Cross-sectional Study

Keratoconus detected by corneal topography in patients seeking refractive surgery in Jazan region, Saudi Arabia: A retrospective cross-sectional study

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ABSTRACT

Background: Keratoconus is a non-inflammatory, chronic, idiopathic, corneal disease characterized by thinning of the core or paracentral part of the cornea. In this study, we demonstrate the prevalence of keratoconus among patients seeking refractive surgery using laser vision correction (LVC) at the Department of Ophthalmology, Private Eye Center, Jazan, Saudi Arabia.

Materials and methods: A retrospective cross-sectional study was undertaken with the data from January 1, 2019 to December 31, 2019 in the ophthalmology department of Jazan city. This study included 1068 eyes of 534 patients of which 56.8% were men. The mean patient age was 28.5 (SD = 8.3) years. The analyst performed chi-square tests for the report. Prevalence was calculated at a 95% confidence interval at specified times in the year (CI).

Results: The prevalence of manifest unilateral keratoconus was 3% and that of bilateral keratoconus was 18.72%; on the other hand prevalence rates of suspected unilateral KC was 16.48% and of bilateral KC 9.36%. Significant differences between eyes were noted and recorded.

Conclusion: The occurrence and spread of this condition are on the rise in the city of Jazan and on the outskirts.

Terminology: eyeball disorder (keratoconus), prevalence, risk factors, treatment of the disorder (vision).

1. Introduction

Keratoconus is an idiopathic chronic non-inflammatory corneal disease that presents with degeneration of the eye structure within the cornea, thereby shrinking and thinning of the eyeball [1–4]. Normally, the disorder begins at a tender age and may last longer, extending to 40 years of age. Variations in geography, race, concurrent disorders, and infections, such as atopy, fever, and asthma, among others, are contributing factors to the onset of keratoconus. Incidentally, poor research methods in different medical facilities and poor diagnosis and treatment methods perpetuate its prevalence and spread. Such cases

explain the tendency to infect [2,3,5,6]. Research on the keratoconus disorder and its prevalence is challenging because of the geographical distribution of patients and their differences limiting the scope of their studies. However, reports state that geographical areas predisposed to warm climates, such as the Middle East and great Asia, recorded relatively large numbers of infections compared to countries experiencing cold climates, such as the United States, the United Kingdom, and Russia [7,8]. Genetic predisposition could also contribute to its occurrence, especially in ethnic groups with a designated way of life, as was found in a certain Asian province. Significant data on the higher rate of infections in this Asian province indicate the need for research on keratoconus

Table 1
Prevalence of keratoconus.

Sd = standard deviation, N = number	
Variable	N (%)/mean (sd)*
Gender	
Male	(56.9%)304
Female	(43.1%)230
Total	(100%)534
Age	(8.3)28.6
Diagnosis	
Normal	(52.43%)280
Suspect unilateral	(16.48%)88
Bilateral	(9.36%)50
Manifest unilateral	(3%)16
Bilateral	(18.72%)100
Total	(100%)534
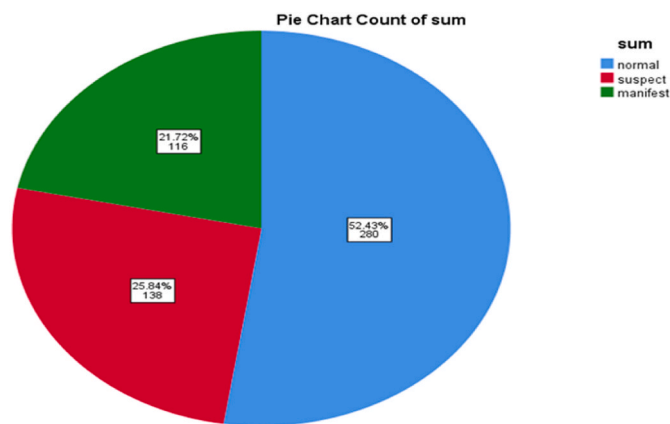
Fig. 1. Total number of keratoconus cases.

Table 2
Prevalence of keratoconus according to age and gender.

Variable	normal	Suspect (KC)	Manifest (KC)	p.value
20 y or less				0.265
Male	20	10	13	
female	12	8	3	
21–25 y				0.081
Male	70	16	16	
female	36	18	6	
26–30 y				0.209
Male	41	19	26	
female	21	16	9	
31–35 y				0.052
Male	17	6	12	
female	25	17	7	
36–40 y				0.243
Male	9	8	7	
female	13	5	3	
41–45 y				0.117
Male	5	1	6	
female	5	5	4	
46–50 y				0.683
Male	1	2	1	
female	2	4	6	
51 y or more				0.091
Male	0	1	2	
female	2	3	5	
Total				0.001
Male	164	62	78	
Female	116	76	38	

diagnosis and infection in the Middle East population [7]. Additionally, there is an urge to evaluate the occurrence and spread rate in locations with a growing number of patients seeking laser vision correction (LVC), as this might provide ophthalmologists with a means of finding cases of keratoconus while screening patients for LVC. The current study investigated the patients of keratoconus in Saudi Arabia who sought LVC services in the refractive surgery centers (1078/1374). Notably, approximately 38.9% of eyes showed an average of 1.50 D astigmatism. The diagnosis process applied a pentagram to measure anterior and posterior tachymetric distribution and keratometry data in human eyes. D values were determined by analyzing the regression versus the standard count of normal and infected individuals. The (BAD) software parameters were defined using a different source. This colored and software-coded parameter depends on the deviation from the average and graded standard below 1.6 SD from the average population is white, doubtful (1.6–2.6 SD yellow), and finally the pathological (2.6 SD red). Keratoconus prevalence was analyzed as 'per patient' in the study population, with an assessment of both eyes. Patients who presented with bilateral keratoconus in the eye had a normal status in the other eye and were identified with manifest keratoconus. The classification of patients depended on whether one manifested bilateral sub-clinical or unilateral with normal scope in the eye. Also, gender-based infection assessment is done with the help of a squared test tool. A value below 0.05 was significant (8). This study aimed to collect and analyze cases of keratoconus and the causes of keratoconus in patients who seek medical treatment in a private hospital in Jazan city.

2. Materials & methods

This retrospective case study was conducted in a city in Saudi Arabia.

The study included all patients who underwent pre-examination for vision correction at the Department of Ophthalmology in a private hospital in Jazan. A total of 1068 eyes of 534 patients who underwent complete ophthalmic examination, which include visual acuity, refraction, pachymetry, keratometry, slit lamp bio microscopy and fundus examination as well as pentacam (Oculus Optikgeraete GmbH Wetzlar Germany using the belin-Ambrosio enhanced ectasia (BAD) in the period January 1, 2019 to December 31, 2019 were included. The following data were obtained: age, sex, corneal thickness the maximum keratometric power thinnest location, anterior elevation map, posterior elevation map, KC diagram, to evaluate the keratocouns status, sub-clinical or manifest, and unilateral or bilateral. Demography was computed according to the patient age, sex, and laterality. After data collection, manual verification was performed, and then the entry into an Excel spreadsheet was analyzed statistically using social science packages. The chi-square test was used to compute the presence of keratoconus for those seeking LVC services. Frequency and prevalence data are presented as percentages (%). Statistical significance was set at p-value ≤ 0.05. The research findings met the guideline of STROCS [17] and was registered with Research Registry (UIN) 7511 [18].The research method adhered to declaration of Helsinki and provisions in the Scientific Research Ethics Committee reference code (REC 42/1/118) by Jazan University.

3. Result

We included 534 patients at the Department of Ophthalmology in a private hospital (Magrabi Eye center) in Jazan, (56.9%) of them were male. The mean age of all patients was 28.6 (SD = 8.3) years. The prevalence rate of manifest keratoconus is 3% unilateral and 18.72% bilateral; on the other hand prevalence rate of suspected KC is 16.48% unilateral and 9.36% bilateral (Table 1, Fig. 1).

Pie charts describe total number of manifest keratoconus, total number of suspect Kc and total number of normal patients (Fig. 1).

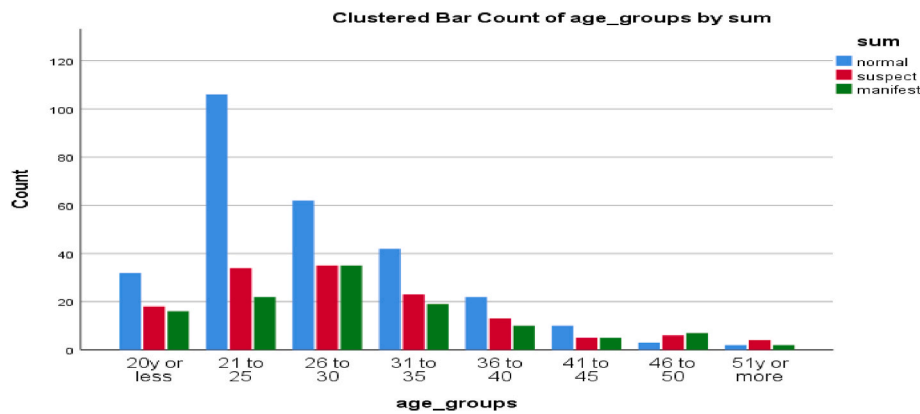There was a significant difference between sex and the prevalence

Fig. 2. Cluster bar chart describes distribution of our population by age.

rate of manifest and suspect keratoconus (P.value = 0.001).

There were no statistically significant associations between the different age groups and prevalence of keratoconus (Table 2, Fig. 2).

There were significant differences in the right eye or left eye in the following variables: k max, thinnest location, asymmetry, anterior elevation map, posterior elevation map, and Kc diagram among normal and suspect keratoconus and manifest keratoconus (P.value < 0.001), and thickness map elevation (P.value = 0.021) (Table 3).

Logistic regression age significantly affected the diagnosis of keratoconus or subclinical keratoconus (suspect) in both eyes; nevertheless, sex was not associated with diagnosis (Table 4).

Logistic regression analysis revealed that age, K max, thinnest location, asymmetry, thickness, and KC diagram in the right eye significantly affected the likelihood that the participants had keratoconus or subclinical keratoconus (suspect) in the left eye. In addition, asymmetry, thickness, and KC diagrams in the left eye were found to significantly affect the likelihood that participants had keratoconus or subclinical keratoconus (suspect) in the right eye (Tables 5–7).

4. Discussion

Pentacam topography is considered the gold standard for detecting keratoconus [9]. It is convenient for easy measurement and efficient preoperative planning because it provides a reliable diagnosis of KC and is financially viable. According to previous studies, the prevalence of keratoconus shows wide variations worldwide; it was 0.138% globally according to previous studies until 2018 [10]. In Iran, the prevalence is 100%, in Turkey, 26.2% in Turkey, 20%, Nepal at 11.3%, in the Gambia, 0.9%, and Italy at 0.77% [11]. However, there are limited studies on the prevalence of keratoconus in Egypt [10–12]. Our study shows 3% manifest unilateral KC, 18.72% manifest bilateral KC, and 16.48% suspected unilateral KC, 9.36% suspected bilateral KC in a relatively large sample of 534 patients, in contrast to published studies in our geographical area (Egypt& Africa) [13]. Ahmed et al. [3] found a prevalence of 7% in a 100 individual sample, Elbedewy et al. [5] reported a prevalence of 1.2% in a large sample of 8124, and Saro et al. [6] of 17.5% in a sample size of 1202. We also found that k max, location of thinnest section, asymmetry, anterior elevation map, posterior elevation map, and Kc diagram are good indices of manifested KC as there are significant differences between normal and manifested KC (p-value < 0.001), In contrast, Elbe dew et al. [4] found no significant difference concerning regions of the cornea with varying thickness between normal and manifest KC, Sidky et al. [7] found a significant difference in the anterior and posterior elevation map between normal, suspected and manifested KC.

5. Strengths and limitations

To the best of our knowledge, few studies have analyzed suspected cases, especially in adults. In addition, our cohort was relatively large, sex was well-balanced, and age was normally distributed. However, the retrospective cross-sectional design of our study is a limitation. The patients were from one private hospital in Jazan City; therefore, they may not be representative of the entire population. The use of a clinical sample rather than a population-based sample introduced an additional constraint on the validity of our results.

6. Conclusions

We report a high prevalence of keratoconus: 3% manifest unilateral KC, 18.72% manifest bilateral KC, 16.48% suspected unilateral KC, and 9.36% suspected bilateral KC. Therefore, we recommend using social media websites, malls, and television to raise awareness about keratoconus. In addition, we recommend screening programs to detect keratoconus early to avoid complications. In addition, future studies that include a larger number of hospitals to estimate the prevalence of keratoconus in the Jazan region are warranted.

Provenance and peer review

Not commissioned, externally peer-reviewed.

Author contributions

Study concept: Mohammed W. Bosaily, Aisha A. Majrashi, Wassem Zakri, and Asma Abdulazim. Design: Mohammed O. Shami, Mohammed W. Bosaily, Majd H. Moafa, and Wassem Zakri. Data collection: Ahmed A. Ageeli, Mohammed O. Shami, Shahad K. Shabaan, and Walid Barakat. Data analysis: I. Abuallut, Ahmed A. Ageeli, Majd H. Moafa, and Walid Barakat. Writing: Ismail I. Abuallut, Aisha A. Majrashi, Shahad K. Shabaan, and A. Abdulazim.

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Table 3
Topographic data of normal group compared to suspect or manifest KC group.

Variable	normal	Suspect (KC)	(KC) manifest	P.value
K ma (OD)				<0.001
Normal	253	105	43	
Suspected	16	33	29	
Manifest	1	0	44	
Thin (OD)				<0.001
Normal	253	98	29	
Suspected	26	33	32	
Manifest	1	7	55	
IS A (OD)				<0.001
Normal	265	111	42	
Manifest	15	27	74	
Ante (OD)				<0.001
Normal	260	110	50	
Manifest	20	28	66	
Post (OD)				<0.001
Normal	268	113	56	
Manifest	12	25	60	
Thick (OD)				0.021
Normal	60	23	36	
suspected	220	115	80	
Kc d (OD)				<0.001
Normal	277	70	6	
Suspected	3	68	13	
manifest	0	0	97	
K ma (OS)				<0.001
Normal	268	114	42	
Suspected	11	24	29	
manifest	1	0	45	
Thin (OS)				<0.001
Normal	255	102	36	
Suspected	23	31	19	
manifest	2	5	61	
IS A (OS)				<0.001
Normal	255	121	47	
manifest	25	17	69	
Ante (OS)				<0.001
Normal	260	121	58	
manifest	20	17	58	
Post (OS)				<0.001
Normal	262	125	63	
manifest	18	13	53	
Thick (OS)				0.012
Normal	134	45	52	
suspected	146	93	64	
Kc d (OS)				<0.001
Normal	280	45	13	
Suspected	0	92	11	
manifest	0	1	92	

KC = keratoconus, OD = oculus dexter (right eye), OS = oculus sinister (left eye),*K ma = kc* max *(the maximum keratometric power),Thin = thinnest location,Is A = asymmetry,Ante = anterior elevation map,Post = posterior elevation map,Thick = the thickness location, K d = Kc diagram.*

Table 4
Logistic regression of total diagnosis in both eyes.

	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
							Lowe	Upper
Age	0.033	0.011	8.967	1	0.003	1.034	1.012	1.057
gender	- 0.036	0.180	0.041	1	0.84	0.964	0.678	1.371

a Variable(s) entered on step 1: Age and gender.

Table 5

Logistic regression of diagnosis of left eye according to variables or right eye.

	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
							Lowe	Upper
Age	−0.001	0.015	0.004	1	0.948	0.999	0.970	1.029
K ma (OD)	−0.023	0.01	5.514	1	0.019	0.977	0.959	0.996
Thin (OD)	−0.02	0.004	21.435	1	0.000	0.980	0.971	0.988
IS (OD)	−0.472	0.126	13.893	1	0.000	0.623	0.487	0.799
Ante (OD)	0.061	0.044	1.893	1	0.169	1.063	0.974	1.160
Post (OD)	0.017	0.023	0.518	1	0.472	1.017	0.972	1.064
Thick (OD)	−0.01	0.005	4.915	1	0.027	0.990	0.981	0.999
KC d (OD)	1.304	0.203	41.423	1	0.000	3.683	2.476	5.479

a Variable(s) entered on step 1: Age, kc max (the maximum keratometric power), thinnest location, asymmetry, anterior elevation map, posterior elevation ma, the thickness location and Kc diagram in right eye.

Table 6

Logistic regression of diagnosis of right eye according to variables of left eye.

	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
							Lowe	Upper
Age	0.029	0.015	3.799	1	0.051	1.029	1	1.060
K ma (OS)	0.068	0.080	0.723	1	0.395	1.070	0.915	1.253
Thin (OS)	0.000	0.004	0.001	1	0.972	1	0.993	1.007
IS (OS)	0.354	0.172	4.240	1	0.039	1.424	1.017	1.995
Ante (OS)	0.055	0.045	1.522	1	0.217	1.057	0.968	1.154
Post (OS)	−0.002	0.008	0.068	1	0.794	0.998	0.981	1.014
Thick (OS)	−0.010	0.005	3.725	1	0.054	0.991	0.981	1
KC d (OS)	1.751	0.252	48.157	1	0.000	5.761	3.513	9.447

a Variable(s) entered on step 1: Age, kc max (the maximum keratometric power), thinnest location, asymmetry, anterior elevation map, posterior elevation ma, the thickness location and Kc diagram in left eye.

Table 7

Prevalence rate of keratoconus in previous studies worldwide.

study	Data collection period	country	Study type	Sample size		Prevalence rate of KC
				M	F	
Netto et al. [8]	2017	Saudi Arabia	Hospital based	219	303	4.79%
Caputo et al. [9]	2012–2013	italy	Hospital based	754	397	0.77%
Totan et al. [10]	1998–1999	turkey	Hospital based	62	20	26.2%
Dantas et al. [11]	2000	brazil	Hospital based	118	55	22.53%
Ahmed et al. [12]	2017–2018	Egypt	Hospital based	66	34	7%
Feng et al. [13]	2013–2018	china	Hospital based	40	131	73%
Sidky et al. [14]	2017	Egypt	Hospital based	265	282	4.8%
Omar et al. [15]	2015–2018	Egypt	Hospital based	47	40	9.2%
Mugho et al. [16]	2016	kenya	Hospital based	63	60	30.89%

Informed consent statement

Waived since it's retrospective data.

Data availability statement

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

Declaration of competing interest

The authors declare that there is no conflict of interests.

Appendix A. Supplementary data

Supplementary data related to this article can be found at https://do i.org/10.1016/j.amsu.2022.103890.

References

[1] T.A. Althomali, I.M. Al-Qurashi, S.M. Al-Thagafi, A. Mohammed, M. Almalki, Prevalence of keratoconus among patients seeking laser vision correction in Taif area of Saudi Arabia, Saudi J Ophthalmol 32 (2) (2018) 114–118.

[2] S. Bak-Nielsen, C.H. Ramlau-Hansen, A. Ivarsen, O. Plana-Ripoll, J. Hjortdal, Incidence and prevalence of keratoconus in Denmark - an update, Acta Ophthalmol. 97 (8) (2019) 752–755.

[3] N. Bejdic, A. Biscevic, M.A. Pjano, B. Ivezic, Incidence of keratoconus in refractive surgery population of Vojvodina - single center study, Mater. Soc. Med. 32 (1) (2020) 46–49.

[4] D.A. Godefrooij, G.A. de Wit, C.S. Uiterwaal, S.M. Imhof, R.P. Wisse, Age-specific incidence and prevalence of keratoconus: a Nationwide registration study, Am. J. Ophthalmol. 175 (2017) 169–172.

[5] B.S. Al-Qahtani, S.A. Al-Swailem, K. Ahmad, R. Khandekar, Vision related quality of life of patients with keratoconus after keratoplasty at a Tertiary Eye Hospital in Saudi Arabia, Eur. J. Ophthalmol. 31 (6) (2021) 3500–3504.

[6] B.K. Armstrong, S.D. Smith, I. Romac Coc, P. Agarwal, N. Mustapha, S. Navon, Screening for keratoconus in a high-risk adolescent population, Ophthalmic Epidemiol. 28 (3) (2021) 191–197.

[7] M.M. Shehadeh, V.F. Diakonis, S.A. Jalil, R. Younis, J. Qadoumi, L. Al-Labadi, Prevalence of keratoconus among a Palestinian tertiary student population, Open Ophthalmol. J. 9 (2015) 172–176.

[8] E.A. Torres Netto, W.M. Al-Otaibi, N.L. Hafezi, S. Kling, H.M. Al-Farhan, J. B. Randleman, et al., Prevalence of keratoconus in paediatric patients in Riyadh, Saudi Arabia, Br. J. Ophthalmol. 102 (10) (2018) 1436–1441.

[9] V. Kavitha, M.M. Heralgi, S. Aafreen, Comparison of posterior corneal elevation in children with and without vernal keratoconjunctivitis using a new tomographer, Indian J. Ophthalmol. 69 (8) (2021) 2060–2063.

[10] Y. Totan, I.F. Hepşen, O. Cekiç, A. Gündüz, E. Aydin, Incidence of keratoconus in subjects with vernal keratoconjunctivitis: a videokeratographic study, Ophthalmology 108 (4) (2001) 824–827.

[11] P.E. Dantas, M.R. Alves, M.C. Nishiwaki-Dantas, Topographic corneal changes in patients with vernal keratoconjunctivitis, Arq. Bras. Oftalmol. 68 (5) (2005) 593–598.

[12] A.S. Ahmed, M.H. El-Agha, M.O. Khaled, S.M. Shousha, The prevalence of keratoconus in children with allergic eye disease in an Egyptian population, Eur. J. Ophthalmol. 31 (4) (2021) 1571–1576.

[13] K. Feng, Y. Zhang, Y-g Chen, Comparison of Tomography Suspect Keratoconus Defined by Sirius and Pentacam in a Chinese Cohort, Research Square, 2021.

[14] M.K. Sidky, D.H. Hassanein, S.A. Eissa, Y.M. Salah, N.M. Lotfy, Prevalence of subclinical keratoconus among pediatric Egyptian population with astigmatism, Clin. Ophthalmol. 14 (2020) 905–913.

[15] I.A.N. Omar, Keratoconus screening among myopic children, Clin. Ophthalmol. 13 (2019) 1909–1912.

[16] M. Sn, D.R. Ilako, E. Nyenze (Eds.), Prevalence of Keratoconus in Patients with Allergic Conjunctivitis Attending Kenyatta National Hospital Eye Clinic, 2018.

[17] G. Mathew, R. Agha, for the STROCSS Group, STROCSS 2021: strengthening the Reporting of cohort, cross-sectional and case-control studies in Surgery, Int. J. Surg. 96 (2021), 106165.

[18] https://www.researchregistry.com/browse-the-registry#home/registrationdetails/61d640ff772052001e0252e0/.