ORIGINAL ARTICLE

An Investigation on the Correlation Between Axial Length Values Obtained Via Lenstar LS900 and Axial Length Estimator

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ABSTRACT

Background: Myopia, commonly known as nearsightedness, is associated with excessive eye elongation, leading to impaired distance vision. Recognizing axial length (AL) as a crucial parameter in managing myopia has prompted this study. The Axial Length Estimator Software (ALE) by CooperVision offers a cost-effective alternative for measuring AL, particularly for optometry centres that cannot afford biometry instruments. However, there is a lack of studies investigating the correlation between AL values acquired through the Lenstar LS900 (Haag-Streit, Bern, Switzerland) and ALE. This study aimed to determine the correlation of AL values between Lenstar LS900 and ALE, investigate any significant differences between the AL values obtained via both methods and explore any gender-related differences in AL values measured by each method. **Methods:** In this cross-sectional study, the AL of 99 participants (emmetrope and myope) were measured using Lenstar LS900 and compared to AL values obtained from the ALE. Estimating AL using ALE requires obtaining corneal curvature and refractive power values. For this purpose, corneal curvature was measured using the Oculus Keratograph 5M (OK5M, Oculus, Wetzlar, Germany), while refractive power was determined through subjective refraction assessments. **Results:** The AL values obtained via both methods showed a strong positive correlation ($r=0.862$, $p<0.005$). No statistically significant differences in AL between both methods were observed. There were also no statistically significant gender-related differences in the AL values obtained by either method. **Conclusion:** The AL values obtained via both methods exhibited a strong positive correlation with no statistically significant differences. Further validation studies are required to confirm the accuracy of ALE across diverse populations and clinical settings.

Keywords:
myopia, axial length, Lenstar LS900, Axial Length Estimator (ALE)

INTRODUCTION

Myopia has garnered the most extensive research attention among all refractive errors (Young, 2007; Tideman et al., 2018). Approximately one-fifth of the world's population is predicted to become highly myopic by 2050, with myopia affecting half of the world's population (Holden et al., 2016). Due to its widespread occurrence and strong relationship with significant clinical disorders, myopia is a significant public health concern (Cooper & Tkatchenko, 2018; Shinojima et al., 2022; Du et al., 2021), especially when its prevalence is high (Pan et al., 2012).

Myopia is associated with excessive eye elongation, causing images of distant objects to fall in front of the retina, resulting in blurry distance vision (Baird et al., 2020).

The degree of myopia can be divided into low myopia consisting of sphere power that is less than -3 diopters (D), medium myopia which falls between -3D to -6D and high myopia which is more than -6D (Goss et al., 2006). Any degree of myopia can elevate the risk of adverse ocular tissue changes. This risk significantly increases in cases of pathologic myopia. Pathologic myopia can result in irreversible visual impairment or blindness and is associated with sight-threatening conditions such as glaucoma, cataracts, retinal detachment, and macular holes (Bullimore & Brennan, 2019; He et al., 2021; Morgan et al., 2020). High myopia causes the globe to enlarge excessively and gradually, leading to the sclera, choroid, Bruch membrane, retinal pigment epithelium (RPE), and neural retina begin to deteriorate (Young, 2007).

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Axial length (AL) is a key parameter for both myopia and hyperopia (Young, 2007). The AL measures the depth of the eye's anterior chamber, the thickness of the lens, and the depth of the vitreous chamber (Meng et al., 2011; Tanaka et al., 2024). Children who have myopic parents are more likely to be affected and have longer AL compared to children who do not have myopic parents (Kurtz et al., 2007). Furthermore, a substantial proportion of the association between AL and myopia can be attributed to hereditary factors, indicating that AL and myopia may share common genetic determinants (Dirani et al., 2008). Thus, this study focuses on the importance of AL as a vital parameter in managing myopia cases. In contemporary optometry practice, optical partial coherence interferometry and ultrasonic velocity measurement equipment are utilized to measure AL and evaluate patients' degrees of myopia (Meng et al., 2011). There are two methods for doing ultrasound biometry: immersion technique and applanation or the probe contacting the cornea (Sen & Tripathy, 2024). The optical low-coherence reflectometry-based Lenstar LS900 (Haag-Streit, Bern, Switzerland) provides an accurate, fast, and easy measurement of ocular variables such as the AL (Jasvinder et al., 2011).

A study by Wang and Chang (2013) investigated the predictability of intraocular lens (IOL) power calculations using the IOLMaster and alternative IOL power calculation formulas in eyes with variable ALs. The study found that both methods were comparable, suggesting the use of alternative formulas in Taiwanese healthcare facilities lacking IOLMaster. However, Wang and Chang (2013) study was conducted on a Chinese population in Taiwan. Thus, the results may not apply to the Malay population in Malaysia due to different eye features.

To date, we were not aware of any study that has attempted to investigate the correlation between AL values acquired via Lenstar LS900 (Haag-Streit, Bern, Switzerland) and Axial Length Estimator (ALE) developed by CooperVision. This is a limitation as it is unclear whether ALE's calculation method can be efficiently and accurately used for the Malaysian population, particularly in monitoring the AL.

Thus, the primary purpose of this study was to investigate the correlation between AL values obtained using an optical biometer (Lenstar LS900) and the calculation method (ALE).

MATERIALS AND METHODS

Study Design

This study adhered to the Declaration of Helsinki's principles on human research. Ethical approval was granted by the IIUM Research Ethics Committee (IREC 2023-KAHS/DOVS3). As proposed by Kang (2021), the G*Power software was used to determine the sample size for this study. This cross-sectional study recruited 99 participants from IIUM Kuantan students (25 males, 74 females) aged 20 to 23, with spherical refractive errors ranging from plano to -8.50D and cylindrical power less than -2.00DC.

The inclusion criteria for this study comprised students from the International Islamic University Malaysia, Kuantan, aged 19 to 25 years, who were generally healthy and free from any diseases. Participants were also not taking any medications or drugs, had never undergone refractive surgery, and had a spherical refractive power ranging from plano to -9.00D with a cylindrical power of less than -2.00DC.

Data Collection

All 99 participants were informed about the study and provided written consent before participation. They were then asked a series of questions to gather background information and ensure they met the inclusion criteria. Objective refraction using dry retinoscopy and subjective refraction was performed on participants to obtain their refractive error and back vertex distance was also measured. The participants' corneal radius of curvature was measured three times using the Oculus Keratograph 5M (OK5M, Oculus, Wetzlar, Germany), and the AL was measured five times using Lenstar LS900. The refractive power, corneal radius of curvature, and back vertex distance were entered into the ALE software to calculate the estimated AL values (ALE). The AL values produced by ALE were then used for statistical analysis.

Statistical Analysis

Data were analysed using the Statistical Package for Social Science Software (SPSS) version 20 for Windows (SPSS, Inc., Chicago, IL, USA). Initial analysis using the Shapiro-Wilk normality test confirmed that all our data was normally distributed and thus, parametric tests were used for subsequent analysis. The Pearson correlation coefficient assessed the correlation between AL values obtained via Lenstar LS900 and ALE. Paired t-tests were used to investigate differences in AL between the methods. Independent t-tests were further employed to examine gender-related differences in AL obtained via each method.

RESULTS

Table 1 provides the mean and standard deviation (SD) values of key parameters assessed in the study, both for the total sample (n = 99) and separately by gender (female: n = 74; male: n = 25). The mean degree of myopia, represented by the spherical equivalent (D), was found to be -1.94±2.010 D across the total population. Females exhibited slightly higher levels of myopia (-2.04±1.986 D) compared to males (-1.64±2.089 D). However, the differences in the degree of myopia between genders were not subjected to statistical significance testing in this study.

The AL measurements, taken with the Lenstar LS900, indicated a mean of 24.076±1.097 mm for the total group, with a marginally longer mean AL observed in females (24.119±1.054 mm) compared to males (23.949±1.232 mm). Measurements from the ALE yielded a slightly higher mean AL (24.151±0.934 mm) than the Lenstar LS900, with females at 24.179±0.943 mm and males at 24.071±0.918 mm. These results suggest minor variations in myopia severity and AL based on gender, although not confirmed statistically.

Table 1: Mean and standard deviation (SD) of the investigated parameters for the total population and by gender.

Parameters	**Mean±SD**		
	Total (n = 99)	Female (n = 74)	Male (n = 25)
Degree of Myopia, Spherical Equivalent (D)	-1.94±2.010	-2.04±1.986	-1.64±2.089
Axial Length, Lenstar LS900 (mm)	24.076±1.097	24.119±1.054	23.949±1.232
Axial Length, ALE (mm)	24.151±0.934	24.179±0.943	24.071±0.918

Correlation Between AL Obtained via Lenstar LS900 and ALE

The bivariate Pearson's correlation established a strong, statistically significant positive linear relationship between AL values obtained via Lenstar LS900 and ALE, r(98) = 0.862, p < 0.005 (Figure 1).

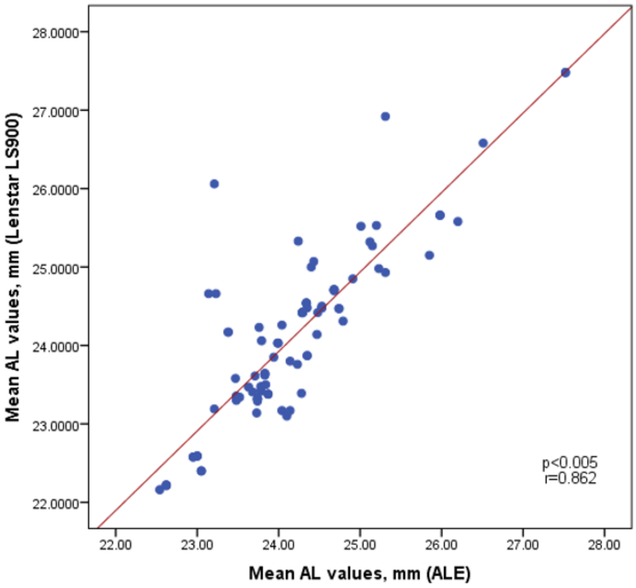

Figure 1: Scatter plot showing the correlation between AL values (mm) obtained via Lenstar LS900 and ALE.

Difference Between AL Obtained via Lenstar LS900 and ALE

The paired samples t-test found no statistically significant difference between AL values obtained via Lenstar LS900 and ALE (24.076±1.097 mm vs. 24.151±0.934 mm), t (98) = 1.339, p = 0.184.

Gender-Related Differences in AL Obtained via Lenstar LS900

There was homogeneity of variances for AL values obtained via Lenstar LS900 for males and females, as assessed by Levene's test for equality of variance. The results from the independent t-test revealed that the mean AL value obtained from Lenstar LS900 between females and males was not statistically significant (24.119±1.054 mm vs. 23.949±1.232 mm), t (98) = 0.667, p = 0.506.

Gender-Related Differences in AL Obtained via ALE

Similarly, there was also a homogeneity of variances for AL values obtained via ALE for males and females, as assessed by Levene's test for equality of variance. Independent t-test results revealed no statistically significant difference in mean AL values obtained from ALE between females and males (24.179±0.943 mm and 24.071±0.918 mm), $t(97) = 0.497$, $p = 0.620$.

DISCUSSION

When it is not feasible to measure the AL of the eye using biometry equipment, optometrists may find it beneficial to estimate the AL of the eye using mathematical formulae to better monitor the progression of myopia. The estimation involves incorporating refractive error, vertex distance, and the corneal radius of curvature, which are all easily obtained during a clinical visit. The ALE formulae proposed by Professor Philip Morgan were used to calculate AL, considering the spherical refractive power and corneal radius of curvature (Morgan et al., 2020). Previous research by Ojaimi et al. (2005) and AlMahmoud et al. (2011) have shown that refractive error, corneal radius of curvature, and AL are highly correlated, validating the parameters used in this current study's estimation method.

A study by Queirós et al. (2022) found a strong ($r > 0.750$) correlation between the estimated and measured AL values, with no statistically significant differences between the two. Kim et al. (2019) also found a statistically significant correlation between the measured and calculated AL in which $r = 0.871$ for the emmetropic group, $r = 0.904$ for the hyperopic group, $r = 0.955$ for the myopic group, and $r = 0.967$ overall. These findings are consistent with our results, which show a strong, statistically significant positive correlation between AL values obtained via Lenstar LS900 and ALE, with no statistically significant differences between the two methods.

Gender-related differences in AL have been previously reported. Roy (2015) found no statistically significant differences in AL between genders in the emmetropic group. However, in the myopic group, a significant difference was observed, with males having longer ALs. Similarly, other studies (Lee, 2009; Tang et al., 2020; Diez et al., 2019; Twelker et al., 2009) reported that males generally have longer ALs, larger corneal radius of curvature, and deeper anterior chamber depths compared to females. However, our study found no statistically significant gender-related differences in AL values obtained via Lenstar LS900 and ALE. This discrepancy might be due to the inclusion of both emmetropic and myopic participants in our study, as well as the imbalance in the male-to-female ratio, with a higher proportion of females.

Queirós et al., (2022) stated that although ALE offers an alternative approach to measuring AL, it should not replace objective measurements obtained via optical biometry. The AL values obtained through biometry are considered 'true' measurements, unlike mathematically derived estimates. Nevertheless, the estimation method provided by ALE can be a valuable tool in clinical decision-making for myopia management when true AL measurements are not available.

STUDY LIMITATIONS

The ALE software allowed only a 0.05 mm step when incorporating the corneal radius of curvature value. Consequently, the corneal curvature was rounded to the nearest available number, which might affect the precision of the estimated AL values. Accurate AL measurement has become a critical component in the management of myopia. It is not only essential for regular follow-up appointments to track the progression of the condition but also plays a significant role in the future classification of the risk of visual impairment (Galvis et al., 2022). Ensuring the precision of these measurements is therefore paramount to providing effective and comprehensive care for myopic patients.

Additionally, the sample size of this study was relatively small and limited to the population of IIUM Kuantan. This restriction might influence the generalizability of the study outcomes (Faber & Fonseca, 2014). In addition, the unequal numbers of males and females could have impacted the results of the current study.

RECOMMENDATIONS FOR FUTURE RESEARCH

Future research should include participants from diverse age groups, ensuring a balanced number of males and females. The calculation method used in this study (ALE) does not account for the age of the population; thus, further investigation is needed to determine whether the relationship formula should be adjusted for different age ranges. Additionally, studies are necessary to examine if the same pattern observed in this study is present in paediatric populations.

In future research, incorporating statistical methods such as Bland-Altman analysis, intraclass correlation coefficient, and coefficient of variation will provide a more comprehensive evaluation of the estimation methods.

Exploring other factors that might influence AL estimation, such as anterior chamber depth, lens thickness, and vitreous chamber depth, could also refine the estimation formulas. Further, longitudinal studies tracking the progression of myopia using both measured and estimated AL would be valuable in assessing the long-term reliability and validity of these methods. By addressing these areas, future research can enhance the accuracy and reliability of AL estimation, ultimately improving myopia management and patient care.

CONCLUSION

This study demonstrates that the ALE Software by CooperVision presents a viable alternative to the Lenstar LS900 for measuring AL. This approach provides a quick and cost-effective means of estimating AL, which is particularly beneficial for optometrists engaged in myopia management when access to commercial biometers is limited. For detailed and continuous AL assessment, a commercial biometer is recommended for the most accurate measurements. Further validation studies are essential to confirm the reliability and validity of ALE as a tool for myopia management.

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