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Research Article



# The Validation of Tele-ophthalmology testing in Saudi Arabia using mobile phone Application

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## Abstract

Tele-ophthalmology is a branch of telemedicine that delivers eye care through digital medical equipment and telecommunications technology. There are various forms of teleophthalmology. Smartphones and tablets currently considered a method of diagnosis and sources of ocular information.

**Aims:** to compare visual acuity as measured by the Ocular Check application and visual field as assessed by the MRF macular lite application with our ophthalmology clinical examination protocols.

**Methods and Materials:** A total of 50 subject's aged 17-27 years old with no ocular health problem were recruited from King Saud University Campus in Riyadh. Full case history was collected from all subjects followed by online examination for visual acuity using the Ocular Check vision app and visual field by the MRF Macular lite app. Moreover, all subjects underwent full ophthalmological clinical examination including the visual acuity using Snellen chart and visual field using static octopus 900. Then a Comparison between the results of online and clinical testing was performed.

**Results:** Measurements revealed significant differences in visual field with no statistically significant difference in mean visual acuity between online and clinical methods of measurement. Furthermore, clinical methods outperform online measurements in terms of mean deviation, false negative, test time, and visual acuity, but online measurements registered higher false positive values

**Conclusion:** teleophthalmology has high rate of testability and provides promising way of testing however it cannot replace clinical examinations. Nevertheless, further studies are needed to evaluate the long-term effect of applying this technology.

**Keywords:** Teleophthalmology; Visual acuity; Visual field; Validation; Saudi arabia

## Introduction

Teleophthalmology is a branch of telemedicine that delivers eye care through digital medical equipment and telecommunications technology [1,2]. In 1891 Gerloff documented the first tiny photographic image of the retina and optic nerve-head using a modified eye-bath and a paraffin lamp [3]. Since then, the development has been significant, and the technology has become a routine diagnostic and documenting tool [3,4] There are various forms of teleophthalmology that aim to treat patients with different ocular diseases everywhere. Smart phones and tablets are currently major sources of ocular information [5]. Typically, patients can walk in for a consultation at a clinic and may be referred to hospital care when it is deemed necessary to follow-up with more specialized care. However, due to the shortage or unavailability of ophthalmologists in the primary clinics, nearly all patients with eye-related medical conditions are referred to the hospital [6].The developing technology allows the doctor to

consult the patient remotely to reduce unnecessary referrals and travel cost [7,8] Furthermore , teleophthalmology permits access to eye specialists for patients in remote areas, for ophthalmic disease screening, diagnosis, and monitoring; as well as distant learning [9]. It is gaining importance as an effective eye care method; also it has progressed from a research method to a clinical tool [10].

Telemedicine and teleophthalmology have been in existence for many years but have recently grown and gained more importance in the present scenario of pandemic COVID-19 [11,12]. The attitude and perception of the doctors and patients have been changing gradually. In the present situation, teleophthalmology allow patients to seek consultation while protecting them from infection [13,14]. There are many barriers faced the patients and doctors that have restricted the use of this technology in the past. However, with a systematic approach to find the best suited technology, these barriers can be overcome and use of friendly platforms can be created. Furthermore, there is increased demand of teleconsultation during this pandemic [15,16].

## Subjects and Methods

An observational prospective cohort study included 50 subjects aged between 17-27 years, best visual acuity (VA) ≥ 6/12 with no chronic ocular diseases and no prior ocular surgery. Subjects were recruited from King Saud University, Riyadh city, KSA in the period from June to November 2021. This study was approved by the ethics committee of deanship of scientific research at King Saud University. The protocol of the study was explained to each participant at the time of recruitment and informed consent was obtained according to the Declaration of Helsinki. The examination is categorized into an online examination and clinical examination. Both test the VA and visual field (VF), in addition to collecting the case history.

### Online examination

**Visual acuity test:** The application used for measuring VA is Ocular Check: Acuity Exam. - The Assessment test is done monocularly and in a well-lit room. The test can be done with and without glasses or contact lenses, and then the instructions are shown at screen. Subjects choose the type of optptypes which is Snellen chart and the number of attempts is chosen. - The screen was placed 10 feet from the subject. Then the subject read the letters; results were recorded by tapping in all correct option or the number of incorrect readings if otherwise. Finally, the screen shows the result and was sent to the doctor.

**Visual field test:** The test uses MRF Macular Lite application. The participants begin by singing up and applying their name and age using their email. The test is done monocular with correction. The device is placed at 33cm (13 inch). There are Three types of tests to perform: First VA test, The participant touches the shape that match the shape in center of screen, there are different targets with varying contrast. Second Amsler grid, while the participants focus on center, unclear or distortion on grid lines are marked. Third static automated perimetry, a dot of flashes of varying size and brightness are projected within the screen. The participant is instructed to look at the center of the screen and tap the screen whenever a light is seen in peripheral vision. After the three tests are completed, the participants touch the screen to view the result. The result can be saved, shared, printed and analyzed.

### Clinical examination

**Visual acuity test:** The test start with visual acuity. Mainly using the E chart. The test performed in good naturally illuminated room. The participant placed at a distance of 6 meters from the chart, sitting. One eye was tested at a time while the other eye was occluded. Then the participants were requested to read. After testing without any correction, the participant was tested wearing his correction and result was recorded.

**Visual field test:** Octopus 900 perimeter was used to measure the VF. The patient name, identification number and prescription were entered before starting the test. Each eye was tested separately and took about 10 minutes for a threshold test. The participant was asked to sit comfortably on the perimeter with chin resting firmly on the chin rest and the head placed against the headrest. The pupil must be aligned with the cross displayed on the video monitor. This helps in monitoring the fixation and the position of the rests can be altered to ensure the correct centration. The eye not being examined was occluded and appropriate corrective lens was placed in front of the eye being examined. Participant was fixated at the fixation target (four green light in the center) throughout the test. Straight ahead in the middle. The light stimuli would be projected in central and peripheral bowl. The response button was given to the participant and was told to press it in response to every visible stimulus. All projected stimuli will not be visible, and the stimulus can vary in brightness from very bright to very dim. All visible stimuli however dim should be reported. In case of fatigue the participant can halt the test by pressing the trigger continuously or informing the examiner. The occluded eye is to be kept open under the occluder and blinking should not be inhibited. Result then appear on the screen.

Data were analyzed using Statistical Package for Social Sciences (SPSS) software (version 17; SPSS, Inc., Chicago, IL, USA). Data were tested for normality and paired t test were utilized to compare online and clinical VA and VF parameters. To assess agreement between measures of VA and VF, intraclass correlations with 95% confidence intervals was computed.

## Results

A total of 50 subjects (99 eyes- one eye was excluded as its clinical visual field test time was 45minutes), recruited from ophthalmology clinic of college of applied medical science, after validating the inclusion criteria; The participants' ages ranged between (18 - 24) years old, where about 68.0% of participants aged between (20-22)

years with a mean age of 20.9±1.568 years, and VA ≥ 6/12 at time of data collection. The mean spherical equivalent for participants were 1.846 D whereas the minimum values reported are -6.75 D and maximum values are 3.75 D. The visual acuity measurements as shown in Table 1 were converted to Log MAR unit and showed that the clinical VA mean score is (0.049 D) higher compared to online measurement (0.033 D). Table 2 showed that there was a significant moderate positive correlation found between VA-Online and VA-Clinical with r (100) = .475, P<.001. Moreover, significant correlation found in visual field parameters between online and clinical measurements at (α=.05). With significant weak positive correlation found between FN-Online and FN-Clinical with r (100) = .205, P =.04. On the other hand, according to data analysis results showed that there was no significant correlation found in mean deviation variable between Online and Clinical measurement methods with, P =.151 >.05 (Tables 1 & 2).

**Table 1:** Descriptive statistics for visual acuity variables (N=99).

| Variable Code | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|
| VA-Online | 0 | 1 | 0.033 | 0.129 |
| VA-Clinical | 0 | 0.7 | 0.049 | 0.122 |

**Note:** VA: visual acuity. Measurements are in LogMAR unite.

**Table 2:** Paired T test results for the parameters measured in the study.

| Pairs[a] | | Mean Difference[b] | Test Statistic (T) | P-value | Pearson's Correlation (r) | P-value |
|---|---|---|---|---|---|---|
| VA-Online | VA-Clinical | -0.016 | -1.245 | .216 | .151 | .475 |
| MD-Online | MD-Clinical | -3.775 | -12.873 | <.001 | .010 | -.145 |
| FP-Online | FP-Clinical | 0.067 | 4.358 | <.001 | .040 | .256 |
| FN-Online | FN-Clinical | -0.067 | -5.078 | <.001 | .946 | .205 |
| TT-Online | TT-Clinical | -456.838 | -14.844 | <.001 | <.001 | .007 |

Note: a. VA: visual acuity (LogMAR), MD: mean deviation (dB), FP: False positive (%), FN: false negative (%), TT: test time (m). b. Test time converted into seconds for mean scores calculations.

**Table 3:** Descriptive statistics for visual field variables (N=99).

| Variable Code | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|
| MD-Online | -6.70 | 0.60 | -0.193 | 1.208 |
| MD-Clinical | -2.20 | 10.20 | 3.582 | 2.503 |
| FP-Online | 0.00 | 0.63 | 0.106 | 0.152 |
| FP-Clinical | 0.00 | 0.50 | 0.039 | 0.082 |
| FN-Online | 0.00 | 0.63 | 0.034 | 0.100 |
| FN-Clinical | 0.00 | 0.50 | 0.100 | 0.107 |
| TT-Online | 1.14m | 4.44m | 1.43m | 0.50m |
| TT-Clinical | 5.20m | 45.47m | 9.20m | 5.40m |

Note: m: minutes, MD: mean deviation (dB), FP: False positive (%), FN: false negative (%), TT: test time (m).

Table 2 summarizes the results of Paired T-test for measurements of interest at (α=.05), it is clear that there were significant differences in mean scores of mean deviations, false positive, false negative, and test time between online and clinical methods of measurement. There were no significant difference found in visual acuity mean scores between online and clinical methods of measurement at (α=.05) with T (99) = -1.245, P =.216. Furthermore, a significant difference found between MD-Online and MD-Clinical with T (99) = - 12.873, P<.001 and mean difference of -3.775 significant for clinical method at (α=.05). In addition, a significant difference found between FP-Online and FP-Clinical with T (99) =4.358, P<.001 and mean difference of 0.067 significant for online method at (α=.05) (Table 2).

The result in Table 3 demonstrates descriptive statistics for the online and clinical visual field variables as It showed the online test time mean scores 1.39m ±0.50m is shorter compared to the clinical test time mean scores with 9.20m ±5.40m. Mean deviation showed that the clinical MD mean score was higher compared to online measurement, where the mean score of MD clinical was 3.582 dB compared to MD online with -0.193dB. It was remarkable to mention that the mean scores for online mean deviation measurements had negative signs. In addition, the online false positive mean score was

higher compared to clinical measurements, where the mean score of FP clinical was 0.039% compared to FP online with 0.106%. The clinical false negative mean score was higher compared to online measurements, where the mean score of FN clinical was 0.100% compared to FN online with 0.034%. In summary, measurements reported no significant difference found in visual acuity (VA) mean scores between online and clinical methods of measurement at (α=.05). In addition, the clinical methods were higher in case of MD, FN, TT and VA compared with online values, but online measurements reported for FP were higher compared to clinical values. Also, a significant difference found in mean scores of mean deviations, false positive, false negative, and test time between online and clinical methods of measurement at (α=.05). Significant correlations found in VA, FP and FN variables between online and clinical methods, while no significant correlations found in MD and TT variables between online and clinical methods.

## Discussion

With the recent rise of teleophthalmology due to corona virus diseases, we are in a need of accurate and reliable methods of checking VA and VF remotely. This research found that visual acuity did not significantly agree between the online and clinical methods. Significant differences found in mean scores of mean deviation (MD), false positive (FP), false negative (FN), and test time (TT) between online and clinical methods of measurement. Moreover significant correlations found in VA, FP and FN variables between online and clinical methods, while no significant correlations found in MD and TT variables between online and clinical methods. Fay et al. [17] conducted a study on 53 participants mainly children revealed modest agreement between the online measurement and the clinical. Which is in agreement with our findings. Moreover, in line with other studies the visual field finding revealed a significant difference found in visual field parameters between online and clinical measurements in mean deviations, false positive, false negative, and test time. Kumar & Thulasidas [18] reported significant reduction of the mean deviation and acceptable false positive and false negative rates. Similar pattern of result was also obtained in a study by Prince, and Chia [19,20] despite the limitations of the English language barrier and the nature of the participant of healthy young individuals in this study. However, Teleophthalmology show a promising way of providing health care.

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## Conflict of Interest

No conflict of interest.

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