

Prevalence of Keratoconus in Individuals Attending Refractive Surgery Centers in Assiut

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Abstract

Background: Keratoconus is a degenerative, non-inflammatory condition causing corneal protrusion and thinning, which causes axial protrusion of the cornea and stromal thinning, eventually making the cornea conical. The study aimed to determine the prevalence of keratoconus according to geographical distribution in the Assiut governorate and identify possible risk factors (1).

Methods: The research involved a cross-sectional study to estimate Keratoconus prevalence in Assiut governorate centers, followed by a case-control study to identify correlations and risk factors of Keratoconus in three refractive surgery centers in Assiut from January to June 2021.

Results: 174 patients (10.7%) in our study of 1631 patients in Assiut were diagnosed with Keratoconus; El-Fath (15.6%), Assiut City (14.5%), and Sedfa (13.7%) had the highest prevalence rates.

Conclusion: Keratoconus, a prevalent condition common among adolescents, is linked to positive consanguinity and ocular allergy, with compound myopic astigmatism being the most common refractive error.

Introduction

Keratoconus is a common degenerative, non-inflammatory illness resulting in axial corneal protrusion and stromal thinning, eventually forming the cornea into a conical shape (1). It affects people of all racial and gender identities and usually manifests in the second decade of life. The regional distribution of the prevalence shows significant variation (2).

The geographics, the diagnostic standards applied, and the chosen patient population all significantly impact the reported prevalence of Keratoconus. Research frequency varies from 0.3 per

100,000 in Russia to 2300 per 100,000 in Central India (0.0003%-2.3%) (3).

Different studies may differ in the rate of Keratoconus diagnosis due to factors such as study population, geographic location, ethnicity, and disease presence (4, 5).

A study in the UK found that Asians had a significantly higher incidence of Keratoconus than White people (6, 7). This is mainly attributed to geographic factors, particularly in Northern Pakistan, where consanguineous marriages are customary, suggesting a genetic factor (8). Low prevalence was found in North

America and Russia (0.2 to 54 persons/100,000 population) (9, 10).

Spring catarrh and chronic allergies in the Middle East, particularly in Egypt, are linked to Keratoconus, with 20.05% of children aged 12-15 having eye allergies (11). A Saudi Arabian study found that vernal keratoconjunctivitis affects 35.6% of children, making it the most common eye condition. Persistent rubbing of the eyes causes permanent corneal warpage, Keratoconus (11-13).

In terms of gender distribution, there was no discernible difference between the male and female genders, with the female gender accounting for 45.1% of cases of Keratoconus and the female gender for 54.9% (14).

The signs and symptoms of Keratoconus in the eyes differ according to the severity of the disease. When Keratoconus is in its early stages, also known as subclinical or *Forme Fruste Keratoconus* forms (FFKC), it typically does not cause any symptoms, so neither the patient nor the healthcare provider may notice it unless corneal tomography is performed to make the diagnosis (15).

Diagnostic Criteria:

Holladay's 2008 criteria for Keratoconus diagnosis include the cone's apex not centered at six o'clock, round appearance on the tangential map, K-readings over 45.00 D, 30 μm thinner corneal thickness at apex, and non-symmetrical topographical patterns (16).

The Amsler-Krumeich Classification (17)

Grades	Characteristics
Stage 1	Eccentric steeping Myopia and astigmatism < 5.00 D Mean central K readings < 48.00 D
Stage 2	Myopia and astigmatism from 5.00 to 8.00 D Mean central K readings < 53.00 D Absence of scarring Minimum corneal thickness > 400 μm
Stage 3	Myopia and astigmatism from 8.00 to 10.00 D Mean central K readings > 53.00 D Absence of scarring Minimum corneal thickness from 300 to 400 μm
Stage 4	Refraction not measurable Mean central K readings > 55.00 D Central corneal scarring Minimum corneal thickness 200 μm

Stage is determined if one of the characteristics applies. **D:** Diopter; **K:** Keratometry.

Aim of the Study:

To determine the prevalence of Keratoconus in the various geographic distributions and identify potential risk factors for the condition in patients attending Assiut governorate's refractive surgery centers.

Patients and Methods:

Patients signed informed consent.

Assiut Faculty of Medicine approved the study.

Type of the Study:

The research involved a cross-sectional study to estimate Keratoconus

prevalence in Assiut and a case-control study to examine patient correlations and risk factors.

Study Setting:

The study randomly chose three refractive surgery centers in Assiut to conduct our study: Al Forsan Center, Al Nour Center, and Modern Eye Center, from January 2021 to June 2021.

Selection of Cases:

Inclusion Criteria:

- The study included all patients attending the refractive surgery centers who were discovered to have fulfilled the diagnostic criteria of Keratoconus over six months.
- Diagnosed patients by history, clinical examination, and by Pentacam.
- The grading of Keratoconus was based on the Amsler-Krumeich classification.

Exclusion Criteria:

- Patients who don't fulfill the Keratoconus diagnostic criteria of Keratoconus.
- Patients attending these centers from districts outside Assiut governorate.
- Patients refused to share their sociodemographic data in our study.
- Patients with ocular surgery or trauma.
- Patients younger than 5 years and after forty –six years old.

Selection of Controls:

The same age group and sex matched the assigned population, which did not have Keratoconus.

Diagnostic Tools:

- Sociodemographic factors include age, sex, residency, occupation, paternal consanguinity, smoking habits, and pregnancy, based on full history taking. Systemic chronic diseases, such as Diabetes Mellitus, Hypertension, and bronchial asthma.
- Other ocular conditions include impaired vision, chronic allergies, eye trauma, chemical injuries, and physical traumas, which can lead to spectacle changes and rubbing eyes. History of congenital anomalies, such as Down syndrome.
- Refraction (uncorrected, best corrected) obtained from recorded data using an auto refractometer.
- Pentacam of the patient from records saved in the assigned centers in our study.

Procedures:

Data from records at these centers was collected from January to June 2021, with missing or incomplete information revised with patients and completed via phone calls.

Prevalence Rate:

$$\text{Prevalence} = \frac{\text{All new and pre – existing cases of a specific disease during a given time period}}{\text{Total population during the same time period}} \times 10^n$$

The formula is used in calculating the prevalence rate (18).

Total Prevalence Rate

$$\frac{(\text{New + old cases of Keratoconus in 6 months duration})}{\text{population attending refractive surgery centers at the same period}} \times 100$$

The Specific Prevalence Rate of Different Geographical Areas in Assiut

$$\frac{(\text{New+old cases of Keratoconus in the area (X) in 6 months duration})}{\text{population attending refractive surgery centers at the same period in the area (X)}} \times 100$$

Ethical Approval:

The study was approved by Assiut University Faculty of Medicine's Ethical Committee (**IRB number: 17100941**).

Consent:

Administer approval was obtained from each center mentioned in our study. Verbal consent was obtained from patients by phone call.

Statistical Analysis

Data were verified, coded by the researcher, and analyzed using IBM-SPSS. A p-value equal to or less than 0.05 was considered significant (19).

Results

Our study included a total number of 1631 patients attending three refractive surgery centers in Assiut. The mean age of the studied sample was 27.18 ± 5.9 , with a range of age (5 – 46). 626 (38.4%) patients were males, and 1005 (61.6%) were females. The geographical distribution of the studied sample was 98 (6%) patients from Abnub, Dairout 174 (10.7%), from El-Qusia 230 (14.1%), Manfalut 165 (10.1%), Assiut 578 (35.4%), from El-Fath 77 (4.7%), from Abu-Tig 96 (5.9%), from El-Ghanayem 31 (1.9%), from Sahl-Sleem 62 (3.8%), from El-Badary 69 (4.2%), and Sedfa 51 (3.1%) (Table 1), with the highest population, was from Assiut city (Fig.1).

Table 1: Baseline characteristics of the total studied sample

Variable	Category	n = 1631
Age in years	• Mean \pm SD	27.18 \pm 5.9
	• Median (Range)	27 (5– 46)
Sex	• Male	626 (38.4%)
	• Female	1005 (61.6%)
Residence	• Abnub	98 (6%)
	• Dairo	174 (10.7%)
	• El-Qusia	230 (14.1%)
	• Manfalut	165 (10.1%)
	• Assiut	578 (35.4%)
	• El-Fath	77 (4.7%)
	• Abu-Tig	96 (5.9%)
	• El-Ghanayem	31 (1.9%)
	• Sahl-Sleem	62 (3.8%)
	• El-Badary	69 (4.2%)
• Sedfa	51 (3.1%)	

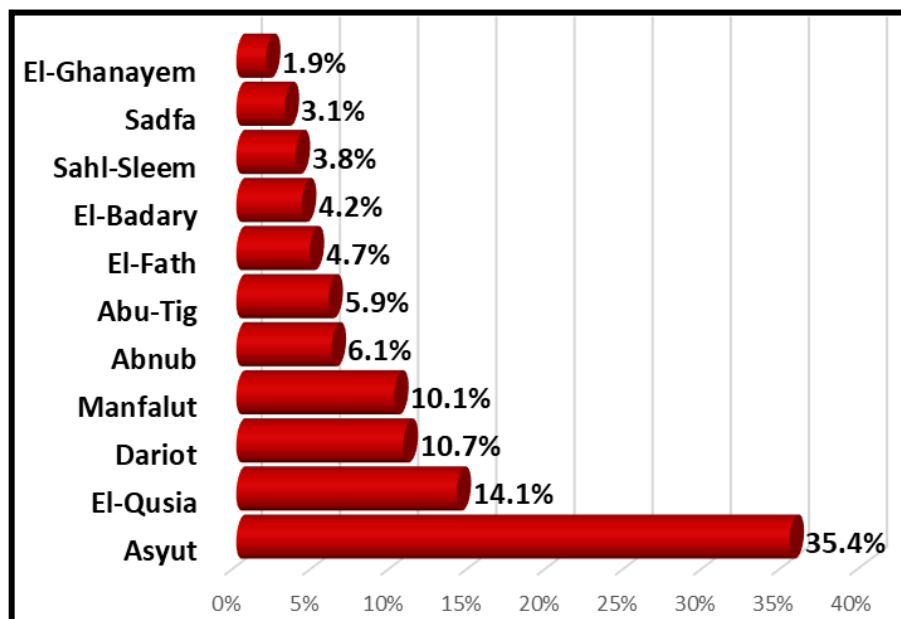


Fig.1: Distribution of the sample according to Residence

A study found that 174 (10.7%) patients diagnosed with Keratoconus had a mean age of 26.04 ± 7.6 , with 50% males and 50% females as in Fig (2).

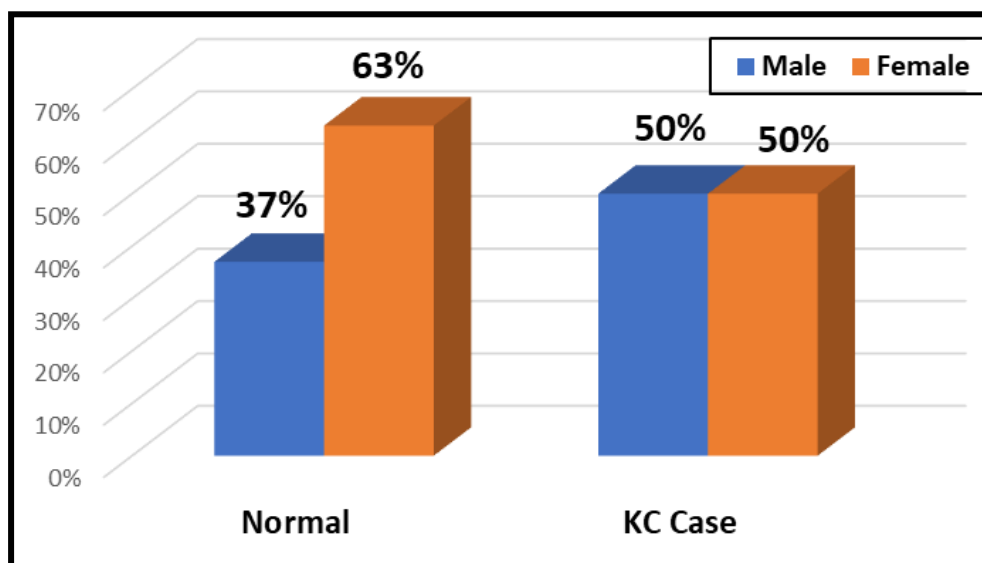


Fig 2: Prevalence of Keratoconus among the studied Cohort according to sex

The prevalence rate varies widely according to geographical distribution, and the statistically significant P-value was 0.015. The highest prevalence was in El-Fath (15.6%), then Assiut City (14.5%), Sedfa (13.7%), El-Badary

(10.1%), Manfalut (9.1%), El-Qusia (8.3%), Abu-Tig (7.3%), Dairout (6.9%), Sahel-Selem (6.5%), El-Ghanayem (6.5%), and Abnub (5.1%) (Table 2) (Pic1).

Table 2: Baseline characteristics Difference in keratoconus cases vs. Normal

Variable	Category	Normal (n = 1457)	Keratoconus (n = 174)	P-value
Age in years	•Mean ± SD	27.09 ± 5.7	26.04 ± 7.6	= 0.028*
	•Median (Range)	27 (5 – 46)	27 (5 – 46)	
Sex	•Male	539 (37%)	87 (50%)	= 0.001**
	•Female	918 (63%)	87 (50%)	
Residence	•Abnub	93 (94.9%)	5 (5.1%)	= 0.015***
	•Dariot	162 (93.1%)	12 (6.9%)	
	•El-Qusia	211 (91.7%)	19 (8.3%)	
	•Manfalut	150 (90.5%)	15 (9.1%)	
	•Assiut	494 (85.5%)	84 (14.5%)	
	•El-Fath	65 (84.4%)	12 (15.6%)	
	•Abu-Tig	89 (92.7%)	7 (7.3%)	
	•El-Ghanayem	29 (93.5%)	2 (6.5%)	
	•Sahl-Sleem	58 (93.5%)	4 (6.5%)	
	•El-Badary	62 (89.9%)	7 (10.1%)	
	•Sedfa	44 (86.3%)	7 (13.7%)	

*Student t-test was used to compare the mean difference.

**The Chi-square test was used to compare the Frequency difference.

*** The Monte Carlo Exact test was used to compare the Frequency difference.



Pic 1: Geographical distribution of Keratoconus in Assiut

Baseline characteristics of the studied KC Cases (Table 3).

Table 3: Baseline characteristics of the studied KC Cases

Variable	Category	n = 174
Consanguinity	• Negative	108 (62.1%)
	• Positive	66 (37.9%)
Smoking	• Non	140 (80.5%)
	• Smoker	34 (19.5%)
Comorbidity	• No	168 (96.5%)
	• DM/HTN	6 (3.5%)
Ocular Disease	• No	99 (56.9 %)
	• Allergy	74 (42.5%)
	• History of Chemical Injury	1 (0.6%)
KC Grade	• 1	33 (19%)
	• 2	65 (37.4%)
	• 3	72 (41.3%)
	• 4	4 (2.3%)
Laterality	• Unilateral	22 (12.6%)
	• Bilateral	152 (87.4%)
Type of RE	• Astigmatism	74 (42.5%)
	• Myope	16 (9.2%)
	• Astigmatism and Myope	84 (48.3%)

Discussion

Keratoconus is a primary corneal ectasia characterized by localized thinning and worsening visual acuity. In Egypt, population-based screening is challenging due to high costs. This study aims to determine Keratoconus prevalence in Assiut governorate and identify associated risk factors (20).

From the study sample in the current study, 174 patients out of 1631 were diagnosed with Keratoconus based on clinical data and pentacam corneal tomography, with a prevalence rate equal to (10.7%). The Sohag governorate study found 210 patients out of 1202 participants to have Keratoconus with a percentage of (14.65%) (21). 59 patients out of 687 participants in the Taif area of Saudi Arabia had Keratoconus, indicating a prevalence rate of (8.59%)

(22). In another Saudi study, 548/2931 (24%) had

Keratoconus (23). However, the Delta Egypt study found that 91/8124 patients had Keratoconus with a percentage of (1.12%) (24).

This can be explained by the high percentage of Keratoconus in hot weather areas. Multiple data confirm this finding since prevalence rates are higher in warm-weather nations like central India (2.3%) (25) and the Middle East (3.9%) (11), compared to countries like Finland that have colder climates (0.03%) (26), Denmark (0.086%) (27), Minnesota, USA (0.05%) (10), Japan (0.009%) (28), and Russia (0.0003%) (9). Like in our study in the Assiut governorate, the Keratoconus prevalence was (10.7 %), and in the Sohag study, keratoconus was (14.65%); this confirms

the high prevalence of Keratoconus in Upper Egypt in comparison to Delta Egypt (1.12%).

The prevalence of Keratoconus varies between studies, with locations with high sunshine and hot weather having a higher prevalence rate (7, 29). Hot, dusty weather can cause chronic allergies and eye rubbing, leading to corneal ectasia (30).

The current study showed that the prevalence rate varies widely according to geographical areas in Assiut. The highest prevalence was in El-Fath (15.6%), then Assiut City (14.5%), Sedfa (13.7%), El-Badary (10.1%), Manfalut (9.1%), El-Qusia (8.3%), Abu-Tig (7.3%), Dairout (6.9%), Sahel-Selem (6.5%), El-Ghanayem (6.5%), and Abnub (5.1%).

El-Fath Center's geographical location and uninhabited desert land contribute to dusty weather, allergies, and eye rubbing. The high prevalence of Keratoconus in Assiut City is due to education and increased demand for refractive surgery.

The study reveals a higher prevalence of Keratoconus among refractive surgery patients, indicating a lack of accurate representation of the Assiut governorate's overall population. The rise in cases is due to advanced diagnostic tools, but it is a bilateral disease. Our recent study showed that 152 patients (87.4%) had bilateral disease, and 22 had unilateral (12.6%). Pentacam screening in the Sohag study revealed that 798 people had bilateral disease (66%) patients and unilateral in 404 (34%) patients. According to a study conducted in Delta, Egypt, only 5 (5.5%) of the 86 cases (or 94.5%) exhibited unilateral affection (24). According to a study conducted in Taif, Saudi Arabia, 23.73% of cases were unilateral, and 76.27% were bilateral. This is in

agreement with another study where (84.8%) of cases were bilateral, and only (15.2%) were unilateral (14). Similarly, (88.5%) of subjects in the Weed et al. study exhibited bilateral Keratoconus (31).

In our study, the average age of patients with Keratoconus was 26.04 ± 7.6 years. This is consistent with the Delta, Egypt study, where the age group with Keratoconus was between (29.40 ± 9.79) (24), the study conducted in Saudi Arabia, where the average age was 24.1 ± 6.6 years (23), and the Sohag study mean age (of 30 ± 5) (21). According to other research, Keratoconus typically begins to develop at puberty, as demonstrated by the Ljubic study, where the mean age was (26.81 ± 1.25 years) (14) and Cruz-Becerril et al. with (28.14 ± 10.30) years of age (32). This was much younger than Hashimi et al. (33), who stated that their diagnosis was made at a mean age of 47.6 years. According to reports, Asian patients had a lower mean age at Keratoconus diagnosis. Assiri et al. (34) in Saudi Arabia with a mean age of 18.5 ± 3.9 years.

Concerning gender distribution, the current study showed a higher percentage of females (61.9%) than males (38.9%) attending refractive surgery centers; this may be explained by the increased demands for refractive correction in females than males. However, there is no variation in the percentage between males and females in the Keratoconus group. Like Taif, Saudi Arabia, female Keratoconus prevalence was equal to male prevalence (22). A literature survey showed no agreement among the investigations on whether Keratoconus was more common in men or women (35); Keratoconus is a disease with no gender predominance (36).

The Delta, Egypt study found a slight gender predominance, with 54.9 percent

of the cases being female and 45.1% being male, with no significant difference between the two genders. This was consistent with the findings of Ljubic, who discovered that 52.9% of all Keratoconus patients were female (14). According to Jonas et al., Keratoconus is significantly more common in women (25), and a Mexican study found that the prevalence of Keratoconus in female patients was twice that of male patients (66.6% versus 33.3%) (25, 37).

In a population-based study, the authors found that the prevalence of Keratoconus in males was approximately five times higher than in females (4.91% versus 1.07%). This finding is consistent with other studies that show a higher prevalence of the condition in male patients (7). Like the Sohag study, 43.75% were females, and 56.25% were males.

Additionally, the current investigation revealed statistically significant risk factors linked to the development of Keratoconus. An ocular allergy is one of the most important risk factors; 42.5% of patients with Keratoconus have a history of rubbing their eyes due to an ocular allergy. A study found a strong correlation between Keratoconus and eye rubbing in teenagers and adults, indicating that a higher frequency of ocular allergy attacks directly impacts Keratoconus development. Additionally, it has been recorded that the younger age group experiences more ocular allergy attacks. These studies also revealed a strong correlation between rubbing of the eyes and the development of Keratoconus (21).

Out of 174 cases of Keratoconus, 66 patients (37.9%) had a statistically significant outcome of positive parent

consanguinity, according to the current study. Positive consanguinity was found in 42% of cases in the Sohag study (21). According to a study conducted in Taif, Saudi Arabia, up to 57% of Saudis are consanguineous. Consanguinity is a factor that contributes to the genetic predisposition for developing Keratoconus, as we have previously discussed [38, 39]. This is corroborated by research that offers compelling evidence for a hereditary component to the illness and supports the theory that consanguinity is a substantial risk factor for KC (38).

Conclusions

- Of patients attending refractive surgery centers in the Assiut governorate, 10.7% have Keratoconus; this varies widely according to geographical distribution.
- El-Fath, Assiut City, and Sedfa, respectively, showed the highest prevalence of Keratoconus.
- Keratoconus's highest prevalence was among adolescents; bilateral affection is the most common presentation. Keratoconus is strongly associated with positive consanguinity and ocular allergy.
- Keratoconus is a disease of progressive course; most of our patients were found in Grades III and II, respectively.
- Of patients visiting refractive surgery centers in the Assiut governorate, 10.7% have Keratoconus.

Recommendations

- Further research is needed to assess the possible underlying risk factors

in El-Fath Center, Assiut City, and Sedfa, which showed the highest prevalence of Keratoconus.

- Population-based and genetic studies must be done in the areas with the highest prevalence of Keratoconus.
- Special habits, ethnicity, and environmental factors may be the underlying risk factors causing this
- geographical variation in the prevalence of Keratoconus.
- Social and medical awareness regarding the Keratoconus risk factors, such as ocular allergy, frequent eye rubbing, and positive consanguinity, may affect the prevalence of the disease.

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