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# Mean Ocular Biometric Values in Pre-Operative Cataract Patients of Marist Cottage Hospital, Uturu

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**Abstract**

Accurate ocular biometric measurements are essential for optimal intraocular lens (IOL) power calculation during cataract surgery. Axial length (AL), anterior chamber depth (ACD), lens thickness (LT), and vitreous chamber depth (VCD) are critical parameters that may vary with age, sex, and ethnicity. Most IOL power formulas are based on biometric data from non-African populations, limiting their precision when applied locally. This study aimed to determine the mean ocular biometric values of pre-operative cataract patients at Marist Cottage Hospital, Uturu, Nigeria, to establish region-specific reference values and assess correlations with age and sex. A prospective cross-sectional study was conducted from May 2023 to April 2024 involving 1,190 pre-operative cataract patients. Biometric parameters including AL, ACD, LT, and VCD were measured using a Sonomed PacScan 300A+ A-scan ultrasound. Demographic data were also recorded. Pearson and Spearman correlation analyses were used to assess linear and monotonic relationships between axial length and other parameters, including age. The mean AL was $22.54 \pm 1.32$ mm, ACD $2.63 \pm 0.49$ mm, LT $3.99 \pm 0.67$ mm, and VCD $15.99 \pm 1.15$ mm. Males had longer axial lengths (23.04 mm) than females (22.83 mm), though not statistically significant ($p = 0.386$). Pearson correlation revealed significant positive relationships between AL and ACD ($r = 0.4931$), LT ($r = 0.3717$), and VCD ($r = 0.5578$), all $p < 0.05$. Spearman correlation showed similar monotonic associations. Notably, axial length had a statistically significant negative monotonic correlation with age (Spearman's $r = -0.3680$, $p < 0.001$), indicating a consistent decline in AL with increasing age. The study provides essential biometric data for cataract surgery in Southeastern Nigeria. The negative correlation between axial length and age underscores the need for age-specific considerations in IOL power calculations. This local dataset enhances accuracy in surgical outcomes and supports evidence-based ophthalmic care in the region.

**Keywords:** mean ocular biometric values; patients; intraocular lens

## Introduction

Cataract surgery is one of the most frequently performed ophthalmic procedures globally, and its success heavily depends on the accuracy of intraocular lens (IOL) power calculation. A critical biometric parameter used in this calculation is axial length measurement—the distance from the anterior surface of the cornea to the retinal pigment epithelium. Even a slight error in measuring axial length can result in a significant postoperative refractive error; for example, a 1 mm deviation in axial length may lead to a refractive error of approximately 2.5-3.0 diopters [1]. While biometric norms from various populations, especially in Europe and North America, are widely documented and utilized in IOL calculation formulas, relying exclusively on these foreign datasets for clinical decision-making in Nigeria may be inadequate and potentially misleading. Ethnic, genetic, and environmental factors play a significant role in influencing ocular biometrics, including axial length. Numerous studies have demonstrated significant variations in axial length across different racial and ethnic groups [2, 3]. For instance, African populations tend to have shorter axial lengths on average compared to Caucasian populations, a factor that can lead to systematic errors in IOL power prediction if not accounted for in clinical practice. Therefore, applying biometric data derived from European or Asian populations to Nigerian patients without local validation could compromise the refractive outcomes of cataract surgeries.

Furthermore, within the diverse Nigeria, ocular parameters can vary between regions and communities due to differences in genetics, nutrition and geographical altitude. Marist Cottage Hospital, Uturu in Isuikwuato of Abia State, serves a unique semi-rural Eastern Nigeria population that may not be well-represented in existing biometric datasets. Local data are essential to identify region-specific trends and improve surgical outcomes through personalized care. This is particularly important for public health institutions and mission hospitals like Marist Cottage,

Uturu which serve both high-risk and underserved populations. In addition to enhancing clinical outcomes, generating axial length data from Marist Cottage Hospital contributes to national and continental databases, thus promoting evidence-based ophthalmic care and research in Nigeria. It also supports the development of customized IOL constants and improves the predictive accuracy of newer biometric formulas in the local population [4]. Without this localized information, ophthalmologists risk using assumptions that may not reflect the true anatomical characteristics of their patient population. Given the above considerations, this study aims to find the mean values of the axial length, anterior chamber depth, crystalline lens thickness and the vitreous depth of the population of preoperative cataract patients that visited the eye surgical unit of the Marist Cottage Hospital, Uturu Isuikwuato between the period of May 2023 and April 2024. The findings will not only aid in rightly deriving IOL power for this population area but also serve as a reference for future biometric research and clinical audits within the region. As findings will be compared to other regions of the globe particularly Asia where most of our surgical materials including IOL brands are sourced.

# Method

This was a prospective study from May 2023 to April 2024. The ocular biometric parameters were measured (with an A-scan device) on the preoperative cataract patients that visited the Cottage Hospital.

## Patient Selection

Only patients who visited for cataract surgery during the May 2023 and April 2024 period were selected. Patients presenting with additional ocular conditions like angle closure glaucoma, retinal detachment, traumatic cataracts and cornea ulcer were excluded from the study.

## Data Variables

The biometric data collected with A-Scan ultrasound were the axial length (the distance from the corneal surface to the retina); the anterior chamber depth (the depth between the cornea and the front surface of the lens); crystalline lens thickness; and vitreous chamber depth. The demographic data of the patients were also recorded. These included the patient's ages at the time of surgery and the gender.

## Data collection procedure

Data collection was with Sonomed PacScan 300A+ A-scan following the procedures (5,6):
1. Patient was comfortably seated and the eye was anesthetized if necessary.
2. The device was turned on and the correct measurement mode was selected.
3. The probe was gently placed on the preoperative cataract patient's eye, ensuring the proper contact and alignment with the visual axis for accurate measurements.
4. Multiple measurements were taken, while ensuring clear and consistent waveforms.
5. The measurement data and calculation results were saved in the device's database for future references.
6. After each eye and patient's measurement, the device probe was cleaned and disinfected according to the manufacturer's instructions.

## Data analysis

The measurements of the axial lengths were correlated with the other ocular biometric parameters. How linear and monotonic was analysed with Pearson and Spearman respectively.

# Result

In the study, a total of 1190 pre-operative cataract patients were seen with mean age as 63.36yrs. In this general population, the mean anterior chamber depth was measured as 2.6278mm, while the mean crystalline lens thickness in the subjects was 3.992 mm. The vitreous chamber length and the ocular axial length were measured with the mean values of 15.995mm and 22.539mm respectively.

**Table 1:** The Mean Ocular Biometrics with Age

| Anterior chamber length | | | | Lens thickness | | Vitreous length | | Axial length | |
|---|---|---|---|---|---|---|---|---|---|
| Age | n | mm | p-value | mm | p-value | mm | p-value | mm | p-value |
| <40 | 30 | 3.12 ± 0.258 | <0.05 | 5.32 ± 0.321 | <0.05 | 15.92±1.340 | 0.03 | 24.35±1.856 | 0.195 |
| 40 to <50 | 210 | 2.65 ± 0.540 | <0.001 | 4.21 ± 0.4 00 | <0.001 | 16.13+1.213 | <0.001 | 22.93+1.745 | <0.001 |
| 50 to <60 | 250 | 2.58 ± 0.459 | <0.001 | 4.03 ± 0.610 | <0.001 | 16.41+ 6.334 | <0.001 | 22.92+1.147 | <0.001 |
| 60 to <70 | 380 | 2.74 ± 0.539 | <0.001 | 3.88 ± 0.680 | <0.001 | 16.21+1.075 | <0.001 | 22.88+1.241 | <0.001 |
| 70 to <80 | 190 | 2.59 ± 0.483 | <0.001 | 3.94 ± 0.679 | <0.001 | 16.2+0.968 | <0.001 | 22.71+0.889 | <0.001 |
| >80 | 130 | 2.81 ± 0.316 | <0.001 | 4.21 ± 0.553 | <0.001 | 14.21+1.112 | <0.001 | 22.89+1.34 | <0.001 |

In table 1: age distribution of the ocular biometrics in the preoperative cataract patients, the group less than 40 years, has the mean anterior chamber length measured as 3.12 ± 0.258mm (P <0.05); while their crystalline lens mean thickness was 5.32 ± 0. 321mm (P <0.05). Still, in this age group, the vitreous length mean was measured as 15.92 ± 1.340mm (P = 0.030) with the axial length as 24. 35 ± 1.856mm (P=0.195). In the other higher age groups, the measured biometric values were more significant, with P-values typically less than 0.001. Age group 40 to <50 years, with a study population of 210 preoperative cataract patients, had 2.65± 0.54mm as the anterior chamber

depth; and a crystalline lens thickness of 4.21± 0.40mm. The vitreous length was 16. 13 ± 1.213 and the entire axial length measured 22. 93 ±1. 745mm. The oldest age group of the more than 80years with the population of 130 had the shallowest vitreous chamber that measured 14.21±1.112mm. The lens thickness and the ocular axial length was longest in the less than 40 years old though not significant (P=0.195).

Axial length decreased with age, from 22.92 ± 1.147mm in the 40 to < 50years to 22.89 ±1.34mm in the greater than 80years with p-values typically less than 0.001.

**Table 2:** The Ocular Biometrics with Sex

| Sex | n | Anterior chamber depth | Lens thickness | Vitreous length | Axial length |
|---|---|---|---|---|---|
| Male | 530 | 2.65 ± 0.474 | 4.07 ± 0.679 | 16.56 ± 1.151 | 23.04 ± 1.171 |
| Female | 660 | 2.7 ± 0.507 | 4.05 ± 0.663 | 16.04 ± 1.069 | 22.83 ± 1.409 |
| P values | | 0.587 | 0.884 | 0.012 | 0.386 |

In table 2, gender distribution of the ocular biometrics, the study population involved 530 males and 660 females; the mean anterior chamber depth in males measured 22.65 ± 0. 474mm this was smaller than the females 2.7 ± 0.507mm. However, this difference is not significant (P=0.587). The males have a thicker crystalline lens 4.07 ± 0.679mm vs the 4.05

+ - 0. 663mm thickness of females (P= 0.884). Also longer in males was the axial length 23.04 + - 1. 171 with the females as 22. 83 + - 1. 409mm (P= 0.386). The difference in measurements between males and females was only significant (P= 0.012) in the mean values of the vitreous length 16.56 + - 1. 51mm for males and 16. 04 + - 1. 069 for females.

**Table 3:** Correlating Patients Biometrics with Axial Length

| | Pearson | | Spearman | |
|---|---|---|---|---|
| Patient's biometrics | r | p | r | p |
| ACD | 0.4931 | <0.05 | 0.625608 | < 0.001 |
| LT | 0.371742 | <0.05 | 0.554647 | <0.001 |
| VCD | 0.557849 | <0.05 | 0.788971 | < 0.001 |
| Age | -0.05711 | 0.537 | 0.368037 | < 0.001 |

Using the Pearson correlation statistical analysis which is a measure of linearity of the ocular axial length with the other biometrics; anterior chamber depth has a positive correlation 0.4931. It was the same positive relationship with lens thickness and vitreous chamber length, r = 0.3717 and r=0. 5578 respectively. This correlation values were significant with each (P< 0.05). The co-relationship was a negative one with age (r= -0.05711); the axial length decreased with the age of the pre-operative cataract patients (P = 0.537). The Spearman correlation measured how monotonic the change in axial length was with each biometric value; and there was consistency in the directions, with p- values less than .001 in each correlation ship.

## Discussion

A-scan ultrasound biometry is a technique used to measure the axial length of the eye. High-frequency sound waves are emitted and reflected off the eye's structures. The reflected waves are used to calculate the axial length and the other ocular biometrics. This provides insight into the eye's internal structure and proportions. Accurate ocular biometric measurements are essential for successful cataract surgery and optimal patient care. The correct axial length (AL) measurements ensure optimal IOL selection, predict potential complications and optimize surgical technique (2,4,1). Anterior Chamber Depth (ACD) which represents the effective

lens position (ELP) (7) informs the cataract surgeon about the available space for IOL placement and the stability of the IOL. It also helps assess the risk of certain complications, such as angle closure or iris damage (2,3,1). The lens Thickness (LT) measurement informs the surgeon about the lens size and phacoemulsification settings. It helps assess the risk of certain complications, such as capsular rupture or lens instability (2,1); and the vitreous Chamber Depth (VCD) helps in understanding and managing various retinal and vitreoretinal conditions (2,1). In this study, the mean ACD with age decreased from 3.12 ± 0.258 mm in the youngest age group to 2.81 ± 0.316 mm in the oldest. Another study in Iran showed the mean ACD was 2.62 mm, which is lower than our study [8]. The mean ACD was comparable with a study in South China (3.13 mm), Myanmar (2.81 mm) and USA (2.86 ± 0.45 mm) [9–11].

Our study showed that the mean ACD is smaller in male with 2.65 ± 0.474 mm than female 2.7 ± 0.507 mm. Gender difference showed in reverse order in Reykjavik Eye Study with mean ACD in male 3.20 mm and female 3.08 mm (12). In Mongolian population, a report also stated that ACD in male is greater than female, with 2.87 mm and 2.77 mm [13]. Meanwhile, the Blue Mountain Eye Study (BMES) showed that the ACD is greater in female than male with 3.06 mm and 3.04 mm [14]. In Table 4, we compare our mean AL for the older age groups which is slightly lower than studies in the USA, South China, Iran and Myanmar where the mean AL was 23.46 ± 1.03 mm, 23.48 mm (23.40–23.55), 23.14 mm and 22.76 mm respectively [8–11]. This study showed that mean AL is slightly longer in male (23.04 ± 1.171 mm) than female (22.83 ± 1.409 mm). This study is also consistent with several studies that showed that males have longer axial length than females. The Iranian population study showed axial length in male 23.41 (23.37–23.46) is longer than in female 22.95 (22.91–22.98) [8]. The Blue Mountain Eye Study within 10-year period showed the mean AL is greater in male 23.76 mm than in female 23.19 mm [14,15]. In an aged population in South China, male AL (23.68 mm) was significantly longer than female AL (23.23 mm) [9].

In this study, the mean crystalline lens thickness (LT) was much similar in both genders; measuring 4.07 ± 0.679 mm in males and 4.05 ± 0.663 mm in females. This result was different compared to a study in Iranian population where males have a significantly shorter LT (3.68–4.85 mm) than female (3.71–4.90 mm) [8]. This study measured a thinner lens thickness than the study in Iran where the mean was 4.28 mm (4.27–4.29) (8), and much thinner compared with the study in the USA where the mean LT was 4.93 ± 0.56 mm (3.03–6.41 mm) [11]. The study showed axial length; anterior chamber depth and Lens Thickness, correlated with age. AL was shortened with the increase of age and ACD were shallowed while LT increased with age. Similar with our study, an Iranian study found that AL and ACD were shortened with age and LT increased [8]. A study in the Los Angeles Latino Eye Study Group also showed that older individuals had shallower ACDs (P < 0.001) [16]. Another study in an older Caucasian population found that from age 59 years or older, there is a mean reduction for 0.12 mm per decade in women and 0.02 mm in men [17]. Jivrajka et al., showed that AL was found to be longer (r = −0.127; P < 0.001) and ACD was found deeper (r = −0.250; P < 0.001) in younger individuals, while LT tended to be thicker (r = 0.385; P < 0.001) in older individuals [11].

The trend for an axial length decreases that is parallel to aging was also found in researches done in the US, China, India, and Mexico [3,9,11,14]. Also linear with this study, is another study in Nigeria that showed a positive correlation between AL and ACD. This study stated that a 1 mm increment of AL is associated with 0.07 mm increment of ACD [18]. Results in this study is also similar to a study conducted in South Africa which found a positive correlation between AL and ACD (r = 0.66; p < 0.001) [19].

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