

Interocular Differences in Lens Morphology in Children With Unilateral Myopia

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Abstract

Purpose

To investigate interocular differences in lens morphology in children with unilateral myopia, aiming to further explore the relationship between lens morphological changes and myopia development in the pediatric population.

Methods

This cross-sectional study enrolled children and adolescents with unilateral myopia. Unilateral myopia was defined as spherical equivalent (SE) ≤ -0.75 D in one eye following cycloplegia, and SE between -0.50 D and $+0.75$ D in the fellow eye. Ocular biometric parameters, including axial length (AL) and lens thickness (LT), were measured using the IOLMaster 700. Lens parameters, including the anterior lens radius of curvature (ALR), posterior lens radius of curvature (PLR), and lens diameter (LD), were measured using the CASIA2 swept-source optical coherence tomography. Lens power (LP) was calculated using the Bennett formula. Paired t-tests were used to assess interocular differences in biometric parameters, and Linear regression analysis was performed to identify factors associated with refractive error.

Results

A total of 130 participants (age range 6–18 years; 49.23% female) were included. Compared with the emmetropic eyes, myopic eyes showed a smaller LT ($P < 0.001$) and larger ALR, PLR, and LD (all $P < 0.05$). Subgroup analyses revealed: In participants aged ≤ 11 years, myopic eyes exhibited larger ALR, PLR, and LD (all $P < 0.05$). In those aged > 11 years, myopic eyes exhibited larger ALR ($P < 0.05$), but no significant differences in PLR or LD. When anisometropia was ≤ 1.50 D, myopic eyes exhibited larger PLR ($P < 0.05$), but no significant differences in ALR or LD. When anisometropia was > 1.50 D, myopic eyes exhibited larger ALR and LD (all $P < 0.05$), but no significant difference in PLR.

Conclusions

In myopic eyes, lens power is reduced, and the lens morphology becomes flatter and thinner. PLR appear to serve as potential tipping points for these morphological changes.

Introduction

In recent years, the prevalence of myopia among children and adolescents has continued to rise substantially. It has been estimated that by 2050, approximately 4 billion people will be myopic [1]. Myopia not only affects visual quality and daily functioning in children but also predisposes to a range of

complications, including retinopathy and glaucoma, thereby posing a potential threat to lifelong visual health [2]. Therefore, understanding the underlying causes of myopia and the changes occurring in myopic eyes is of great importance for developing novel myopia control strategies.

During childhood and adolescence, the refractive state of the eye undergoes significant changes, typically shifting from hyperopia toward emmetropia [3]. Given that corneal refractive power remains relatively stable after approximately two years of age [4], developmental refractive changes in the eye depend primarily on the dynamic balance between axial length (AL) and the crystalline lens. It is well established that the lens progressively loses refractive power to compensate for axial elongation during ocular development [5–7]; however, excessive axial elongation accompanied by dysregulation of lens power may lead to the onset of myopia [6].

Previous studies have reported that myopic children have thinner lenses with lower refractive power compared with emmetropic individuals, and that higher myopia is associated with even thinner lenses [8, 9]. However, the confounding effects of individual differences (e.g., age, sex) cannot be overlooked when interpreting these findings. Longitudinal cohort studies examining within-individual lens changes have yielded conflicting results [10–12], and it remains difficult to determine whether observed lens changes are attributable to age-related development or to myopia-related effects. In this context, the contralateral eye study design represents an optimal approach, allowing direct comparison of eyes with differing myopic statuses while minimizing confounding factors [13].

Most previous relevant studies have focused on lens refractive power (LP) and lens thickness (LT). Of note, other important lens biometric parameters, such as radii of curvature and lens diameter, may also undergo changes during myopia development and progression. The recent availability of the CASIA2, an anterior segment swept-source optical coherence tomographer (SS-OCT), enables automated measurement of multiple lens parameters with high resolution and reproducibility. Accordingly, the present study enrolled Chinese children and adolescents with unilateral myopia and compared interocular differences in multiple lens-related biometric parameters obtained using the CASIA2, with the aim of further exploring the potential relationship between lens morphological changes and myopia in the pediatric population.

Methods

Study Design and Participants

This cross-sectional study was conducted at Xi'an No.1 Hospital. The study protocol was approved by the Ethics Committee of Xi'an No.1 Hospital (Approval No. [2022] 001), and the study procedures adhered to the tenets of the Declaration of Helsinki. Written informed consent was obtained from all participants and their legal guardians.

Children and adolescents aged 6–18 years with unilateral myopia were enrolled. Unilateral myopia was defined as spherical equivalent (SE) ≤ -0.75 D in one eye and SE between -0.50 D and $+0.75$ D in the

fellow eye. Participants with a history of ocular diseases, including keratoconus, congenital glaucoma, congenital cataract, spherophakia, or pediatric vitreoretinal disorders, were excluded from the study.

2.1 Refraction Measurement

Cycloplegic refraction was performed in all participants. Cycloplegia was induced by administering two drops of 1% cyclopentolate (Cyclogyl; Alcon, USA) in each eye at 5-minute intervals, followed by a third drop after 20 minutes. Pupil size and light reflex were examined 30 minutes after the last drop.

Cycloplegia was considered adequate if the pupil diameter was ≥ 6 mm and the light reflex was absent. Otherwise, an additional drop of cyclopentolate was given. Automated refraction (KR8800; Topcon, Tokyo, Japan) was performed under cycloplegia. Three consecutive readings were obtained for each eye, with a standard error of less than 5%. Refractive error was expressed as spherical equivalent, calculated as $SE = \text{sphere} + \frac{1}{2} \text{cylinder}$.

2.2 Ocular Biometric Measurements

After cycloplegia, ocular biometric parameters were measured using the IOLMaster 700 (version 5.02; Carl Zeiss, Germany), including axial length (AL), flat and steep meridian corneal curvatures (K1 and K2), anterior chamber depth (ACD), white-to-white distance (WTW), and lens thickness (LT). Mean corneal curvature (Km) was calculated as $Km = (K1 + K2)/2$. Vitreous chamber depth (VCD) was calculated using the formula: $VCD = AL - ACD - LT$.

Lens biometric parameters were obtained using the CASIA2, including lens tilt (LTilt), lens decentration (LDec), lens diameter (LD), anterior lens radius of curvature (ALR), posterior lens radius of curvature (PLR), anterior lens steepest radius (ALRs), anterior lens flattest radius (ALRf), posterior lens steepest radius (PLRs), and posterior lens flattest radius (PLRf).

Lens power (LP) was calculated using the Bennett formula, based on reference data from the Gullstrand-Emsley model eye. The formula used was:

$$LP = -[1000n \times Scv + Km] / [1000n - ACD + C1 \times LT \times Scv + Km] + 1000n / (-C2 \times LT + VCD),$$

where $Scv = SE / (1 - 0.014 \times SE)$, $C1 = 0.596$, $C2 = -0.358$, and $n = 1.336$.

The refractive power of the anterior lens surface (LSPa) and posterior lens surface (LSPp) was determined using the ALR, PLR, a refractive index of 1.3709 for the lens cortex [14, 15], and a refractive index of 4/3 for the aqueous humor and vitreous humor [16]:

$$LSPa = (1.3709 - 4/3) \times 1000 / ALR;$$

$$LSPp = (4/3 - 1.3709) \times 1000 / PLR.$$

During measurements with the IOLMaster 700 and CASIA2, participants were instructed to keep their eyes as wide open as possible and to fixate on the device's internal target. All measurements were

performed and reviewed by the same ophthalmologist. Each measurement was repeated three times, and the mean values were used for statistical analysis.

2.3 Subgroup Analyses

Given previously reported age-related inflection points for lens thinning between 9 and 11 years of age[17–19], subgroup analyses were performed for participants aged ≤ 11 years and those aged > 11 years. In addition, based on previous studies[20, 21], subgroup analyses were also performed according to the magnitude of anisometropia, using a cutoff value of 1.50 D.

2.4 Statistical Analysis

Statistical analyses were performed using SPSS software (version 25.0; IBM Corp., Armonk, NY, USA). A P value < 0.05 was considered statistically significant. The normality of distribution for ocular biometric parameters, including SE, Km, and LT, was assessed using the Kolmogorov–Smirnov test. All continuous variables followed a normal or approximately normal distribution and were presented as mean $\pm$ standard deviation (SD). Paired t-tests were used to compare interocular differences in ocular biometric parameters. Linear regression analysis was performed to identify factors associated with refractive error.

Results

3.1 Demographic and Ocular Characteristics

A total of 130 participants were enrolled, including 64 girls (49.23%). The mean age was 10.3 ± 2.8 years. In myopic eyes, the mean SE was -1.90 ± 1.05 D, compared with 0.19 ± 0.71 D in emmetropic eyes ($P < 0.001$). The mean anisometropia between the two eyes was 2.09 ± 1.25 D.

Table 1 presents the distribution of ocular biometric parameters in myopic and emmetropic eyes. Compared with emmetropic eyes, myopic eyes showed significantly longer AL, ACD, and VCD (all $P < 0.001$), but significantly smaller LT and LP (both $P < 0.001$). Both ALR and PLR were larger in myopic eyes than in emmetropic eyes ($P = 0.001$ and $P = 0.010$, respectively), and correspondingly, LSPa and LSPp were significantly smaller ($P = 0.001$ and $P = 0.006$, respectively). In addition, LTilt was significantly smaller in myopic eyes ($P = 0.003$), whereas LDec and LD were significantly larger ($P = 0.004$ and $P = 0.013$, respectively).

Table 1
Characteristics of the included study participants with unilateral myopia (n = 130).

AL, mm	Myopic Eyes	Emmetropic Eyes	t-value	P-value
	24.31 ± 0.91	23.44 ± 0.83	19.938	< 0.001
Km, D	43.27 ± 1.28	43.27 ± 1.29	-0.003	0.998
ACD, mm	3.68 ± 0.31	3.64 ± 0.31	5.907	< 0.001
VCD, mm	17.29 ± 1.03	16.42 ± 0.99	19.516	< 0.001
WTW, mm	11.96 ± 0.41	11.96 ± 0.46	-0.120	0.905
LT, mm	3.40 ± 0.18	3.43 ± 0.18	-5.918	< 0.001
LP, D	22.19 ± 2.03	22.70 ± 2.09	-7.336	< 0.001
ALR, mm	13.03 ± 1.41	12.72 ± 1.56	3.532	0.001
ALRs, mm	12.95 ± 4.17	12.14 ± 1.49	2.209	0.029
ALRf, mm	13.62 ± 1.54	13.30 ± 1.73	3.234	0.002
PLR, mm	5.97 ± 0.47	5.87 ± 0.50	2.623	0.010
PLRs, mm	5.73 ± 0.44	5.64 ± 0.49	2.146	0.034
PLRf, mm	6.21 ± 0.64	6.10 ± 0.60	2.104	0.037
LSPa, D	2.92 ± 0.34	3.00 ± 0.40	-3.375	0.001
LSPp, D	-6.33 ± 0.50	-6.45 ± 0.53	2.771	0.006
LTilt, degree	4.52 ± 1.39	4.91 ± 1.14	-3.045	0.003
LDec, mm	0.22 ± 0.10	0.19 ± 0.09	2.903	0.004
LD, mm	9.61 ± 0.50	9.50 ± 0.36	2.524	0.013

Abbreviations: AL, axial length; Km, mean corneal curvature; ACD, anterior chamber depth; VCD, vitreous chamber depth; WTW, white-to-white distance; LT, lens thickness; LP, lens power; ALR, anterior lens radius of curvature; ALRs, anterior lens steepest radius; ALRf, anterior lens flattest radius; PLR, posterior lens radius of curvature; PLRs, posterior lens steepest radius; PLRf, posterior lens flattest radius; LSPa, refractive power of the anterior lens surface; LSPp, refractive power of the posterior lens surface; LTilt, lens tilt; LDec, lens decentration; LD, lens diameter.

Note: Data are presented as mean ± standard deviation. P-values were calculated using paired t-tests.

3.2 Subgroup Analyses

Table 2 shows the distribution of ocular parameters in myopic versus emmetropic eyes across subgroups defined by age and magnitude of anisometropia. Across all subgroup analyses, myopic eyes consistently exhibited smaller LP, thinner LT, and deeper VCD compared with emmetropic eyes (all $P < 0.05$).

Age-stratified analyses: In participants aged ≤ 11 years, myopic eyes showed larger ALR, PLR, and LD than emmetropic eyes ($P = 0.010$, $P = 0.010$, and $P = 0.018$, respectively), with no significant differences in other parameters. In participants aged > 11 years, myopic eyes showed significantly larger ALR ($P < 0.05$), but no significant differences in PLR or LD (both $P > 0.05$).

Anisometropia-stratified analyses: When anisometropia was ≤ 1.50 D, myopic eyes showed significantly larger PLR compared with emmetropic eyes ($P = 0.034$), with no significant differences in other parameters (all $P > 0.05$). When anisometropia was > 1.50 D, myopic eyes showed significantly larger ALR and LD ($P < 0.001$ and $P = 0.046$, respectively), with no significant differences in other parameters.

Table 2
Distribution of Ocular Parameters by Age and Degree of Anisometropia.

	Myopic Eyes	Emmetropic Eyes	P-value	Myopic Eyes	Emmetropic Eyes	P-value
	≤ 11 yrs(n = 79)			> 11 yrs(n = 51)		
Km, D	43.44 ± 1.16	43.43 ± 1.19	0.691	43.01 ± 1.41	43.03 ± 1.42	0.676
ACD, mm	3.68 ± 0.30	3.66 ± 0.29	< 0.001	3.68 ± 0.31	3.63 ± 0.33	< 0.001
VCD, mm	17.10 ± 1.03	16.35 ± 1.01	< 0.001	17.58 ± 0.97	16.54 ± 0.94	< 0.001
LT, mm	3.39 ± 0.17	3.42 ± 0.17	0.001	3.41 ± 0.20	3.45 ± 0.20	< 0.001
LP, D	22.51 ± 1.95	22.96 ± 2.03	< 0.001	21.72 ± 2.07	22.31 ± 2.12	< 0.001
ALR, mm	13.01 ± 1.41	12.68 ± 1.51	0.010	13.06 ± 1.44	12.78 ± 1.66	0.020
ALRs, mm	13.27 ± 5.25	12.09 ± 1.43	0.051	12.46 ± 1.41	12.23 ± 1.59	0.059
ALRf, mm	13.58 ± 1.55	13.28 ± 1.70	0.029	13.67 ± 1.54	13.34 ± 1.80	0.018
PLR, mm	5.93 ± 0.46	5.80 ± 0.44	0.010	6.02 ± 0.49	5.97 ± 0.57	0.374
PLRs, mm	5.69 ± 0.44	5.59 ± 0.43	0.103	5.78 ± 0.44	5.70 ± 0.56	0.174
PLRf, mm	6.17 ± 0.67	6.01 ± 0.53	0.020	6.26 ± 0.59	6.23 ± 0.67	0.737
LSPa, D	2.92 ± 0.33	3.01 ± 0.38	0.014	2.91 ± 0.34	2.99 ± 0.43	0.028
LSPp, D	-6.37 ± 0.49	-6.51 ± 0.49	0.011	-6.28 ± 0.51	-6.35 ± 0.59	0.259
LTilt, degree	4.72 ± 1.50	5.01 ± 1.17	0.120	4.22 ± 1.14	4.77 ± 1.08	0.002
LDec, mm	0.21 ± 0.10	0.19 ± 0.09	0.062	0.24 ± 0.09	0.20 ± 0.10	0.028
LD, mm	9.60 ± 0.58	9.45 ± 0.32	0.018	9.62 ± 0.34	9.58 ± 0.40	0.427
	Anisometropia ≤ 1.5D(n = 56)			Anisometropia > 1.5D(n = 74)		

	Myopic Eyes	Emmetropic Eyes	P-value	Myopic Eyes	Emmetropic Eyes	P-value
	≤ 11 yrs(n = 79)			> 11 yrs(n = 51)		
Km, D	43.30 ± 1.25	43.26 ± 1.29	0.323	43.25 ± 1.31	43.28 ± 1.30	0.460
ACD, mm	3.66 ± 0.30	3.65 ± 0.30	0.244	3.69 ± 0.32	3.64 ± 0.31	< 0.001
VCD, mm	17.05 ± 1.16	16.60 ± 1.13	< 0.001	17.46 ± 0.89	16.29 ± 0.85	< 0.001
LT, mm	3.40 ± 0.16	3.44 ± 0.16	0.002	3.39 ± 0.19	3.43 ± 0.19	< 0.001
LP, D	22.39 ± 2.07	22.76 ± 1.97	< 0.001	22.05 ± 2.01	22.66 ± 2.18	< 0.001
ALR, mm	12.84 ± 1.28	12.56 ± 1.46	0.105	13.17 ± 1.50	12.84 ± 1.64	< 0.001
ALRs, mm	12.86 ± 4.48	12.00 ± 1.39	0.160	13.01 ± 3.96	12.25 ± 1.56	0.097
ALRf, mm	13.41 ± 1.41	13.12 ± 1.61	0.130	13.77 ± 1.62	13.43 ± 1.82	0.002
PLR, mm	5.93 ± 0.51	5.81 ± 0.49	0.034	6.00 ± 0.45	5.91 ± 0.51	0.108
PLRs, mm	5.69 ± 0.47	5.59 ± 0.48	0.185	5.75 ± 0.42	5.67 ± 0.50	0.095
PLRf, mm	6.16 ± 0.76	6.03 ± 0.56	0.100	6.24 ± 0.54	6.15 ± 0.62	0.193
LSPa, D	2.96 ± 0.31	3.03 ± 0.38	0.100	2.89 ± 0.35	2.98 ± 0.41	0.001
LSPp, D	-6.38 ± 0.53	-6.51 ± 0.51	0.036	-6.30 ± 0.48	-6.40 ± 0.55	0.072
LTilt, degree	4.51 ± 1.22	4.88 ± 1.06	0.029	4.53 ± 1.51	4.94 ± 1.20	0.033
LDec, mm	0.22 ± 0.10	0.19 ± 0.08	0.096	0.23 ± 0.10	0.19 ± 0.10	0.022
LD, mm	9.53 ± 0.36	9.46 ± 0.36	0.125	9.66 ± 0.57	9.53 ± 0.35	0.046

Abbreviations: Km, mean corneal curvature; ACD, anterior chamber depth; VCD, vitreous chamber depth; LT, lens thickness; LP, lens power; ALR, anterior lens radius of curvature; ALRs, anterior lens steepest radius; ALRf, anterior lens flattest radius; PLR, posterior lens radius of curvature; PLRs, posterior lens steepest radius; PLRf, posterior lens flattest radius; LSPa, refractive power of the

Myopic Eyes	Emmetropic Eyes	P-value	Myopic Eyes	Emmetropic Eyes	P-value
≤ 11 yrs(n = 79)			> 11 yrs(n = 51)		
anterior lens surface; LSPp, refractive power of the posterior lens surface; LTilt, lens tilt; LDec, lens decentration; LD, lens diameter.					
Note: Data are presented as mean ± standard deviation. P-values were calculated using paired t-tests.					

3.3 Linear Regression Analysis

In the myopic eyes, the AL (Y) showed a significant linear correlation with ALR (X1)–PLR(X2)–LT–X3–and LD–X4–, described by the equation $Y = 0.286X1 + 20.55$ ($R^2=0.196,P<0.001$)– $Y = 0.909X2 + 18.897$ ($R^2=0.217,P<0.001$)– $Y=-1.583X3 + 29.694$ ($R^2=0.097,P<0.001$) and $Y = 0.675X4 + 17.806$ ($R^2=0.135,P<0.001$)(see Fig. 1). It should be noted that the relatively low R^2 values indicate that lens morphology alone explains only a portion of the AL .

Discussion

In this study, we compared lens morphological parameters between myopic eyes and their contralateral emmetropic eyes in children with unilateral myopia. Our findings demonstrate that compared with emmetropic eyes, myopic eyes exhibit thinner lens thickness and lower lens power.

The relationship between lens thickness (LT) changes and myopia development remains controversial. Shih et al.[12] reported that myopic children had thinner LT compared with emmetropic and hyperopic children. Gao et al. [8] included 3,575 young myopic adults aged 15–23 years and found that LT was significantly thinner in individuals with high myopia (AL > 26 mm) than in those with moderate myopia. In contrast, Xie et al. [22] studied 108 young adults with varying degrees of myopia and reported no statistically significant differences in LT across myopia severity subgroups. Given that LT changes are influenced by age-related effects and individual heterogeneity, we propose that the discrepancies among these studies may be largely attributable to imbalances in age distribution and individual differences across study groups. A previous study investigating interocular differences in lens parameters in patients with anisometropia [15] enrolled individuals with high myopia, in whom lens changes may not accurately reflect natural lens alterations under myopic conditions. In the present study, we enrolled children aged 6–18 years with unilateral myopia and used an interocular comparison design, which effectively controlled for confounding effects of age and individual heterogeneity, thereby enhancing the reliability of our conclusions.

It is widely reported that lens thickness and power decrease during early childhood to compensate for axial elongation during normal ocular growth[10, 11, 19, 23]. The rate of lens thinning decreases with age, and around the age of 11 years, lens thinning is replaced by lens thickening, regardless of myopic status[23]. Notably, in the present study, we observed that although myopic eyes had thinner lenses than emmetropic eyes across all age groups, children aged ≤ 11 years showed larger ALR, PLR, and LD in

myopic eyes compared with emmetropic eyes, whereas in children aged > 11 years, only ALR remained significantly larger in myopic eyes. These findings suggest that at approximately 11 years of age, lens morphology begins to shift toward a steeper configuration, with changes potentially initiating from the posterior lens surface. Furthermore, age appears to exert a greater regulatory influence on LT changes than does myopia development or progression.

During early ocular growth, the lens loses refractive power by flattening both its anterior and posterior surfaces [7, 24]. Our study showed that both ALR and PLR were significantly larger in myopic eyes than in emmetropic eyes, consistent with findings by Shang et al. [24], who compared lens parameters between myopic and hyperopic eyes in children aged 6–12 years and reported that myopic children had significantly larger lens radii of curvature and lower lens power, indicating flatter lenses. In contrast, Liu et al.[25] reported no significant differences in anterior or posterior lens curvature between highly myopic eyes and their contralateral eyes. Another study found that in individuals with AL > 27 mm, LT did not continue to decrease with increasing AL, as was observed in those with AL ≤ 26 mm [18]. We speculate that once myopia reaches a certain level, the lens may cease to deform in response to further increases in refractive error, possibly because the lens has a physiological limit beyond which further morphological change cannot occur. In the present study, we found that when anisometropia was ≤ 1.50 D, myopic eyes exhibited larger PLR than emmetropic eyes; however, when anisometropia exceeded 1.50 D, myopic eyes showed larger ALR and LD, with no significant interocular difference in PLR. Previous research has shown that a ± 20% change in PLR alters lens power by – 2.18 D to 3.27 D, whereas a comparable change in ALR alters lens power by only – 1.16 D to 1.73 D[7], suggesting that PLR not only is the primary contributor to lens power but also undergoes the earliest changes during myopia development.

These findings have several implications. First, the identification of age 11 years and 1.50 D of anisometropia as potential tipping points for lens morphological changes may help refine the timing of myopia control interventions. Children younger than 11 years or those with anisometropia below 1.50 D may still have residual lens compensatory capacity, whereas beyond these thresholds, the lens may have approached its morphological limits. Second, the observation that posterior lens surface changes (PLR) precede anterior surface changes (ALR) suggests that monitoring PLR could serve as an early sensitive indicator of lens remodeling during myopia development.

The present study has several limitations. First, given the difficulty of recruiting participants with unilateral myopia, the study included only Chinese individuals and the sample size was relatively modest. Future studies with larger sample sizes and greater ethnic diversity are needed to validate our findings. Second, the cross-sectional design cannot fully capture the dynamic changes in lens morphology or their interplay with axial elongation during myopia onset and progression. Third, we did not include eyes with hyperopia in our analysis; therefore, lens morphological changes during the transition from hyperopia to myopia remain unclear. Future studies with expanded inclusion criteria are warranted to further address this question.

In conclusion, using an interocular comparison design, this study systematically evaluated interocular differences in lens morphology in children with unilateral myopia. Our findings indicate that compared with emmetropic eyes, myopic eyes exhibit significantly thinner lenses, larger anterior and posterior radii of curvature, and reduced lens power. PLR may serve as potential tipping points for lens morphological changes.

Declarations

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Authors' contributions

Conceived and designed the experiments: HZ, XZ, LK, SP. Performed the experiments: HZ, LK, SP, YL, YG, HW. Analyzed the data: LK, YG, XZ. Contributed materials/analysis tools: HZ, XZ, SP. Wrote the paper: HZ, LK, SP. All authors read and approved the final manuscript.

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Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

This study was approved by the Ethics Committee of Xi'an No.1 Hospital (Approval No. [2022] 001).

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Figures

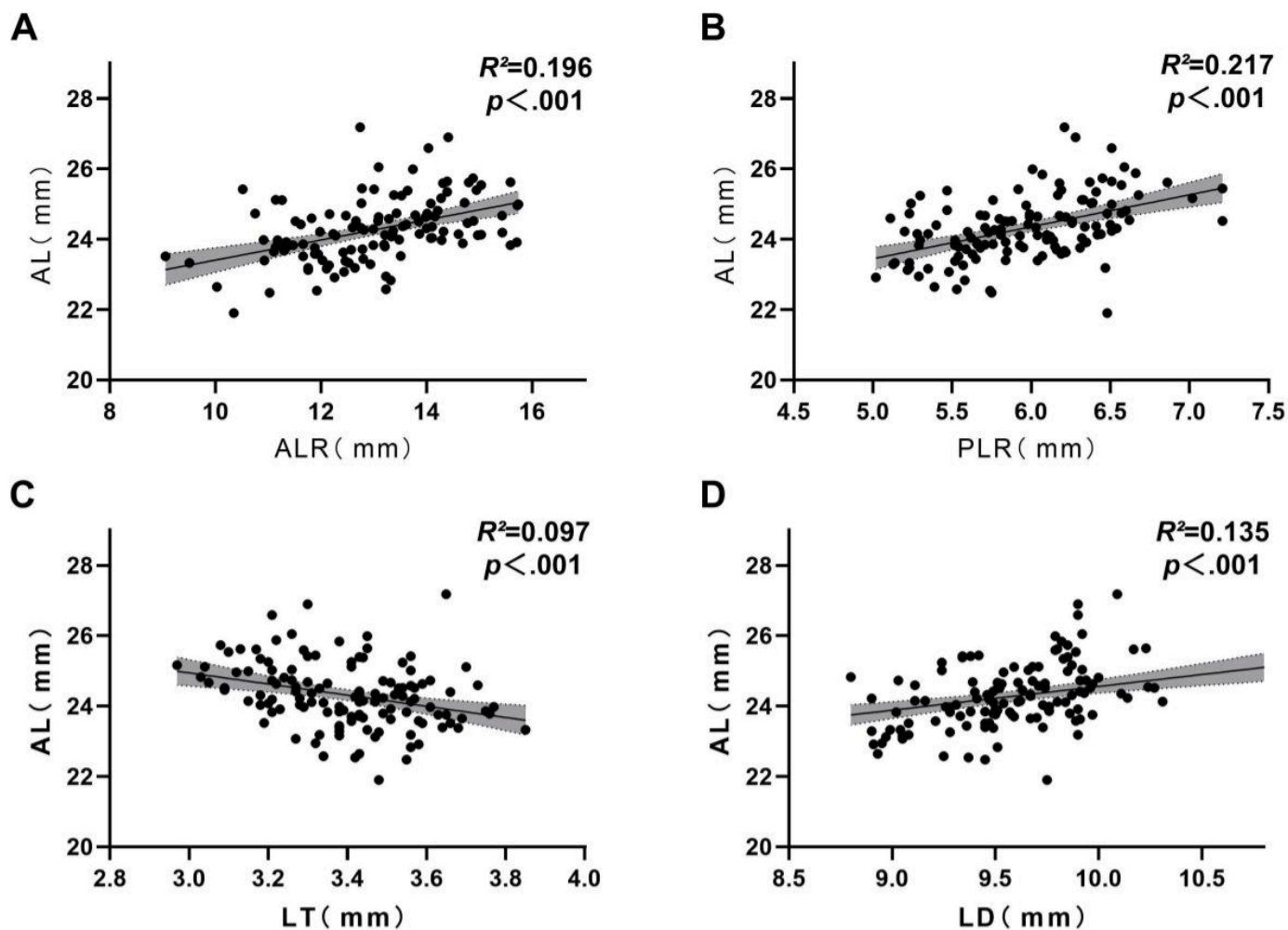


Figure 1

Scatter plots showing the linear correlation between AL and ALR (A) PLR (B) LT (C) and LD (D) in the myopic eyes .