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Research Article

Effect of Age, Gender, Region, and Refractive Errors on Central Corneal Thickness among Saudi Population; A Cross-Sectional Study

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Abstract

Purpose: To determine the average central corneal thickness (CCT) in healthy Saudi adults and to analyze the variations based on gender, age, region, and refractive errors.

Methods: Cross-sectional study of average CCT of subjects between the ages of 20 - 40 who were randomly invited to participate at a gathering center in Riyadh, Saudi Arabia. Volunteers were excluded if they had corneal or ocular pathology, a history of ocular surgery or trauma, and contact lenses wear within 7 days of data collection. CCT was measured using Scheimpflug tomography. Statistical analysis was performed to determine any association of CCT with age, gender, refractive error, and geographic location. A P value less than 0.05 was considered statistically significant.

Results: A total of 379 subjects (755 eyes) with a mean age of 28.88 ± 5.77 years. More than half of the participants were females 244 (64.4%). The mean CCT was 544.32 ± 36.25 μm (range, 447 - 654 μm). CCT was statistically significantly influenced by age (P = 0.0001) where CCT was significantly lower as age increases. Although there was no statistically significant relationship between CCT and regions, nor refractive errors. A tendency toward thinner cornea in participants from north and west regions (P > 0.05) and among hyperopic eyes (P-value 0.06).

Conclusions: The average CCT in the healthy adult Saudi population was comparable to the regional and global averages. There was a significant negative association between age and CCT, where CCT values decrease with older ages. Hyperopic eyes, north and west regions have a tendency to a thinner CCT.

Keywords: *Central Corneal Thickness; Pachymetry; Scheimpflug Tomography; Saudi Arabia*

Introduction

The increasing popularity of refractive surgery worldwide has led to a renewed interest in the importance of central corneal thickness (CCT). CCT has and always been a critical feature in clinical decisions regarding the volume of laser ablation, residual corneal thickness, and corneal ectasia. CCT varies among normal individuals as evidenced in many studies that reported genetic and ethnic background, gender, age, and refractive errors as contributing factors to the differences. Hence population samples of CCT may help distinguish healthy eyes from diseased eyes [1-5]. The average CCT of normal corneas is approximately 540 μm, and a CCT above 640 μm is considered a risk factor for postsurgical symptomatic corneal edema [6].

Due to the relative paucity of literature on CCT in the Saudi Arabian population. In this study, we determined the average CCT in healthy Saudi adults and assessed the variations in sex, age, refractive error, and region.

Materials and Methods

A total of 379 adult participants (755 eyes) were enrolled in this cross-sectional study. Three eyes were excluded because of contact lens wear. the participants were invited to participate at a busy mall in Riyadh, Saudi Arabia from the period of December 2018 until January 2019. The sample size was chosen based on the calculation of the population of Saudi adults between the ages of 20 - 40 years in Riyadh which were 1,656,711 according to the latest estimation by the General Authority of Statistics (GASTAT) of 2017 and with a confidence interval of 95% and a margin of error of 5% [7].

Ethical approval was obtained from the King Abdullah International Medical Research Center (KAIMRC). This study was conducted by The Code of Ethics of the World Medical Association (Declaration of Helsinki). The data were collected on paper collection sheets, and every participant signed an ethical consent in both Arabic and English.

Volunteers were asked about their demographic data (age, gender, and region), contact lens use, family history of Keratoconus, and ocular pathology or surgery. The study inclusion criteria were healthy adults (20 - 40 years of age only) as this age represents the majority of refractive surgery seeking patients, free of ophthalmic and systemic diseases, and with no history of ophthalmic surgeries. Exclusion criteria included non-Saudi, undergone previous refractive or ocular surgeries or other ocular diseases or contact lenses wear (within the last 2 weeks). After initial evaluation individuals underwent auto-keratometry and auto-refraction (KR-800; Topcon Corp; Tokyo, Japan).

Subsequently, an anterior segment examination and Scheimpflug tomography and pachymetry (Ziemer Ophthalmic Systems AG, Zurich, Switzerland) were performed. Individuals with abnormal tomography were instructed to follow up with their ophthalmologists.

Statistical analysis

The data analysis process of this study consisted of two stages. The first stage included a descriptive analysis where numerical variables were reported in terms of means and standard deviation, while categorical variables were described using frequencies and percentages. The second stage comprised of hypothesis testing using Independent samples T-test and One-Way ANOVA test, and it was applied by IBM SPSS Statistics 25.0 (IBM Corp., New York, NY, USA). A P-value less than 0.05 was considered statistically significant.

Results

The study sample was comprised of 379 participants (755 eyes) with a mean age of 28.88 ± 5.77 years (range 20 - 40 years). 379 (50.2%) were right eyes. More than half of the participants were females 244 (64.4%). The most common age group was within the age range of 20 - 25 years old which included 106 participants (28.2%). Furthermore, there were 212 participants from the central region, which represented more than half of the study sample (56.1%). The mean CCT was 544.32 ± 36.25μm (range, 447 - 654 μm). Although, the mean CCT was higher in females, the difference between genders was not found to be statistically nor clinically significant (P-value, 0.646) (Table 1). On the other hand, CCT was statistically significantly influenced negatively by age (P > 0.001) and those in the age group of 35 years and above have a propensity to have lower mean CCT (535.03 μm ± 34). (Table 2). While no statistically significant difference in CCT among regions were found, there was a tendency toward thinner cornea in north and west regions (P-value 0.168, 536 ± 34 μm, 532 ± 40 μm, respectively). Around half of the study population were myopes (372 eyes) and 4 eyes had missing Autorefraction. Hyperopic cases tend to have lower mean CCT (541 μm) than Emmetropes (549 μm) and myopes (547 μm) however this was statistically insignificant (P- value 0.06) (Table 3).

Characteristic	n (%)
Eye (n = 755)	
Right	379 (50%)
Left	376 (49%)
Sex (n = 379)	
Female	244 (64%)
Male	134 (35%)
Age (n = 379)	
20 - 24	102 (26%)
25 - 29	106 (28%)

30 - 34	91 (24%)
More than 35	79 (20%)
Age (n = 379)	
Mean – SD	28.88 – 5.77
Region (n = 379)	
Central	212 (56%)
South	73 (19%)
North	35 (9%)
West	8 (2%)
East	50 (13%)

Table 1: *Patient demographics and clinical characteristics.*
SD denotes standard deviation; CCT denotes central corneal thickness.

Variable	CCT Mean (SD)	P value
Eye		
Right Eye	543 (36)	0.34
Left Eye	545 (37)	
Sex		
Female	544.(37.0)	0.1
Male	540 (36.4)	
Age		
20 - 24	552 (37)	0.000*
25 - 29	549 (38)	
30 - 34	538 (34)	
More than 35	535 (34)	
Region		
Central	544 (35)	0.168
South	543 (38)	
North	536 (34)	
West	532 (40)	
East	544 (41)	

Table 2: *Mean comparison of central corneal thickness with different variables.*
**Statistically significant at 5% level of significance. SD denotes standard deviation; CCT denotes central corneal thickness.*

	Myopia (n=372)	Emmetropia (n = 59)	Hyperopia (n = 322)	P value
Mean SE (range)	-1.31888 (-0.125 to -12.25)	Plano	0.817 (0.125-6.75)	
Mean CCT µm (range)	547.28 (447-645)	548.50 (452-636)	540.66 (451-645)	0.06

Table 3: *Mean comparison of central corneal thickness with refractive errors.*

Discussion

Measurement of central corneal thickness (CCT) is important to establish national baseline data and to evaluate patients with corneal disease or glaucoma and in patients undergoing refractive surgery.

The current study found that the average CCT among the healthy adult Saudi population was 544.32 ± 36.25 μm. Similarly, Al-Mezaine., *et al.* reported CCT among adult Saudi myopes and emmetropes was 545.7 ± 27.6 μm. Nonetheless, compared to our study, their study was performed in a single eye center and excluded patients with hyperopia and astigmatism [8]. The mean CCT was lower in our population compared to that reported from Turkish (552 μm ± 35.9 μm) and Iranian (555.6 ± 39.9 μm) populations. Yet, our study was comparable to an Iraqi population (543.95 ± 32.58 μm) [9-11].

Some articles have reported that genetic and ethnic factors are involved in determining corneal thickness [1-3]. Aghaian., *et al.* for example, measured CCT in an ethnically diverse population and reported that mean CCT for African American participants was the lowest at 521.0 μm than that of all races ($P \leq 0.05$). While the mean CCT was 550.4 μm for Caucasians, 548.1 μm for Hispanics, 531.7 μm for Japanese, 555.6 μm for Chinese, and 550.6 μm for Filipino participants. In comparison, the mean CCT of this study was comparable to the average CCT of the entire study sample (542.9 ± 3.7 μm) reported by Aghaian., *et al.* [12] Another study by Sardiwalla., *et al.* have compared the ethnic variation in CCT among 18 - 25 years old blacks and Indians. In their study, the mean CCT was 519.5 ± 38.6 μm and was higher in Indians (526.5 ± 37.2 μm) than in Blacks (512.4 ± 38.9 μm) ($p = 0.01$). However, both groups and the whole sample (mean CCT = 519.5 ± 38.6 μm) had lower CCT than the current study [13]. Furthermore, Pan CW., *et al.* studied the Chinese population comparing ethnicity among Bai, Yi, and Han. CCT reading were 536.4 ± 34.2 μm, 532.1 ± 32.1 μm, and 529.6 ± 32.7 μm in Bai, in Yi, and in Han, respectively ($P < 0.001$) [14]. however, their sample included participants aged 50 years or older which may give a reason for their mean CCT was lower than the current study CCT.

In the present study, the mean CCT for the four ages groups: 20 - 25, 26 - 30, 31 - 35 and 36 - 40 years were, 552 ± 37 μm, 549 ± 38 μm, 538 ± 34 μm and 535 ± 34 μm, respectively. CCT had a negative statistically significant correlation to age ($P > 0.001$). This result is in agreement with various reports found in the literature. For example, Galgauskas., *et al.* study 1,650 Caucasians of Lithuanian origin aged 18 - 89 years, that reported a mean CCT of 544.6 ± 30.5 μm. Additionally, their study showed that CCT decreased with age, and this correlation is stronger in males [4]. Similarly, Varghese., *et al*. studied patients presenting to ophthalmology clinics at a tertiary center in North Kerala and found that the mean CCT of 536.71 μm which was also found to decrease with age [5]. A study by Mercieca., *et al,* have reported a mean CCT of 535 ± 38 μm in a normal population and was significantly related to older age (P value 0.002) [15]. Correspondingly, Weizer., *et al.* studied CCT in two visits 8 years apart and found a decrease in mean CCT of 17 to 23 μm [16]. Nemesure., *et al*. also establish an inverse relationship between age and CCT in their study on the black adult population. They found that the mean CCT was 533.3 ± 37.2 μm among 50 to 59 years, 532.4 ± 38.6 μm among 60 to 69 years and 525.0 ± 37.8 μm among 70 years and older [17]. On the other hand, Schuster., *et al.* reported a positive relationship between age and CCT with an average increase of 0.34 μm per year of age among the Germen population [18]. Nonetheless, different studies on the Spanish, Indian, and American populations failed to find a significant relationship between CCT and age [28-30].

Variation of CCT by gender has been evaluated in many published reports, and our analysis found no statistically significant variation by gender [19-22]. This outcome is similar to previous literature where there was no significant relationship of CCT by gender [19,20,23-26]. Conversely, Hahn., *et al*. reported statistically significant variation between genders, yet, this variation was clinically insignificant because the difference was less than 4.6 μm between eyes as per the authors [19].

In our study, we evaluated the relationship between CCT and refractive errors. The mean spherical equivalent (SE) in a normal population of myopic -1.31888 D (mean CCT 547.28 μm), hyperopic + 0.817 D (mean CCT 540.66 μm), and emmetropic (mean CCT 548.50 μm) eyes did not show a significant correlation with CCT ($P = 0.06$). Nevertheless, the relationship between CCT and refractive errors is controversial throughout previous studies. A local study by AlMezaine., *et al.* on myopic eyes, concluded that the difference in mean CCT between myopia and emmetropia groups was not statistically significant ($P = 0.5$). Furthermore, studies on Egyptian, Indian, Pakistani., and

Chinees population conveyed by Mostafa A., *et al.* [27], Lavanya K., *et al.* [28], Nauman H., *et al.* [29] and Zhang H., *et al.* [30] respectively failed to demonstrate a significant correlation between CCT and refraction which agrees with the current study. On the contrary, Chang., *et al.* found that the corneas were thinner in more myopic eyes in a study on 216 young Taiwanese adults with an averaged refractive error of −4.17 diopters. They theorized that a decrease in corneal thickness was a result of a change in the anterior segment as the eyeball elongated in myopic progression [31]. A similar relationship was described in the Sudanese population by Mohammed., *et al.* who founded that CCT correlates with refractive error; where myopes have the thinnest CCT (449.65 ± 39.27 μm), followed by emmetropes (542.66 ± 46.35 μm) and hyperopes (557.67 ± 41.83 μm). They stated that thin central corneal thickness and thin lamina cribrosa in highly myopic eyes may explain the presumably increased susceptibility to glaucoma in highly myopic eyes compared with non–highly myopic eyes [32]. Yasir., *et al.* described comparable conclusions in their study on the Iraqi population. The relationship between refraction and CCT showed a statistically significant positive correlation between the two parameters (Pearson r = 0.153, P = 0.002). Also, they found a significant difference between the whole myopic group and the emmetropic group (P = 0.019) [11].

In addition to race and age, discrepancies in the measurement methods and techniques can explain the statistical inaccuracies, accounting for the lack of agreement demonstrated in the various studies.

Some of the previous studies used ultrasonic pachymetry to measure CCT, however, we used Scheimpflug-derived pachymetry values. CCT results using Scheimpflug pachymetry is to be comparable to and reproducible with ultrasonic Pachymetry [33-35].

There is debate among Saudi ophthalmologists concerning which region has the lowest CCT and to the best of our knowledge, this issue has not been studied yet. In our study, we have measured CCT by region and found variability among regions with a tendency towards lower CCT in the Western and Northern regions. However, this variability was not statistically significant (P = 0.168).

Conclusion

The average value of CCT in the healthy adult Saudi population was 544.32 ± 36.25 μm and was comparable to the regional and global averages. There was also a significant negative association between age and CCT where CCT values decrease with older ages. Additionally, No other studied variable had a statistically significant mean relationship with CCT. However, a tendency towards thinner corneas was noted in the hyperopic eye and among eyes from western and northern provinces which was not of statistical significance.

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Conflicts of Interest

There are no conflicts of interest.

Author Contributions

Study concept and design (A-A, F-A, T-A); data collection (everyone); analysis and interpretation of data (A-A, T-A); statistical analysis (A-A) and writing the manuscript (A-A, F-A, T-A, T-M).; critical revision of the manuscript (A-A, F-A, T-A).

Bibliography

1. Toh T., *et al*. "Central corneal thickness is highly heritable: The twin eye studies". *Investigative Ophthalmology and Visual Science* 46.10 (2005): 3718-3722.

2. Zheng Y., *et al*. "Heritability of central corneal thickness in Chinese: The Guangzhou twin eye study". *Investigative Ophthalmology and Visual Science* 49.10 (2008): 4303-4307.

3. Dimasi DP., *et al*. "The genetics of central corneal thickness". *British Journal of Ophthalmology* 94.8 (2010): 971-976.

4. Galgauskas S., *et al*. "Age-related changes in central corneal thickness in normal eyes among the adult Lithuanian population". *Clinical Interventions in Aging* 9 (2014): 1145-1151.

5. Varghese V., *et al*. "Study of factors influencing central corneal thickness among patients attending ophthalmology outpatient department at a tertiary care center in North Kerala". *Kerala Journal of Ophthalmology* 28.3 (2016): 193.

6. Hierro Zarzuelo A del. "External Disease and Cornea". *Archivos de la Sociedad Española de Oftalmología* 83.7 (2008): 455-456.

7. Statistics GA for 2018.

8. Al-Mezaine HS., *et al*. "The relationship between central corneal thickness and degree of myopia among Saudi adults". *International Ophthalmology* 29.5 (2009): 373-378.

9. Altinok A., *et al*. "Factors influencing central corneal thickness in a Turkish population". *Current Eye Research* 32.5 (2007): 413-419.

10. Hashemi H., *et al*. "Corneal thickness in a population-based, cross-sectional study: The tehran eye study". *Cornea* 28.4 (2009): 395-400.

11. Kadhim YJ and Farhood QK. "Central corneal thickness of Iraqi population in relation to age, gender, refractive errors, and corneal curvature: A hospital-based cross-sectional study". *Clinical Opthalmology* 10 (2016): 2369-2376.

12. Aghaian E., *et al*. "Central corneal thickness of Caucasians, Chinese, Hispanics, Filipinos, African Americans, and Japanese in a glaucoma clinic". *Ophthalmology* 111.12 (2004): 2211-2219.

13. Sardiwalla Z., *et al*. "A comparative study of central corneal thickness (CCT) and intraocular pressure (IOP) in University of KwaZulu-Natal students of Black and Indian ethnicity". *African Vision and Eye Health* 71.4 (2012): 171-177.

14. Pan CW., *et al*. "Ethnic variations in central corneal thickness in a rural population in China: The yunnan minority eye studies". *PLoS One* 10.8 (2015): 1-11.

15. Mercieca K., *et al*. "Comparing central corneal thickness in a sub-Saharan cohort to African Americans and Afro-Caribbeans". *Cornea* 26.5 (2007): 557-560.

16. Weizer JS., *et al*. "Longitudinal changes in central corneal thickness and their relation to glaucoma status: An 8 year follow up study". *British Journal of Ophthalmology* 90.6 (2006): 732-736.

17. Nemesure B., *et al*. "Corneal thickness and intraocular pressure in the Barbados Eye Studies". *Archives of Ophthalmology* 121.2 (2003): 240-244.

18. Schuster AKG., *et al*. "Central Corneal Thickness in Spectral-Domain OCT and Associations with Ocular and Systemic Parameters". *Journal of Ophthalmology* (2016).

19. Hahn S., *et al*. "Central corneal thickness in Latinos". *Investigative Ophthalmology and Visual Science* 44.4 (2003): 1508-1512.

20. Gros-Otero J., *et al*. "Central corneal thickness in a healthy Spanish population". *Archivos de la Sociedad Española de Oftalmología* 86.3 (2011): 73-76.

21. Prasad A., *et al*. "Relationship of age and refraction to central corneal thickness". *Cornea* 30.5 (2011): 553-555.

22. Kalikivayi L., *et al*. "Comparison of central corneal thickness in myopes, hyperopes and emmetropes of different age groups". *Journal of Clinical Ophthalmology* 02.02 (2018).

23. Cho P and Lam C. "Factors affecting the central corneal thickness of Hong Kong-Chinese". *Current Eye Research* 18.5 (1999): 368-374.

24. AK L and WA D. "The corneal-thickness profile in Hong Kong Chinese". *Cornea* (1998).

25. Ashwin PT., *et al*. "The relationship of Central Corneal Thickness (CCT) to Thinnest Central Cornea (TCC) in healthy adults". *Contact Lens Anterior Eye* 32.2 (2009): 64-67.

26. Lifshitz T., *et al*. "Central corneal thickness and its relationship to the patient's origin". *Eye* 20.4 (2006): 460-465.

27. AMMM. "Correlation between Central Corneal Thickness and Degree of Myopia". *The Egyptian Journal of Hospital Medicine* 70.1 (2018): 109-113.

28. Kalikivayi L., *et al*. "Comparison of central corneal thickness in myopes, hyperopes and emmetropes of different age groups". *Journal of Clinical Ophthalmology* 02.02 (2018).

29. Hashmani N., *et al*. "Effect of age, sex, and refractive errors on central corneal thickness measured by oculus pentacaml®". *Clinical Ophthalmology* 11 (2017): 1233-1238.

30. Zhang H., *et al*. "Central corneal thickness in adult Chinese. Association with ocular and general parameters. The Beijing eye study". *Graefe's Archive for Clinical and Experimental Ophthalmology* 246.4 (2008): 587-592.

31. Chang SW., *et al*. "The cornea in young myopic adults". *British Journal of Ophthalmology* 85.8 (2001): 916-920.

32. Mohamed N. "Central corneal thickness in Sudanese population". *Archives of Ophthalmology* 1.1 (2009): 29-32.

33. Piotrowiak I., *et al*. "Measuring Corneal Thickness with SOCT, the Scheimpflug System, and Ultrasound Pachymetry". *ISRN Ophthalmology* (2012): 1-5.

34. Yu A., *et al*. "Evaluation of Central Corneal Thickness Using Corneal Dynamic Scheimpflug Analyzer Corvis ST and Comparison with Pentacam Rotating Scheimpflug System and Ultrasound Pachymetry in Normal Eyes". *Journal of Ophthalmology* (2015).

35. Barkana Y., *et al*. "Central corneal thickness measurement with the Pentacam Scheimpflug system, optical low-coherence reflectometry pachymeter, and ultrasound pachymetry". *The Journal of Cataract and Refractive Surgery* 31.9 (2005): 1729-1735.

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