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Central Corneal Thickness and Its Association with Refractive Error in School-Aged Children in Rural Nigeria

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ABSTRACT

Background: Central corneal thickness (CCT) is an important ocular biometric parameter that influences intraocular pressure measurement and refractive status interpretation. Variations in CCT have been reported across age, gender, ethnicity, and refractive error; however, data on pediatric populations in rural Nigerian settings remain limited. This study investigated the association between central corneal thickness and refractive error among school-aged children in Isuikwuato LGA, Abia State, Nigeria.

Materials and Methods: A cross-sectional descriptive study was conducted involving 450 children aged 10-18 years. All participants underwent comprehensive ocular examinations including cycloplegic refraction and CCT measurement using ultrasound pachymetry. Data were analyzed using descriptive statistics, independent t-tests, and one-way ANOVA at $p<0.05$ significance level.

Results: Mean CCT values were 537.5 ± 24.6 µm in the right eye and 538.0 ± 24.1 µm in the left eye. Females showed slightly higher mean CCT values than males (539.5 µm vs 536.2 µm), but the difference was not statistically significant ($p=0.15$). Children aged 10-12 years had marginally higher CCT values than older age groups, though no significant age-related differences were observed ($p=0.60$ for OD, $p=0.11$ for OS). Hyperopic participants recorded higher mean CCT values (539.9 µm) than emmetropic (537.8 µm) and myopic children (536.4 µm), but these variations were not statistically significant ($p=0.50$).

Conclusion: Central corneal thickness among school-aged children in Isuikwuato LGA is within normal limits and shows no significant association with age, gender, or refractive error status. These findings provide valuable baseline data for pediatric ocular health assessment in rural Nigerian settings.

Keywords: Central Corneal Thickness; Refractive Error; Pachymetry; School Children; Nigeria

I. Introduction

Central corneal thickness (CCT) is an anatomical characteristic of the eye that has been implicated in the variability of refractive outcomes and ocular biomechanics [1]. As a biometric index, CCT reflects the structural and functional health of the cornea, providing insight into barrier integrity, endothelial pump function, and susceptibility to pathological changes[2,3]. Clinically, CCT plays a pivotal role in intraocular pressure measurement accuracy, glaucoma diagnosis, and refractive surgery candidacy[4].

From a refractive standpoint, the cornea's thickness and curvature are major determinants of how light is focused on the retina. Variations in CCT may influence corneal biomechanics, refractive power, and susceptibility to refractive errors. Some studies suggest that thinner corneas may predispose to myopic shifts, whereas thicker corneas may correspond to hyperopic tendencies[5]. However, this association remains inconsistent, particularly in pediatric populations where ocular growth is ongoing[6].

Despite gaining increasing relevance in clinical and research settings, the specific association between CCT and refractive errors in Nigerian children remains under-investigated. The absence of region-specific data on the association between refractive errors and central corneal thickness could hinder the design of effective vision screening and intervention programs. In rural Nigerian settings such as Isuikwuato LGA, the burden may be compounded by limited access to pediatric eye care, low awareness, and inadequate school-based screening initiatives.

This study aimed to investigate the association between central corneal thickness and refractive errors in school-aged children in Isuikwuato LGA, Abia State, Nigeria.

II. Materials and Methods

Study Area

The study was conducted in Isuikwuato Local Government Area (LGA) of Abia State, Nigeria, a rural community with a mix of government-owned and private schools.

Study Design

A cross-sectional descriptive survey design was employed.

Study Population

The target population consisted of school children aged 10 to 18 years enrolled in selected secondary schools within Isuikwuato LGA.

Inclusion and Exclusion Criteria

Inclusion criteria: (1) Children aged 10-18 years; (2) Enrolled in selected schools; (3) Parental consent and child assent obtained. Exclusion criteria: (1) Active ocular infections or eye disease; (2) History of ocular surgery or corneal pathology; (3) Inability to cooperate; (4) Contraindications to cycloplegic agents.

Sample Size Determination

Using the Leslie Kish formula, a total of 450 school-aged children were enrolled.

Sampling Technique

A multistage sampling strategy was employed: random selection of wards, schools, and participants.

Research Equipment

- Hand-held pachymeter, iPac® (Reichert Technologies)
- Handheld autorefractometer (Nidek Ark - 30)
- Pen torch
- Keeler ophthalmoscope
- 0.5% Amethocaine
- 1% Cyclopentolate

Data Collection Procedures

Central Corneal Thickness Measurement: CCT was determined using the iPac ultrasound pachymeter. One drop of 0.5% amethocaine was instilled. The probe was gently placed perpendicular to the central cornea. Three measurements were taken for each eye and the lowest value was recorded.

Cycloplegic Autorefraction: Two drops of 1% cyclopentolate were instilled 10 minutes apart. Refractive values were recorded and spherical equivalent calculated.

Data Analysis Techniques

Data were analyzed using SPSS version 27.0. Descriptive statistics, independent t-tests, and one-way ANOVA were employed. A p-value <0.05 was considered statistically significant.

Ethical Considerations

Ethical approval was obtained from the Ethics Committee of the Faculty of Paediatric Optometry, Nigerian Postgraduate College of Optometrists. Written informed consent was obtained from parents/guardians.

III. Results

Sociodemographic Characteristics

A total of 450 participants were enrolled (100% response rate). Mean age was 12.4 ± 3.2 years. Males constituted 51.1% (n=230) and females 48.9% (n=220).

Mean Central Corneal Thickness

Mean CCT was 537.5 ± 24.6 μm (OD) and 538.0 ± 24.1 μm (OS), with 95% CI of 535.5-540.1 μm and 535.8-540.3 μm respectively.

Table 1: Mean Central Corneal Thickness

Eye	Minimum (μm)	Maximum (μm)	Mean (μm)	SD (μm)	CI @ 95%
OD	500	584	537.5	24.6	535.5-540.1
OS	500	583	538.0	24.1	535.8-540.3

Variation by Gender

Females had slightly higher mean CCT (539.5 ± 24.2 μm) than males (536.2 ± 24.9 μm). The difference was not statistically significant (t=-1.42, p=0.15).

Table 2: Mean CCT by Gender

Gender	Eye	Mean (μm)	SD (μm)	t-value	p-value
Male	OD	536.2	24.9	-1.42	0.15
Female	OD	539.5	24.2		
Male	OS	536.4	23.7	-1.45	0.15
Female	OS	539.7	24.5		

Variation by Age

Children aged 10-12 years had higher CCT values (539.4 ± 23.7 μm, OD) compared to older groups. One-way ANOVA showed no significant difference (p=0.60 for OD, p=0.11 for OS).

Table 3: Mean CCT by Age Group

Age Group	Eye	Mean (μm)	SD (μm)	F-value	p-value
10-12	OD	539.4	23.7	0.5	0.60
13-15	OD	536.7	25.0		
16-18	OD	537.8	25.0		
10-12	OS	541.4	23.6	2.15	0.11
13-15	OS	535.9	24.0		
16-18	OS	538.3	25.0		

Variation by Refractive Status

Hyperopes had the highest mean CCT (539.9 µm, OD), followed by emmetropes (537.8 µm) and myopes (536.4 µm). One-way ANOVA showed no significant difference (p=0.50).

Table 4: Mean CCT by Refractive Status

Refractive Status	Eye	Mean (µm)	SD (µm)	F-value	p-value
Emmetropia	OD	537.8	23.7	0.8	0.50
Hyperopia	OD	539.9	23.0		
Myopia	OD	536.4	24.2		
Emmetropia	OS	537.4	24.3	0.7	0.50
Hyperopia	OS	540.2	24.9		
Myopia	OS	537.0	23.6		

IV. Discussion

Mean Central Corneal Thickness

The mean CCT values of 537.5 ± 24.6 µm (OD) and 538.0 ± 24.1 µm (OS) fall within the generally accepted normal range for children and are comparable to findings reported in African pediatric populations. Beyuo (2022), in a study of Ghanaian school children aged 6-15 years, reported a mean CCT of 538.8 ± 27 µm[7], which closely aligns with the values obtained in the present study.

Similarly, Nigerian studies by Nzewulu-Egwuonwu (2012) and Uche et al. (2021) reported mean CCT values ranging from approximately 527-533 µm in their populations. Although these values are slightly lower than those observed in the present study, the difference may be explained by variations in study population, as those studies included older adolescents and adults.

In contrast, studies conducted in non-African populations have generally reported higher mean CCT values. Hashemi et al. (2019) documented a mean CCT of 556.3 ± 34.0 µm among Iranian children[10], while Kim et al. (2020) reported mean values exceeding 530 µm in Korean school children[11]. The relatively lower mean CCT observed in the present study compared to these populations may be related to ethnic differences, as children of African descent have consistently been reported to possess thinner corneas compared to Caucasian and Asian counterparts.

Variation with Gender

Female participants exhibited slightly higher mean CCT values compared to males (539.5 µm vs 536.2 µm), but the difference was not statistically significant (p=0.15). This finding aligns with Beyuo (2022) in Ghanaian children[7], who reported no significant difference in CCT between boys and girls. Similarly, the Pediatric Eye Disease Investigator Group (PEDIG, 2011) noted that while boys had marginally thicker corneas than girls across most age categories, the difference was minimal and secondary to other factors such as ethnicity[12].

However, some studies have reported a more pronounced gender effect. Kim et al. (2020) found a statistically significant gender difference (p=0.015) in Korean schoolchildren, where boys had thicker corneas (540.4 ± 32.8 µm) than girls (531.4 ± 32.1 µm)[11]. These inconsistencies across populations suggest that while biological sex may influence ocular biometry, its impact on CCT is likely modulated by other factors such as ethnicity, geographical location, and environmental exposures.

Variation with Age

Participants aged 10-12 years exhibited the highest mean CCT values (539.4 ± 23.7 µm, OD) compared with older age groups. However, one-way ANOVA showed no statistically significant difference among the three age groups (p=0.60 for OD, p=0.11 for OS). These results suggest that within this specific pediatric age range, CCT remains relatively stable.

The finding of no significant age-related variation is consistent with Beyuo (2022) in Ghanaian schoolchildren[7], which found that while mean CCT values fluctuated slightly across age brackets (ranging from 534.9 µm to 541.4 µm), there was no significant difference among age groups. Hussein et al. (2012) also reported no statistically significant difference in CCT between age groups in Egyptian children[13].

Conversely, PEDIG (2011) documented that mean CCT increased steadily between ages 1 and 11 years before stabilizing[12]. The difference may be attributed to the fact that the current study focused on an older pediatric demographic (10-18 years) where the cornea may have already reached adult-like maturation.

Variation with Refractive Error

Hyperopic participants demonstrated the highest mean CCT values (539.9 µm, OD), while participants with myopia exhibited relatively lower mean CCT values (536.4 µm, OD). Despite these numerical differences, comparison of mean CCT across refractive groups revealed no statistically significant difference (p=0.50), indicating that refractive status was not significantly associated with CCT among the school-aged children studied.

This finding aligns with Chen et al. (2009), who found no significant correlation between refractive error and CCT in a Taiwanese population (r = −0.034, p = 0.445)[14]. Similarly, the Beijing Eye Study by Zhang et al. (2009) reported no significant association between CCT and refractive error (p=0.43) [15].

However, other studies have reported differing patterns. PEDIG (2011) observed that CCT was thinner in myopic eyes compared to hyperopic or emmetropic eyes[12]. Chang et al. (2001) reported thinner CCT values in more myopic eyes ($r=0.16$, $p=0.021$)[16]. Kotb and Eissa (2021) also demonstrated a negative correlation between myopic refractive error and corneal thickness in an Egyptian adult population[17].

The variability in findings across studies may be related to differences in age groups, ethnicity, refractive assessment methods, and ocular biometric characteristics.

V. Conclusion

This study provides important insights into the ocular biometric profile of school-aged children in Isuikwuato LGA. The mean CCT values obtained fall within established pediatric reference ranges. Although variations in CCT were observed across age, gender, and refractive categories, neither age nor gender showed a statistically significant influence on corneal thickness. Similarly, no significant association was found between CCT and refractive error status.

These findings contribute valuable baseline data on pediatric central corneal thickness in a rural Nigerian setting, where such information remains limited. The absence of significant associations with age, gender, or refractive error suggests that CCT can be interpreted independently of these variables when examining school-aged children in this population.

Recommendations

1. Central corneal thickness measurement should be considered as part of comprehensive school eye screening programs where resources permit.
2. Eye care institutions should encourage the development of locally derived pediatric corneal thickness reference values.
3. Optometrists should interpret CCT measurements independently of age, gender, and refractive status in school-aged children.
4. Further research should investigate the relationship between CCT, axial length, and other ocular biometric parameters.

Limitations

The cross-sectional design limits causal inferences. The study was limited to a single LGA. Other potential factors influencing CCT, such as axial length, corneal curvature, and environmental exposures, were not assessed.

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Declarations

Ethics approval and consent to participate
The author(s) declare that it is not applicable.

Consent for publication
The author(s) declare that this is not applicable.

Competing interests
The author(s) declare that they have no competing interests.

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