**Objectives:** (1) To assess the inter-session variability of refraction measured using a smartphone-based autorefractor, VisionCheck (VC, Eyeque, California). (2) To characterize the distribution of measurement errors in refraction using VC. (3) To evaluate user perception of VC.

**Methods:**

Participants

Scholars enrolled in the Southwest Eye Institute’s first virtual Eye and Vision Summer School 2020 will be recruited as participants by posting an open invitation on the school’s online discussion forum. Inclusion criteria include spherical power ranging from -10.00DS to +8.00DS, cylindrical power ≤ 5.00DC and accessibility to a smartphone that runs on Android 5.0.x or iOS 10.0, or above, with a pixel density ≥ 250 pixel/inch. No specific attempt will be made to exclude prospective participants with any underlying health and ocular conditions from the study. The present study will adhere to the principles of open science by hosting the data on an open access repository, GitHub, under the GNU General Public License v3.0. Written informed consent will be obtained from every participant.

Data Collection

A VC device and precise instructions will be sent to each eligible participant by post. Briefly, the participants will be asked to use the device as per the manufacturer’s operations manual. One set of readings (i.e. sphere, cylinder and axis) will be taken on each eye after an initial practice session. The participants will then be asked to repeat the measurement, once every day, for the next 9 days. The order of measurements will be randomized between both eyes. To ensure compliance, every participant will receive daily electronic reminders until day 10. The primary outcome measure will be the autorefractor readings in dioptres, while the secondary outcome measures are the proportion of participants with successful acquisition of measurements, measurement time and user perception of the device in terms of their confidence in the measurements as well as its ease of use — assessed quantitatively using a five-point Likert scale and qualitatively using a set of open-text questions (see appendix).

Data Analysis

All refraction data points will be considered for data analysis. To address the statistical conundrum surrounding astigmatism in its conventional polar form, the sphero-cylindrical prescription (i.e. sphere / cylinder Χ axis) generated by the VC device will be transformed into power vector coordinates — M (the spherical equivalent), J0 (the vertical Jackson Cross Cylinder) and J45 (the oblique Jackson Cross Cylinder).The coefficient of variation (CV), coefficient of repeatability (CR) and the effect size of the individual power vector components will be calculated to assess the inter-session variability of refraction. In addition, Bland-Altman plots will be created with 95% limits of agreement to describe the magnitude of variability between every two unique between-session measurements. Finally, the distribution of measurement errors in spherical refraction in each of the nine measurement meridians will also be characterized in every participant.

**Significance:** It is known that > 50% of visual impairments worldwide are due to uncorrected refractive errors, mainly in regions with poor access to primary eye care services. In this regard, a number of relatively low-cost, smartphone-based autorefractors have been made available in recent years, including VC. However, the repeatability and accuracy of VC remain unknown. It is not inconceivable that a device of the sort with good repeatability and accuracy can potentially be used as a low-cost means to reduce the number of uncorrected refractive errors among the underserved populations.

**Ethics:** Many countries have statutory regulations around eye examinations, including what constitutes a comprehensive eye examination. While it seems obvious to those with ophthalmic background, others may mistake refraction by VC for a comprehensive eye examination. Therefore, every participant will be advised that the VC test is not a substitution for their routine eye examination.

**Appendix**

**Pre-measurement questionnaire**

1. **Do you have any experience using a home-based vision-testing device?** *NB proceed to question 2 if you have selected a, b or c.*
2. *Yes*
3. *No, but I have heard of one before*
4. *No, but I have seen someone using one before*
5. *Not at all*
6. *Optional comment:*
7. **What was/were the name(s) of the device(s)?**
8. **The device(s) was/were used to measure (select all that apply)**
9. *The power of the spectacles I might need to see clearly, i.e. spectacle prescription*
10. *My vision with or without spectacles/ contact lenses*
11. *Others (please specify)*
12. **I was confident in the results generated by the device(s)** *NB if more than one device, please indicate and respond for each device*
13. *Strongly agree*
14. *Agree*
15. *Neither agree nor disagree*
16. *Disagree*
17. *Strongly disagree*
18. *Optional comment:*
19. **I found the device(s) useful** *NB if more than one device, please indicate and respond for each device*
20. *Strongly agree*
21. *Agree*
22. *Neither agree nor disagree*
23. *Disagree*
24. *Strongly disagree*
25. *Optional comment:*

**Post-measurement Questionnaire**

1. **I found the device easy to learn**
2. *Strongly agree*
3. *Agree*
4. *Neither agree nor disagree*
5. *Disagree*
6. *Strongly disagree*
7. *Optional comment:*
8. **I found the device easy to use**
9. *Strongly agree*
10. *Agree*
11. *Neither agree nor disagree*
12. *Disagree*
13. *Strongly disagree*
14. *Optional comment:*
15. **I am confident that the device generated my spectacle prescription with a level of accuracy that would be comparable to that established by a qualified eye care professional, e.g. optometrist, ophthalmologist**
16. *Strongly agree*
17. *Agree*
18. *Neither agree nor disagree*
19. *Disagree*
20. *Strongly disagree*
21. *Optional comment:*
22. **Even if the spectacle prescription generated by the device was not as accurate as that measured by a qualified eye care professional, I think the difference would be negligible and unimportant.**
23. *Strongly agree*
24. *Agree*
25. *Neither agree nor disagree*
26. *Disagree*
27. *Strongly disagree*
28. *Optional comment:*
29. **I would rather visit my optometrist than to use the device alone to get my spectacle prescription**
30. *Strongly agree*
31. *Agree*
32. *Neither agree nor disagree*
33. *Disagree*
34. *Strongly disagree*
35. *Optional comment:*
36. **The device was rather difficult to learn**
37. *Strongly agree*
38. *Agree*
39. *Neither agree nor disagree*
40. *Disagree*
41. *Strongly disagree*
42. *Optional comment:*
43. **The device was rather difficult to use**
44. *Strongly agree*
45. *Agree*
46. *Neither agree nor disagree*
47. *Disagree*
48. *Strongly disagree*
49. *Optional comment:*
50. **I do not think my spectacle prescription generated by the device would be as accurate as that determined by a qualified eye care professional**
51. *Strongly agree*
52. *Agree*
53. *Neither agree nor disagree*
54. *Disagree*
55. *Strongly disagree*
56. *Optional comment:*
57. **Any difference in the spectacle prescription between that generated by the device and that determined by an eye care professional would be unacceptable**
58. *Strongly agree*
59. *Agree*
60. *Neither agree nor disagree*
61. *Disagree*
62. *Strongly disagree*
63. *Optional comment:*
64. **Given the choice to visit an optometrist, I would not be willing to use the device alone to get my spectacle prescription**
65. *Strongly agree*
66. *Agree*
67. *Neither agree nor disagree*
68. *Disagree*
69. *Strongly disagree*
70. *Optional comment:*
71. **What are your views on the use of the device (or one of similar type) as a vision-testing tool?**
72. **What are the greatest obstacles to the use of home-based vision-testing tools among the general public?**
73. **What other features (in addition to its current feature of establishing one’s spectacle prescription) would you like to see added to the current device?**