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Feasibility study for measuring patients' visual acuity at home by their caregivers

Navya Deepthi Davara, Raghavachary Chintoju, Neelima Manchikanti, Chodup Thinley, Pravin Krishna Vaddavalli[1], Padmaja Kumari Rani[2], PremNandhini Satgunam

Purpose: To assess the feasibility of measuring patients' visual acuity (VA) in their homes by their caregivers. **Methods:** Patients consulting in a tertiary eye care institute were prospectively enrolled with informed consent. All underwent standard COMPlog distance VA testing. Patients and caregivers were oriented to test distance VA using the Peek Acuity app. The app was installed on the caregiver's or patient's smartphone. The patient's VA was measured by the caregiver in the clinic (baseline value) under supervision. After 1 week, the caregivers recorded the patient's VA with the Peek Acuity app at their home and reported the value in a telephone consultation. A questionnaire to assess the ease of using the app was administered at both the baseline visit and 1 week later. **Results:** A total of 100 patients (age group: 13 to 76 years) and 100 caregivers (age group: 17 to 65 years) participated. VA measurements with the Peek Acuity app were comparable with COMPlog ($P > 0.1$) both during the baseline and after 1-week measurement, regardless of the underlying ocular condition or educational level of the caregivers/patients. Most caregivers (95%) felt the app was easy to use. **Conclusion:** Though the Peek Acuity app was originally developed for health care workers to be used in field visits, we found that with proper orientation, the layperson can also use it. Such orientation can enable caregivers to effectively measure VA at home. Such a tool would enhance teleophthalmology consultations and can minimize the need for short follow-up visits.

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Telemedicine technology is facilitating medical care to patients in the present COVID-19 situation and it is most likely to continue in the near future as well.[1] This trend is true for teleophthalmology as well. Considering the reduction in the number of in-clinic consultations after COVID-19[2] and the increased inclination to use teleconsultation services both by practitioners[3-5] and public,[6] the scope for expanding the teleophthalmology services through teleconsultation needs to be investigated. Attempts at measuring visual acuity (VA) in a teleconsultation setting are currently explored by many, starting with identifying the appropriate test or app to be used.[7-9]As a part of this attempt, we investigated to see if the caregivers could measure the patient's VA at home, with a smartphone vision-testing app.

Smartphones are increasingly used in health care, especially for telemedicine, diagnostics, and research as well.[3,10] Some of the smartphone applications such as Peek Acuity used for vision testing were primarily developed for eye care practitioners to be largely used in community eye care.[11,12] It has been shown that healthcare workers could quickly learn to use the Peek Acuity app and a good correlation was also obtained with the measured VA with the Snellen chart and Early Treatment Diabetic Retinopathy Study (ETDRS) charts.[12] Peek Acuity app also uses pre-determined screen brightness irrespective of settings done by the user, and this minimizes the variability of screen brightness and contrast factors.[13,14] The app can measure VA values up to 1.8 logMAR and also has a provision to measure until the perception of light. Peek Acuity app is not a registered medical device; however, it can be used globally.[15]A recent study showed that VA measurements using the Peek Acuity app and COMPlog acuity chart were comparable.[7] However, this study was performed on normally sighted individuals and was administered by an eye care professional. The comparability of VA measurements in patients with reduced acuity with the Peek Acuity app was not tested. It was also not shown if a layperson could administer Peek Acuity vision testing at home. A study[16] on home vision testing for children who were follow-up patients, unable to visit the clinic during the pandemic, showed that parents could test their children. In that study, 10 of them used the Peek Acuity app, and 5 used iSightPro depending on the availability of the smartphone, most of these families found it easy to use. Upon comparing the overall data of VA measurements of both applications with clinical measurements, a 0.14 logMAR bias and a variability of 1.48 logMAR lines (upper limit: 0.88 logMAR and lower limit: –0.60 logMAR), that is, about more

Brien Holden Institute of Optometry and Vision Sciences, [1]Cornea Institute and [2]Smt. Kanuri Santhamma Centre for Vitreo-Retinal Diseases, L V Prasad Eye Institute, Hyderabad, Telangana, India

Correspondence to: Dr. PremNandhini Satgunam, Hyderabad Eye Research Foundation, L V Prasad Eye Institute, Hyderabad - 500 034, Telangana, India. E-mail: premnandhini@lvpei.org

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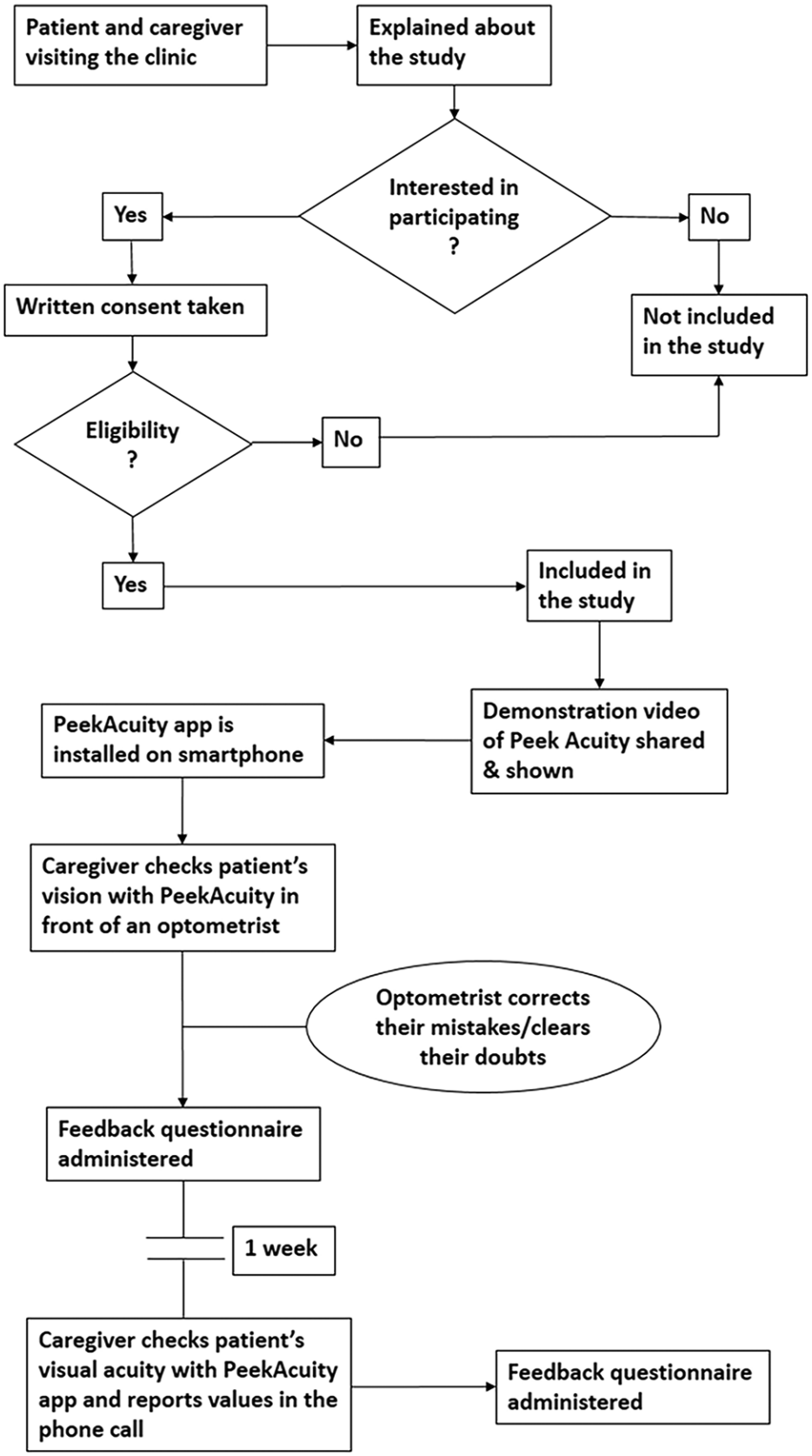

Figure 1: Flow chart depicting the study design

than six lines of variation was found. Considering the low sample size and the large variation in the VA values, it is unclear if home vision measurements are feasible or not.

We undertook a study to address the following questions: Can patients and their caregivers be trained to use the Peek Acuity app? Will VA measurements performed at home be comparable to in-clinic measures? Addressing both these questions will give us a feasibility indication for expanding teleconsultations for eye care to also include VA measurements. This would be particularly beneficial for patients who require multiple follow-up visits. Additionally, in-clinic visit time can be reduced if VA is already measured at home before visiting the clinic.

Methods

The Institutional Review Board of our institute approved this prospective study through an online review process. The study protocol adhered to the tenets of the Declaration of Helsinki. Prospective data collection was done from October 2020 to January 2021 under strict COVID-19 protocol of social distancing, wearing appropriate personal protection masks (patients and examiners) and face shields (examiners), hand sanitization, and sterilization of the equipment after every use during the study. Subjects were a convenience sample of patients and their caregivers visiting the institute, seeking consultation in different subspecialties that includes the retina, refractive surgery, glaucoma, and comprehensive departments. The participants were explained about the study. If they were willing to participate, informed written consent was taken from patients, and for children (age < 18 years) consent was taken from their parents. No specific inclusion and exclusion criteria were enforced. Any patient with a VA of 20/320 or better was included in the study. As long as the caregiver knew how to use a smartphone and can follow instructions they were included in the study. Patients

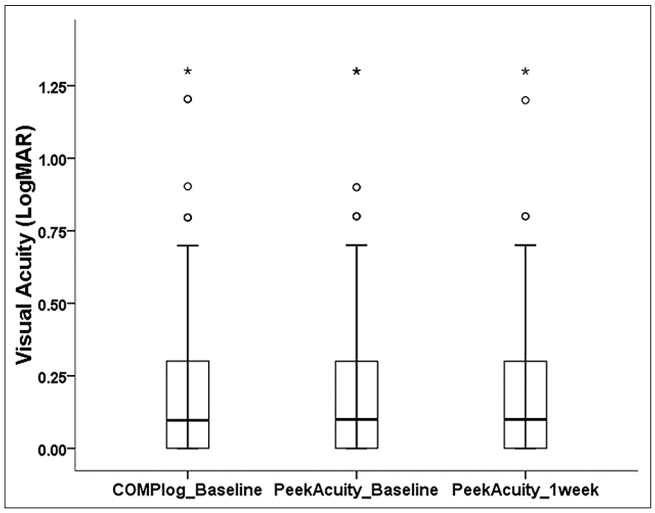

Figure 2: Boxplot showing the visual acuity distribution at different visits. The horizontal line inside the box is the median and the length of the box is the interquartile range

Table 1: Total number of patients included with age and gender distribution and level of education of patient and caregiver

	Patient (male=47, female=53)	Caregiver (male=67, female=33)
Age	mean (±SD)	mean (±SD)
Refractive (*n*=30)	25 (±4.2)	40 (±11.3)
Retina (*n*=25)	71 (±3.5)	30 (±8.4)
Glaucoma (*n*=31)	60 (±11.3)	37 (±13.4)
Comprehensive (*n*=14)	20 (±1.4)	36 (±21)
Level of education	**Number of participants**	
No formal education	9	0
Primary	4	0
Secondary	16	18
Under graduation	51	46
Post-graduation and beyond	20	36

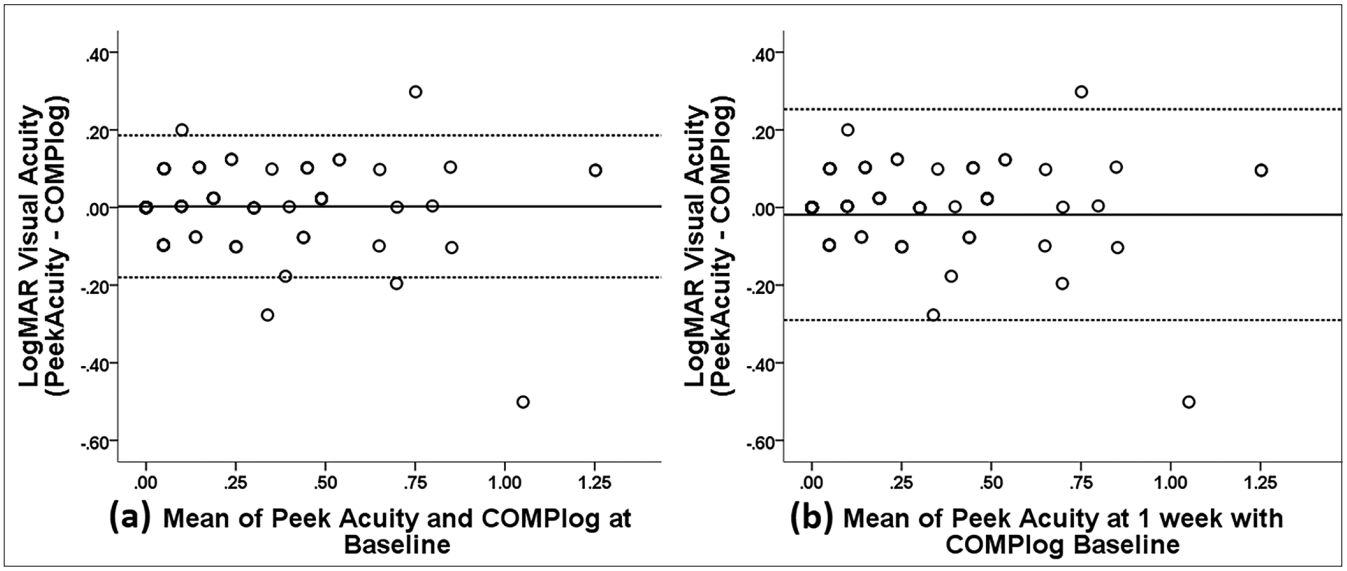

Figure 3: Bland–Altman plot with 95% limits of agreement for VA measurements between (a) Peek Acuity and COMPlog at the baseline visit (b) Peek Acuity at 1 week and COMPlog at baseline visit

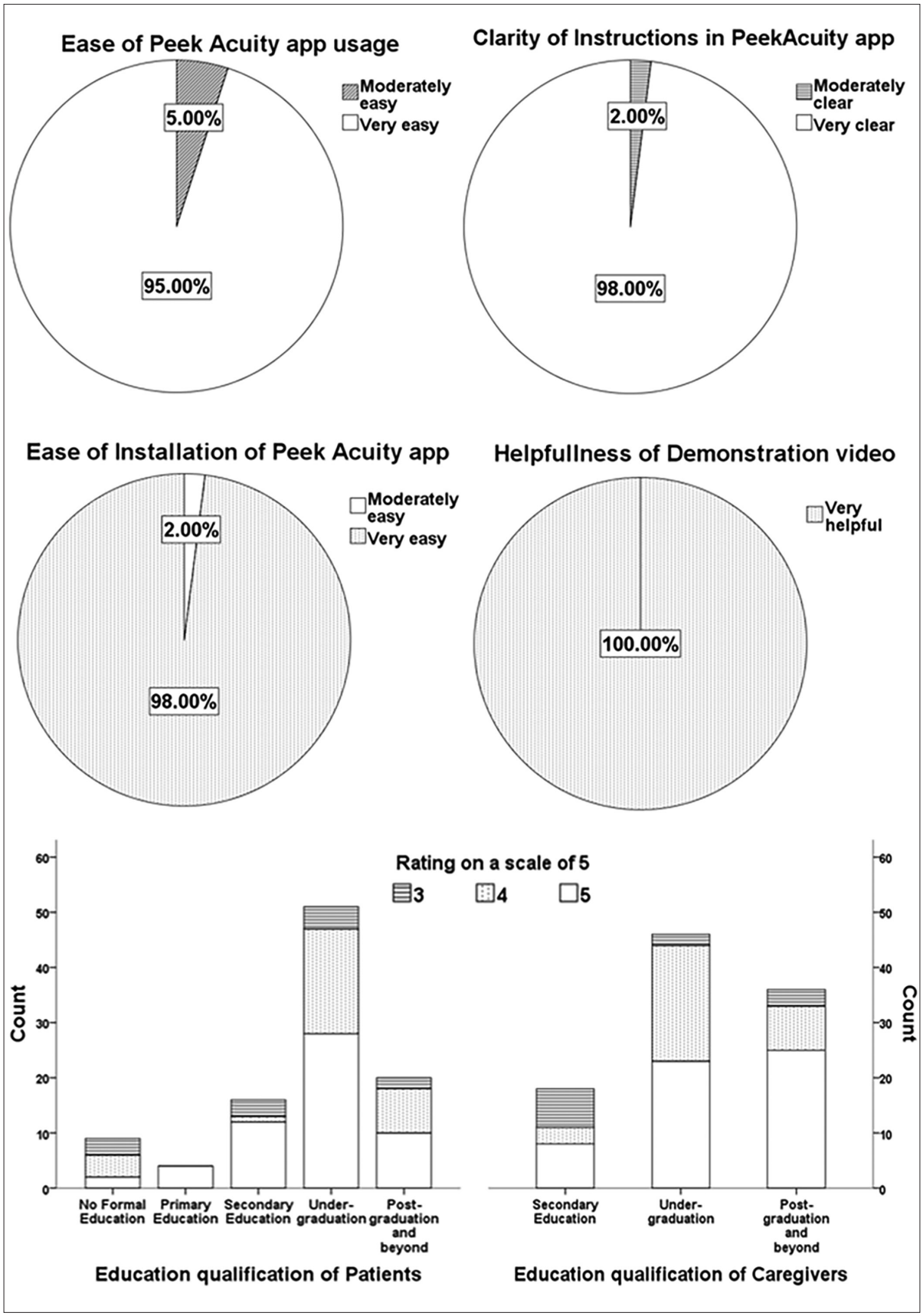

Figure 4: Feedback responses from patients and caregivers regarding Peek Acuity application and demonstration video shown in the pie chart. The overall rating for the Peek Acuity app is shown in the stacked column bar chart

undergoing refractive surgery were also included. VA was not expected to change in these surgery patients as they usually achieve their best-corrected visual acuity (BCVA) within a week. Monocular VA was checked in all patients. In patients undergoing refractive surgeries, both eyes' monocular data were collected; however, for analysis, only one eye VA value was considered randomly. In other subspecialties, the eye diagnosed with ocular pathology was selected, if patients had bilateral ocular pathology, then randomly one eye's VA value was considered.

After the regular clinical examination and before dilatation and fundus examination, the patient's VA was also measured by the caregiver with the Peek Acuity app. Both the patient and the caregiver were oriented for using the Peek Acuity with a demonstration video in a language (English, Hindi, or Telugu) desired by them. Although the instructions to use the app were already available in English, the video was made, to practically demonstrate for the ease of understanding and reach out to a larger group of patients or caregivers with different educational and socio-economic backgrounds. This video was shared with the patient or the caregiver's android phone in the form of a.mp4 file through WhatsApp messenger. The flow of the study procedure is shown in Fig. 1.

After testing with the app, demographic details such as educational background, understanding the English language, and ease of using the smartphone were obtained from both the patients and their caregivers. Feedback questions about the use of the Peek Acuity app and demonstration video were also asked on the same day. Caregivers were instructed to check the patient's VA after 1 week (+3 days), a range of 3 days was considered in these follow-up patients, as some of these patients could forget to check the vision. An examiner called the patient to document the measured VA at 1 week. Feedback questions were also asked again in this telephone call.

Data analysis

VA readings and feedback data were the outcome measures. All the VA (COMPlog and Peek Acuity) values were converted to logMAR units for analysis. SPSS software (SPSS Inc., ver. 20.0, Chicago, USA) was used for statistical analysis. Qualitative measures were descriptively analyzed. VA data were checked for normality with one-sample Kolmogorov–Smirnov test. As the data were not normally distributed, a non-parametric test (one sample Wilcoxon Rank test) was done to compare the VA between the two measurements. Additionally, Bland–Altman plots were examined for limits of agreement.

Results

A total of 100 patients (53 females) were enrolled from various sub-specialties that included 30 patients from refractive surgery, 25 patients from the retina, 31 from glaucoma, and 14 from comprehensive sub-specialties. Only one patient who consented to participate had to be excluded because she/he did not have a smartphone. The age range for the patients was from 13 to 76 years (mean ± SD: 40 ± 18 years) and 17 to 65 years (37 ± 12) for their caregivers. About 72% of these patients were non-surgical and 28% underwent refractive surgeries. One-week follow-up data for VA were obtained from 96 patients, and only 74 patients completed the feedback questionnaire. The remaining patients wanted to give feedback later and were not reachable afterward. The demographic details of all patients are shown in Table 1.

VA distribution ranged from 20/20 to 20/320 Snellen fraction (0.0 to 1.2 logMAR) as shown in Fig. 2. Overall VA measurements from COMPlog baseline were comparable to both PeekAcuity baseline (Wilcoxon Z= –1.64, P = 0.10) and to 1-week Peek Acuity measurements (Wilcoxon Z= –0.25, P = 0.81). These measurements were also comparable when analyzed based on different sub-specialties. The Bland–Altman plot [Fig. 3] shows the mean difference between Peek Acuity and COMPlog to be less than one letter difference (0.003 ± 0.09 SD), and the limits of agreement were within two lines in the baseline visit. The 1-week measurement [Fig. 3] showed about two-letter differences (0.018 ± 0.14 SD) and the limits of agreement were within three lines between the Peek Acuity measurement and the baseline COMPlog measurement.

The feedback questionnaire about the app and the demonstration video collected at the baseline visit and after 1-week were comparable. The results of 1-week are as shown in Fig. 4. Overall, most patients found the Peek Acuity app easy to use and the demonstration video to have clear instructions. About 33% of patients reported having no need to recheck the demonstration video, whereas 25% reported having to view it three times. The remaining patients viewed it once or twice. Overall, the ease of the Peek Acuity app did not show any difference based on age, gender, or education status (P > 0.05, Chi-Square tests).

Discussion

This is the first study to show that with minimal training, the Peek Acuity app can be used by a layperson for home VA assessment. Peek Acuity app was developed for community eye care, to be used by eye care professionals for VA testing and school screenings.[12,17-19] In the current study, this app was used as a home VA testing tool that was administered by a caregiver who was given training and orientation to use the app. Except for one patient, everyone had access to an android smartphone and the internet to download the app. This shows that the vast majority of patients/caregivers seeking care in a tertiary eye care center have access to smartphones. We observed that VA measures obtained in the clinic and that measured by the caregiver, both on the baseline visit administered with supervision and 1 week later on their own, were comparable [Fig. 3].

The demonstration video on how to use the Peek Acuity app was found to be helpful to orient the patient and the caregiver. About 67% of the participants had to view this video again to be able to perform the test 1 week later. This indicates that a review of instructions will be needed before using the app at a later time. Demonstration videos can be made available in the local languages that the patient is familiar with. The type of ocular condition, age, gender, and educational status did not influence the ease of using the Peek Acuity app. This is encouraging especially when the original use of Tumbling E optotype for this app was to cut these potential barriers. On the flip side, caution needs to be exercised, indicating to the patient and the caregiver that a good measure of VA does not necessarily indicate an absence of an ocular condition. Regular in-person eye check-ups would still be needed to ensure overall ocular health. Such counseling was given to the cohort of the recruited patients and caregivers in this study. This was done so that they do not use this app on their own and reassure for a condition.

Unlike an earlier study[16] that showed a moderate correlation to home acuity testing and in-clinic measurements, the present study showed a better agreement. The earlier study had a smaller sample size and only a few (n = 5) parents in that study used the Peek Acuity app. The Peek Acuity app has already been shown to have a good agreement with the COMPlog acuity values.[7] However, in that study, the clinician administered both the Peek Acuity and the COMPlog VA tests. From the present study, we can observe that the layperson can also be trained to make the measurement with the app. The feedback on the Peek Acuity app was favorable [Fig. 4] with the majority of the patients/caregivers indicating that the instructions were clear and it was easy to use.

Limitations in this study include only a smaller number of patients with poor VA and the number of children included was also less. A study done on the pediatric age group has checked the VA with Peek Acuity and demonstrated its utility for school screening by eye care practitioners. This study showed a 71% correlation with in-clinic Snellen acuity measurement.[19] Future studies can include more children and patients with poor VA to be tested by their caregivers.

Older patients who may have age-related ocular changes with poor vision and who are unable to visit a hospital due to reasons beyond the pandemic situation can also find this testing beneficial to follow-up with teleconsultation. Although the caregivers were asked to measure within 1 week of the visit, it is unclear if they will be able to remember and do this test beyond this time (e.g., 1 month later). Sharing a demonstration video before testing may help refresh their memory to use this app. However, caution needs to be applied and ensured that the patients do not misuse this. It may be better to delete the shared video in WhatsApp after the video has been viewed and the teleconsultation is completed.

Conclusion

This study has demonstrated the feasibility of measuring VA by a caregiver with the Peek Acuity application. Such a measurement is comparable within three lines of in-clinic measurement. It is encouraging that the majority of the patients and their caregivers found the app easy to use. The use of the Peek Acuity app can be expanded to be integrated into telemedicine, where there is a need to measure VA. It will be particularly useful for follow-up visits, such as post-refractive surgical patients, and patients in other subspecialties can also be benefited from this app. Most patients and caregivers remembered the procedure, and some were required to view the demonstration video again to refresh the instructions. Peek Acuity app can be used as a home-vision testing tool by caregivers with proper orientation.

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Conflicts of interest

There are no conflicts of interest.

References

1. Samuels EA, Clark SA, Wunsch C, Jordison Keeler LA, Reddy N, Vanjani R, *et al*. Innovation during COVID-19: Improving addiction treatment access. J Addict Med 2020;14:e8-9.
2. Fatih A, Oktem C. Evaluation of patients presenting to the ophthalmology department of a tertiary hospital for nonemergency reasons during the Covid-19 pandemic. Cesk Slov Oftalmol 2020;76:260-4.
3. Li JO, Liu H, Ting DSJ, Jeon S, Chan RVP, Kim JE, *et al*. Digital technology, tele-medicine and artificial intelligence in ophthalmology: A global perspective. Prog Retin Eye Res 2021;82:100900.
4. Nair AG, Gandhi RA, Natarajan S. Effect of COVID-19 related lockdown on ophthalmic practice and patient care in India: Results of a survey. Indian J Ophthalmol 2020;68:725-30.
5. Pandey N, Srivastava RM, Kumar G, Katiyar V, Agrawal S. Teleconsultation at a tertiary care government medical university during COVID-19 Lockdown in India-A pilot study. Indian J Ophthalmol 2020;68:1381-4.
6. Sehgal S, Bhattacharya B, Datta S, Satgunam PN. Public willingness for accessing teleconsultation services for eye care. Indian J Ophthalmol 2021;69:3772-3.
7. Satgunam P, Thakur M, Sachdeva V, Reddy S, Rani PK. Validation of visual acuity applications for teleophthalmology during COVID-19. Indian J Ophthalmol 2021;69:385-90.
8. Steren BJ, Young B, Chow J. Visual acuity testing for telehealth using mobile applications. JAMA Ophthalmol 2021;139:344-7.
9. Perera C, Chakrabarti R, Islam FM, Crowston J.The eye phone study: Reliability and accuracy of assessing Snellen visual acuity using smartphone technology. Eye (Lond) 2015;29:888-94.
10. Bastawrous A. mHealth possibilities in a changing world. Distribution of global cell phone subscriptions. J Mobile Technol Med 2013;2:22-5.
11. Morjaria P, Bastawrous A, Murthy GVS, Evans J, Gilbert C. Effectiveness of a novel mobile health education intervention (Peek) on spectacle wear among children in India: Study protocol for a randomized controlled trial. Trials 2017;18:168.
12. Brady CJ, Eghrari AO, Labrique AB. Smartphone-based visual acuity measurement for screening and clinical assessment. JAMA 2015;314:2682-3.
13. Bastawrous A, Rono HK, Livingstone IAT, Weiss HA, Jordan S, Kupe H, *et al*. Development and validation of a smartphone-based visual acuity test (peek acuity) for clinical practice and community-based fieldwork. JAMA Ophthalmol 2015;133:930-7.
14. Kawamoto K, Stanojcic NN, Li J-PO, Thomas PBM. Visual acuity apps for rapid integration in teleconsultation services in all resource settings: A review. Asia Pac J Ophthalmol (Phila) 2021;10:350-4.
15. Peek Acuity. Uses and Limitations for Remote Healthcare. 2021. Available from: https://peekvision.org/assets/Documents/July2021_PeekAcuity_remote_healthcare.pdf. [Last Accessed on: 2022 Feb 20].
16. Painter S, Ramm L, Wadlow L, O'Connor M, Sond B. Parental home vision testing of children during Covid-19 pandemic. Br Ir Orthopt J 2021;17:13-9.
17. Andersen T, Jeremiah M, Thamane K, Littman-Quinn R, Dikai Z, Kovarik C. Implementing a school vision screening program in Botswana using smartphone technology. Telemed J E Health 2020;26:255-8.
18. Rono HK, Bastawrous A, Macleod D, Wanjala E, Di Tanna GL, Weiss HA, *et al*. Smartphone-based screening for visual impairment in Kenyan school children: A cluster randomised controlled trial. Lancet Glob Health 2018;6:e924-32.
19. de Venecia B, Bradfield Y, Trane RM, Bareiro A, Scalamogna M. Validation of peek Acuity application in pediatric screening programs in Paraguay. Int J Ophthalmol 2018;11:1384-9.