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ORIGINAL RESEARCH

# Ocular Biometry Profile and Its Associations with Systemic and Demographic Factors in Thai Cataract Patients

Anyarak Amornpetchsathaporn[1], Somporn Chantra[1], Kornkamol Annopawong[1], Kasem Seresirikachorn[1], Kittipong Kongsomboon[2], Boonsong Wanichwecharungruang[1,3]

[1]Department of Ophthalmology, Rajavithi Hospital and College of Medicine, Rangsit University, Bangkok, Thailand; [2]Department of Preventive and Social Medicine, Faculty of Medicine, Srinakharinwirot University, Nakhon Nayok, Thailand; [3]Department of Ophthalmology, Priest Hospital, Bangkok, Thailand

Correspondence: Somporn Chantra, Department of Ophthalmology, Rajavithi Hospital and College of Medicine, Rangsit University, 2, Phayathai Road, Ratchathewi District, Bangkok, 10400, Thailand, Tel +66 86-541-3765, Email chantrasomporn@yahoo.com

**Objective:** To investigate the differences in ocular biometry between cataract patients with and without systemic diseases and assess relationships between ocular biometry and demographic factors in Thai cataract patients.

**Methods:** A cross-sectional study was conducted from November 2020 to May 2023 at Rajavithi Hospital, Thailand. Ocular biometry was measured using the IOL Master 700, and demographic data were extracted from medical records. Pearson's and Spearman correlations assessed relationships between ocular biometry and demographic/systemic factors. Univariate and multivariate regression analyses identified associated factors.

**Results:** The study included 6,330 participants. The most common systemic disease was diabetes (25.7%), followed by hypertension (6.9%), dyslipidemia (5.4%), and chronic kidney disease (CKD) (3.0%). Age correlated positively with lens thickness and negatively with axial length (AL), anterior chamber depth (ACD), and central corneal thickness (CCT). Multivariate analysis showed AL decreased with age ($\beta = -0.012$, $p < 0.001$) and was shorter in females ($\beta = -0.193$, $p < 0.001$) and diabetics ($\beta = -0.130$, $p < 0.001$). ACD was shallower with age ($\beta = -0.008$, $p < 0.001$) and in CKD patients ($\beta = -0.079$, $p = 0.013$), while females had shallower ACD ($\beta = -0.159$, $p < 0.001$). LT increased with age ($\beta = 0.018$, $p < 0.001$) and was greater in diabetics ($\beta = 0.044$, $p = 0.012$), CKD patients ($\beta = 0.162$, $p < 0.001$), and females ($\beta = 0.070$, $p = 0.001$). CCT decreased with age ($\beta = -0.279$, $p < 0.001$) but was higher in diabetics ($\beta = 4.905$, $p < 0.001$) and dyslipidemia ($\beta = 6.881$, $p = 0.003$).

**Conclusion:** Ocular biometry varies significantly with gender, systemic diseases (diabetes, dyslipidemia, CKD), and demographic factors among Thai cataract patients. These findings highlight the importance of incorporating systemic disease management into preoperative planning to optimize cataract surgery outcomes.

**Keywords:** ocular biometry, cataract, systemic diseases, demographic factors

## Introduction

Cataracts are among the leading causes of visual impairment and blindness around the world.[1] Phacoemulsification with intraocular lens (IOL) insertion stands out as the most modern and effective treatment method for cataract patients. Achievement of optimal postoperative visual acuity relies on accurate measurement of ocular biometry, which is crucial for evaluating ocular dimensions and determining the appropriate IOL power for each patient.[2]

Beyond IOL power calculation, ocular biometry has been investigated for its association with various ocular diseases such as primary angle closure disease, refractive error, and diabetic retinopathy. Additionally, studies have explored the link between ocular biometry and systemic diseases. A comprehensive understanding of how ocular biometry differs among genders, ages, and systemic disorders could improve preoperative management and facilitate early detection of certain systemic diseases.

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Recent studies have highlighted significant associations between systemic diseases and ocular biometry. Diabetes mellitus (DM) has been linked to increased lens thickness (LT) due to osmotic changes caused by hyperglycemia, which can lead to a myopic shift in refraction.[3,4] Several studies have also explored the relationship between systemic hypertension and ocular biometry parameters. Evidence suggests that hypertension may contribute to an increase in axial length (AL), potentially due to alterations in ocular perfusion pressure and scleral remodeling. Blood pressure has been shown to influence retinal susceptibility to intraocular pressure elevation, indicating a possible link between systemic hypertension and AL.[5] However, some studies have reported no significant association between hypertension and AL.[6]

Other systemic diseases have also been associated with ocular structural changes. Chronic kidney disease (CKD), for example, has been associated with choroidal thinning. One study found that patients with CKD exhibited significant choroidal thinning compared to healthy controls, with the degree of thinning correlating with declining estimated glomerular filtration rate (eGFR) and increased kidney scarring. Interestingly, an increase in choroidal thickness was observed following kidney transplantation, suggesting a reversible component linked to kidney function.[7] However, the relationship between CKD and AL remains unclear.[8]

Our study aimed to investigate the differences in ocular biometry between cataract patients who have systemic diseases and those who do not. Additionally, we strived to determine the average ocular biometry in Thai cataract patients and assess the relationships between ocular biometry and factors such as age, weight, and height.

## Materials and Methods

This cross-sectional study enrolled patients whose ocular biometric parameters were measured at the ophthalmology outpatient department of Rajavithi Hospital (Bangkok, Thailand) between November 2020 and May 2023, and whose medical data were stored in the hospital electronic medical record database. During data collection, the research team accessed de-identified records to ensure the confidentiality of participants. The data were accessed for research purposes between 15 January 2024 and 15 April 2024. All patient data were fully anonymized and protected in compliance with institutional privacy protocols to prevent any risk of identifying individual participants. No identifiable patient information was collected, stored, or reported. The study protocol was approved by the Ethics Committee of Rajavithi Hospital and conducted in accordance with the Declaration of Helsinki. Due to the retrospective nature of the study, the Institutional Review Board waived the requirement for informed consent.

### Inclusion and Exclusion Criteria

The study involved cataract patients attending the outpatient department at Rajavithi Hospital, Bangkok, Thailand. Inclusion criteria encompassed individuals aged 20 years or older with available biometry data for at least one eye and demographic information stored in the hospital's electronic medical record database.

Exclusion criteria included participants who had undergone intraocular surgery in both eyes, as well as those with opaque optical media or significant visual impairment due to anterior and/or posterior segment diseases that could impair fixation image quality on the IOL Master, such as severe dry eye, diabetic retinopathy, or maculopathy. Additionally, individuals with a history of ocular trauma or prior ocular surgeries, such as refractive surgery, cataract surgery, glaucoma procedures (trabeculectomy and/or glaucoma tube shunt), or vitreoretinal surgery, were also excluded from the study. Furthermore, we excluded patients with poor quality IOL measurements after checking all image quality and segmentation to ensure that the devices were correctly marked.

### Data Collection

We identified patients scheduled for cataract surgery from the hospital's cataract surgery waiting list. Upon identification, we utilized their hospital numbers to retrieve two main components of data: ocular biometry and demographic data.

Firstly, we obtained ocular biometry data directly from the IOL Master 700 machine (Carl Zeiss Meditec, CA, USA), which included AL, anterior chamber depth (ACD), LT, central corneal thickness (CCT), white-to-white diameter (WTW), and keratometry (K1, K2). Data from a single eye were used, with preference given to the eye with the most complete dataset. In cases where both eyes had complete data, a coin toss was used as a simple randomization method to select between the right and left eye.

Secondly, patients' demographic information was sourced primarily from the hospital's electronic medical records database. Patient age was recorded as the age on the day of biometry collection, and weight and height measurements were included if they were documented within 6 months before or after the biometry collection date. Information regarding systemic diseases was gathered based on ICD-10 coding; a patient was classified as having a disease if the corresponding ICD-10 code was documented before or not more than 6 months after the biometry collection date. The systemic diseases recorded (ICD-10) included diabetes (E10-E14), hypertension (I10, I119, I150-I152, I158-I161, I169, I1A0), dyslipidemia (E78), and CKD (N18).

## Quality Control and Calibration

The IOL Master 700 underwent daily calibration in accordance with the manufacturer's guidelines. Calibration procedures included verifying AL and keratometry measurements using a standard reference model, ensuring consistency with the recommended practices outlined in the IOL Master 700 DICOM Conformance Statement.[9]

Image quality was assessed for all biometry scans using the analysis window in the device software. Proper fixation was confirmed by visualizing the foveal pit with a 1-mm central retina scan. The following images were analyzed separately for each eye: biometry scan, keratometry scan, WTW image, sclera image, and fixation check. These images were examined for artifacts, including out-of-focus areas in B-scans, distortions in WTW and sclera images, and missing spots in keratometry scans. Poor-quality scans were excluded from analysis.

# Sample Size Estimation

We used the mean and standard deviation of ACD from the study by Kim et al[10] to calculate the sample size using the following single mean estimation formula as follows:

$$n = \frac{Z^2_{\alpha/2} x (\mathrm{SD})^2}{\mathrm{d}^2}$$

$n$ = Sample size
$Z_{\alpha/2}$ = 1.96, at a standard normal deviation of 95% CI
SD = Standard Deviation
$d$= The degree of precision (the amount of sampling error)
The results indicated that the study needed at least 5,165 subjects.

## Statistical Analysis

All measurement data were recorded in Microsoft Excel (Microsoft Office 2019; Microsoft, Redmond, WA, USA) and then transferred to SPSS (version 22, SPSS Inc., IBM, Chicago, USA) for analysis.

Data were presented as mean ± standard deviation (SD). Normal distribution was assessed using Kolmogorov–Smirnov tests. Correlations between ocular biometry parameters and variables such as age, weight, and height were evaluated using Pearson's correlation for normally distributed data and Spearman correlation for non-normally distributed data. Univariate and multivariate regression analyses were conducted to identify factors associated with ocular biometry. Variables with a p-value < 0.25 in the univariate analysis were included in the multivariate regression model for further analysis. Collinearity among independent variables was assessed using the Variance Inflation Factor. Statistical significance was defined as $p < 0.05$.

# Results

Our study recruited all patients who met the inclusion and exclusion criteria. This resulted in a total of 6,330 participants, with 2,749 males (43.4%) and 3,581 females (56.6%). Diabetes was the most common systemic disease among the participants, affecting 1,627 individuals (25.7%). This was followed by hypertension (6.9%), dyslipidemia (5.4%), and CKD (3.0%). The majority of participants were elderly, with an average age of 62.96 ± 11.69 years. The mean ocular biometric measurements are summarized in Table 1.

Table 2 presents the Spearman correlation coefficients between ocular biometric measurements (AL, ACD, LT, CCT, WTW diameter, K1, K2), age, weight, and height.


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All correlations between ocular biometry and demographics were significant. Ocular biometry showed positive links with age, notably LT, which had the highest correlation (0.431) and keratometry, while those with negative correlations included AL, ACD, CCT and WTW diameter. Additionally, positive correlations were observed between ocular biometry and weight, seen in AL, ACD, CCT, and WTW diameter. Conversely, negative correlations were seen with LT, K1, and K2. Similarly, positive correlations existed between ocular biometry and height, affecting AL, ACD, CCT, and WTW diameter, while there were negative correlations with LT, K1, and K2.

Table 3 presents the ocular biometric parameters stratified by gender, diabetes, hypertension, dyslipidemia, and CKD, along with their respective mean differences and 95% confidence intervals. Ocular biometric parameters exhibited trends based on gender and systemic conditions. Males generally had longer AL and deeper ACD, while females showed steeper K1, K2 and slightly increased LT. However, the overlapping standard deviations suggest that these differences may not always be clinically meaningful. Diabetic eyes showed a trend toward steeper corneal curvature and slightly

**Table 1** Demographic Data (N=6,330)

| Variable | |
|---|---|
| **Gender** | |
| Male (%) | 2749 (43.4) |
| Female (%) | 3581 (56.6) |
| **Systemic disease** | |
| Diabetes (%) | 1627 (25.7) |
| Hypertension (%) | 437 (6.9) |
| Dyslipidemia (%) | 340 (5.4) |
| Chronic kidney disease (%) | 192 (3.0) |
| **Ocular biometry** | |
| AL (mm, mean ± SD) | 23.64 ± 1.43 |
| ACD (mm, mean ± SD) | 3.07 ± 0.46 |
| LT (mm, mean ± SD) | 4.60 ± 0.49 |
| CCT (μm, mean ± SD) | 0.53 ± 0.04 |
| WTW (mm, mean ± SD) | 11.88 ± 0.47 |
| K1 (D, mean ± SD) | 43.65 ± 1.64 |
| K2 (D, mean ± SD) | 44.73 ± 1.69 |
| **Age** (years, mean ± SD) | 62.96 ± 11.69 |
| **Weight** (kg, mean ± SD) | 62.66 ± 13.80 |
| **Height** (cm, mean ± SD) | 158.12 ± 8.45 |

**Abbreviations**: AL, axial Length; ACD, anterior chamber depth; LT, lens thickness; CCT, central corneal thickness;WTW, white-to-white diameter; K, keratometry; SD, standard deviation.

**Table 2** Correlations Between Ocular Biometry and Age, Weight, and Height

| Ocular Biometry | Spearman Correlation Coefficient (p-value) | | |
|---|---|---|---|
| | **Age** | **Weight** | **Height** |
| **AL** | −0.121 (<0.001) | 0.235 (<0.001) | 0.338 (<0.001) |
| **ACD** | −0.275 (<0.001) | 0.230 (<0.001) | 0.239 (<0.001) |
| **LT** | 0.431 (<0.001) | −0.118 (<0.001) | −0.133 (<0.001) |
| **CCT** | −0.104 (<0.001) | 0.090 (<0.001) | 0.088 (<0.001) |
| **WTW** | −0.216 (<0.001) | 0.194 (<0.001) | 0.273 (<0.001) |
| **K1** | 0.061 (<0.001) | −0.143 (<0.001) | −0.249 (<0.001) |
| **K2** | 0.120 (<0.001) | −0.159 (<0.001) | −0.260 (<0.001) |

**Abbreviations**: AL, axial length; ACD, anterior chamber depth; LT, lens thickness; CCT, central corneal thickness; WTW, white-to-white diameter; K, keratometry.

**Table 3** Ocular Biometric Parameters Stratified by Gender, Diabetes, Hypertension, Dyslipidemia, and Chronic Kidney Disease with Mean Differences and 95% Confidence Intervals

| | AL (mm, mean ± SD) | ACD (mm, mean ± SD) | LT (mm, mean ± SD) | CCT (mm, mean ± SD) | WTW (mm, mean ± SD) | K1 (D, mean ± SD) | K2 (D, mean ± SD) |
|---|---|---|---|---|---|---|---|
| **Gender** | | | | | | | |
| Male | 23.99 ± 1.42 | 3.20 ± 0.44 | 4.53 ± 0.49 | 0.54 ± 0.04 | 12.03 ± 0.47 | 43.27 ± 1.62 | 44.33 ± 1.68 |
| Female | 23.37 ± 1.39 | 2.97 ± 0.45 | 4.65 ± 0.48 | 0.53 ± 0.04 | 11.77 ± 0.45 | 43.95 ± 1.58 | 45.04 ± 1.63 |
| MD (95% CI) | 0.63 (0.56, 0.70) | 0.23 (0.21, 0.25) | −0.12 (−0.14, −0.09) | 0.01 (0.00, 0.01) | 0.25 (0.23, 0.28) | −0.68 (−0.76, −0.60) | −0.71 (−0.79, −0.63) |
| **Diabetes** | | | | | | | |
| Yes | 23.40 ± 1.14 | 3.09 ± 0.43 | 4.62 ± 0.51 | 0.54 ± 0.04 | 11.86 ± 0.44 | 43.76 ± 1.55 | 44.82 ± 1.62 |
| No | 23.72 ± 1.51 | 3.06 ± 0.47 | 4.59 ± 0.48 | 0.53 ± 0.04 | 11.89 ± 0.48 | 43.61 ± 1.66 | 44.70 ± 1.71 |
| MD (95% CI) | −0.32 (−0.39, 0.25) | 0.03 (0.00, 0.05) | 0.03 (0.00, 0.06) | 0.01 (0.00, 0.01) | −0.04 (−0.06, −0.01) | 0.15 (0.06, 0.24) | 0.12 (0.02, 0.21) |
| **Hypertension** | | | | | | | |
| Yes | 23.47 ± 1.19 | 3.04 ± 0.43 | 4.68 ± 0.44 | 0.53 ± 0.03 | 11.83 ± 0.44 | 43.88 ± 1.64 | 44.97 ± 1.73 |
| No | 23.65 ± 1.45 | 3.07 ± 0.46 | 4.59 ± 0.49 | 0.53 ± 0.04 | 11.89 ± 0.48 | 43.63 ± 1.63 | 44.71 ± 1.69 |
| MD (95% CI) | −0.18 (−0.30, −0.06) | −0.03 (−0.08, 0.01) | 0.09 (0.40, 0.14) | 0.00 (0.00, 0.00) | −0.06 (−0.10, −0.01) | 0.24 (0.08, 0.40) | 0.26 (0.09, 0.42) |
| **Dyslipidemia** | | | | | | | |
| Yes | 23.59 ± 1.32 | 3.03 ± 0.41 | 4.68 ± 0.43 | 0.54 ± 0.03 | 11.85 ± 0.42 | 43.80 ± 1.63 | 44.76 ± 1.69 |
| No | 23.64 ± 1.44 | 3.07 ± 0.46 | 4.59 ± 0.49 | 0.53 ± 0.04 | 11.89 ± 0.48 | 43.64 ± 1.64 | 44.73 ± 1.69 |
| MD (95% CI) | −0.05 (−0.21, 0.11) | −0.04 (−0.08, 0.01) | 0.09 (0.04, 0.13) | 0.01 (0.00, 0.01) | −0.04 (−0.09, 0.01) | 0.16 (−0.02, 0.34) | 0.04 (−0.15, 0.22) |
| **CKD** | | | | | | | |
| Yes | 23.42 ± 1.24 | 3.03 ± 0.39 | 4.75 ± 0.52 | 0.53 ± 0.04 | 11.87 ± 0.43 | 43.78 ± 1.62 | 44.94 ± 1.64 |
| No | 23.65 ± 1.44 | 3.07 ± 0.46 | 4.59 ± 0.49 | 0.53 ± 0.04 | 11.89 ± 0.48 | 43.65 ± 1.64 | 44.72 ± 1.69 |
| MD (95% CI) | −0.23 (−0.44, −0.22) | −0.04 (−0.10, 0.01) | 0.15 (0.08, 0.22) | 0.00 (0.00, 0.01) | −0.01 (−0.08, 0.06) | 0.14 (−0.10, 0.37) | 0.21 (−0.03, 0.45) |

**Abbreviations**: AL, axial length; ACD, anterior chamber depth; LT, lens thickness; CCT, central corneal thickness; WTW, white-to-white diameter; K, keratometry; SD, standard deviation; MD, mean difference; CI, confidence interval.

increased LT compared to non-diabetic eyes. Hypertension was associated with a subtle increase in LT and keratometry values, while dyslipidemia showed a minor effect on LT but no significant impact on other biometric parameters. Patients with CKD had slightly thicker lenses compared to those without CKD. However, other ocular parameters remained comparable between the two groups.

Multivariate linear regression revealed the following associations: Table 4A**: Axial length (mm)** decreased with age and was positively associated with height and weight. Diabetic individuals had shorter AL, while females had significantly shorter AL than males. Hypertension, dyslipidemia, and CKD did not show significant associations with AL. Table 4B**: Anterior chamber depth (mm)** decreased with age and was positively associated with weight while height did not show a significant association. Chronic kidney disease was linked to shallower ACD, while females had significantly shallower ACD than males. Diabetes, hypertension, and dyslipidemia were not significantly associated with ACD. Table 4C**: Lens thickness (mm) i**ncreased with age and was significantly greater in individuals with diabetes and CKD. Females had thicker lenses than males. Weight, height, hypertension, and dyslipidemia were not significantly associated with LT. Table 4D**: Central corneal thickness (µm)** decreased with age, while diabetes and dyslipidemia were associated with increased CCT. Females had thinner corneas than males. Weight, height, hypertension, and CKD did not show significant associations with CCT. Table 4E**: White-to-white diameter (mm)** showed a negative association with age and a positive association with height and weight. Diabetes was associated with a smaller WTW diameter. Females had significantly smaller WTW diameter than males. Hypertension, dyslipidemia, and CKD were not significantly associated with WTW diameter. Table 4F**: Keratometry 1 (diopters)** was significantly associated with height, with taller individuals having flatter K1. Females had steeper K1 than males. Age, weight, hypertension, diabetes, dyslipidemia, and CKD were not significantly associated with K1. Table 4G**: Keratometry 2 (diopters)** was also significantly associated with height hypertension, diabetes, and dyslipidemia. Females had steeper K2 than males. Age, weight, and CKD were not significantly associated with K2.

**Table 4** Relationship Between Ocular Biometry and Gender, Diabetes Mellitus, Hypertension, Dyslipidemia, and Chronic Kidney Disease with Multiple Linear Regression

| Factors | Unstandardized Coefficients | 95% Confidence interval | Standardized Coefficients | p-value |
|---|---|---|---|---|
| **A: Axial length (mm)** | | | | |
| Age | −0.012 | −0.017, −0.008 | −0.098 | <0.001 |
| Weight | 0.005 | 0.001, 0.009 | 0.055 | 0.008 |
| Height | 0.028 | 0.020, 0.036 | 0.176 | <0.001 |
| Hypertension | −0.270 | −0.284, 0.023 | −0.099 | 0.095 |
| Diabetes | −0.130 | −0.445, −0.245 | −0.034 | <0.001 |
| Dyslipidemia | −0.345 | −0.019, 0.310 | −0.125 | 0.083 |
| Chronic kidney disease | 0.146 | −0.394, 0.009 | 0.034 | 0.061 |
| Female - Male | −0.193 | −0.394, −0.146 | −0.034 | <0.001 |
| **B: Anterior chamber depth (mm)** | | | | |
| Age | −0.008 | −0.010, −0.007 | −0.214 | <0.001 |
| Weight | 0.004 | 0.002, 0.005 | 0.116 | <0.001 |
| Height | 0.001 | −0.001, 0.003 | 0.019 | 0.447 |
| Hypertension | 0.017 | −0.031, 0.064 | 0.014 | 0.495 |
| Diabetes | −0.001 | −0.032, 0.030 | −0.001 | 0.942 |
| Dyslipidemia | 0.011 | −0.041, 0.062 | 0.008 | 0.685 |
| Chronic kidney disease | −0.079 | −0.142, −0.017 | −0.044 | 0.013 |
| Female -Male | −0.159 | −0.197, −0.120 | −0.185 | <0.001 |

(*Continued*)

**Table 4** (Continued).

| | | | | |
|---|---|---|---|---|
| **C: Lens thickness (mm)** | | | | |
| Age | 0.018 | 0.017, 0.020 | 0.409 | <0.001 |
| Weight | −0.001 | −0.003, 0.000 | −0.035 | 0.081 |
| Height | 0.001 | −0.001, 0.004 | 0.024 | 0.315 |
| Hypertension | −0.024 | −0.076, 0.028 | −0.018 | 0.360 |
| Diabetes | 0.044 | 0.010, 0.077 | 0.044 | 0.012 |
| Dyslipidemia | 0.004 | −0.052, 0.060 | 0.003 | 0.881 |
| Chronic kidney disease | 0.162 | 0.093, 0.230 | 0.081 | <0.001 |
| Female -Male | 0.070 | 0.028, 0.112 | 0.072 | 0.001 |
| **D: Central corneal thickness (μm)** | | | | |
| Age | −0.279 | −0.405, −0.153 | −0.084 | <0.001 |
| Weight | 0.109 | −0.002, 0.220 | 0.041 | 0.055 |
| Height | −0.034 | −0.248, 0.180 | −0.008 | 0.756 |
| Hypertension | −3.131 | −7.360, 1.097 | −0.031 | 0.147 |
| Diabetes | 4.905 | 2.160, 7.651 | 0.067 | <0.001 |
| Dyslipidemia | 6.881 | 2.337, 11.424 | 0.062 | 0.003 |
| Chronic kidney disease | −2.178 | −7.730, 3.373 | −0.015 | 0.442 |
| Female -Male | −5.731 | −9.147, −2.315 | −0.079 | 0.001 |
| **E: White-to-white diameter (mm)** | | | | |
| Age | −0.005 | −0.007, −0.004 | −0.121 | <0.001 |
| Weight | 0.002 | 0.001, 0.004 | 0.072 | 0.001 |
| Height | 0.007 | 0.004, 0.010 | 0.134 | <0.001 |
| Hypertension | −0.018 | −0.069, 0.033 | −0.014 | 0.480 |
| Diabetes | −0.043 | −0.076, −0.010 | −0.047 | 0.011 |
| Dyslipidemia | 0.029 | −0.025, 0.084 | 0.021 | 0.293 |
| Chronic kidney disease | −0.008 | −0.075, 0.059 | −0.004 | 0.816 |
| Female -Male | −0.123 | −0.164, −0.082 | −0.136 | <0.001 |
| **F: Keratometry 1 (D)** | | | | |
| Age | −0.004 | −0.009, 0.002 | −0.026 | 0.166 |
| Weight | −0.003 | −0.008, 0.001 | −0.029 | 0.164 |
| Height | −0.037 | −0.047, −0.028 | −0.196 | <0.001 |
| Hypertension | 0.158 | −0.029, 0.344 | 0.034 | 0.099 |
| Diabetes | 0.106 | −0.016, 0.227 | 0.032 | 0.087 |
| Dyslipidemia | −0.073 | −0.273, 0.128 | −0.014 | 0.478 |
| Chronic kidney disease | 0.078 | −0.167, 0.324 | 0.012 | 0.531 |
| Female -Male | 0.240 | 0.089, 0.391 | 0.074 | 0.002 |
| **G: Keratometry 2 (D)** | | | | |
| Age | 0.005 | −0.001, 0.010 | 0.031 | 0.105 |
| Weight | −0.005 | −0.010, 0.000 | −0.040 | 0.059 |
| Height | −0.039 | −0.049, −0.030 | −0.201 | <0.001 |
| Hypertension | 0.220 | 0.028, 0.413 | 0.046 | 0.025 |
| Diabetes | 0.135 | 0.010, 0.260 | 0.040 | 0.035 |
| Dyslipidemia | −0.245 | −0.452, −0.038 | −0.047 | 0.020 |
| Chronic kidney disease | 0.183 | −0.070, 0.435 | 0.026 | 0.157 |
| Female -Male | 0.183 | 0.028, 0.339 | 0.054 | 0.021 |


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## Discussion

To the best of our knowledge, our study is the first to analyze baseline ocular biometry in patients with cataracts in Thailand. These results are comparable with those of previous studies conducted of East Asian populations.

The mean AL in our sample was 23.64 ± 1.43 mm, which appeared to be shorter than the reported means in Chinese 24.61 ± 2.36 mm,[11] Korean 24.22 ± 1.87 mm,[12] and Japanese 24.78 ± 1.46 mm[13] populations Similarly, the mean ACD in our sample was 3.07 ± 0.46 mm, which was comparable to the Korean mean of 3.09 ± 0.44 mm[12] but lower than the Chinese mean of 3.30 ± 0.51 mm,[11] while slightly greater than the Japanese mean of 2.92 ± 0.41 mm.[13] The LT in our sample, with a mean of 4.60 ± 0.49 mm, is comparable with that of Korean cataract patients with a mean LT of 4.53 ± 0.50 mm.[12] The CCT of 0.53 ± 0.04 mm is also similar to the Korean mean of 0.54 ± 0.04 mm[12] and the Japanese mean of 0.55 ± 0.03 mm.[13]

Overall, ocular biometry among East Asian populations showed subtly different but generally comparable results.[11–13] Similar findings have been observed in other countries including Europe, Australia, and North America.[14] This suggests that, although there is heterogeneity in ocular biometry values, these differences do not appear to be significantly related to geographic location.

Ocular biometry showed significant differences between genders. Males tended to have larger globes, while females had a smaller ACD and thicker lenses, which could explain their higher prevalence of angle-closure glaucoma compared with that of males.[15] Additionally, males generally had flatter cornea than their female counterparts. These refractive findings are consistent with those of a previous study of a population in Korea.[16] These differences may be attributable to variations in body dimensions, such as height and weight, as well as to the influence of sex hormones, which may also play a role in these biometric disparities. Moreover, the correlations observed between ocular biometry parameters and demographic factors, such as age, weight, and height, highlight the interconnectedness of ocular dimensions with overall body dimensions.

Using the IOLMaster 700, which evaluates AL from the front of the cornea to the internal limiting membrane at the central fovea, our study confirmed that diabetic eyes commonly have a shorter AL[17]. This measurement may be influenced by subtle diabetic macular edema (DME), which is prevalent among diabetic patients, potentially resulting in a reduced AL measurement. Future studies categorizing diabetic retinopathy (DR) and DME status are necessary for a more nuanced understanding of this observation.

Similarly, eyes with diabetes tended to show increased LT. This result corroborates previous reports suggesting that diabetes is associated with increased LT, likely due to changes in lens metabolism, including accumulation of advanced glycation end products within the lens tissue.[3,4] These changes can contribute to cataract progression and complicate cataract surgery. Increased LT may also affect the accuracy of refractive outcomes post-surgery, particularly when using standard formulas for IOL power calculations. In diabetic patients, the thicker lens alters the effective lens position (ELP), which may lead to an underestimation of AL and changes in ACD, ultimately resulting in improper IOL positioning. Standard IOL power calculation formulas, which often assume average lens characteristics, may not fully account for these changes, potentially leading to refractive errors. Advanced formulas such as the Barrett Universal II, Haigis, Holladay II, and Olsen provide more accurate predictions by incorporating LT and other individual factors, including ACD and WTW diameter, thereby improving postoperative refractive outcomes.[18]

We also found that diabetic eyes exhibited a slightly higher CCT, and this is consistent with the findings of Su et al[19] and Amerasinghe et al.[20] Specifically, the study by Suraida et al[21] demonstrated that CCT is greater in eyes with DR compared to those without it. This increase in CCT can be attributed to compromised endothelial function and decreased cell density, leading to corneal edema.[22–24] Alterations in endothelial cell function may also influence corneal shape and refractive status.

In our study, HT did not show a significant association with several ocular biometry parameters, including AL, ACD, LT, WTW diameter, CCT, K1, and K2. These findings suggest that hypertension, in isolation, may not have a direct or consistent effect on ocular biometry in the studied population of Thai cataract patients.

However, previous studies have indicated that chronic hypertension can potentially affect ocular health, including influencing retinal microcirculation and intraocular pressure, which may indirectly influence ocular measurements.

Hypertension directly impacts blood vessels, including those in the eye. Alterations are significant in hypertensive patients and can be detected using optical coherence tomography angiography (OCTA).[25,26] Systemic hypertension reduces choroidal thickness[27,28] and thins the retinal nerve fiber layer (RNFL)[28,29] Despite the lack of significant associations in our study, it remains essential to consider the long-term effects of hypertension on ocular health, particularly in relation to the development of other ocular conditions, such as hypertensive retinopathy and glaucoma, which may complicate cataract surgery management and affect postoperative outcomes.

CKD results in alterations in body electrolytes, fluid balance, and the vascular system.[30] This systemic disease is associated with changes in the ocular microcirculation, which can be observed using OCTA.[31,32] Our study showed that individuals with CKD had increased LT and shallower ACD. The reason for this finding can be explained similarly to that found in diabetic patients, where abnormalities in body electrolyte levels[30] may accelerate cataract formation, leading to thicker lenses. The thickening of the lens in CKD patients could potentially affect refractive outcomes after cataract surgery by altering the ELP, much like in diabetic patients. This should be carefully considered when planning cataract surgery, as it may impact intraocular lens positioning and overall surgical outcomes.

Previous studies have demonstrated significant differences in ocular biometry, including changes in AL, LT, ACD, and CCT, have been observed in end-stage CKD patients who underwent kidney that patients with end-stage CKD often exhibit shorter AL and increased LT. These changes in ocular biometry in patients with CKD are reversible after hemodialysis[33,34] and renal transplantation,[35] as these treatments normalize the condition. In contrast, our study, which included patients at all stages of CKD, did not find significant differences in AL, WTW diameter, CCT, K1, and K2. This discrepancy may be attributed to the more pronounced ocular changes that typically occur in patients with end-stage CKD who require renal transplantation, suggesting that earlier stages of CKD may have less impact on ocular biometry.

No clear ocular disease or ocular biometry has been proven to be associated with dyslipidemia.[36,37] In our study, we found no significant associations between dyslipidemia and ocular biometric parameters such as AL, lens thickness LT, ACD, WTW diameter, K1 or K2. Our study found that patients with this disease exhibited a mildly higher CCT. In a murine model, hyperlipidemia has been shown to affect tight junctions and pump function in corneal endothelial cells,[38] suggesting that a similar effect might occur in humans. However, the impact of dyslipidemia on ocular biometry may vary depending on the severity and duration of the condition, as well as other comorbidities. Further research is needed to clarify the potential link between dyslipidemia and ocular biometric changes, particularly over longer follow-up periods and in larger patient populations.

We observed that keratometric values (K1 and K2) in our study remained within normal ranges, suggesting that corneal curvature did not significantly change in patients with systemic conditions such as diabetes, hypertension, dyslipidemia, or CKD. However, previous studies have indicated that systemic conditions, including diabetes[19,20] and dyslipidemia,[36,37] may influence corneal shape, potentially leading to alterations in keratometry readings. Although we did not find significant associations in our study, it is important to acknowledge that changes in keratometry could affect refractive outcomes following cataract surgery.

The formation of cataracts in systemic diseases involves multiple mechanisms. In diabetes mellitus, the polyol pathway converts glucose to sorbitol, causing osmotic stress and lens fiber degeneration, which generates free radicals that damage the lens. Nonenzymatic glycation leads to protein aggregation and opacity.[39–41] Hypertension contributes to cataract development through systemic inflammation, oxidative stress, and changes in ion transport in the lens capsule.[42–45] Dyslipidemia results in lipid peroxidation and oxidative damage to the lens,[46,47] while CKD induces cataractogenesis through systemic inflammation, oxidative stress, and electrolyte imbalances, which accelerate lens degeneration.[48–50]

The prevalence of both systemic diseases and cataracts increases with age, making the coexistence of these conditions common in the elderly population. Cataracts are associated with increased morbidity and mortality due to accidents caused by impaired vision and related comorbidities.[51–53]

Cataract surgery is generally safe, and it is considered a minor procedure that typically does not require extensive preoperative management or investigation because the final surgical outcomes and complication rates are not significantly different in patients with and without systemic diseases.[54,55] However, preoperative investigations may be beneficial for patients with previously unknown underlying systemic conditions. Rather than solely focusing on surgical outcomes,

emphasizing the importance of detecting these systemic diseases, which have a high prevalence in the elderly population with cataracts, could improve overall patient care and management.

Our study has several limitations. First, we did not grade the type and severity of cataracts or systemic diseases, limiting our ability to assess their associations in terms of severity. Data on systemic diseases were collected using the ICD-10 coding system, without laboratory results or medication details, which may introduce misclassification bias. Additionally, we did not account for medication use, disease duration, or the control of systemic diseases such as glycemic control and blood pressure, which are important confounders that can influence ocular biometry. These factors could potentially impact the findings and should be considered in future studies. Furthermore, our study was conducted at a single tertiary hospital, which may affect the generalizability of the findings and introduce a selection bias, as the cohort may not represent broader populations. The retrospective design of the study also limits the ability to establish causal relationships between the variables. Lastly, the lack of disease severity stratification limits the depth of our analysis, and future studies should incorporate this to better understand its impact on outcomes.

In conclusion, our study provides essential insights into the baseline ocular biometry of Thai cataract patients and highlights the differences in ocular parameters across various systemic diseases such as diabetes, hypertension, dyslipidemia, and CKD. Our findings suggest that ocular biometry, particularly LT is influenced by factors such as age, gender, and body dimensions. Specifically, systemic conditions like diabetes and CKD are shown to affect ocular biometry, leading to increased LT and altered ACD, which can potentially impact surgical outcomes and refractive results after cataract surgery. Detecting and managing these systemic diseases prior to cataract surgery is crucial for optimizing patient care and improving preoperative management of ocular biometry. The extent of these ocular changes may be influenced by whether the disease is controlled or uncontrolled, with uncontrolled conditions leading to more significant alterations. Ensuring proper disease management before surgery is essential to ensure optimal visual outcomes. Further research with larger cohorts and assessments of disease severity will be vital for refining preoperative strategies and providing tailored, effective care for this patient population.

## Data Sharing Statement

The data supporting the findings in this study are available in the main text and table Supplementary data can be requested by emailing the corresponding author.

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## Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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## Disclosure

The authors declare no competing interests.

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