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COMPARISON OF VISUAL ACUITY TESTING METHODS USING SMARTPHONE APPS, SNELLEN CHART AND EARLY TREATMENT DIABETIC RETINOPATHY STUDY CHART

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ABSTRACT **AIM:** To investigate if smartphone apps (EyeChart app for iPhone and Peek acuity app for android phones) and traditional Snellen chart measure accurate visual acuity (VA) as compared to the gold-standard Early treatment diabetic retinopathy study (ETDRS) chart.

METHODS: A cross sectional period study including 252 participants was conducted over 2 months. Patients above 18 years of age and of VA 6/60 or better at 6 metres were included in the study. VA of both the eyes of each participant was measured by 4 charts- Snellen chart at 6 m, ETDRS at 3 m, EyeChart app at 1.2 m, Peek acuity app at 2 m. Each VA score measured using smartphone apps and Snellen chart was compared to the VA score measured using ETDRS chart.

RESULTS: The mean VA scores obtained were: 0.44 logMAR on Snellen chart, 0.40 logMAR on ETDRS chart, 0.41 logMAR on EyeChart app, 0.37 logMAR on Peek acuity app. After performing paired-score t-tests, the difference between the EyeChart app and ETDRS chart ($p = 0.077$), the difference between Peek acuity app and ETDRS chart ($p = 0.091$), and the difference between snellen chart and ETDRS chart ($p = 0.204$) did not reach statistical significance. Pearson correlation coefficients revealed that the EyeChart app, Peek acuity app and Snellen chart had a strong positive correlation with ETDRS chart ($p < 0.01$).

CONCLUSION: This study found out that visual acuity measured using smartphone apps and Snellen chart were accurate and reliable compared to ETDRS chart in a healthy adult population.

KEYWORDS : Visual acuity; smartphone apps; EyeChart app, Peek acuity app.

INTRODUCTION:

Visual acuity (VA) examination plays a significant role in assessing the functioning of the visual system. Therefore, one must ensure that any chart which is used for the purpose of recording VA is reliable and accurate. The Snellen chart, which was first developed in 1862, is now considered as the traditional chart and is still commonly used for recording VA in clinical practice.(1) To ensure accuracy and standardisation in recording the VA score, the Early Treatment Diabetic Retinopathy Study developed the ETDRS chart based on logMAR chart design principles, which is now considered the gold-standard chart for VA testing.(2)

Incorporation of smartphone technology into modern medical practice has been evolving rapidly in hospitals worldwide. Such technology involving electronic devices are being welcomed by many medical professionals. This rise in demand for smartphone technology has urged us to develop several medical programs and applications which can be used even by non-medically trained staffs.(3)

Mobile devices, like smart phones and tablets, help in extending the boundaries of telemedicine even further, giving rise to a new entity called as mobile health or mHealth. The World Health Organization (WHO) defines mHealth as 'medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants, and other wireless devices.'(4)

In this study, we compare the visual acuity measured using smart phone apps (EyeChart app for iPhone and Peek acuity app for android phones) and traditional Snellen and ETDRS charts.

METHODS:

After obtaining approval from the Institutional ethics committee, a cross-sectional study was conducted over a period of 2 months (April 2021-May2021). About 252 participants who presented to the department of ophthalmology were recruited for the study based on the inclusion and exclusion criteria. Informed written consent was obtained from all volunteers before participating in the study. Detailed history and clinical examination were carried out and the data was entered in preformatted - proforma.

Inclusion Criteria:

1) Patients above 18 years of age
2) Patients of visual acuity of 6/60 or better at 6 metres (irrespective of strabismus, amblyopia, or any ocular pathology)

Exclusion Criteria:

1) Age less than 18 years
2) Presbyopic individuals requiring reading glasses.

After assessing eligibility, visual acuity of both the eyes of each participant was measured by all 4 charts using a counterbalanced testing order.

1) Snellen chart (wall mounted) presented at 6 metres
2) ETDRS chart presented at 3 metres
3) EyeChart app in iPhone XS max presented at 1.2 metres (4 feet)
4) Peek acuity app in android phone presented at 2 metres.

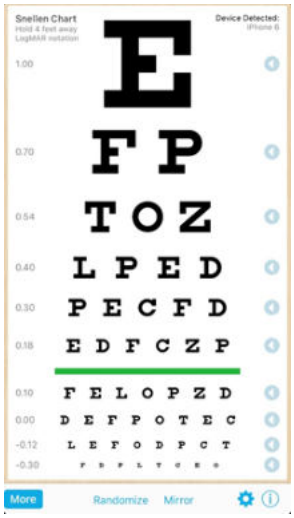

Image 1: Eyechart App

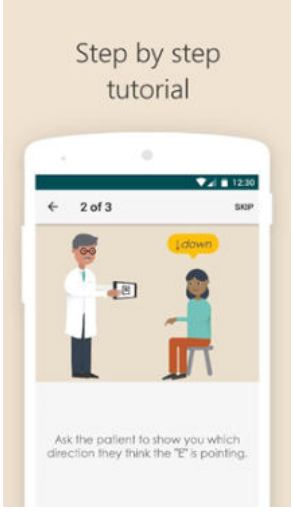

Image 2: Peek Acuity App

All the VA charts were hidden from the participants view and were presented to them one at a time in a predetermined randomised order only during assessing VA.

When using the EyeChart app and Peek acuity app, the phone screen was placed away from any sources that could cause glare and strain to the participant, which possibly causes eye strain to the patient, that could affect the accuracy of the VA score obtained. Participants were given rest for a period of 30 seconds between testing each VA chart to reduce any fatigue effects.(5)

The VA scores from the Snellen chart were recorded in metric Snellen fractions and converted to logMAR. VA from ETDRS chart, EyeChart app, Peek acuity app were directly recorded in logMAR values.(6)

Each visual acuity score measured using Snellen chart and the smartphone apps were compared to the visual acuity measured using ETDRS chart as this is being considered as the gold standard.

Statistical Analysis:
A critical p-value ≤ 0.05 indicated statistical significance whereas, the results were said to be highly statistically significant if the critical p-value was ≤ 0.01. The mean VA scores obtained using each chart were denoted to be significantly different based on paired-score t-tests.

RESULTS:
Of the 252 participants, 21 were hypermetropic (8.3%), 136 were myopic (53.9%), and 95 were emmetropic (37.6%).

The mean VA scores obtained using the different charts were as follows:
- Snellem chart: 0.44 logMAR
- ETDRS chart: 0.40 logMAR
- EyeChart app: 0.41 logMAR
- Peek acuity app: 0.37 logMAR (Table1)

Descriptive Statistics (Table 1)

	N	Minimum	Maximum	Mean	Standard Deviation
SNELLEN CHART	252	.00	1.00	.4424	.28914
ETDRS CHART	252	.00	1.00	.4097	.27144
EYECHART APP	252	-.06	1.00	.4166	.27716
PEEK ACUITY APP	252	.00	1.00	.3721	.26502
Valid N	252				

After performing paired-score t-tests, the p-value based on the comparison of different VA testing charts were as follows:
- Snellen chart and ETDRS chart: p = 0.204
- EyeChart app and ETDRS chart: p = 0.077
- Peek acuity app and ETDRS chart: p = 0.091

Hence, the difference between Snellen chart and ETDRS chart, EyeChart app and ETDRS chart, Peek acuity app and ETDRS chart did not reach statistical difference as the p-value between each chart was found to be > 0.05.

Pearson correlation coefficients revealed that the EyeChart app, Peek acuity app and Snellen chart had a strong positive correlation with ETDRS chart (p < 0.01).

DISCUSSION:
From this study we found out that the VA scores obtained using the EyeChart app, Peek acuity app and Snellen chart are accurate and reliable, when compared to the results achieved using the gold-standard ETDRS chart in general population.

It is vital to note that comparing the results of this study directly to those of the previous studies are limited due to the difference in the experimental set-ups. For example, Bastawrous et al. in 2015 performed their study using tumbling E optotypes(7), whereas Pathipati et al. in 2016 presented the patients with single optotypes, and a matching card was used to indicate the correct answer.(8)

Another significant difference is the type of population employed in the studies. Patients who presented to an emergency eye department were assessed in the study conducted by Pathipati et al. (2016), whereas Bastawrous et al. (2015) conducted their study using app at the comfort of the participant's home and in certain clinics in the outskirts of Kenya. These differences limits the comparisons that can be obtained from the results of the studies.

This study found that the EyeChart app and Peek acuity app gives accurate VA scores when the test is performed in patients after providing them with their refractive correction. When the patients are tested without their refractive correction, the testing distance becomes even more closer. To ensure that this close testing distance does not grossly affect the VA scores obtained, both the smartphone apps must be proven to be sensitive enough to detect the VA of myopic and hypermetropic patients even without their refractive correction.(9)

Both the inter and intra-examiner repeatability of the smartphone apps in normal as well as patient population is essential, before introducing it as tool to assess the VA, as these will help the examiners to come to a conclusion if any significant change in VA detected using the smartphone apps is true.

CONCLUSION:
This study found out that visual acuity measured using smartphone apps and Snellen chart were accurate and reliable compared to ETDRS chart. Therefore, introducing smartphone apps for assessing visual acuity may improve the standard of care provided to patients who are unable to access the traditional ophthalmology clinics. Another major advantage is that, due to its easy portability, these smartphone apps can be used for VA testing even during emergency crisis outside the traditional clinical setup where the routine VA charts are not available such as hospital wards and emergency medicine department. (10). Teleconsultation is a rapidly growing trend especially during pandemic outbursts, where such visual acuity assessing apps comes into play. However, large-scale studies are necessary to investigate these smartphone apps on a variety of patient population , before it could possibly be advocated into clinical practice as a visual acuity assessment tool.(11)

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