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

**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 after they have read through a participant information sheet.

Data Collection

A PVT 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 so that by the 10th day, each participant will have generated 10 sets of refraction data for each eye. On this note, 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.

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 PVT device will be transformed into power vector coordinates described by Thibos, Wheeler and Horner (1997). According to this convention, refractive error is represented by M (the spherical equivalent), J0 (the vertical Jackson Cross Cylinder) and J45 (the oblique Jackson Cross Cylinder) using the following formulas:

1. *M = S + C/2*
2. *J0 = (-C/2)cosine(2a)*
3. *J45 = (-C/2)sine(2a)*

*Where S = sphere; C = Cylinder; a = axis of the conventional sphero-cylindrical prescription.*

After converting all data to this notation, the coefficient of variation (CV), coefficient of repeatability (CR) and the effect size of the individual power vector components (i.e. M, J0, J45) 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 between-session measurements, e.g. individual means of M, J0, J45 from day 1 readings versus means of M, J0, J45 from day 2 readings. Thus, there will be 9 different plots for each power vector component corresponding to a total of 9 unique between-session comparisons. Furthermore, the distribution of measurement errors of each power vector component will also be characterized in every participant. The measurement error of each power vector component (e.g. M) is defined as the magnitude of deviation from the best estimate of the true value of that component in dioptres (e.g. true value of M), which is the mean of all 10 measurements generated by each individual (e.g. mean of 10 measurements of M). Finally, the overall distribution of measurement errors will also be characterized in every participant by computing the overall error strength (OES) using the following formula:

*Where M’, and are the estimated true values of M’, and , respectively (i.e. mean of all 10 measurements).*

**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 PVT. However, the repeatability and accuracy of PVT 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 PVT for a comprehensive eye examination. Therefore, every participant will be advised that the PVT test is not a substitution for their routine eye examination.