Original Article

Investigate the Effect of Age, Sex, and Refractive Errors on the Central Thickness of the Cornea in Ophthalmology Centers in Jiroft City

Bahareh kermani [1], MD; Mohsen pourshahrokhi [1], MD; Rasoul Raesi [2], PhD; Akbar Mehralizadeh [3], PhD; Rezvan Sadat Maleki [4], PhD; Eisa Nazar [5, 6], PhD; Salman Daneshi [7, *], PhD

1. Assistance professor, School of Medicine, Jiroft University of Medical Sciences, Jiroft, Iran.
2. PhD in Health Services Management, Mashhad University of Medical Sciences, Mashhad, Iran.
3. School of Health, Jiroft University of Medical Sciences, Jiroft, Iran.
4. School of Medicine, Jiroft University of Medical Sciences, Jiroft, Iran.
5. Postdoctoral Research Fellow, International UNESCO Center for Health-Related Basic Sciences and Human Nutrition, Mashhad University of Medical Sciences, Mashhad, Iran.
6. Student Research Committee, Department of Biostatistics, School of Health, Mashhad University of Medical Sciences, Mashhad, Iran.
7. Department of Public Health, School of Health, Jiroft University of Medical Sciences, Jiroft, Iran.

***Corresponding Author:** Salman Daneshi
E-mail: salmandaneshi008@gmail.com

Abstract

Background: The central thickness of the cornea, as one of the parameters of the anterior segment of the eye, is one of the important factors in the evaluation of patients with eye disorders. This research was conducted to investigate the effect of age, gender, and refractive errors on the central thickness of the cornea in the ophthalmology centers of Jiroft city.
Material and methods: This cross-sectional study was conducted by census method in the summer of 1400 on 255 patients referred to Jiroft ophthalmology centers. Data were collected using a researcher-made checklist and analyzed using SPSS version 22 statistical software and Student's t-tests, one-way analysis of variance, and Pearson's correlation coefficient at a significance level of $P < 0.05$.
Results: 159 people (62.3 %) of the participants were women, and the average age of all people was 34.99 ± 7.33 years. The average central thickness of the cornea in the right eye in the three myopic, binocular and emmetropic groups was 501.93, 519.76, and 512.10, respectively, with the highest average central corneal thickness scores corresponding to the binocular group and the lowest average central thickness scores. The cornea of the myopic group is observed and the results of the analysis of variance showed that there is a statistically significant difference between the three groups in terms of the average scores obtained ($P < 0.001$).
Conclusion: This study showed that age, gender, and refractive errors had a significant effect on the central thickness of the cornea in ophthalmology centers of Jiroft city, and there was a wide range of central corneal thickness values with normal distribution.
Keywords: Central Corneal Thickness; Refractive Error; Ophthalmology.

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Introduction

The cornea is the first layer of the eye, which is the most important factor in the formation of a clear image in the retina with the highest refractive power in the clear environments of the eye [1]. The cornea is a connective tissue without blood vessels, which acts as the first barrier against the spread of infection into the eyeball as well as the building that forms the wall of the eye. Also, the cornea with the tear layer covering it provides the anterior refractive surface of the eye [2].

For light to enter the eye and reach the retina, it must first pass through the cornea, therefore the transparency of the cornea is very important in vision. After passing through the cornea and the lens of the eye, the light reaches the retina, where the image is formed, and after interactions, the information of this image is transferred to the brain in the form of electrical-neural waves, and the act of vision will be completed [3].

The cornea is affected by the internal biomechanical structure and the external environment, and the strength of the anterior stroma is particularly important in maintaining the curvature of the cornea [4]. The structural differences of collagen fibers in the anterior stroma may contribute to the cohesion of the corneal tissue in this area and also explain the reason why the anterior stroma is more resistant than the posterior stroma against corneal edema, which causes the formation of folds in this area. Hydration of the stroma changes the response of the cornea to the corneal tensile and tearing forces [5].

Although the human cornea is completely devoid of blood vessels, it needs a blood supply to maintain its health. These drinking parts are the delicate vessels in the other part of the corneal environment (limbus) and also the blood products in the aqueous humor and tear layer that is oozed by the end branches of the ophthalmic and pink arteries [6].

The cornea is one of the tissues with high innervation and is extremely sensitive. The nerves and sense of the cornea are supplied by the nasociliary branch of the ophthalmic nerve, which is the first branch of the trigeminal nerve. Sensory nerves with a thick trunk enter vertically in the superficial stroma and finally, after piercing Bowman's layer, they form a rich nerve network under the basal epithelial layer, in addition, the cornea also contains sympathetic nerve fibers [7].

Central corneal thickness (CCT), as one of the parameters of the anterior segment of the eye, is considered one of the important factors in the evaluation of patients with eye disorders [8]. Measuring CCT and comparing it with normal limits is effective in screening, diagnosing, and treating eye disorders including keratoconus [9]. Today, due to the rapid progress of corneal refractive surgery, the need for the accurate evaluation of CCT in pre-surgery examinations is felt more than ever [10]. Accurate determination of the central thickness of the cornea allows the doctor to use the best surgical method to correct the patient's refractive error [11].

The central thickness of the cornea is also an influential factor in measuring intraocular pressure [12]. Some studies have shown that if the CCT is 70 micrometers more or less than the normal limits for that age group, there will be an error of about 5 mmHg when measuring the intraocular pressure [13].

With increasing age, optical and biometric changes occur in the physiological-anatomical parameters of different eye tissues in such a way that the different components of the eye have separate and independent but coordinated growth, which indicates the related growth of the biometric components of the eye and leads to the Emmetropization [14] and if this

phenomenon does not occur, the parts of the eye do not grow harmoniously [15] and leads to refractive errors (hyperopia, myopia) [16].

Hyperopia is a common refractive condition among pediatrics, most infants are hyperopic, and at least 95 % of them have hyperopia above +3.5 dioptres at birth [17]. Also, myopia is one of the most common causes of correctable visual impairment in developed societies and one of the preventable causes of blindness in developing societies [18].

Biometric and topographic features of the eye provide important measurements in various fields of ophthalmology [19]. Therefore, the importance of investigating these parameters leads to obtaining accurate quantitative and qualitative information about the morphology and anatomy of the cornea and anterior segment, which helps surgeons, this qualitative information can affect the results of some surgeries and cause increasing the safety of surgery and reducing the complications after it [20].

Central corneal thickness is the main indicator of corneal health and helps us to evaluate corneal diseases [21]. Vernal Keratoconjunctivitis (VKC) is a type of bilateral, chronic, and external inflammatory eye disorder that mainly affects patients in their first or second decade. This disease is common in warm and temperate climates in spring and summer. The onset of the disease is generally before the age of 10 years and lasts 2 to 10 years, usually resolving in late puberty. Central corneal thickness is low in patients with vernal keratoconjunctivitis (VKC) compared to age- and sex-matched controls [22].

Optical coherence tomography (OCT) is a type of tomography in medicine. From the 18th century onwards, microscopes and imaging devices such as X-rays and MRIs have been essential tools in medicine and biology. But tomography devices have problems such as high price, invasiveness, and low resolution, so for eliminating these problems, many researchers introduced OCT devices (from recent advances in the field of medical imaging). OCT imaging was first introduced by Huang and his colleagues in 1991. This technology can perform cross-sectional imaging of the microscopic structure of biological tissues. It also has a micrometer-scale resolution. In this method, similar to ultrasound imaging, several Cross-sectional A-Scans or line scans together produce B-Scans or cross-sectional images. Light energy is used for imaging with an OCT device instead of an audio signal, and image formation depends on the optical properties of the structure. It has textures due to the high speed of light, and measurement of echo signal delay is not possible. For this reason, OCT systems work based on low-coherence interferometry, which is either by super luminescent diodes or by femtosecond lasers (which have very short pulses feasible. OCT systems are used in ophthalmology (non-invasively) and heart disease diagnosis (invasively) [23]. In OCT, there is no damage to the tissue because the laser output is low [24].

According to the investigations carried out in previous research, so far, no study has been found to determine the normal limits of CCT variables in Jiroft city, and according to the weather conditions and tropical conditions and the effect of sunlight on the corneal surface and corneal thickness, the results of the research could help prevent of occurrence KCN in this region by conducting the necessary investigations and simultaneously investigating the prevalence of VKC and their timely treatment.

Material and Methods

This is a cross-sectional study (descriptive-

analytical) that was conducted in the summer of 2021 on all patients referred to ophthalmology centers in Jiroft city. After eye examinations, the patients were divided into three categories: myopia, hyperopia, and no refractive errors based on visual acuity and refractive errors. Then, the central thickness of the cornea of their eyes was measured free of charge using an OCT device. The sample size in this study was 255 participants. Inclusion criteria considered were age ranges from 20 to 50 years, eye pressure lower than 21 mmHg, no use of soft contact lenses (two weeks before eye examinations) and hard contact lenses (three weeks before eye examinations), history of effective eye and systemic disease, history of eye surgery, use of drugs affecting the eyes, and no pregnancy, and having the necessary cooperation during the test, and exclusion criteria considered were lack of consent to participate in the study.

The data was collected using a researcher-made checklist that included demographic information such as age, sex, determination of eye refractive error status, refractive error dioptre size, central corneal thickness, and KCN. After collecting the data and their initial processing, the data was recorded in the statistical software SPSS version 22. First, all data were described using descriptive statistical methods, including frequency distribution tables, statistical charts, and descriptive statistics indices. Then, examine the research questions and objectives used the Kolmogorov-Smirnov test to check the normality of the central corneal thickness variable and it was concluded that the left and right eye corneal thickness variables have a normal probability distribution. Student t-tests were used to compare two independent groups, a one-way analysis of variance, and Pearson's correlation coefficient test.

findings

This study was conducted to determine the effect of age, sex, and refractive, errors on the central thickness of the cornea in the ophthalmology centers of Jiroft city, and 255 referring patients were included in the study in the summer of 2021. 159 people (62.3 %) of the participants were women, and the average age of all people was 34.99 ± 7.33 years. The average central thickness of the cornea in the right eye and left eye of the patients is 509.7 ± 25.46 and 509.17 ± 25.98, respectively.

The average thickness of the cornea in the right eye in the three groups of 20 to 30, 30 to 40, and 40 to 50 years old is 514.16, 507.95, and 503.63, respectively, which is the most. The average central corneal thickness scores are observed for the 20 to 30-year-old group and the lowest average central corneal thickness scores are observed for the 40 to 50-year-old group according to the results of the analysis of variance, there is a statistically significant difference between the three age groups in terms of the average sizes obtained ($P < 0.001$). Also, the average corneal thickness measurements in the left eye in three groups of 20 to 30, 30 to 40, and 40 to 50 years old are 510.51, 509.17, and 505.87, respectively, and the highest average central corneal thickness scores are related to 20 to 30 years old group and the lowest average central corneal thickness scores are observed in the 40 to 50 years old group and the results of variance analysis showed that there is a statistically significant difference between the three age groups in terms of the average measurements obtained ($P < 0.001$). Table 1 shows the relationship between age and the central thickness of the cornea.

The average measurements of the central thickness of the cornea in the right eye in the two groups of men and women are 519.03 and 503.43,

Table 1: Determining the relationship between age and central thickness of the cornea in the referrals to Ophthalmology Centers in Jiroft city

Variable	Age group	Mean	Deviation	P value
Right eye	20-30	514.16	26.91	<0.001
	30-40	507.95	24.24	
	40-50	503.63	23.14	
Left eye	20-30	510.51	25.68	<0.001
	30-40	509.17	25.98	
	40-50	505.87	23.31	

respectively, and the highest average central corneal thickness scores are observed in women, and the results of the t-test of two independent samples showed that there is a statistically significant difference between the two groups of men and women in terms of the average scores obtained ($P < 0.001$).

Also, the average values of the central thickness of the cornea in the left eye in both male and female groups are 13.519 and 502.75, respectively, and the highest mean scores of the central thickness of the cornea are observed for women, and the results of the t-test of two independent samples showed that there is a statistically significant difference between male and female groups in terms of average scores ($P < 0.001$). Table 2 shows the relationship between gender and the central thickness of the cornea in patients.

The average measurements of central corneal thickness in the right eye in the two groups that have VKC and those without VKC are 68.509 and 1.519, respectively, the highest mean central thickness scores are related to the group that does not have VKC. It can be seen that the results of the t-test of two independent samples showed that there is a statistically significant difference between the two groups with VKC and those without VKC in terms of the average scores obtained ($P < 0.001$).

Also, the average central corneal thickness measurements in the left eye in the two groups that have VKC and those without VKC are 506.9 and 520.01, respectively, and the highest average central corneal thickness scores are observed in the group without VKC, and the results of the t-test showed that there is a statistically significant difference between the two groups that have VKC and those that do not have VKC in terms of the average scores obtained ($P < 0.001$). Table 3 shows determining the relationship between VKC and the central thickness of the cornea.

The average measurements of the central thickness of the cornea in the right eye in the three groups of myopes, binoculars, and emmetropes are 501.93, 519.76, and 512.10, respectively, and the highest average central corneal thickness scores are related to the hyperopia group and the lowest average central corneal thickness scores are observed for the myopic group, and the results of the analysis of variance test showed that there is a statistically significant difference between the three groups in terms of the average scores obtained ($P < 0.001$).

Table 2: Determining the relationship between gender and central thickness of the cornea in patients who refer to Ophthalmology Centers in Jiroft city

Variable	Gender	Number	Mean	Standard deviation	P Value
Right eye	women	159	519.03	23.82	< 0.001
	men	96	503.43	24.53	
Left eye	women	159	519.13	25.32	< 0.001
	men	96	502.75	24.65	

Also, the average measurements of central corneal thickness in the left eye in the three myopic, binocular, and entropic groups were 502.21, 522.83, and 510.51, respectively. The center of the cornea corresponding to the myopic group is observed and the results of the analysis of the variance test showed that there is a statistically significant difference between the three groups in terms of the average measurements obtained ($P < 0.001$). Table 4 shows determining the relationship between refractive errors of the eye and the central thickness of the cornea.

Discussion

The cornea is one of the densest tissues in the body in terms of innervation and the most sensitive tissue in the human body. The decrease in thickness hurts the cornea, and when the shape of the cornea thins and changes, keratoconus appears [25]. In this type of disease, the cornea changes shape into a cone and bulge. This disease has a great impact on the quality of eyesight and causes it to decrease [26], so this research was conducted to relate age, sex, and refractive errors to the central thickness of the cornea in ophthalmology centers of Jiroft city, and 255 people from patients referred to the ophthalmology clinic of Imam Khomeini Hospital (RA) in Jiroft were examined in the summer of 2021.

The results of this research showed that with increasing age, the average central thickness of the cornea decreases. The results of Mirzajani et al showed that age has a significant effect on the central thickness of the cornea and there is

Table 3: Determining the relationship between VKC and the central thickness of the cornea in patients referred to ophthalmology centers in Jiroft city

Variable	Group	Number	Mean	Standard deviation	Statistic	P Value
Right eye	have VKC	90	509.68	27.72	4.93	<0.001
	do not have VKC	165	519.1	24.08		
Left eye	have VKC	90	506.9	29.34	4.51	<0.001
	do not have VKC	165	520.01	24.17		

Table 4: Determining the relationship between refractive errors of the eye and central thickness of the cornea in patients who refer to ophthalmology centers in Jiroft city

Variable	Group	Number	Mean	Standard deviation	Statistic	P Value
Right eye	Myopia	92	501.93	26.12	7.52	< 0.001
	Hyperopia	29	519.76	18.32		
	emmetropia	134	512.10	24.95		
Left eye	Myopia	92	502.21	26.88	7.80	< 0.001
	Hyperopia	29	522.83	21.85		
	emmetropia	134	510.51	25.06		

a significant difference in the central thickness of the cornea in all age groups [27]. In the study of HSU et al., age had a significant effect on CCT [28]. According to Hashemi's results, people younger than 20 years old had more corneal thickness in different areas than people 20 years old and older, and this difference was quite significant [29]. In another study in Italy, the normal thickness of the center of the cornea in the age group of 20 to 45 years was 0.972 gr/mm2 and in the age group of 46 to 70 years it was 0.965 gr/mm2, the central thickness of the cornea was constant until the age of fifty and after that encountered a significant decrease [30]. In a study conducted in Thailand, the central thickness of the cornea in the age group of 12 to 20 years was 599 ± 0.6, which gradually decreases with age until it reaches 586 ± 2.7 in the age group over 50 years old and has decreased significantly compared to previous age groups [31].

In this study, the central thickness of the cornea decreases significantly from the age of 36, and this is earlier than the results reported by Millodot [32], Roszkowska [30], and Booranapong (after the age of fifty) [33]. This difference in the results can be a result of racial and environmental factors such as climate and exposure to ultraviolet rays, as previous studies have been conducted in Thailand and Italy, which have more humid and cloudier climates than Iran. We live in a country with a sunny climate and this may alter the central corneal thickness in the normal population. At least 9 months a year, people in Iran are exposed to ultraviolet rays, and wearing sunglasses is not a common habit among Iranians. An adverse effect of ultraviolet radiation on our bodies is the formation of reactive oxygen species [34]. These substances are dangerous for biological systems, they may react with lipids, proteins, and DNA and cause cellular oxidative damage. There is evidence that oxidative damage may lead to age-related changes in tissues [35, 36]. In addition, the association between UV exposure and age-related cataracts and age-related changes has been reported in previous studies [36]. This explanation, in turn, can justify the faster-aging process for the central thickness of the cornea in the population examined in this study.

Myopic subjects had less central corneal thickness than nearsighted and emmetrope subjects. In the study of Linke and his

colleagues, it was published that the central thickness of the cornea was significantly different in nearsighted and farsighted people, and a significant negative correlation was seen between refractive error and keratometry [43]. Chen et al showed that by examining 500 eyes with an age range of 40 to 80, central corneal thickness is related to refractive errors, corneal curvature, anterior chamber depth, and axial length [44]. However, the findings of the present study are in contrast with the results of Qasimpour et al. their results show that refractive errors did not affect the central thickness of the cornea [45]. In Mohammadi et al.'s study, there is a significant difference between the two variables of refractive error and corneal thickness in myopic people, but it was not significant between farsighted and astigmatic people [46]. In their research, Kadhim et al. concluded that CCT had a significant relationship with refractive error, that near-sighted people had a thinner cornea than tropics, and that there was a weak but significant correlation between corneal curvature and CCT [47].

The limitations of the research require caution in the field of interpretation and generalization of the research findings. Limiting the research to one city, the small number of samples and the type of cross-sectional study are among the limitations of the current research. Considering that few studies have been done in this field and also considering the climatic conditions of Iran, for a better understanding and favorable comparison of the results, it is suggested to conduct similar studies in other parts of the country with more samples.

Conclusion

The results of this research showed that age, gender, and refractive errors had a significant effect on the central thickness of the cornea in the ophthalmology centers of Jiroft city, and there was a wide range of central corneal thickness values with a normal distribution.

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Authors ORCIDs

Bahareh kermani:
https://orcid.org/0000-0002-6041-7284
Salman Daneshi:
https://orcid.org/0000-0002-9199-0382

References

1. Zhang SX, Ma J-x. Ocular neovascularization: Implication of endogenous angiogenic inhibitors and potential therapy. Progress in retinal and eye research. 2007;26(1):1-37.
2. West SK. Trachoma: new assault on an ancient disease. Progress in retinal and eye research. 2004;23(4):381-401.
3. Li X, Eriksson U. Novel vegf family members: Vegf-b, vegf-c and vegf-d. The international journal of biochemistry & cell biology. 2001;33(4):421-6.
4. Robinson CJ, Stringer SE. The splice variants of vascular endothelial growth factor (VEGF) and their receptors. Journal of cell science. 2001;114(5):853-65.
5. Gan L, Fagerholm P, Palmblad J. Expression of basic fibroblast growth factor in rabbit corneal

alkali wounds in the presence and absence of granulocytes. Acta Ophthalmologica Scandinavica. 2005;83(3):374-8.
6. Hong J-W, Liu JJ, Lee J-S, Mohan RR, Mohan RR, Woods DJ, et al. Proinflammatory chemokine induction in keratocytes and inflammatory cell infiltration into the cornea. Investigative ophthalmology & visual science. 2001;42(12):2795-803.
7. Nakao S, Hata Y, Miura M, Noda K, Kimura YN, Kawahara S, et al. Dexamethasone inhibits interleukin-1β-induced corneal neovascularization: role of nuclear factor-κB-activated stromal cells in inflammatory angiogenesis. The American journal of pathology. 2007;171(3):1058-65.
8. Tsujii M, Kawano S, Tsuji S, Sawaoka H, Hori M, DuBois RN. Cyclooxygenase regulates angiogenesis induced by colon cancer cells. cell. 1998;93(5):705-16.
9. Baer JC, Foster CS. Corneal laser photocoagulation for treatment of neovascularization: efficacy of 577 nm yellow dye laser. Ophthalmology. 1992;99(2):173-9.
10. Yoon K-C, You I-C, Kang I-S, Im S-K, Ahn J-K, Park Y-G, et al. Photodynamic therapy with verteporfin for corneal neovascularization. American journal of ophthalmology. 2007;144(3):390-5. e1.
11. Pleyer U, Dannowski H, Volk H-D, Ritter T. Corneal allograft rejection: current understanding. Ophthalmologica. 2001;215(4):254-62.
12. Muthukkaruppan V, Kubai L, Auerbach R. Tumor-induced neovascularization in the mouse eye. Journal of the National Cancer Institute. 1982;69(3):699-708.
13. Mansouri K, Mostafaei A, Mirshahi M, MOHAMMADI MH, Maleki A, Keshavarz M. Human coagulated plasma as a natural and low cost matrix for in vitro angiogenesis. 2009.
14. Ganguly A, Zhang H, Sharma R, Parsons S, Patel KD. Isolation of human umbilical vein endothelial cells and their use in the study of neutrophil transmigration under flow conditions. JoVE (Journal of Visualized Experiments). 2012(66):e4032.
15. Hassan ZM, Feyzi R, Sheikhian A, Bargahi A, Mostafaie A, Mansouri K, et al. Low molecular weight fraction of shark cartilage can modulate immune responses and abolish angiogenesis. International immunopharmacology. 2005;5(6):961-70.
16. Mansouri K, Mirshahi M, Pourfathollah A, Hassan Z, Taheripak R. Anti-plasminogen monoclonal antibody (MC2B8) inhibites angiogenesis. Pakistan Journal of Biological Sciences: PJBS. 2007;10(19):3450-3.
17. Shakiba Y, Mansouri K, Mostafaie A. Anti-angiogenic effect of soybean kunitz trypsin inhibitor on human umbilical vein endothelial cells. Fitoterapia. 2007;78(7-8):587-9.
18. Hoseinkhani Z, Norooznezhad F, Rastegari-Pouyani M, Mansouri K. Medicinal plants extracts with antiangiogenic activity: where is the link? Advanced Pharmaceutical Bulletin. 2020;10(3):370.
19. Mohammadi Motlagh H. The study of anti-angiogenic effects of shallot (Allium hirtifolium) extract and isolation of effective fraction. MS c Thesis Tabriz, IR, Azarbayjan University of Tarbiat Moallem. 2008.
20. Nirankari VS, Karesh J, Bastion F, Lakhanpal V, Billings E. Recurrence of keratoconus in donor cornea 22 years after successful keratoplasty. The British Journal of Ophthalmology. 1983;67(1):23.
21. Gonzalez V, McDonnell PJ. Computer-assisted corneal topography in parents of patients with keratoconus. Archives of ophthalmology. 1992;110(10):1412-4.
22. Fabre E, Bureau J, Pouliquen Y, Lorans G. Binding sites for human interleukin 1 α, gamma interferon and tumor necrosis factor

on cultured fibroblasts of normal cornea and keratoconus. Current eye research. 1991;10(7):585-92.
23. Karseras A, Ruben M. Aetiology of keratoconus. British Journal of Ophthalmology. 1976;60(7):522-5.
24. Kahán I, Varsanyi-Nagy M, Toth M, Nadrai A. The possible role of tear fluid thyroxine in keratoconus development. Experimental eye research. 1990;50(4):339-43.
25. Vijaya L, George R, Arvind H, Ramesh SV, Baskaran M, Raju P, et al. Central corneal thickness in adult south Indians: The Chennai glaucoma study. Ophthalmology. 2010;117(4):700-4.
26. Ameerh MAA, Al Refai RM, Al Bdour MD. Keratoconus patients at Jordan University Hospital: a descriptive study. Clinical Ophthalmology (Auckland, NZ). 2012;6:1895.
27. Mirzajani A, Khezri F, Jafarzadehpur E, Karimian F. Evaluation of central corneal sensitivity in different age groups with healthy cornea in Tehran. Journal of Paramedical Sciences & Rehabilitation. 2013;2(2):7-12.
28. Hsu S-L, Chang C-H, Lai Y-H, Wen M-H, Cheng K-C, Ho C-K. Refractive status of mountain aborigine schoolchildren in southern Taiwan. The Kaohsiung journal of medical sciences. 2008;24(3):120-5.
29. Yazdani K, Fotouhi A, Hashemi H, Parsafar H, Mehravaran S, M.Sc AK. Corneal Thickness Measurement By Orbscan Ii In Tehran: A Population Based, Cross-Sectional Study. Journal Of Current Ophthalmology. 2004;17(2).
30. Roszkowska AM, Colosi P, Ferreri FM, Galasso S. Age-related modifications of corneal sensitivity. Ophthalmologica. 2004;218(5):350-5.
31. Iyamu E, Iyamu JE, Amadasun G. Central corneal thickness and axial length in an adult Nigerian population. Journal of Optometry. 2013;6(3):154-60.
32. Millodot M. Diurnal variation of corneal sensitivity. The British Journal of Ophthalmology. 1972;56(11):844.
33. Booranapong W, Tanthuvanit P, Suwannik A. Corneal sensitivity in normal Thai population. Siriraj Medical Journal. 2005;57(7):262-5.
34. Gracy R, Talent J, Kong Y, Conrad C. Reactive oxygen species: the unavoidable environmental insult? Mutation Research/ Fundamental and Molecular Mechanisms of Mutagenesis. 1999;428(1-2):17-22.
35. Rittié L, Fisher GJ. UV-light-induced signal cascades and skin aging. Ageing research reviews. 2002;1(4):705-20.
36. Vinson JA. Oxidative stress in cataracts. Pathophysiology. 2006;13(3):151-62.
37. Hahn S, Azen S, Ying-Lai M, Varma R, Group LALES. Central corneal thickness in Latinos. Investigative ophthalmology & visual science. 2003;44(4):1508-12.
38. Thomas R, Korah S, Muliyil J. The role of central corneal thickness in the diagnosis of glaucoma. Indian journal of ophthalmology. 2000;48(2):107.
39. Ostadi MH, Payandeh A, Doroodgar F. Assessment of Age, Gender, and Refractive Errors on Central Corneal Thickness in Subjects Referring to Al-Zahra Eye Hospital of Zahedan. 2018.
40. Goldich Y, Barkana Y, Pras E, Fish A, Mandel Y, Hirsh A, et al. Variations in corneal biomechanical parameters and central corneal thickness during the menstrual cycle. Journal of Cataract & Refractive Surgery. 2011;37(8):1507-11.
41. Reidy J, Bouchard C, Florakis G, Goins K, Rootman D, Parrish C. External Disease and Cornea: Basic and Clinical Science Course: American Academy of Ophthalmology, section 8. United States. 2011:187-90.
42. Allansmith MR, Ross RN. Ocular

allergy and mast cell stabilizers. Survey of ophthalmology. 1986;30(4):229-44.
43. Linke SJ, Steinberg J, Eddy M-T, Richard G, Katz T. Relationship between minimum corneal thickness and refractive state, keratometry, age, sex, and left or right eye in refractive surgery candidates. Journal of Cataract & Refractive Surgery. 2011;37(12):2175-80.
44. Chen M-J, Liu Y-T, Tsai C-C, Chen Y-C, Chou C-K, Lee S-M. Relationship between central corneal thickness, refractive error, corneal curvature, anterior chamber depth and axial length. Journal of the Chinese Medical Association. 2009;72(3):133-7.
45. Ghasempour Z, Jafarzadehpour E, Kangari H. The Association between Central Corneal Thickness and Retinal Fiber Layer Thickness with Refractive Error. Journal of Paramedical Sciences & Rehabilitation. 2015;4(1):35-40.
46. Mohammadi AA, Jafarzadehpur EE, Rafiee M. Corneal Thickness, Corneal Curvature and Refractive Errors of University Student in Arak. Journal of Arak University of Medical Sciences. 2013;16(8):85-91.
47. Kadhim YJ, 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 Ophthalmology (Auckland, NZ). 2016;10:2369.

Footnotes and Financial Disclosures

Conflict of interest:

The authors have no conflict of interest with the subject matter of the present manuscript.