

Original Research Article

Corneal curvature in young high myopic undergraduates in southern Nigeria

Juno Ohiremere Okukpon^{1*}, Oluwashola Michael Ojo²

¹Department of Optometry, Faculty of Life Sciences, University of Benin, Benin City, Edo State, Nigeria

²Department of Optometry and Vision Science, Faculty of Life Sciences, University of Ilorin, Ilorin, Kwara State, Nigeria

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*Correspondence:

Dr. Juno Ohiremere Okukpon,

E-mail: juno.okukpon@uniben.edu

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ABSTRACT

Background: Corneal curvature is important for contact lens fitting and management, ocular aberration analysis, corneal refractive surgery as well as diagnoses and management of corneal pathological conditions such as keratoconus and it is also an important biometric factor affecting refractive errors, myopia inclusive.

Methods: This was an observational cross-sectional study conducted at the Optometry Teaching Clinic, Department of Optometry, University of Benin, Benin City, Edo State, Nigeria. Two hundred and twenty myopic eyes of 113 (54 males, 59 females) undergraduates students, between 16 and 25 years with myopia of -5.00 to -20.50 participated in this study. Non-cycloplegic refraction was done by retinoscopic measurement and spherical equivalent refraction (SER) of the eyes was calculated. The corneal curvature was determined with a Bausch and Lomb one position Keratometer (Bausch and Lomb Corp., USA).

Results: The mean age, spherical equivalent, corneal curvature and corneal power were 20.44 ± 2.24 years, -7.12 ± 3.14 DS, 7.72 ± 0.26 mm and 43.77 ± 1.48 D respectively. Most of the students had a myopia of -5.75 to -10.50DS (46.8%) and a corneal curvature of 7.61-7.90mm (46.82%). There was a difference between the corneal curvature of males and females ($P=0.0001$). A relationship was also found with gender and corneal curvature ($P=0.001$).

Conclusions: This study found that high myopic females had shorter corneal curvature, with greater corneal powers than their males counterparts ($P<0.01$). We also found that gender had a significant relationship with the corneal curvature unlike age and the spherical equivalent which showed no relationship ($P>0.01$).

Keywords: Corneal, Corneal curvature, High myopia, Keratometry

INTRODUCTION

Myopia is often regarded as a benign disorder because vision can be corrected with glasses, contact lenses, and refractive surgery, however people with high myopia are at a substantially increased risk of potentially blinding myopic pathologies, which are not prevented by optical correction.¹ Even low levels of myopia are associated with an increased risk of ocular complications such as

retinal detachments, glaucoma and cataract, and progression to higher levels of myopia increases these risks further.²

Myopia is measured by the spherical power in dioptres (D) of the diverging lens needed to focus light onto the retina, which can be expressed as the spherical equivalent (SE) in dioptres sphere (DS) or refraction in the least myopic meridian.³

The causes of myopia are unclear, although evidence supports both genetic and environmental components; it has been associated with socioeconomic status, level and length of education, parental myopia, exposure to near work, level of intelligence and amount of time spent for indoor activities.⁴ Ocular biometrics, in this case corneal curvature are also among the most important factors affecting refractive errors. The participants of the World Health Organisation-Brien Holden Vision Institute's, Joint Scientific meeting on Myopia in Sydney, Australia agreed that a classification of high myopia as $-5.00D$ is the best definition, as a person who has $-5.00D$ uncorrected myopia has a visual acuity of $6/172$, which is much worse than the threshold for blindness ($<3/60$ in the better eye).⁵ The prevalence of refractive errors especially myopia is currently attracting worldwide attention as many recent studies report dramatic increases over the last 20 years.⁶

Anterior corneal curvature expressed in radii (mm) is important for contact lens fitting and management, ocular aberration analysis, corneal refractive surgery as well as diagnoses and management of corneal pathological conditions.⁶ A cornea that is too curved (radii are abnormally small) is found in keratoconus and a cornea that is too flat is found in conditions such as cornea plana, which is a rare bilateral condition associated with severe refractive errors, cataracts and coloboma.⁷ The measurement of the corneal curvature can be done by various instruments, such as a keratometer, keratoscope, IOL Master, or corneal topographer. In clinical practice, both horizontal and vertical anterior corneal curvatures are usually measured.

A number of cross-sectional studies have investigated the correlation between corneal power and myopia in juvenile and young adult myopia, with most studies finding no relationship in any category of myopia.⁷ However, Goss and Erickson found a lack of correlation in juvenile myopia, but a significant correlation in young adult myopia.⁸

Previous studies, have explored the relationship between corneal curvature and gender, they found that corneal curvature varied significantly by gender with females showing a greater mean corneal curvature in both meridians when compared with males.⁹

Although the axial length has been found to be the most important singular, biometric variable affecting final refractive status of individuals, the relationship between corneal curvature and refractive status has been inconsistent.¹⁰ It is not yet clear how the other ocular components such as corneal curvature affect myopia progression and stabilization.¹¹ Limited studies are available that have exclusively evaluated young Nigerian adults especially university students with high myopia. Hence, we studied the corneal curvature in young myopic undergraduates with refractive error between -5.00 and $-20.50 DS$.

METHODS

This was an observational cross-sectional study conducted at the Optometry Teaching Clinic, Department of Optometry, University of Benin, Benin City, Edo State, Nigeria. Two hundred and twenty myopic eyes of 113 (54 males, 59 females) University of Benin undergraduate students, between 16 and 25 years with myopia of -5.00 to -20.50 participated in this study. The subjects were recruited on the basis of inclusion criteria: high myopia and young undergraduates. The procedure was explained thoroughly to each subject and informed consent obtained. The experiment was conducted in accordance with the tenets of the Declaration of Helsinki and Ethical Approval was obtained from the ethical committee of The Department of Optometry, Faculty of Life Sciences, University of Benin. Ocular examinations were carried out to exclude cases with ocular pathology except refractive errors and myopia associated chorioretinal changes. General examination was done on each eye and eyes that did not meet the criteria were excluded. Final refractive error was obtained with subjective refraction after non-cycloplegic objective retinoscopic measurement and spherical equivalent refraction (SER) of the eyes was calculated. The corneal curvature was determined with a Bausch and Lomb one position Keratometer (Bausch and Lomb Corp., USA). The instrument was calibrated by using a stainless-steel ball bearing of $44.75D$ curvature. Measurements were made along the two major meridians. The average of both values represented the mean corneal curvature. All examinations and measurement were carried out by one experienced examiner for each participants.

Data analysis was performed using Chi square which was used to check for relationship between variables and student t-test to determine mean differences between variables as processed by SPSS Version 22.0 (SPSS Inc., Chicago, IL, USA). Statistical significance was set at $P \leq 0.01$.

RESULTS

A total of 113 undergraduates with high myopia were involved in this study, after careful examination 220 eyes (113, 51.4% female and 107, 48.6% males) met the inclusion criteria. Of which female students accounted for 52.2% (59 students) and males 47.8% (54 students). The participants were divided into two groups based on age 15-20 years (124, 56.4% eyes) and 21-25 years (96, 43.6% eyes).

The frequency of students with high myopia after grouping them into four categories of high myopia are given in Table 1 with $\leq -5.50DS$ and -5.75 to $-10.50DS$ having the highest frequency of 46.8% (103 eyes) and 43.2% (95 eyes) respectively, also shown is the grouped corneal power of the participants with majority of the students having a corneal power of 42.01 to $44.00D$ and

44.01 to 46.00D (49.6%, 109 eyes and 33.2%, 73 eyes respectively).

Table 1: Frequency distribution of high myopia and corneal power of the undergraduate students.

	Frequency	Percent (100%)
High myopia (DS)		
< -5.50	95	43.2
-5.75 to -10.50	103	46.8
-10.75 to -15.50	14	6.4
-15.75 to -20.50	8	3.6
Corneal power (D)		
40.01 to 42.00	26	11.8
42.01 to 44.00	109	49.5
44.01 to 46.00	73	33.2
46.01 to 48.00	12	5.5

N=220, (Student t-test)

The difference in mean age, equivalent sphere, corneal curvature and corneal power of undergraduates males and females with high myopia are reported in Table 2, where it can be seen that high myopic females had shorter eyes (corneal curvature), with greater corneal powers than males with high myopia (P<0.01).

Table 2: Mean differences in variables between males and females with high myopia and p-value.

Variables	Males (n=107)	Females (n=113)	P-value
Age (yrs)	20.7±2.075	20.19±2.37	0.094
SE (Ds)	-7.51±3.549	-6.76±2.656	0.079
CC (mm)	7.782±0.287	7.660±0.221	0.0001**
CP (D)	43.428±1.619	44.097±1.264	0.001**

N=220 eyes, *Significant, **Highly significant, P>0.01, SE=Spherical Equivalent, CC=Corneal Curvature, CP= Corneal Power

The minimum, maximum and mean of the age, spherical equivalent, corneal curvature and corneal power of the high myopic undergraduate students that participated in this study are shown in Table 3. The minimum and maximum corneal curvature of all the participants was 7.05mm and 8.43mm respectively with a mean of 7.719±0.262mm.

Table 3: Descriptive statistics of age, spherical equivalent, corneal curvature and corneal power.

Variables	Min.	Max.	Mean ± SD
Age (years)	16	25	20.440±2.239
SE (DS)	-5.00	-20.50	-7.122±3.138
CC (mm)	7.05	8.43	7.719±0.262
CP (D)	40.04	47.88	43.771±1.483

SE=Spherical Equivalent, CC=Corneal Curvature, CP= Corneal Power

The frequency distribution of the corneal curvature in the high myopic undergraduate students is displayed in

Figure 1 with majority of the high myopic eyes of the undergraduates falling within a curvature range of 7.61 to 7.91mm (46.82%, 103 eyes) and 8.21 to 8.51mm (4.55%, 10 eyes) having the least number of students (Figure 1).

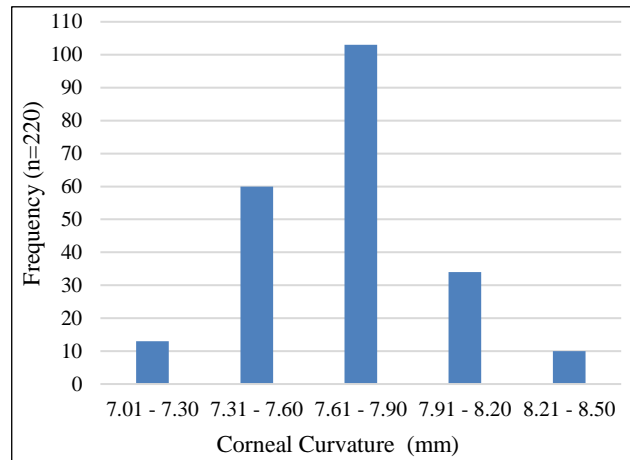


Figure 1: Frequency distribution of corneal curvature in the high myopic undergraduate students.

The Chi square relationship between corneal curvature with sex, age and spherical equivalent of high myopic undergraduates is shown in Table 4, where "results here showed" that corneal curvature has a strong relationship with "gender" (P=0.001) but no relationship was found with age and SE.

Table 4: Pearson Chi square relationship with corneal curvature, sex, age and SE of high myopic undergraduates.

Variables	Corneal Curvature
Gender	0.001 **
Age	0.206
SE	0.775

SE=Spherical equivalent * Significant, ** Highly significant, P>0.01

DISCUSSION

The corneal curvature relates to the shape of the front surface of the cornea and is one of the important measurements used to characterize optical properties of the cornea.⁷ The average corneal curvature and power of young undergraduates students with high myopia in our study was significantly different (P=0.0001) from the normal average value recorded for emmetropes from previous studies, which was about 7.85mm that is in myopes the corneal curvature was found to be relatively decreased.^{1,12,13} We found in our study that female students with high myopia had shorter mean average corneal curvature, similar to Li et al, but females without refractive errors had slightly higher mean average corneal curvature than males in another study.^{13,14} A result similar to a study done by Iyamu and Osuobeni were they found that age and gender did not affect corneal curvature in

emmetropes, however we only found a significant effect with gender on the corneal curvature of the young undergraduates with high myopia.¹³ Our study is also in agreement with a previous study that there was no significant mean differences ($P>0.05$) between the various degrees of high myopia.¹ Although, this study did not find any correlation between spherical equivalent and corneal curvature, some studies revealed that the spherical refractive error has statistically highly significant positive correlation with corneal curvature but other studies reached a similar conclusion that no significant correlation was present between spherical refractive error and corneal curvature.^{6,10,15-17} Several reasons may account for these differences in results from different studies, such as differences in age groups, refractive error ranges, sample size, populations, ethnicities, statistical power of the studies and various methods of measurement of various ocular parameters.⁶

CONCLUSION

This study concluded that females had shorter corneal curvature, with greater corneal powers than males ($P<0.01$), furthermore that the corneal curvature had a strong significant relationship with the gender of the participants ($P=0.001$). The age and spherical equivalent showed no relationship with the corneal curvature ($P>0.05$). We also found that majority of the high myopic eyes of the undergraduates had a corneal curvature of 7.61 to 7.91mm.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee of The Department of Optometry, Faculty of Life Sciences, University of Benin, Edo State, Nigeria

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