differs in the results of near visual acuity (p-value= 0.00). That difference may be due to environmental factors like lightening of the setup and brightness level of the smartphone.

The study conducted by NF Yulianti in 2022, aimed to assess whether electronic device-based applications can provide reliable and high-quality visual acuity tests. A systematic review of studies published between 2011 and 2021 was conducted, searching databases like PubMed, MEDLINE, Springer, and the Cochrane Library. Out of 1,409 studies, 19 were included for review. The apps were even more accurate for near visual acuity, with smaller ranges of agreement. The analysis also revealed that the accuracy of the apps improved for patients with better vision. The results of the current study show strong agreement with above meta-analysis.

A review was carried out by C Perera in 2015 to determine the most suitable Snellen chart apps for iPhone and evaluate the accuracy of optotype size. 11 apps were identified but the accuracy was variable with optotype size. The second analysis included a hospital study that comprised 88 patients. No app was able to forecast the visual acuity of the patient to within one Snellen line, and the precision of the apps varied from quite poor to very good. Further testing and validation, especially in more severely affected patients, are obviously warranted. In the current, “Snellen chart” application was selected as it has flexible distance settings i.e. the chart in the application will be updated to optotype size depending upon the distance. The results from this application highlights that it shows similarity in distance visual acuity taken with conventional logMAR chart. This study also indicates that near visual acuity shows better results with the application.

According the study conducted by A Hanyuda in 2022, near functional visual acuity was assessed by smart vision check application and compared with that of a conventional device, AS-28. A total of 115 healthy volunteers aged 20 years or above, and with a visual acuity not worse than 20/25, were studied. The results were not significantly different between the two methods, $P > 0.05$. Spearman correlation between the measurements was over 0.60, indicating a strong relationship. So, in conclusion, the Smart Vision Check app does indeed provide an easy-to-use and reliable measurement of NFVA and can potentially be a valuable tool for screening presbyopia, or age-related difficulty in focusing on objects that are closer up. The present study included two generations; gen Z and gen Alpha in which minimum age was 5 years and maximum age was 28. The results of the current study correlate with the above study. After comparing VA recorded by conventional charts and smartphone-based charts; the p-value of distance VA is not significant (p-value= 0.143) and the p-value of near VA is significant (p-value=0.00) and the smartphone-based charts can be used in home screening of visual acuity.

According to the research conducted in 2022, the visual acuity was measured by the VR system and then compared to that visual acuity measured by the conventional Snellen chart. Factors such as the eye to be tested for visual acuity, whether the subject was a wearer of corrective lenses or not, and other effects due to learning from the system itself constituted data that were collected. The results indicated that the VR system was very accurate when the subjects were not corrective lens wearers. The system also proved its strong correlation with traditional methods. The results of this study show strong concurrence with the above described study.

A study done by E Silverstein in 2021 included 53 children between 3 and 18 years of age. The visual acuity was measured in three different methods: GoCheck Kids mobile app by a family member, HOTV-ATS by the study personnel, and through regular clinic procedure by an ophthalmic technician. Through intraclass correlation coefficients (ICC), agreement between the different measurement methods was analyzed. There is no significant difference from GoCheck Kids and the regular clinic measurements with a P value of 0.010, and the ICC is 0.59. The difference between the measurements obtained in the HOTV-ATS and in the clinic (0.084) was also statistically significant (P < .001). The current study also determine that the is no significant difference in the distance VA of both smartphone and conventional methods with the p value 0.143 but there is significant difference in the Near VA of both conventional and smartphone methods with the p value 0.00.

In April 2020, a systematic search was done by A Samanta in PubMed, Embase, and Medline databases to source studies related to remote VA tests published between 2010 and 2020. It screened 4,338 articles which filtered down to 14 studies. The highest quality, consistency, and correlation with in-clinic visual acuity were observed with those using the Peek Acuity app. Studies included the age group from 3 to 97 years, from people with and without vision correction, and with diverse eye conditions. The Peek Acuity app was shown to have the best correlation with ETDRS and to have high reliability between repeated tests. In fact, it performed as well or better than traditional Snellen and ETDRS charts in measuring vision. The present study contradicts with the above study such that they included vast age group and the patients with diverse eye condition but the age of participants in this study range from 5 to 28 years and no pathological eye was included. The results of both studies resemble for distance VA, no significant difference was found.

This study has some limitations; the included participants belong to a certain age group (the age ranges from 5 to 28 years). No pathological eye was included. Sample size was small.

The suggestions for further studies are to include; diversity of age group. Large sample size. Include eyes with pathology.

CONCLUSION

It is concluded from the results of this study that there is no significant difference in distance visual acuity recorded by both methods; conventional age matched visual acuity charts and smartphone-based visual acuity charts. But there is a significant difference in the near visual acuity taken by conventional and smartphone-based charts.

Conflict Of Interest: None to declare

Ethical Approval: The study was approved by the Institutional Review Board / Ethical Review Board Reference No. NEC/ERB/23818/2024 dated 08.09.2024, National Eye Center, Lahore.

Authors' Contributions:

Aimen Munir; Literature search, Data acquisition, Statistical analysis, Manuscript preparation, Manuscript review.

Asra Fayyaz; Data, Design, Literature search, Data acquisition, Data analysis, Statistical analysis, Manuscript editing, Manuscript review.

Moin Yaqin; Concept, Manuscript review.

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