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Comparison of the Accuracy of Phone Applications with Snellen Chart in Determining Visual Acuity

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ABSTRACT

Objective: To correlate the visual acuity assessment as tested by smartphone application with standard Snellen visual acuity.

Methodology: A total of 136 individuals were included in this analytical cross-sectional survey conducted at Shifa Foundation Community Health Center, Islamabad between January 2022 and January 2023. Individual's age ≥ 18 years were included. Snellen's visual acuity was assessed using a standard Snellen's visual acuity chart by the optometrist, while the Paxos checkup by DigiSight technologies was used to assess visual acuity on smart phone using one appropriately color calibrated I-phone 7 device. Both assessments were done in physically separate areas to reduce observation bias. Visual acuity from each assessment was noted in the decimal format. Frequency distribution and Pearson's correlation was calculated to ascertain the relationship between the two study variables.

Results: A total of 88 males and 48 females were included in the study (n=136). The mean age of patients was 29.72±9.0 years. The mean visual acuity of right and left eyes as assessed with Snellen's chart were 0.88±0.2 and 0.86±0.22, respectively. The mean visual acuity for right and left eyes as assessed by Paxos checkup were 0.84±0.19 and 0.86±0.21, respectively. There was positive correlation was present in both eyes. The Pearson's correlation for right eyes was r = 0.66 and significant at p = 0.001, while the correlation for left eyes was r = 0.71 and significant at p = 0.001.

Conclusions: There is a strong correlation between Snellen's visual acuity assessment and assessment of visual acuity by the smartphone application. This makes the latter a viable strategy for screening at places where taking a Snellen's chart might not be feasible.

Keywords: Cell phone, Diagnostic techniques, Ophthalmological, Ophthalmology, Visual acuity, Snellen's chart.

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Introduction

An estimated 2.3 billion people in the world have impaired vision.[1] In a national survey conducted in Pakistan, among the moderately visually impaired, the leading cause for vision defect was refractive error.[2] It is a cause of severe visual impairment in rural settings of Pakistan as compared to the urban population.[3] One of the ways of assessing visual impairment is the visual acuity test. The use of this measurement is widespread in hospital settings.[4] Visual acuity measurement determines the clarity of near and far vision. The Snellen's chart, which was developed by Dutch ophthalmologist Dr. Hermann Snellen in the 1860s, is the clinical standard and the most common method for the visual acuity test today.[5] However, it's limitations in terms of portability and availability has prompted the emergence of alternative means of testing visual acuity of a person. Modern technology has allowed the Snellen's

chart to be readily available on smartphones as downloadable applications. The portability and availability of smartphones provides ophthalmologists a great advantage when treating patients in settings of meager facilities or in remote areas where scarcity of resources poses a big problem.[6] Use of mobile applications in health care settings has seen a rapid increase in recent years.[7] In a recent survey, the majority of physicians are using smartphones.[8] Currently there are more than a hundred applications available online to test the visual acuity of a person.[9] The application used in this study was 'Paxos Checkup by DigiSight Technologies Inc,[10] downloaded from the Apple app store, which has been investigated to be the best free app to measure visual acuity.[11] The rationale of the study was, in rural areas where there is shortage of resources, such as power outages, faulty or unavailable equipment,[12] this could be of great help to medical practitioners. This could be used as a screening tool for identifying vision defects in the general populace by ophthalmologists and opticians. This study aims to compare the accuracy of smartphone applications with a standard 6m Snellen (6SVA) visual acuity and to identify the feasibility of using smartphones in clinical/community settings in Pakistan.

Methodology

This analytical cross-sectional study was conducted at Shifa Foundation Community Health Center, Islamabad between January 2022 and January 2023. A total of 136 individuals (WHO sample size calculator was used and the following parameters were applied; 95% confidence interval alpha error was 5% and the incidence of visual acuity was 10%),[2] aged 18 to 60 years who presented with normal vision. Those with myopia (near sightedness) and hyperopia (far sightedness) were also included if they had their corrected glasses with them. Simple random sampling was used to gather subjects in the study. Individuals with vision deprivation due to corneal opacities, cataract, glaucoma, retinal and optic nerve pathologies were excluded from the study. A consent form was given to these individuals in which they were informed about the purpose of the research itself. Anonymity was maintained by using numbered forms.

A standard 6SVA box chart was used in this study along with Paxos Checkup by DigiSight Technologies, Inc. iOS application on an i0S compatible device, namely I-Phone 7 (dimensions-138.3 x 67.1 x 7.1 mm).

The visual acuity testing by the Snellen chart was performed by the optometrist. The 6SVA box chart was placed next to the subject who was instructed to read the chart which was present at a distance of 6m. The test was conducted under proper illumination. The use of distance correction glasses was allowed during the course of examination. Both eyes were assessed. The visual acuity testing by the smartphone was done by the researchers in an adjacent room under the supervision of an ophthalmologist. The smartphone was at its full brightness. The participants were instructed to wear their reading glasses if they use them. The device was held by the participant at a distance of 36" (36cm) from their eyes. The adjacent eye was covered. The data was collected by the optometrist and the researcher in separate rooms as to eliminate any bias or discrepancies.

The data was prospectively recorded, converted to decimals and then compiled onto a database for analysis. IBM's SPSS Statistics 23 was used and the means were compared using the paired t-test. Visual acuity measured by the Snellen's chart and the phone application for both eyes were compared.

Results

Total 136 participants (272 eyes) were enrolled in the study. In the Snellen's visual acuity, the ophthalmologist recorded the visual acuity of the 136 participants, whereas the visual acuity of the application for the same group of people was recorded. The average age for the participants listed in the study is 29.72±9.0 years. There are more males in our study with 88 (64.71%) compared to 48 (35.29%) females.

Table I: Visual acuity at Snellen's chart and Paxos checkup application. (n = 136)

	Snellen's Chart	Paxos Checkup
	Mean±SD	Mean±SD
Visual acuity of right eye	0.88±0.2	0.84±0.19
Visual acuity of left eye	0.86±0.22	0.86±0.21
T-test, p-value		.001

Table II: Correlation between the Snellen visual acuity chart and the phone application in both eyes. (n = 136)

Visual acuity right eye		**VAR-SN**	**VAR-APP**
VAR-SN	Pearson correlation	1	.668
	Sig. (2-tailed)	-	.001
VAR-APP	Pearson correlation	.668	1
	Sig. (2-tailed)	.001	-
Visual acuity left eye		**VAL-SN**	**VAL-APP**
VAL-SN	Pearson correlation	1	.713
	Sig. (2-tailed)	-	.001
VAL-APP	Pearson correlation	.713	1
	Sig. (2-tailed)	.001	-

The mean visual acuity of right and left eyes as assessed with Snellen's chart and Paxos Checkup application (Table I). There is a strong positive correlation between the Snellen visual acuity chart and the phone application. The right and left eye has a strong positive correlation of 0.668 and 0.713, respectively with a p-value ≤ 0.05 (Table II).

Discussion

The results of our investigation show that visual acuity as measured using a smartphone application is comparable to Snellen's visual acuity (VA). A study conducted by Pathipati et al reported smartphone-based VA assessment to have greater accuracy as compared to the traditional Snellen's VA.[13] In their study, patients who reported to the emergency department were evaluated for VA using the Snellen's chart and a smartphone application (Paxos Checkup). The application used to assess visual acuity was similar to ours.

However, not all investigations show similar conclusions. The eye phone study could not identify an application that had an optotype size that could be considered as standard.[11] Though there was no statistically significant difference between VA measurements between smartphone applications and Snellen's VA, when stratified for severity of vision impairment showed that patients with VA worse than 6/18 had the greatest difference between the mean acuities of the two measurement methodologies (smartphone vs Snellen's). This study did not include the smartphone application investigated in our research thus a comparison cannot be made.[11] However, it does imply that not all smartphone applications are equally capable when it comes to recording VA that is comparable to that of Snellen's VA.

Automated smartphone-based visual acuity apps simplify the task of measuring visual acuity for healthcare providers who are untrained in ophthalmology.[9] The distinction between near and far assessments of visual acuity may have contributed to the observed difference in visual acuity with the introduction of the smartphone-based visual acuity app.[11] The visual acuity was first measured by the baseline methodology of visual acuity assessment on the Snellen's chart as practiced by ophthalmology residents and opticians.[14] After this step we measured the visual acuity by the smartphone-based visual acuity test, which is a test of near visual acuity at 14 inches self-administered by patients. The results suggest that automated, smartphone-based visual acuity tests have virtually the same credibility in measuring visual acuity as compared to the traditional Snellen's chart. There are other applications for automated, smartphone based visual acuity tests.[15] Efficiency of ophthalmic care can be improved by directly linking these tests into the medical record. Because these apps are self-administered, they can readily be used by patients at the comfort and ease of their homes, accessible any time. One of the cornerstones of this study is that it simulates a rural based medical setting and provides a very accurate result of what would happen in a facility deprived primary medical health setting in a third world country.[16]

We suspect that our results can be reciprocated in a number of medical health settings if the instructions are carried out as per the apps instructions. We found that the use of an automated, smartphone-based, self-administered visual acuity test provides a less accurate representation of the visual acuity ultimately recorded by ophthalmologists when compared to a distance Snellen chart in the context of emergent ophthalmic care. Our results indicate that such apps may function as supplementary resources for coordinated care between patients and ophthalmologists.

Further research in different settings that overcome the shortcomings and limitations of this research need to be done to refine this area of advance and modern medical technology and in particular to this medical device.[17] Furthermore, the Snellen's chart itself has been in recent times criticized as not being the most accurate test for measurement of visual acuity.[18,19] Further suggestions would be to do a three-way comparison while using EDTA LoG MAR as a gold standard. Furthermore, other fields of medicine such as pain management are evolving and accepting modern day phone apps and are benefiting from such actions.[20] Technology might have its flaws but it's the need of the hour to improve whatever deficiencies it may have than ignore it.

Conclusion

The study concluded that there is a strong correlation between Snellen's visual acuity assessment and assessment of visual acuity by the smartphone application. This makes the latter a viable strategy for screening at places where taking a Snellen's chart might not be feasible.

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