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Demographic and clinical presentations of keratoconus in Trinidad and Tobago: a retrospective study

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Abstract

Background Keratoconus is a progressive corneal disorder characterised by thinning and protrusion of the cornea, leading to irregular astigmatism and visual impairment. Data describing the demographic and clinical profiles of Caribbean populations are limited. This study evaluated the demographic and clinical characteristics of keratoconus among patients in Trinidad and Tobago.

Method A retrospective chart review was conducted among patients diagnosed with keratoconus who attended the University of the West Indies Optometry Clinic in Trinidad and Tobago between January 2010 and December 2022. Data collected included demographics, clinical signs, visual acuity, keratometry, pachymetry, refractive error, and known risk factors (family history, history of allergy, dry eye, and systemic diseases). Diagnosis of keratoconus was based on a combination of clinical signs and imaging findings, and severity was graded using the Amsler-Krumeich classification. Descriptive analysis and chi-square tests were performed to assess associations between variables.

Results There was a total of 189 participants, most of who were aged 21–30 years (38.6%, $n=73$), females (53.4%, $n=101$), had Indian background (50.8%, $n=96$), and many lived in the urban areas (91%, $n=172$). Eye rubbing was reported in 45.5% ($n=86$) and was significantly associated with ethnicity ($p=0.047$) and occupation ($p=0.027$). Advanced keratoconus (K > 55D) was present in ~30% of eyes. Common signs included Munson's sign (27%, $n=44$), Vogt's striae (23%, $n=21$), and Fleischer's ring (19%, $n=35$). Treatments included corneal cross-linking (24.3%, $n=47$), glasses (13.8%, $n=27$), and scleral lenses (11.6%, $n=21$). Mean visual acuity improved post-treatment (mean LogMAR: right eye from 0.53 to 0.29; left eye from 0.51 to 0.30).

Conclusion This study provides the first comprehensive profile of keratoconus in Trinidad and Tobago, revealing a predominance among young adults of Indian descent and a substantial number of advanced cases at diagnosis. These findings highlight the need for early detection strategies, public education, and improved access to diagnostic and therapeutic interventions in the region.

Keywords Keratoconus, Demography, Clinical presentations, Disease stage, Trinidad and Tobago, Caribbean

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Introduction

Keratoconus (KC) is a progressive, non-inflammatory ectatic disorder of the cornea characterized by localized stromal thinning and anterior protrusion, resulting in irregular astigmatism, visual distortion, and, in advanced stages, significant visual impairment [1–3]. Although typically bilateral, KC progression is often asymmetric, with onset usually occurring during adolescence or early adulthood and progressing at an unpredictable rate before stabilizing [4].

Management depends on disease severity and ranges from spectacles and rigid contact lenses in early stages to corneal cross-linking, intracorneal ring segments, and corneal transplantation in advanced cases [5]. The aetiology of KC is multifactorial, involving genetic predisposition, environmental triggers, and biomechanical stressors [5–7]. Several grading systems, such as the Amsler-Krumeich and the ABCD classifications, are used to assess severity and monitor progression [8–11]. Diagnosis is supported by clinical examination and imaging modalities, including corneal topography and tomography, which detect subtle changes in corneal curvature and thickness [12–14].

Clinical signs vary by disease stage, ranging from mild visual disturbances to advanced corneal thinning, scarring, and the presence of features such as Vogt's striae and Fleischer's ring [13, 15, 16]. Risk factors associated with KC include chronic eye rubbing, atopy, vernal keratoconjunctivitis, parental consanguinity, and systemic disorders such as Down and Marfan syndromes [12, 17, 18].

Epidemiological studies have demonstrated significant ethnic and geographic variations in the occurrence and severity of keratoconus. More aggressive disease forms are frequently observed among individuals of Middle Eastern, North African, and South Asian descent [18–20]. Gender distribution remains debated, with conflicting reports on whether males or females are more commonly affected [14, 18, 21]. Also, the distribution of KC severity varies in different age groups [14].

Despite the growing global interest in KC, data from the Caribbean remain scarce. Trinidad and Tobago (T&T), with its unique and ethnically diverse population, predominantly of African and East Indian descent, presents a valuable context for studying KC epidemiology. Understanding KC in this setting could reveal important differences in disease onset, severity, and management needs, particularly given the known ethnic variability in KC presentation [14, 18].

Methodology

Study design and sampling

This retrospective, clinic-based study of patients diagnosed with keratoconus between January 2010 and December 2022 were eligible for inclusion, and data were manually extracted from their clinical records. Data extraction was done between January to May 2023. A non-probability convenience sampling approach was used, as all eligible patient records available during the study period were reviewed.

Study setting

The study took place at the UWI Optometry Clinic, situated in Couva—a town in west-central Trinidad, south of Port of Spain and Chaguanas. The clinic provides primary eye care services, including the diagnosis and management of KC, to the population of T&T. The country is home to an ethnically diverse population of approximately 1.4 million, primarily of East Indian (40.3%) and African (39.6%) descent, along with individuals of mixed (18.4%) and other (1.7%) ethnic backgrounds [22].

Study population

The study population comprised all patients diagnosed with KC at the UWI Optometry Clinic. All eligible cases during this timeframe were included; no sample size calculation was necessary.

Inclusion and exclusion criteria

Included patients were those diagnosed with KC at the clinic during the study period. Data was excluded for patients with corneal pathology not related to KC (e.g., trauma, other ectasias), those who had undergone corneal keratoplasty for reasons unrelated to KC, and those with incomplete or missing clinical data in patient records.

Data collection procedure

As the clinic uses a paper-based record-keeping system, patient files were manually retrieved from the archives with the assistance of the clinic secretary and with approval from the unit head. A standardized data collection sheet was used to extract demographic and clinical data for all eligible cases. Demographic data included age at presentation, gender, ethnic group, place of residence, and occupation. Clinical data included presenting visual acuity (measured in LogMAR), subjective refraction (sphere and cylinder), minimum, maximum, and mean keratometry readings, and KC symptoms. Observed clinical signs included findings from slit-lamp biomicroscopy, corneal topography, presence of a scissor reflex, optical coherence tomography (OCT), and pachymetry. Treatment modality—surgical or non-surgical—was also documented.

Diagnostic criteria

Keratoconus diagnoses were made by different clinicians over the 13-year review period as part of routine

clinical care. However, diagnosis was based on consistently applied clinical criteria, including symptoms suggestive of keratoconus, irregular astigmatism, a scissor reflex on retinoscopy, slit-lamp signs such as Fleischer's ring, Vogt's striae, Munson's sign, stromal thinning, and cone-shaped protrusion, together with imaging findings where available. Imaging data were obtained using corneal topography, optical coherence tomography, and pachymetry. Severity was graded using the Amsler-Krumeich classification, which is widely used in clinical practice in T&T. All imaging performed during this study period used the same devices or brands available in the clinic, ensuring measurement consistency across the review period.

Table 1 Demographic and risk factors of KC among Trinidadians

Variables	Sub-group	Frequency (%)
Demography		
Age	10–20	41 (21.7)
	21–30	73 (38.6)
	31–40	54 (28.6)
	41–50	16 (8.5)
	51 and above	5 (2.6)
Gender	Female	101 (53.4)
	Male	88 (46.6)
Ethnicity	African	70 (37.0)
	Indian	96 (50.8)
	Mixed	23 (12.2)
Area of residence	Rural	17 (9.0)
	Urban	172 (91.0)
Occupation	Employed	46 (24.3)
	Student	58 (30.7)
	Unemployed	8 (4.2)
	Unspecified	77 (40.7)
Clinical measures		189 (100.0)
Year of presentation	2010–2015	79 (41.8)
	2016–2021	99 (52.4)
	Unspecified	11 (5.8)
Years since diagnosis	Less than 5 years	78 (41.3)
	5 years and above	100 (52.9)
	Unknown	11 (5.8)
Has a family history of KC	Yes	17 (9.0)
	No	172 (91.0)
Has allergy	Yes	30 (15.9)
	No	159 (84.1)
Has a history of eye rubbing	Yes	86 (45.5)
	No	103 (54.5)
Systemic diseases present	Yes	29 (15.3)
	No	160 (84.7)
Has a history of dry eye	Yes	24 (12.7)
	No	165 (87.3)

KC: Keratoconus

Ethical considerations

The study adhered to the ethical guidelines outlined in the Declaration of Helsinki. Approval was obtained from the University of the West Indies (UWI) Research and Ethics Committee (CREC-SA.1181/09/2021). The ethics committee waived the requirement for informed consent because the study involved a retrospective review of existing clinical records with no direct patient contact and minimal risk to participants. Patient confidentiality, privacy, and anonymity were maintained throughout the data collection and analysis.

Data analysis

Data were analysed using the Statistical Package for the Social Sciences (SPSS) version 27.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics, including frequencies, means, standard deviations, and ranges, were used to summarise the variables. Associations between demographic or behavioural variables and clinical features were assessed using chi-square tests. Missing data were handled using a complete-case approach, in which analyses for each variable were performed using only the available data, and cases with missing values were excluded on a per-variable basis. Because of the relatively small sample size and missingness in some key variables. A p-value of < 0.05 was considered statistically significant.

Results

Demographic profile of participants

Most participants were between 21 and 30 years old (38.6%, $n = 73$), followed by those aged 31–40 years (28.6%, $n = 54$). Females represented a slightly higher proportion (53.4%, $n = 101$) compared to males (46.6%, $n = 88$). In terms of ethnicity, half of the participants were of Indian descent (50.8%, $n = 96$), and most participants (91.0%, $n = 172$) resided in urban areas. A good proportion of the participants were students (30.7%, $n = 58$), though the majority had not specified their occupational status (40.7%, $n = 77$) (Table 1).

Known risk factors of keratoconus

Over half of the participants (52.4%, $n = 99$) first presented between 2016 and 2021, and 52.9% had been diagnosed with KC for five or more years. A positive family history of KC was uncommon (9.0%, $n = 17$), as were reported allergies (15.9%, $n = 30$), systemic diseases (15.3%, $n = 29$), and dry eye (12.7%, $n = 24$). Nearly half of the participants (45.5%, $n = 86$) reported a history of frequent eye rubbing (Table 1).

Clinical presentations of keratoconus among participants

Most participants presented with bilateral KC (59.3%, $n = 112$). The mean presenting VA measured in LogMAR was 0.53 (± 0.43) in the right eye (RE) and 0.51

(± 0.43) in the left eye (LE). Following treatment, mean VA improved to 0.29 logMAR (RE) and 0.30 logMAR (LE). Slit-lamp examination revealed Munson's sign as the most common clinical feature ($n = 51$, 22.2%), followed by Vogt's striae ($n = 44$, 19.1%). Scissors reflex was documented in a few patients' records ($n = 21$, 11.1%).

Table 2 Clinical presentations of Keratoconus among participants for the right and left eyes. *Values are mean SD, otherwise specified*

Variables	Right Eye	Left Eye
Visual acuity in LogMAR, $n = 165$		
Baseline	0.53 (0.43); range – 0.12–1.30	0.51 (0.43); range – 0.12–1.30
After treatment	0.29 (0.46); range 0–1	0.30 (0.46); range 0–1
Slit lamp findings (per patient), n(%)*		
Munson sign	51 (22.2)	
Vogts striae	44 (19.1)	
Rizzuti sign	36 (15.7)	
Fleischer's ring	35 (15.2)	
Apical scar	14 (6.1)	
Acute hydrops	10 (4.3)	
Oil droplets	8 (3.5)	
Central stromal thinning	6 (2.6)	
Others	26 (11.3)	
Presence of scissors reflex*		
Yes	21 (11.1)	
No	168 (88.9)	
Symptoms of Keratoconus*		
Decreased visual acuity	152 (80.4)	
Increased sensitivity to light	10 (5.3)	
Presence of Keratoconus, N (%)	16 (8.5)	17 (9)
Keratometry Readings		
Keratometry reading 1	45.67 (4.48)	46.62 (4.66)
Keratometry reading 2	48.54 (5.31)	49.50 (5.61)
Stage of Keratoconus		
Mild/Early (< 48 D)	39 (20.6)	33 (17.5)
Moderate (48–53 D)	51 (27.0)	47 (24.9)
Severe (> 53–55 D)	16 (8.5)	20 (10.6)
Advance (> 55 D)	57 (30.2)	56 (29.6)
Topographic Keratoconus Classification		
Possible/0	4 (2.1)	8 (4.2)
1	45 (23.8)	32 (16.9)
2	25 (13.2)	22 (11.6)
3	17 (9.0)	14 (7.4)
4	7 (3.7)	3 (1.6)
Central corneal thickness Refraction	486.88 (50.35)	485.52 (46.19)
Sphere power	-2.31 (3.22)	-2.64 (3.67)
Cylinder power	-3.76 (2.71)	-3.33 (2.10)

*= measurements represent findings for both eyes. Keratometry readings were from a topographer. NB: Slit lamp signs; there were 230 KC signs found among the 189 patients

Decreased VA was the most reported symptom (80.4%), while photophobia was less frequently noted (5.3%). Topographic analysis showed a mean K1 of 45.67 D (RE) and 46.62 D (LE), and mean K2 values of 48.54 D (RE) and 49.50 D (LE). Approximately 30% ($n = 57$) of cases were classified as advanced KC (K readings > 55 D). Central corneal thickness (pachymetry) averaged 486.88 µm (RE) and 485.52 µm (LE). Refraction results demonstrated moderate to high myopic astigmatism, with a mean cylinder of -3.76 D in the RE and – 3.33 D in the LE (Table 2).

Management of KCS

In the right eye, the most utilised treatment modality was corneal cross-linking (CXL) (24.3%), followed by spectacles (13.8%) and scleral lenses (11.6%). A few of the participants either went for a corneal transplant (3.7%) or were referred for additional care (3.2%). Combination treatments, such as CXL with scleral lenses, were noted in 3.7% of cases. Other methods, such as monitoring, intacs, and soft contact lenses, were used in less than 5% of the participants (Fig. 1). For the left eye, glasses remained the most common treatment (13.2%), followed by scleral lenses (4.8%) and CXL (3.7%). Fewer patients received RGP lenses or corneal grafts.

Association between demographics, risk factors and stage of KC

Chi-square tests revealed no statistically significant associations between age group, gender, or area of residence and risk factors such as family history of KC, allergy, eye rubbing, systemic disease, or dry eye (All p-values > 0.05). However, ethnicity was significantly associated with a history of eye rubbing ($X^2 = 6.097$, df = 2, $p = 0.047$). Occupation ($n = 122$) was not associated with both eye rubbing and reported allergy ($X^2 = 0.167$, df = 3, $p = 0.983$), with students more affected (56.9%). In terms of the stage of KC or severity, there was a significant association between stage of KC in the LE and age group ($X^2 = 35.53$, df = 16, $p = 0.003$), with the highest proportion of KC severity (severe and advanced) among those aged 21–30 years (47.9%). However, there was no association between severity and gender, ethnicity, area of residence, or occupation ($p > 0.05$).

Discussion

This study provides the first known clinical and demographic profile of patients with KC in T&T, offering important insights into disease presentation within this ethnically diverse Caribbean population. The findings reveal several notable patterns in age of onset, gender distribution, ethnicity, clinical features, and treatment, many of which align with global trends, while others suggest unique regional characteristics.

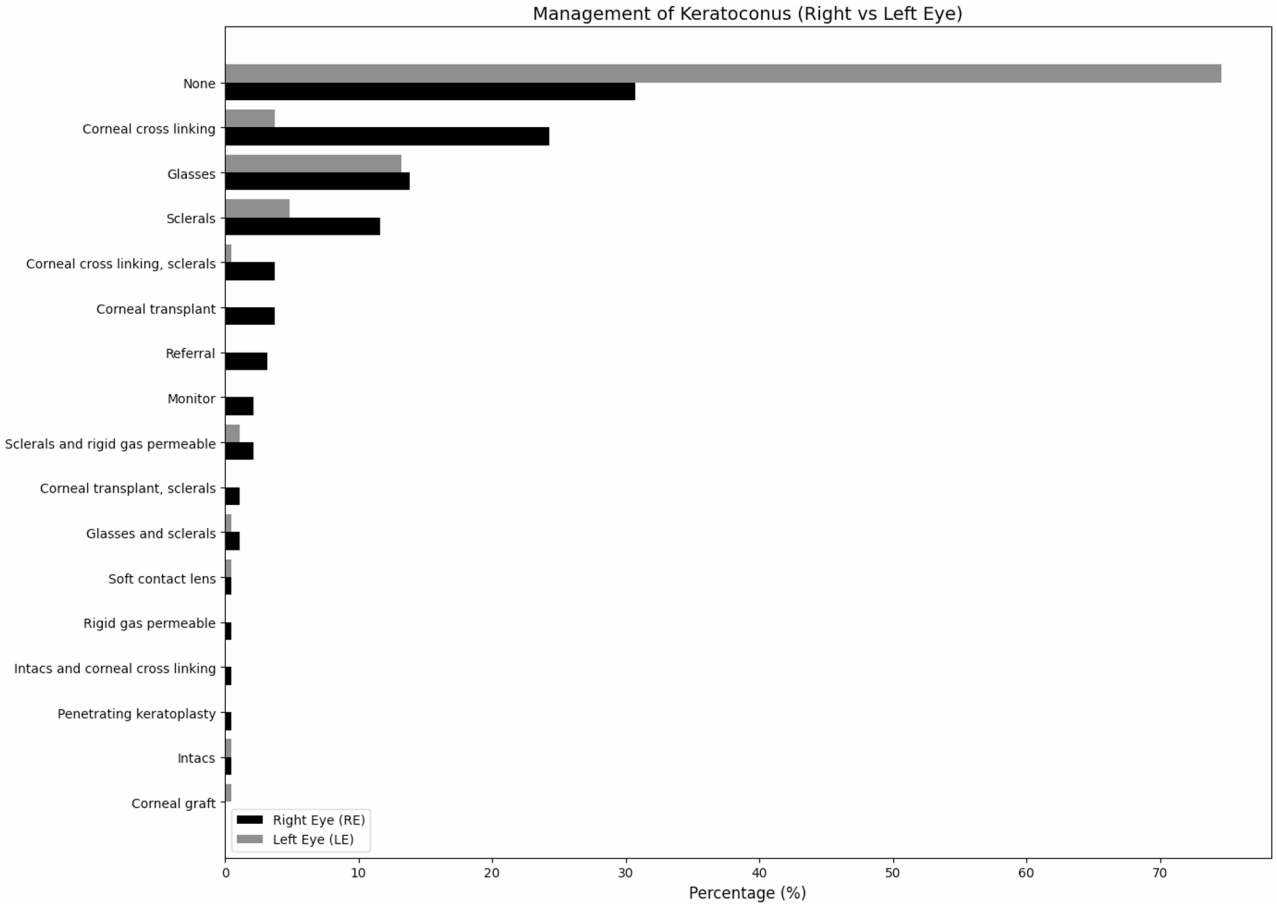

Fig. 1 Management of KC in the right and left eye

This study found the highest KC proportion among individuals aged 21–30 years, consistent with global literature identifying adolescence and early adulthood as the typical age of onset [10, 23–25]. Our findings showed a predominance of older individuals. This may reflect the environmental and diagnostic landscape in T&T, where cultural or health system-related delays in diagnosis could mask the typical age pattern seen elsewhere.

Indian ethnicity accounted for over half of KC cases in the current study, aligning with previous reports showing increased KC prevalence in South Asians [19, 26]. Past studies reported that most participants of Indian descent are generally considered at risk of an earlier onset of KC [26]. Gender findings were less conclusive. While some literature shows a male predominance [5, 19, 27], we observed a slight female majority, aligning with newer reports suggesting increasing recognition of KC among females [24]. Others found no gender difference [28]. These variations may reflect sampling, cultural health-seeking behaviours, or regional differences in disease expression. Interestingly, a previous study has shown that KC severity tends to be greater in females [17]. The relatively higher female representation in our study might also suggest that more severe cases were captured within the sample studied.

Environmental factors such as atopy, allergies, and behaviours like eye rubbing are well-known contributors to KC development and progression [29]. In this study, nearly half of the participants (45.5%) reported a history of eye rubbing, which was significantly associated with ethnicity ($p < 0.05$). Also, digital screen exposure may contribute to visual discomfort and eye rubbing in some individuals, but its direct role in the development of keratoconus remains uncertain. More established risk factors, such as chronic eye rubbing and allergic eye disease, remain more strongly supported by the literature. This finding supports existing literature linking chronic mechanical trauma from frequent eye rubbing with keratoconus [30].

In most countries, although the level of development can differ widely between urban and rural areas, environmental exposure to allergens can be similar. Rural areas may have higher levels of dust and pollen due to unpaved roads and vegetation, while urban areas may have higher levels of industrial pollutants due to a more robust, diverse industrial sector. In both rural and urban

settings, the allergens found can cause allergic conjunctivitis, which can influence behaviours such as eye rubbing. Despite these competing risks, most participants in this study resided in urban areas. However, this pattern should be interpreted cautiously, as it may reflect the clinic's catchment area, easier access to specialist services, and differences in health-seeking behaviour rather than a true geographic difference in the occurrence of keratoconus. Urban residents may be more likely to access eye care and therefore receive a diagnosis, while individuals in rural areas may be underdiagnosed due to barriers to care. Although environmental exposures may differ between urban and rural settings, our data do not allow firm conclusions regarding their contribution [31]. Moreover, the urban-rural climate differences in T&T might also contribute to this urban predominance observed in this study. Only 9% reported a family history of KC, which is lower than findings in other studies [17]. Similarly, the proportion with allergies and systemic disease was relatively low; however, this may reflect underreporting or limitations in retrospective data collection rather than a true difference in associated risk factors. The observed association between occupation and risk factors (eye rubbing and allergy) suggests a potential impact of occupational exposures, warranting further investigation and possible targeted interventions.

Nevertheless, consistent with global trends, the number of diagnosed cases presenting at this centre increased between 2016 and 2021. This increase should be interpreted cautiously, as clinic volume and referral patterns were not systematically documented and may also have contributed to the observed trend. Most diagnoses occurred more than five years before the study, suggesting an increasing trend likely driven by improved awareness of eye care professionals about KC and access to refractive eye care services, including surgery [28]. These gains are also likely attributable to recent advancements in diagnostic and treatment modalities for KC [28].

Clinically, 59.3% of KC diagnoses were bilateral, and advanced stages (K > 55D) were observed in most participants (30%). This suggests late presentation, potential delays in diagnosis, or limited access to early-stage care. A notable finding in this study was that approximately 30% of eyes were classified as having advanced keratoconus at presentation. This is clinically important and may indicate delayed detection or referral. Similar concerns about late presentation have been reported in other low-resource or referral-based settings, where early diagnosis is critical for timely referral and interventions such as corneal collagen cross-linking that can slow disease progression [32–34]. Early diagnosis is essential because timely treatment can prevent disease progression and reduce the need for invasive procedures such as corneal transplantation. The relatively high proportion of advanced disease in this cohort underscores the need for earlier screening and intervention in Trinidad and Tobago.

Similarly, signs such as Munson's sign, Vogt's striae, and Fleischer's ring were relatively common, indicating moderate to advanced disease in many cases. Similar findings were recorded in a study in South Africa [35].The most common sign in this cohort (Munson sign) is different from other studies that reported Fleischer's ring and corneal thinning as the most common signs, mostly in pediatric populations [4]. This variation could be accounted for by the demographic differences in the populations studied. We note that the commonest clinical presentation may also depend on the stage of the disease. Typically, early stages present with Fleischer's ring, while Munson's sign characterises late and severe stages of the disease [1]. Considering that the majority (30%) of cases in this study were at an advanced stage, our finding of Munson's sign as the commonest clinical presentation is consistent with our sample characteristics.

Our measure of average central corneal thickness, although reduced, was higher than previous studies on younger populations diagnosed with mild KC [36]. With a greater proportion of advanced cases, we would expect lower average corneal thickness values; however, this was not the case in our study. This can be attributed to the fact that the computed mean value includes measurements from the different stages of the disease; hence, higher values are cancelled out by equally lower values. In other words, participants altogether (mild, moderate, severe) had less advanced cases of the disease (56.1%) compared to those with advanced cases alone (30%). Thus, the overall mean corneal thickness measures will be higher than expected compared to other similar studies.

Treatment outcomes were generally positive, with most patients reporting an improvement in visual acuity (up to two lines) following intervention. These improvements were achieved mostly using corneal crosslinking (CXL) as the most used treatment for KC, followed by glasses and scleral lenses. These results support prior evidence that early intervention, especially with CXL and specialty lenses, significantly improves outcomes [4, 37]. The relatively lower use of specialty contact lenses, such as RGPs, Rose K, and scleral lenses, may reflect barriers including limited availability of fitting expertise, higher costs, and access constraints within the local eye care system. This is noteworthy, as specialty contact lenses are well established to provide superior visual rehabilitation in keratoconus, including in post-CXL patients, where they can further optimise visual acuity. These findings suggest a potential gap in comprehensive KC management. However, the predominance of late-stage cases reinforces the need for earlier detection, improved public awareness,

equitable access to affordable KC services, and wider access to advanced technology in primary eye care settings, including diagnostic tools such as a corneal topographer and OCT for early detection and intervention.

While our findings directly demonstrate differences in age distribution, ethnicity, clinical severity, and treatment patterns, explanations relating to health-seeking behaviour, access to care, and environmental exposures require further investigation in prospective and population-based studies.

Implications and recommendations for future studies

The high proportion of advanced cases highlights the need for routine screening protocols, particularly in high-risk ethnic groups and younger individuals. There is a need to create more eye health education programs targeting behaviours like eye rubbing and awareness about KC symptoms to facilitate earlier diagnosis. Our study findings support the need for investment in diagnostic tools (e.g., topographers, OCT) at primary eye care facilities and training for early detection. Our study provided insights from an underrepresented region to the global understanding of KC presentations. To address the challenges identified in the current study, several strategic actions are advised. First, integrating regular eye health screenings into school-based programs could facilitate earlier detection of KC among adolescents and young adults, the age group most affected by the condition. Second, public education campaigns should be strengthened to raise awareness of modifiable risk factors, such as chronic eye rubbing, particularly among individuals with allergic eye conditions. These campaigns could help in reducing behaviours that contribute to disease onset and progression. Third, transitioning from paper-based to electronic health record systems is recommended to improve the efficiency of patient data management, support clinical audits, and facilitate future research initiatives. In addition, prospective, longitudinal research is needed to monitor KC progression and assess the effectiveness of various treatment modalities over time within the local context. Finally, improving referral pathways between primary optometry clinics and tertiary ophthalmic centers would enhance timely access to advanced diagnostic services and interventions, such as corneal cross-linking and transplantation, ultimately reducing the burden of advanced-stage KC at presentation.

Strengths and limitations

To our knowledge, this is the first study to investigate KC characteristics in a Caribbean population, providing baseline data for future research and public health planning. By spanning over a decade (2010–2022), this study captures the patterns of KC diagnosis and management among clinicians in T&T. The use of all eligible KC patient records during the study period allows for a broad, real-world clinical representation without selection bias. The ethnically diverse makeup of T&T enhances the generalizability of the findings to similar multicultural settings. However, several limitations should be noted. The use of a single tertiary centre and the retrospective study design may overrepresent more severe cases and limit generalizability. Incomplete records for certain variables, including occupation and imaging, may have influenced some analyses, and the absence of electronic health records restricted data retrieval and consistency. Inter-eye correlation was not formally accounted for in eye-level analyses, and post-treatment visual acuity data were limited by small sample sizes and not adjusted for baseline VA. Finally, statistical analyses were primarily limited to chi-square tests, and multivariate regression was not performed due to sample size and missing data, restricting the ability to identify independent predictors of advanced KC. Despite these limitations, the study provides valuable insights into KC presentation, management, and risk factors in a Caribbean context.

Conclusion

This study provides the first clinic-based description of the demographic and clinical characteristics of keratoconus in Trinidad and Tobago. The findings show that keratoconus was commonly diagnosed among young adults, particularly those of Indian ethnicity, and that a substantial proportion of cases presented at severe or advanced stages. Eye rubbing was common and associated with ethnicity. These findings support the need for earlier detection, greater public and professional awareness, and improved access to diagnostic and treatment services. Future prospective and multi-center studies are needed to better understand keratoconus risk factors, progression, and management in Trinidad and Tobago.

Abbreviations

KC	Keratoconus
T&T	Trinidad and Tobago
UWI	University of the West Indies
CREC	Campus Research Ethics Committee
VA	Visual Acuity
RE	Right Eye
LE	Left Eye
LogMAR	Logarithm

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12886-026-04812-x.

Supplementary Material 1

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Author contributions
N.E.E, E.B, and D.L: Writing – original draft; N.E.E, M.A.K, K.P.M, S.T and U.L.O: writing – review and editing; K.P.M, N.E.E, M.A.K, S.T and U.L.O: Supervision; N.E.E, E.B. and D.L: Data curation and resources: M.A.K: Data analysis. All authors read and approved the final manuscript.

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Data availability
The data used to support the findings of this study are made available from the corresponding author upon reasonable request.

Declarations

Ethical approval and consent to participate
The study adhered to the ethical guidelines outlined in the Declaration of Helsinki. Approval was obtained from the University of the West Indies (UWI) Research and Ethics Committee (CREC-SA.1181/09/2021). The ethics committee waived the requirement for informed consent because the study involved a retrospective review of existing clinical records with no direct patient contact and minimal risk to participants.

Consent for publication
N/A.

Competing interests
The authors declare no competing interests.

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