

Investigation of the Morphometric Origin of Myopia: The Role of Axial Length and Corneal Curvature

Investigación del Origen Morfométrico de la Miopía: El Papel de la Longitud Axial y la Curvatura Corneal

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SUMMARY: The aim of this study is to investigate the morphometric origins of myopia, specifically focusing on the roles of axial length and corneal curvature in the development of myopia. A retrospective analysis was conducted on individuals aged 7-18 who were newly diagnosed with myopia, with key parameters such as axial length, corneal curvature (K1 and K2), and cylindrical values measured using the MYAH Topcon device. The study found a significant positive correlation between myopia degree, axial length, and astigmatism (CYL). A strong relationship between axial length and the degree of myopia and astigmatism was identified, indicating that axial elongation plays a primary role in the progression of myopia. Additionally, sex differences were observed, with males having flatter corneas. The findings emphasize the importance of evaluating both axial length and corneal curvature in the diagnosis and management of myopia. This research provides valuable insights into the morphometric risk factors of myopia, offering a deeper understanding for personalized treatment strategies and future studies in the field.

KEY WORDS: Axial length; Corneal curvature; Keratometry; Morphometry; Myopia.

INTRODUCTION

Myopia is a refractive vision disorder where light focuses in front of the retina, causing distant objects to appear blurry. It is highly prevalent, with an estimated 4.75 billion people expected to be affected by 2050, which will represent 49.8 % of the global population. Myopia is especially common in East Asia, where 80.0 %–90.0 % of young adults are affected (Zou *et al.*, 2024). The prevalence of myopia is increasing significantly worldwide, becoming a major public health concern. This condition can lead to serious vision loss and eye diseases associated with high myopia, such as myopic macular degeneration and optic neuropathy. High myopia notably increases the risk of blindness, emphasizing the need for early diagnosis and accurate treatment to ensure effective management and prevent further complications (Zuo *et al.*, 2025).

In previous studies, the distribution and correlation of axial length and corneal curvature measurements with age, sex and race have been explored. These studies have provided valuable insights into how these two key parameters vary

across different demographic groups and how they contribute to refractive errors such as vision defects (Cui *et al.*, 2014; Collier Wakefield *et al.*, 2016; Yu *et al.*, 2017; De Bernardo *et al.*, 2020; Zvornicanin *et al.*, 2023; Ganesh & Lin, 2023). However, despite these contributions, there is a significant gap in the literature regarding a direct comparison of the roles of axial length and corneal curvature in the morphometric origins of myopia. While the relationship between these two factors and refractive errors has been widely studied individually, no study to date has specifically addressed whether myopia is more influenced by axial length or corneal curvature. This study aims to fill this gap by investigating the morphometric origins of myopia. Our focus will be on determining whether myopia is more closely associated with axial length or corneal curvature. Given the lack of direct studies on this topic, our research offers an innovative approach to understanding the relative contributions of these two critical parameters. By focusing on newly diagnosed myopic individuals and utilizing the MYAH device, which provides detailed and comprehensive

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morphometric measurements, our study offers a deeper understanding of the underlying causes of myopia. The results of this research may have important implications for the diagnosis and management of myopia, offering new insights into the factors that contribute to its development. Axial length is a critical parameter in evaluating eye health and refractive errors, particularly myopia, hyperopia, and astigmatism. It plays a key role in understanding the optical characteristics of the eye and provides essential data for refractive surgical planning, as well as for ensuring the accuracy of glasses and contact lens prescriptions. The change in axial length by age serves as an important indicator for understanding refractive errors and developmental changes in the eye. The data on this curve provide valuable references for monitoring eye health and making informed interventions when necessary. The primary aim of this study is to explore the morphometric origins of myopia, focusing on the potential relationship between axial length and corneal curvature. Several hypotheses have been proposed to explain the relative contributions of these two parameters to the development of myopia.

Hypothesis 1 posits that the morphometric origin of myopia is more strongly linked to the increase in axial length. This hypothesis suggests that the primary driver of myopia is the elongation of the axial length rather than alterations in corneal curvature. Numerous studies have shown that axial elongation, especially during childhood and adolescence plays a pivotal role in the progression of myopia. As the eye grows longer, it leads to a shift in the focal point, causing blurred distant vision a hallmark of myopia. In contrast, Hypothesis 2 suggests that the development of myopia is more prominently influenced by changes in corneal curvature. According to this hypothesis, alterations in the curvature of the cornea may have a greater impact on refractive error than axial length elongation. Research in this area focuses on how the anterior surface of the cornea, through its shape and steepness, can contribute to the development of myopia, especially when changes in curvature occur over time. Lastly, Hypothesis 3 proposes that myopia development results from the combined interaction of both axial length elongation and changes in corneal curvature. This hypothesis acknowledges that myopia is likely a multifactorial condition, where the interplay between these two factors, rather than the influence of one alone, leads to the manifestation of refractive error. In line with this, given the importance of these morphometric parameters, this study specifically aims to investigate the relationship between axial length, keratometry values (K1 and K2), and cylinder measurements with the degrees of myopia.

Axial length stands out as a parameter directly related to the development and progression of myopia. Various studies have found a strong correlation between the increase

in axial length and unilateral myopic refractive error. For example, one study found that in myopic eyes, the axial length and vitreous cavity length were significantly longer, and the spherical equivalent refractive error was most strongly associated with the axial length and vitreous cavity length (Erdem *et al.*, 2018). Another parameter in our study, K1 (Keratometry 1) value was used to measure the curvature of the flattest meridian of the cornea. K1 provides important information about corneal curvature, making it a key parameter in evaluating astigmatism and other refractive errors. Accurate measurement of K1 is critical for monitoring eye health and planning surgical interventions. K1 refers to the corneal curvature measurement, specifically the curvature of the flattest meridian of the cornea. It is commonly used in keratometry measurements, which assess the shape and curvature of the cornea. K1 provides valuable information about the cornea's shape and curvature, which is crucial in identifying refractive errors such as myopia, hyperopia, and astigmatism. In keratometry, the cornea is examined along different meridians. K1 represents the curvature value of the flattest meridian, while K2 corresponds to the curvature of the steepest meridian. Also, the K2 (Keratometric 2) value was used to measure the curvature of the steepest meridian of the cornea. K2 provides essential information about the shape of the cornea and plays an important role in evaluating astigmatism and other refractive errors. The K2 value reflects the curvature of the steepest part of the cornea and helps us understand optical asymmetry and refractive disorders in the eye. These values are essential for understanding the optical structure of the eye and are used in prescribing eyeglasses or contact lenses. Additionally, they play a vital role in planning for refractive surgeries (Lu *et al.*, 2020; Zhou *et al.*, 2023, 2025). Another key anatomical parameter examined in our study is the cylindrical (CYL) and axial cylindrical degree (axial CYL degree). A cylindrical lens is an optical correction tool used to address astigmatism, which arises from irregular curvature of the cornea or lens, causing light to focus improperly. Cylindrical power (CYL) refers to the degree of astigmatism, while the axial cylindrical degree indicates the axis of astigmatism, representing the direction of light aberrations in the eye. The axial CYL degree provides insight into the specific orientation of the astigmatism, allowing for a more detailed evaluation of refractive errors in the eye. These parameters play a critical role in investigating the morphometric origins of myopia, as the presence and degree of astigmatism, alongside axial length and corneal curvature, contribute to understanding the pathophysiology of refractive errors. Accurate measurement of cylindrical and axial cylindrical degrees is essential not only in understanding the development and prognosis of myopia but also in determining treatment strategies tailored to the individual's unique ocular structure (Xu *et al.*, 2022; Tong *et al.*, 2024; Wang *et al.*, 2024).

By exploring the impact of these parameters, this research seeks to provide a more comprehensive understanding of the morphometric origins of myopia, potentially revealing how the axial length and corneal curvature, individually or interactively, contribute to the development and progression of myopia. Additionally, our study aims to provide significant and novel data to the literature in evaluating the morphometric risk factors for myopia in children, thereby contributing to the understanding in this field.

MATERIAL AND METHOD

The aim of this study was to investigate the morphometric origins of myopia, specifically to explore whether myopia development is primarily associated with axial length or corneal curvature. We focused on individuals who had recently been diagnosed with myopia, recording their morphometric measurements using the most up-to-date and comprehensive MYAH device. This study was designed as a retrospective analysis, where we analyzed the morphometric data of newly diagnosed myopic individuals to better understand the contributing factors behind myopia. By focusing on this cohort, we aimed to clarify the relative contributions of axial elongation and corneal curvature in the development of myopia. This study includes patients aged 7-18 who were diagnosed with myopia at Sevgi Eye Center between January 2023 and December 2024. The study was conducted in accordance with the principles of ethical principles stemming from the Declaration of Helsinki. All patients provided informed written consent prior to study commencement. Written informed consent was provided by the patients to have the case details and any accompanying images published. Ethical approval was obtained from the Çukurova University Faculty of Medicine Non-Interventional Clinical Research Ethics Committee on October 4, 2024 (approval number: 148/9). The aim of the study is to investigate the morphometric origins of myopia.

The inclusion criteria are as follows:

1. First-Time Myopia Diagnosis: Only individuals diagnosed with myopia for the first time were included in the study. Participants had not previously been diagnosed with any other ocular diseases and had not undergone any treatment related to myopia.
2. No Previous Myopia Treatment: Individuals who had not received any myopia treatment (optical correction, glasses, or contact lenses) were included in the study. This ensures that the effects of treatment on the morphometric parameters are excluded from the study.
3. Data Collection and Measurement Process: All measurements in this study were taken using the same

brand and model of equipment (MYAH® Topcon Healthcare Inc., Tokyo, Japan) and were performed by the same ophthalmologist. To ensure consistency, all measurements for each participant were carried out by a single expert.

4. Parental Consent: Written informed consent was obtained from the parents or legal guardians of the participants, allowing the use of their children's visual data and personal information for research purposes. This process was carried out in compliance with institutional ethical guidelines, and the necessary ethical approvals were obtained.

5. Additional Inclusion Criteria: Only individuals diagnosed with myopia and those who were eligible for morphometric measurements (such as axial length and corneal curvature) were included. Individuals with other ocular conditions (such as glaucoma, cataracts, retinal diseases, etc.) or those requiring treatment for other visual impairments were excluded from the study.

Anatomic Measurements

Axial length: In our study, axial length was measured as the distance between the anterior and posterior surfaces of the eye globe. Figure 1 presents the age-related axial length distribution curve, with measurements recorded for both the right and left eyes. Axial length measurements were systematically obtained to assess the visual and optical differences between the two eyes.

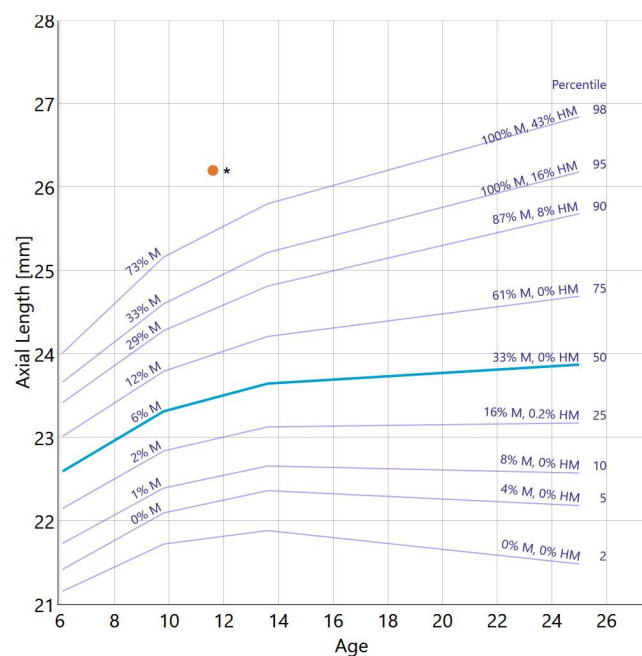


Fig. 1. Axial length curve by age (measurement result of the individual represented by*).

Keratometry 1 (K1): K1 refers to the corneal curvature measurement, specifically the curvature of the flattest meridian of the cornea. It is commonly used in keratometry measurements, which assess the shape and curvature of the cornea. In Figure 2, the K1 values for both the right and left eyes are mapped. These maps visually represent the K1 values obtained by measuring the curvature of the cornea's flattest meridian. K1 is measured using keratometry devices, which analyze the light reflection from different meridians of the cornea to calculate its curvature. Differences in K1 values between the right and left eyes help us better understand the optical asymmetry and refractive disorders of the eye.

Keratometry 1 degree (K1 degree): K1 Degree refers to the curvature of the flattest meridian of the cornea and is typically determined through keratometry tests. The K1 value is measured using keratometry devices. These devices analyze the light reflection from different meridians of the cornea and calculate its curvature. Typically, the device measures the curvature of two meridians: the K1 meridian, which is the flattest.

Keratometry 2 (K2): In Figure 2, K2 values for both the right and left eyes are mapped. These maps visually represent the K2 values obtained by measuring the curvature of the steepest meridian of the cornea. K2 is measured using keratometry devices, which analyze the light reflection from different meridians of the cornea and calculate its curvature. Since K2 reflects the curvature of the steepest meridian of the cornea, it plays a critical role in identifying refractive errors such as astigmatism.

Keratometry 2 degree (K2 degree): The K2 degree refers to the curvature of the steepest meridian of the cornea. The K2 degree is measured using keratometry devices. The K2 value reflects the curvature of the steepest meridian, making it a key measurement for detecting optical disorders such as astigmatism.

Cylinder (CYL): CYL refers to the amount of astigmatism in the eye. Astigmatism occurs when the cornea or lens of

the eye has an irregular shape, which results in blurred vision. CYL is used to express the degree of astigmatism and its orientation (Fig. 2). It is measured in diopters, which is the unit of refractive power.

Positive CYL: Indicates that the astigmatism is in the meridian with a larger curvature (usually related to distance vision).

Negative CYL: Indicates that the astigmatism is in the meridian with a smaller curvature (usually related to near vision).

Cylinder degree (CYL degree): The CYL degree indicates how strong the refractive error is (its degree) and in which meridian (direction) it occurs. In the context of eye measurements, the AX (axis) degree refers to the orientation or direction of the astigmatism in the eye. It is expressed in degrees (0° to 180°) and indicates the meridian in which the cylindrical correction is required. AX (axis) is always perpendicular to the CYL (cylinder) value, meaning it describes the orientation of the corneal irregularity where astigmatism occurs. AX helps to determine the direction in which the cylindrical lens correction should be applied to correct the blurry or distorted vision caused by astigmatism.

Measurement Instrument

The MYAH Topcon device used in this study is recognized as a highly reliable and valid tool for astigmatism and other refractive error measurements. The device is an advanced automatic refractometer and corneal topography instrument manufactured by Topcon Corporation. MYAH Topcon accurately measures eye morphometric parameters, astigmatism analysis, corneal curvature, and tear film break-up time, and it is widely used in clinical settings.

Validity: The measurement results obtained from the MYAH Topcon device have been validated through various clinical and scientific studies. The device's ability to measure astigmatism and corneal topography parameters accurately has been confirmed through comparisons with gold standard

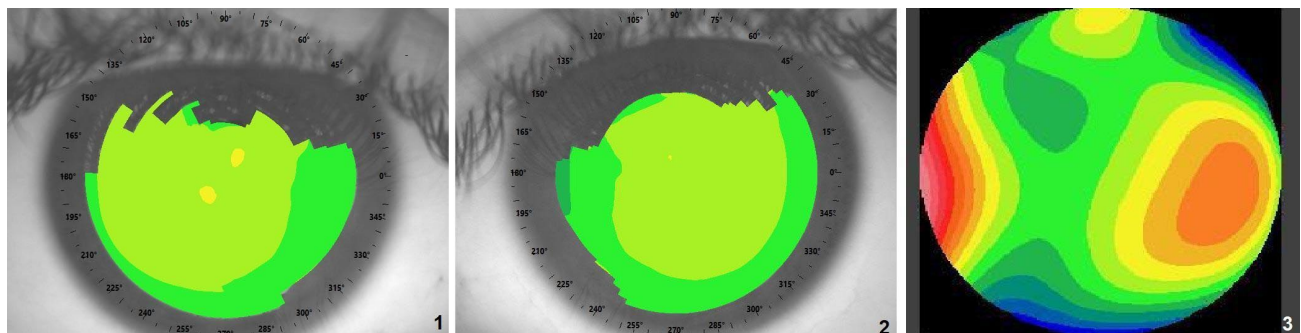


Fig. 2. Ocular pathway diagnosis mapping. 1.Oculus dexter; 2. Oculus sinister; 3. Total aberration.

tests. Validation studies have shown that the device provides accurate and reliable data.

Reliability: The MYAH Topcon device is known for its high repeatability and low error rate. The device provides consistent results when measurements are taken multiple times under the same conditions. The results are reliable and unaffected by user or environmental factors. Reliability tests have shown that the device yields stable results across different time periods and conditions.

Currency: MYAH Topcon continuously adapts to technological innovations and keeps both its hardware and software up to date. The software is periodically updated based on user feedback and scientific advancements, allowing the device to provide more efficient and precise measurements.

Scope: The MYAH Topcon device offers a wide range of measurements, including astigmatism, corneal curvature, visual acuity, and optical refraction, as well as corneal topography and tear break-up time. The device is suitable for both eyeglass prescriptions and contact lens applications, providing a comprehensive assessment of ocular health.

Statistical Analysis. The SPSS 22 package program was used for statistical analysis, and statistically significant results were considered with $p < 0.05$. Normality tests were conducted using the Kolmogorov-Smirnov test to evaluate the distribution of the data. The results indicated that the parameters AL right ($p = 0.097$), K1 right ($p = 0.200$), K1 left ($p = 0.200$), and CYL left ($p = 0.200$) did not significantly deviate from normal distribution and were found to be normally distributed. Therefore, nonparametric tests (Independent Samples) were applied to these parameters. The remaining parameters showed normal distribution, and parametric tests (Independent Samples t-Test) were applied to them. Continuous variables were summarized by mean and standard deviations along with minimum- maximum values where relevant. Additionally, Boxplot and Simple Scatter plots were utilized for data visualization. A Boxplot was used to identify outliers, the range of the data, and the spread of the distribution. It helps to assess the symmetry and identify any extreme values in the dataset. The Simple Scatter plot was employed to examine potential relationships between variables, allowing for a visual inspection of correlations or trends. Both of these visual tools assisted in understanding the distribution and relationships of the data before conducting the statistical tests. Moreover, a correlation analysis was performed to examine the relationship between the degree of myopia and the study parameters. Bivariate correlation was employed to assess the strength and direction of the association between these variables.

RESULTS

In this study, the visual data and analysis results of 73 individuals were included, with a mean age of 12.37 ± 2.54 years. Of the participants, 34 were male with a mean age of 12.03 ± 2.22 years, while 39 were female with a mean age of 12.67 ± 2.78 years. The data for both right and left eyes were compared, and sex-based differences were also examined. Overall averages were calculated, and correlation and graphical analyses were conducted to assess the relationship between the morphometric parameters, such as axial length and corneal curvature, and myopia. These analyses provided insights into the morphometric origins of myopia and contributed to a deeper understanding of the factors influencing its development in the study population.

When analyzing the results of the study, it was observed that the K2 degree value was significantly different between the right and left eyes, while other parameters showed similar results in both eyes (Table I and VI). Specifically, the K2 degree was found to be significantly higher in the left eye. This suggests that the left eye has a steeper meridian of the cornea, and therefore, astigmatism may be more pronounced in that eye. This finding highlights a notable difference in corneal curvature measurements and underscores the importance of considering individual eye evaluations when assessing visual parameters. These results emphasize that corneal morphology may vary between the right and left eyes, and it is essential to conduct separate

Table I. Comparison of mean values for the right and left sides.

Parameters	Right Mean $\pm$ SD Min-Max)	Left Mean $\pm$ SD (Min-Max)	p
Myopia degree	3.32 $\pm$ 1.94 (0.5-8.5)	3.47 $\pm$ 2.0 (1.00-9.75)	0.643
AL	24.61 $\pm$ 1.31 (22.37-27.06)	24.58 $\pm$ 1.18 (22.31-26.28)	0.890
K1	7.77 $\pm$ 0.36 (6.97-8.50)	7.77 $\pm$ 0.35 (6.99-8.57)	0.908
K1 degree	98.31 $\pm$ 83.48 (1-180)	87.66 $\pm$ 82.20 (1-180)	0.438
K2	7.53 $\pm$ 0.32 (6.77-8.30)	7.52 $\pm$ 0.33 (6.74-8.31)	0.811
K2 degree	86.81 $\pm$ 9.11 (55-109)	91.77 $\pm$ 12.06 (69-123)	0.006
CYL	-1.34 $\pm$ -0.74 (-0.31- -2.61)	-1.50 $\pm$ -0.79 (-0.28- -3.29)	0.193
CYL degree	93.38 $\pm$ 83.83 (0-180)	80.81 $\pm$ 82.29 (0-185)	0.362

SD, Standard Deviation; Min, Minimum; Max, Maximum; p, Significance Value; AL, Axial Length; K1, The keratometry value of the least curved meridian of the cornea; K2, The keratometry value of the most curved meridian of the cornea; CYL, Cylindrical value.

analyses for each eye. The higher K2 value in the left eye may be a factor to consider when determining astigmatism treatment or prescribing glasses/contacts. When comparing the study parameters between women and men, significant differences were observed in both the right and left K1 values (Tables II and V). Other parameter values were similar between both women and men. Specifically, both right and left K1 values were found to be higher in men. This finding suggests that men tend to have a flatter cornea, which may result in different refractive characteristics. Since the K1 value reflects the curvature of the flattest meridian of the cornea, the higher K1 value in men may indicate potentially lower levels of astigmatism. These results highlight the possibility of sex-based differences in corneal curvature, and underscore the importance of considering these

differences when assessing visual parameters. The higher K1 values in men emphasize the relevance of conducting sex-specific analyses when determining prescriptions for glasses or contact lenses.

The correlation analysis revealed a significant and strong positive correlation between myopia degree, cylindrical value (CYL) ($r: 0.500, p:0.000$) and axial length (AL) ($r: 0.648, p:0.000$) indicating a clear relationship among these three parameters (Tables III and IV).

Correlation between Myopia Degree and Axial Length (AL): Myopia is generally associated with an increase in axial length. As the axial length of the eye increases, it becomes more difficult for light to focus correctly on the retina, resulting in myopia (distance vision impairment). This positive correlation suggests that as axial length increases, the degree of myopia also increases, indicating that structural changes in the eye are linked to the degree of myopia (Tables III and IV).

Correlation between Myopia Degree and Cylindrical Value (CYL): Cylindrical value (CYL) measures astigmatism, which refers to irregularities in the curvature of the cornea. Astigmatism and myopia often occur together. This positive correlation suggests that astigmatism becomes more pronounced in myopic individuals, and both refractive errors are related to structural changes in the eye. With increased axial length, there may also be an increase in astigmatism (Tables III and IV).

These findings suggest that structural changes in the eye (such as axial length and astigmatism) are directly related to myopia, and that myopic abnormalities tend to occur in parallel with changes in other ocular parameters. Myopia and astigmatism are influenced by changes in the structure of the eye, with both becoming more prominent as axial length increases.

Table II. Comparison of average values for the right and left sides by sex.

Parameters	Male (n=33) Mean±SD (Min-Max)	Female (n=39) Mean±SD (Min-Max)	p
Myopia degree (R)	3.14±2.00 (0.50-6.60)	3.47±1.91 (0.75-8.5)	0.475
Myopia degree (L)	3.17±1.59 (1.00-6.00)	3.72±2.29 (1.25-9.75)	0.242
AL (R)	24.89±1.26 (22.37-27.06)	24.37±1.32 (22.37-27.06)	0.083
AL (L)	24.79±1.08 (22.53-26.28)	24.40±1.24 (22.31-26.28)	0.154
K1 (R)	7.88±0.33 (7.16-8.50)	7.67±0.36 (6.97-8.25)	0.014
K1 (L)	7.88±0.34 (7.09-8.57)	7.68±0.35 (6.99-8.22)	0.016
K1 degree (R)	81.71±83.95 (1-175)	112.79±81.38 (1-180)	0.113
K1 degree (L)	96.09±82.25 (3-180)	80.31±82.51 (1-180)	0.417
K2 (R)	7.66±0.28 (7.11-8.30)	7.42±0.33 (6.77-7.94)	0.007
K2 (L)	7.64±0.29 (7.04-8.31)	7.41±0.33 (6.74-7.93)	0.003
K2 degree (R)	86.12±9.85 (55-100)	87.41±8.50 (73-109)	0.912
K2 degree (L)	91.68±12.86 (69-123)	91.85±11.49 (75-123)	0.690
CYL (R)	-1.16±-0.65 (-0.31- -2.60)	-1.49±-0.79 (-0.31- -2.61)	0.092
CYL (L)	-1.39±-0.86 (-0.35- -3.29)	-1.60±-0.73 (-0.28- -3.29)	0.175
CYL degree (R)	81.71±83.95 (1-175)	103.56±83.47 (0-180)	0.244
CYL degree (L)	80.21±81.88 (0-174)	81.33±83.70 (1-185)	0.803

SD, Standard Deviation; Min, Minimum; Max, Mximum; n, number of people; p, Significance Value; R, Right; L, Left; AL, Axial Length; K1, The keratometry value of the least curved meridian of the cornea; K2, The keratometry value of the most curved meridian of the cornea; CYL, Cylindrical value.

Table III. Correlation between myopia degree and other variables.

Parameters	Myopia degree r	Myopia degree p
AL	0.648	0.000
K1	0.140	0.094
K1 degree	0.041	0.626
K2	-0.062	0.457
K2 degree	-0.101	0.229
CYL	0.500	0.000
CYL degree	0.035	0.676

AL, Axial Length; K1, The keratometry value of the least curved meridian of the cornea; K2, The keratometry value of the most curved meridian of the cornea; CYL, Cylindrical val; r, Correlation Coefficient; p, statistical significance.

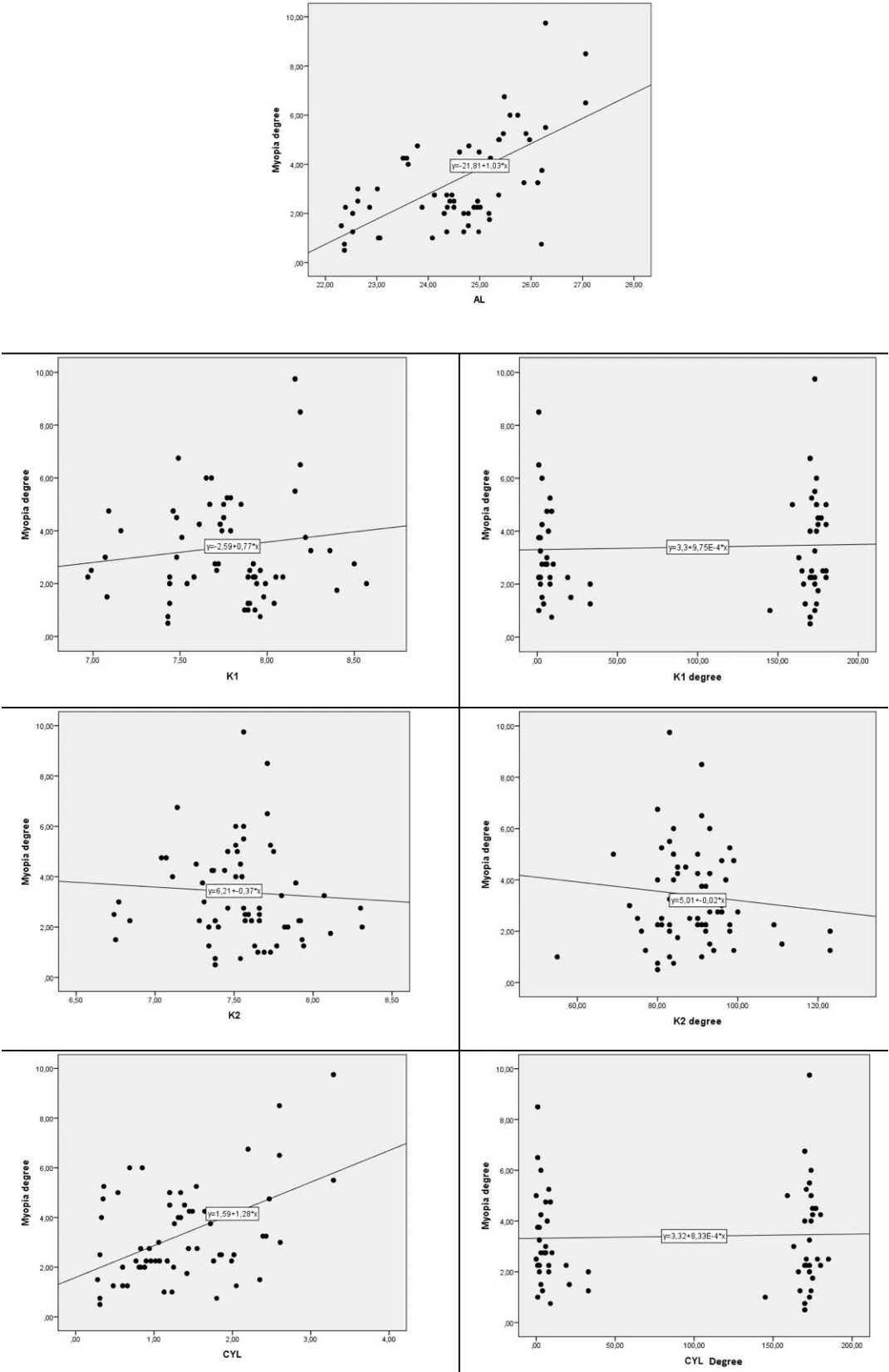


Table IV. Distribution of morphometric parameters according to myopia degree.

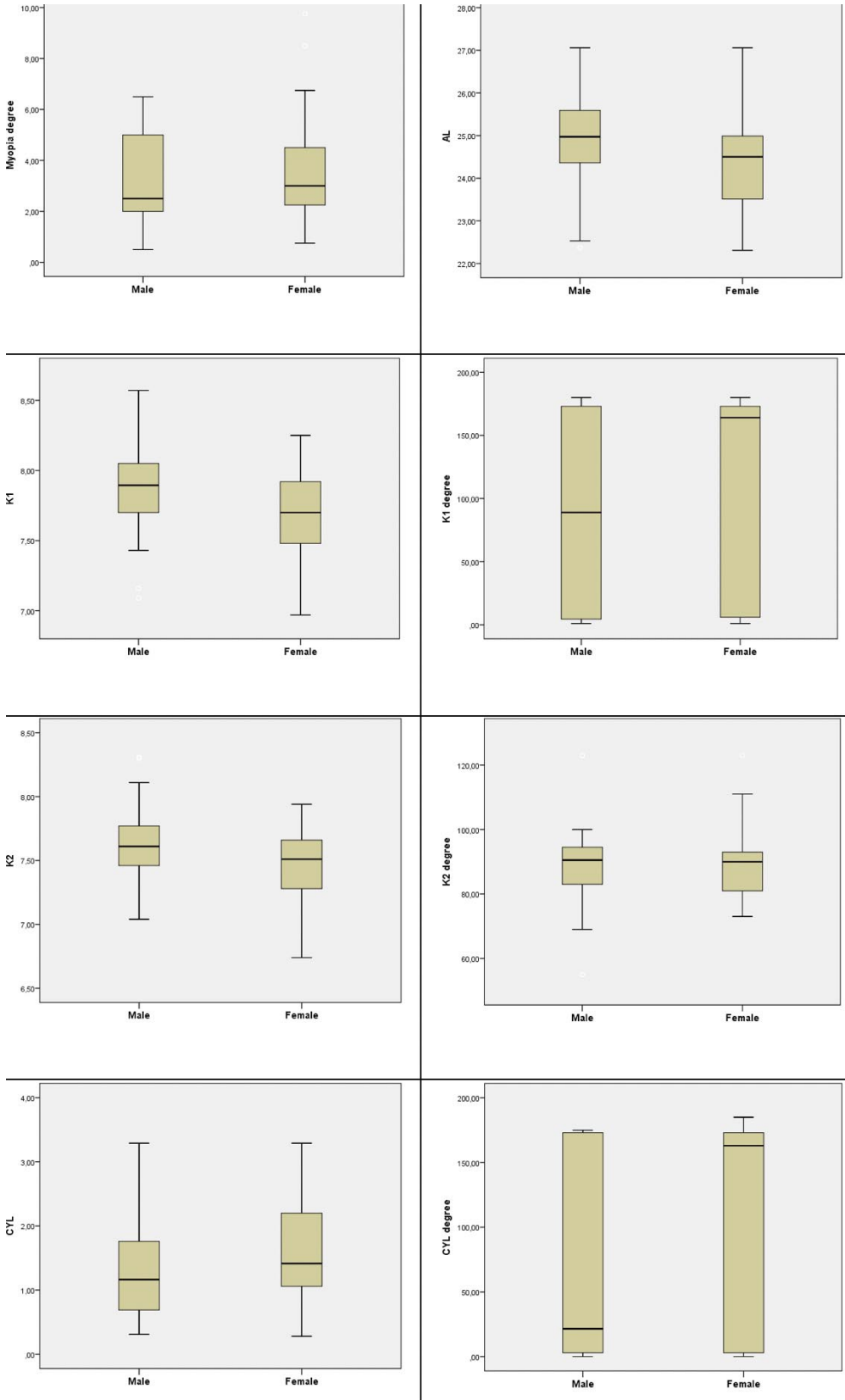


Table V. Distribution of anatomical parameters according to sex.

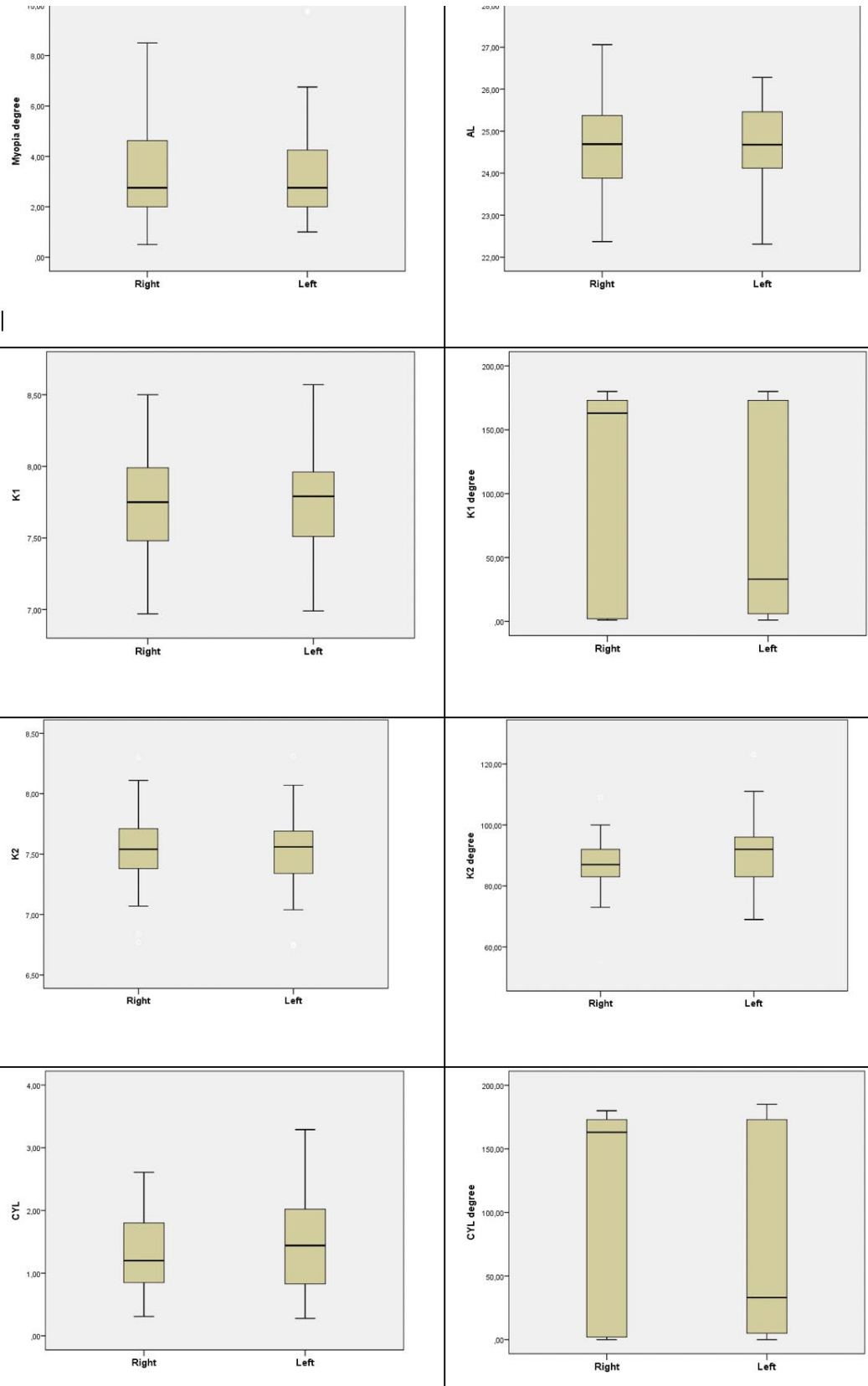


Table VI. Distribution of anatomical parameters according to right and left eyes.

DISCUSSION

This study aims to investigate the morphometric origins of myopia by providing valuable insights into the role of axial length and corneal curvature in the development and progression of myopia.

In our study, significant differences were observed in the K1 values between male and female participants, but no significant differences were found in K2 or cylindrical values (CYL) between sexes. Both right and left eyes exhibited similar K2 and CYL values, indicating that there were no notable sex-based differences in corneal curvature and astigmatism. Similarly, the axial length (AL) showed no significant differences between males and females, suggesting that structural factors, such as axial length, have similar effects on myopia development across sexes. While corneal curvature (K2) and astigmatism (CYL) did not show sex differences, axial length had a consistent impact on myopia across both males and females. These results suggest that while corneal curvature and astigmatism may not vary significantly by sex, a uniform approach to the treatment of myopia can be applied, with careful attention to individual corneal evaluations. In the study conducted by Liang *et al.* (2023) astigmatism was found to be associated with retinal health and visual acuity, but sex and axial length did not play a role in this relationship. Similarly, in our study, the astigmatism (CYL) parameter has an effect on visual acuity, and the influence of axial length is not overlooked. However, it is evident that astigmatism does not create sex differences, and this finding aligns with previous research in the literature. In another study, it was shown that axial length does not affect the rotational stability of toric intraocular lenses, and that the role of these parameters in myopia development is more limited (Zvorničanin *et al.*, 2023). In our study, no sex differences were found regarding axial length, suggesting that the effect of axial length on myopia is similar for both sexes, influenced by genetic and environmental factors. The literature emphasizes that axial length is a more significant factor than astigmatism and plays a more dominant role in myopia development. Additionally, it has been stated that treatment approaches related to axial length may be similar for both sexes.

Moreover, a significant difference in K2 values was observed between the right and left eyes, with the left eye showing a higher K2 value. However, axial length (AL) and cylindrical values (CYL) were similar between the right and left eyes. This indicates that, while there are differences in the corneal curvature (K2) between the two eyes, axial length remains consistent across both eyes in the study population. The similarity of K2 and CYL values between the right and left eyes supports the conclusion that axial length has a

similar structural effect on myopia development in both eyes. The greater K2 value in the left eye suggests a steeper corneal curvature in that eye, which could result in more pronounced astigmatism, but axial length did not vary between the eyes. These findings highlight the importance of considering each eye individually when evaluating visual parameters for myopia and astigmatism treatment. A study in the literature has investigated the comparison between children with and without myopic anisometropia (MAI). This study found that interocular differences in refractive errors, particularly in peripheral refractive errors, are more prominent in myopic anisometropia (Tong *et al.*, 2024). In our study, we focused on central corneal curvature and axial length, and while no significant difference in axial length was found between the eyes, a difference in K2 was observed between the right and left eyes. These findings show that both studies detect asymmetry between the eyes, but the variables investigated differ (peripheral refraction vs. central corneal curvature).

Another study demonstrated that, in myopia, peripheral refraction is associated with axial length and spherical equivalent refraction (SER). It was found that axial length is particularly related to peripheral refractive differences in the nasal region of the retina (Zhao *et al.*, 2024). A further study emphasized that in children with different refractive errors (hyperopia, emmetropia, and myopia), axial length correlates with peripheral refractive differences in specific regions (Wu *et al.*, 2024). Both our study and the literature findings indicate that axial length remains consistent between the right and left eyes, and it has a similar effect on myopia development in both eyes. Axial length is consistently highlighted as a key factor in myopia development across all studies. In our study, axial length did not vary between the eyes, which aligns with the findings in the literature, where axial length is associated with peripheral refractive errors and myopia progression. Furthermore, both our study and the literature emphasize the importance of considering each eye individually when evaluating refractive parameters, as we observed differences in K2 values between the right and left eyes, and the literature found differences in peripheral refractive errors. This suggests that the degree of asymmetry between the eyes may vary depending on the specific refractive parameters being measured (peripheral refraction vs. central curvature and length).

Our study revealed a strong positive correlation between axial length (AL), cylindrical value (CYL), and myopia degree. Specifically, an increase in axial length correlated with an increase in myopia degree and more pronounced astigmatism. This positive correlation suggests that as the axial length of the eye increases, myopia degree and astigmatism (CYL) also tend to increase, indicating that

structural changes in the eye, such as axial elongation, are associated with both myopia and astigmatism.

The similarity of K2 and CYL values between the right and left eyes further emphasizes that these structural changes (such as axial length and corneal curvature) are linked to myopia development. The parallel increase in myopia and astigmatism with increased axial length suggests that both refractive errors are influenced by the same underlying structural changes in the eye. This relationship supports the idea that axial length, corneal curvature (K2), and astigmatism are interrelated factors that contribute to myopia progression.

The results of our study strongly suggest that axial length, corneal curvature (K1, K2), and astigmatism (CYL) are interrelated, with axial length being the most significant factor influencing myopia degree. No significant differences were found in axial length and astigmatism between sexes and between right and left eyes, although K2 values showed differences between the eyes. This indicates that, while axial length has a similar effect on myopia across all participants, corneal curvature may vary slightly between individuals and between eyes.

The findings highlight the importance of considering axial length, corneal curvature, and astigmatism as interconnected parameters when diagnosing and treating myopia. The similarity of CYL and K2 values across sexes and eyes, combined with the strong correlation between axial length and myopia degree, suggests that these parameters work together to influence myopia progression. This emphasizes the need for a comprehensive and individualized approach when prescribing treatments for myopia and astigmatism, taking into account the structural characteristics of each eye.

These results contribute to the understanding of how different structural parameters interact to affect myopia and astigmatism development. By considering the correlations between these factors, the findings suggest that a multidimensional approach is necessary for more accurate diagnosis and tailored treatments in myopic patients.

There are several limitations to our study. First, the sample size in our study is relatively small, and it is well-established that studies with larger sample sizes tend to provide more reliable results. Furthermore, the inclusion of a control group consisting of individuals of the same age group without myopia would have strengthened the comparison and provided more robust findings. However, as this is a retrospective study, and data from individuals seeking medical care at an eye hospital for various complaints

do not reflect the general population, it was not possible to include a control group. Future prospective studies that include healthy individuals from the same age group as a control group are recommended. Such studies would improve the generalizability and accuracy of the findings, as the inclusion of a control group would provide a clearer evaluation of the parameters associated with myopia.

CONCLUSION

Our study demonstrates a significant relationship between axial length, corneal curvature, and myopia, with axial length showing a strong positive correlation with both myopia degree and astigmatism. So, this study reveals how the interaction between axial length and corneal curvature individually or together, contributes to the onset and progression of myopia. Additionally, by evaluating cylindrical and axial cylindrical degree measurements, we have advanced the understanding of refractive errors, particularly myopia and astigmatism. This research contributes to the identification of morphometric risk factors for myopia in children, offering new perspectives for personalized treatment strategies and providing a foundation for future studies in this field.

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KABAKCI, A. G.; BOZKIR, D. M.; ERSÖZ, T. R. & BOZKIR, M. G. Investigación del origen morfométrico de la miopía: El papel de la longitud axial y la curvatura corneal. *Int. J. Morphol.*, 43(5):1702-1713, 2025.

RESUMEN: El objetivo de este estudio fue investigar los orígenes morfométricos de la miopía, centrándose específicamente en el papel de la longitud axial y la curvatura corneal en su desarrollo. Se realizó un análisis retrospectivo en personas de 7 a 18 años con diagnóstico reciente de miopía, con parámetros clave como la longitud axial, la curvatura corneal (K1 y K2) y los valores cilíndricos medidos con el dispositivo MYAH Topcon. El estudio encontró una correlación positiva significativa entre el grado de miopía, la longitud axial y el astigmatismo (CYL). Se identificó una fuerte relación entre la longitud axial y el grado de miopía y astigmatismo, lo que indica que la elongación axial desempeña un papel fundamental en la progresión de la miopía. Además, se observaron diferencias en el sexo, ya que los hombres presentan córneas más planas. Los hallazgos enfatizan la importancia de evaluar tanto la longitud axial como la curvatura corneal en el diagnóstico y el tratamiento de la miopía. Esta investigación proporciona información valiosa sobre los factores de riesgo morfométricos de la miopía, lo que facilita una comprensión más profunda para estrategias de tratamiento personalizadas y futuros estudios en este campo.

PALABRAS CLAVE: Longitud axial; Curvatura corneal; Queratometría; Morfometría; Miopía.

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