ORIGINAL ARTICLE

Prevalence and clinical profile of keratoconus in patients presenting at a provincial hospital in KwaZulu, Natal, South Africa: A case study

NONKULULEKO M. GCABASHE, VANESSA RAQUEL MOODLEY and REKHA HANSRAJ

Discipline of Optometry, School of Health Science, University of KwaZulu-Natal, Durban, South Africa

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Abstract. Keratoconus (KC) is a progressive, asymmetrical corneal disease, characterized by stromal thinning that leads to distortion, causing vision loss. The visual loss is secondary to corneal scarring, irregular astigmatism, and myopia. The prevalence of KC has been reported to differ in different parts of the world. The study aimed to determine the prevalence and profile of patients with KC presenting to a provincial hospital in KwaZulu-Natal, South Africa. A retrospective study design was used to review 412 clinical records of patients attending the McCord Provincial Eye Hospital (MPEH) during a five-year period (2016-2020). Data on age, race, refraction, clinical profile, treatment plan, and diagnosis were ascertained. The prevalence of KC in MPEH was found to be 13.7% with a mean age of 24.7±7.94 years. Black African and females had a higher frequency of KC compared to males and other ethnic groups. Most of the patients presented with a severe stage of KC and referral was the most common management. Central corneal thinning and Munson's sign were the most prevalent clinical signs. There was no statistically significant difference between the worse and better eye when comparing the clinical signs. The prevalence and clinical profile of patients with KC in this study was similar to that reported by previous studies and more in Blacks and females. Population based epidemiological studies are needed to determine the prevalence of KC in South Africa to enable early clinical interventions.

Introduction

Keratoconus (KC) is a progressive, non-inflammatory thinning of the cornea associated with myopia and irregular astigmatism. Patients experience a decrease in the quality of vision due to monocular diplopia, halos or ghost images (1). It is the most common form of corneal dystrophy, which may lead to severe visual impairment if left untreated (2). In the absence of a single identifiable cause, ongoing research into the aetiology of KC has revealed complex interactions between genetic, environmental and hormonal factors (3,4). Risk factors for KC already identified include demographics, ethnicity, genetics and the environment (5). Ecological factors associated with KC include, among others, eye rubbing, atopy and exposure to ultraviolet radiation (5). While KC has been noted in populations worldwide, it is more frequently reported in certain ethnic groups such as South Asians, East Mediterranean's and North Africans (6,7).

The incidence and prevalence of KC vary worldwide; with its diagnosis being made using a variety of methods such as retinoscopy, slit-lamp biomicroscopy, pachymetry, keratometry and video keratography, topography and tomography (8,9). The prevalence of KC was reported to be 54.5 per 100 000 population in the United States of America, while the prevalence of KC in a hospital-based study in Denmark in 2007 reported an estimated prevalence of 86 patients per 100 000 residents with an annual incidence of 1.3 per 100 000 (10,11). However, a similar study, conducted in the same hospital in Denmark in 2019, reported a prevalence of 44 per 100 000 and an increase in the incidence rate of 203 folds during the last 10-15 years (11,12). A study done in Jerusalem reported a prevalence of 2.34% and a significantly higher prevalence in men (4.91%, CI 2.6-7.3) than women (1.07%, CI 0.3-1.9) (13). An African hospital-based study found a prevalence of 10.6% by clinical diagnosis, 14.6% by keratometry and 30.9% by topography in patients with allergic conjunctivitis attending Kenyatta National Hospital (14).

The onset of KC is usually at puberty and progresses until 40-50 years of age. However, due to the self-limiting nature of the disease, this progression may stop at any stage between mild to severe KC (13-15). Although the disease is bilateral, it presents asymmetrically in line with studies reporting that the disease starts unilaterally, with delayed onset in the other eye (16,17). Ocular signs and symptoms vary with the severity of KC (18). Vinciguerra *et al* (2016) noted that abnormal biomechanical changes are observed

Correspondence to: Nonkululeko M. Gcabashe, Discipline of Optometry, School of Health Science, University of KwaZulu-Natal, Durban, South Africa
E-mail: thwala@ukzn.ac.za

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at an early stage before tomographic changes and conical signs (19). The early signs of KC may go unnoticed, with symptoms varying from increased sensitivity to light and glare to distorted vision (19). In moderate cases, Fleischer's ring is seen around the base of the cone together with Vogt's striae which are vertical, fine, whitish lines in the deep/posterior stroma (20). In advanced stages, Munson's sign, Rizzuti's sign and corneal hydrops and or corneal scarring, which develop as a result of a split in the Descemet's membrane, may be observed (20,21).

The severity of KC has been classified by previous studies using either the Amsler-Krumeich (AKC), ABCD, Keratoconus Severity Score (KSS) or Collaborative Longitudinal Evaluation of Keratoconus (CLEK) classification systems (22-25). AKC is based on the mean corneal power, astigmatism, transparency and thinnest corneal thickness while the CLEK classification is founded on the change in visual acuities, mean keratometry, slit-lamp biomicroscopic signs, presence or absence of corneal scarring, and visual-related quality of life (22). The ABCD keratoconus staging system incorporates anterior and posterior curvature centered on the thinnest point of the cornea, thinnest pachymetry values and distance visual acuity (24).

The management of KC is dependent on the severity of the condition, with the first treatment option for reduced visual acuity (VA) generally being spectacles. For mild or moderate KC, soft-toric and custom soft spherical or toric contact lenses can be used. Moderate to severe KC requires the use of corneal and scleral rigid gas permeable (RGP) lenses (26). Contact lenses often provide better vision than spectacles by masking higher-order aberrations due to irregular astigmatism (15). When vision can no longer be corrected with optical corrections such as spectacles and contact lenses, corneal surgery is then recommended (27). The surgical management of KC includes intrastromal rings, corneal intrastromal corneal ring segments (INTACS) and keratoplasty, amongst others. Corneal cross-linking (CXL) is a minimally invasive surgical procedure used to stabilize the progression of KC (28). Studies have shown that CXL is effective in halting the progression of keratoconus over a couple of years (28,29).

Keratoconus is a significant cause of severe visual impairment (VI) worldwide, if undiagnosed and left untreated. Despite this observation, it has received little attention in terms of public health efforts to address the health care needs of affected persons, particularly in Africa, including South Africa. The estimation of prevalence is important in establishing strategies and programs geared towards the prevention of VI caused by an ocular condition that can be treated (30). Even though a few studies on KC have been conducted on the African continent, no previous study has been conducted in a hospital in South Africa, nor at the site of the current study to determine prevalence of KC (14,31,32). Anecdotal evidence suggests that there has been an increase in the number of referrals of patients with KC to the MPEH, currently dedicated as the only public eye hospital in the province of KZN, South Africa. Therefore, this study aimed at identifying the prevalence and clinical profile of patients with KC presenting at MPEH to better understand this corneal ectasia towards an improvement in the diagnosis and management of presenting KC patients.

Materials and methods

This quantitative study involved a retrospective review of clinical records that were randomly selected to obtain information on the prevalence, demographic and clinical profiles, and management of patients with KC at MPEH. The study commenced after ethical clearance and relevant gatekeeper permissions were obtained from the Biomedical Research Ethics Committee (BE332/19), Department of Health in KZN, and MPEH, respectively. As MPEH is the only public eye hospital situated in the eThekwini district that offers eye care services at a provincial level, patients seen at this hospital are referred from other health care providers. A random sampling method was used to determine the minimum sample size of 391. Data on the demographic, clinical presentation and management strategy for keratoconic patients seen at MPEH over five years were extracted and analyzed using descriptive and inferential statistics with the Statistical Package for Social Sciences version 25.

Results

Demographics. A random sample of 412 patient clinical records from 2016 to 2020 were reviewed, however, 70 of the clinical records did not have the diagnosis for the respective patients recorded and were excluded. The prevalence of KC was therefore calculated based on the remaining 342 clinical records that had a diagnosis recorded. Of these, 47 were noted to have KC indicating the facility prevalence of KC of 13.7%. The mean age of patients with KC was 24.7±7.94 years (median age of 24.0 years) with a higher percentage (63.8%) being female. There were more Black African patients with KC (66%) compared to Indians (29.8%) with no Caucasians or patients of mixed race, and a further 4.2% for whom race count not be classified.

Clinical data. The most common ocular disease and medical condition noted in patients with KC was vernal keratoconjunctivitis (VKC) (53%) and sinusitis (6.4%), respectively. Marfans syndrome was noted for 2.1% of keratoconic patients with no other underlying systemic condition recorded. While refractive status was not noted in 53.2% of the record cards for the keratoconic patients, based on those cards in which refractive findings and best-corrected visual acuity (VA) were recorded (n=22), 19.1% had no VI, 12.8% had mild VI, 12.8% had moderate VI and 2.1% severe VI.

Keratoconus profile. All of the keratoconic patients had bilateral KC and the most common clinical sign that was noted was apical scarring (n=12) and central corneal thinning (413±80.1 μm) (n=11). Fig. 1 illustrates the clinical signs noted in the keratoconic patients. These values are derived from only 42 of the 47 record cards for KC patients, as in the remaining five cards, there was no recording of the absence or presence of the clinical signs.

Table I outlines a comparison of the frequency of clinical signs being present in the better eye and the worse eye of the keratoconic patients. Only hydrops was found to be present in a significant number of better eyes than worse eyes (P=0.007). Furthermore, no significant difference was noted in the visual

Table I. Frequency of clinical signs present in the better and worse eye.

	Better eye (%)	Worse eye (%)
Munson's Sign (n=38)	21.05	21.05
Vogt's Striae (n=38)	10.5	10.5
Fleischer's Ring (n=38)	7.89	7.89
Hydrops (n=38)	10.5	10.5
Corneal Thinning (n=38)	21.05	21.05
Apical Scarring (n=36)	22.2	27.78

acuities of the better eye in patients that presented with clinical signs.

Table II shows the mean and standard deviation for corneal curvature (K), central corneal thickness (CCT), and the nearest equivalent sphere (NES RX) of the left and right eyes of patients that have KC. The NES range for right and left eyes was -18.75 DS to +0.75DS, with corneal curvature range of 40.25 to 73.30 D and that for corneal thickness of 217 to 516 μm. The better eyes had mean visual acuity (in decimal notation) of 0.449±0.253 respectively while the worse eyes had mean visual acuity mean of 0.160±0.158 with a range of 0.01 to 0.63.

The severity of KC was graded using the AKC. As shown in Fig. 2, most of the keratoconic patients (35.5%) had Stage 3 KC, followed by Stage 1 (25.8%), Stage 2 (22.6%), and lastly Stage 4 (16.1%). In terms of the CLEK, most patients had severe KC (66.7%), followed by moderate (30.3%), and then mild (3%). Chi-squared analysis was run to determine if there was any association between the clinical signs and stages of KC as per CLEK and AKC and there was no significant relationship noted.

The most common treatment plans used for patients with KC at MPEH, amongst other management options as shown in Fig. 3, was referral only (36.2%) followed by monitoring the condition only (14.9%).

Discussion

The prevalence of KC was found to be 13.7% (n=47) which is similar to the prevalence of KC using clinical diagnoses (10.6%) and keratometry (14.6%) reported in Kenyatta hospital, Kenya in patients with allergic conjunctivitis (14). Although both studies were conducted in Africa and were hospital-based, the participants in the study by Mugho (2016) were considerably younger (mean of 14.9 years vs. 24.7 years in the current study) with all participants diagnosed with allergic conjunctivitis (14). Lower prevalence has been reported elsewhere. Nielsen *et al* in 2007, found a prevalence of 86 per 100 000 in Denmark with more recent studies revealing the prevalence of KC in middle eastern countries including Iran, Saudi Arabia, and Israel to vary from 3.18 to 4.91% (11,33-35). While Netto *et al* (2018) also calculated the prevalence of KC in Saudi Arabia to be 4.79% using a retrospective chart review, it was based on a pediatric sample with a mean age of 16.8±4.2 years (35). The study by Shneor *et al* (2014) determined the prevalence of KC in Israel by analyzing the video keratographic indices and images to confirm if the students with a mean age of 25.08±8.83 had KC (34). Millodot *et al* (2011), in a cross-sectional study, found that the prevalence amongst the 981 volunteers (mean age 24.4 years) was higher (2.3%) in Jerusalem as compared to Western Countries such as the Republic of Macedonia with a mean age of 26.81 years ±1.25 (6.8:100 000) and Norway (192.1 per 100 000) (13,36,37). The comparatively higher prevalence of KC reported by African studies could be because many of those studies were hospital-based while the European studies were mainly population-based and may also be associated with environmental factors and genetics. Many studies have also suggested links between allergy, atopy, or asthma and KC (13,38). A study by Lucas and Burdon (2020) stated that genetics play a major role in some individuals showing a pattern of autosomal inheritance, with eye rubbing also implicated (39). Furthermore, the higher prevalence of KC found in the current study could be related to the capacity at the study site; as MPEH serves as a referral hospital in KwaZulu-Natal due to the facility having all the necessary equipment for accurate and early diagnosis of KC. This may result in a greater likelihood of referrals from lower-level facilities and increased attendance by patients with KC at MPEH. Variations in prevalence of KC previously reported in studies worldwide may thus be attributed to differences in research designs, such as population-based vs. hospital-based, differences in methods used to investigate and diagnose the condition, demographics of the participants, as well as the utilization of varying KC classification criteria.

Keratoconus starts as a unilateral corneal ectasia however, it progresses to the fellow eye within the first five to six years after the onset (3). In the present study, all the keratoconic participants presented with bilateral KC which was similar to the 98.3% of bilateral keratoconics reported by Rashid *et al* (2016) in a study in Africa (40). In addition, a clinic-based study conducted by Rupnarain *et al* (2020), in KZN, South Africa also found that most (71.3%) of their participants had bilateral KC (31). Outside of Africa, Naderan *et al* (2015) reported bilateral KC in all their participants, in Iran. Other studies, in similar low-to-middle-income countries, have also shown that bilateral KC prevalence ranges between 56 to 93% (41,42). A possible reason for a predominance of bilateral KC could be that perhaps in the absence of KC advocacy programmes and limited resources, patients only seek medical help when vision in both eyes is affected and they can no longer function adequately. Early signs of KC are not easily visible without the use of equipment such as tomographers and topographers. Many of the referral centers may not have the necessary diagnostic equipment and, in the current study the instruments used to diagnose KC was not documented and no images (tomography/topography) were attached to the participants' records. It is likely therefore that some early keratoconic participants, who may also have had unilateral KC, might have been misdiagnosed or KC not identified.

In the current study, there were twice as many female (66.7%) than male (33.3%) keratoconics. Several studies revealed that, on average, females generally frequent primary health care facilities than males which could be the reason why higher number of females than males having been referred to

Table II. Corneal radius power (K), corneal thickness (CCT) and refractive error (NES).

	Laterality	Minimum	Maximum	Mean	Std. Deviation
NES RX (DS)	Right eye	-17.00	+0.75	-5.63	5.01
	Left eye	-18.75	+1.00	-5.87	5.15
Steepest K-reading (D)	Right eye	40.75	72.50	55.97	7.79
	Left eye	40.25	73.30	54.99	9.36
Corneal thickness (*μm)*	Right eye	217	513.00	414.17	75.03
	Left eye	242	516.00	397.23	72.28

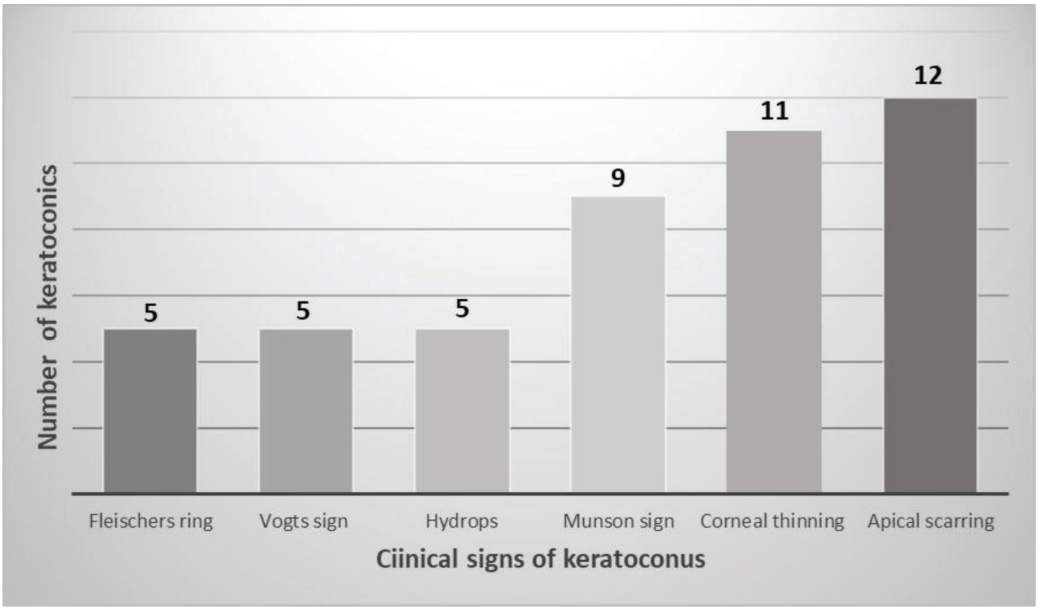

Figure 1. Clinical signs of keratoconus.

this site (43,44). Another South African study by Chetty and Rubin (2019) reported similar results of a higher prevalence of KC in females (53%) (32). Valdez-Garcia *et al* (2014), in a study amongst Mexican adolescents, found a higher prevalence in females (66.7%) compared to males (33.3%), which was the same ratio as noted in the current study (45). In contrast, other studies have reported a higher prevalence of KC in males than in females (1,4). The study conducted by Godefrooji *et al* (2017) reported 72% of their keratoconic sample being male compared to female, with Millodot *et al* (2011) reporting a slightly higher prevalence of 4.91% in men compared to in women (1.07%) (4,13). Although KC has been mentioned to affect both genders, studies have reported different prevalence when comparing the genders. The differences in prevalence of KC between genders may be attributed to demographics, biological and anatomical factors unique to different regions, as well as physiological factors such as pregnancy and the menstrual cycle which could also lead to variability, and thus further investigation into gender predilection may be warranted (46).

Ethnicity has been noted as an important risk factor in KC. A study by Pearson *et al* (2000), found a higher prevalence of KC in Asians of 229 per 100 000 compared to 57 per 100 000 in the Caucasian population, which is similar to that reported by Georgiou *et al* (2004) (47,48). Both studies concluded that the high prevalence could be due to ethnic differences (47,49). Of the total number of keratoconus identified in this study, there were only Black Africans and Indians with a higher percentage being in Black Africans (66%). The vulnerability of the Black race to KC was also noted by Tuft *et al* (1994) during an investigation of the prognostic factors for the progression of KC in a study sample which constituted 79.0% White, 15.7% Asian, and 5.3% Black subjects (49). Their study revealed that racial grouping had a significant effect on the time from diagnosis to requiring penetrating keratoplasty (PK) and that Black patients progressed to PK at a greater rate than either Asians or Whites (P<0.001) (49). The findings of the current study are similar to that reported by Chetty and Rubin (2019) in their university-based clinic study conducted in another province in South Africa (Johannesburg). The majority (74%) of the keratoconics were Black Africans when compared to other ethnic groups such as Indians (12%), Caucasians (9%), and Mixed race (5%) (32). The high number of Black patients with KC in these two studies could be attributed to the fact that the majority of South Africans are Black (81%) compared to other races and thus their predominance at the chosen sites. It was also noted in the current study that the

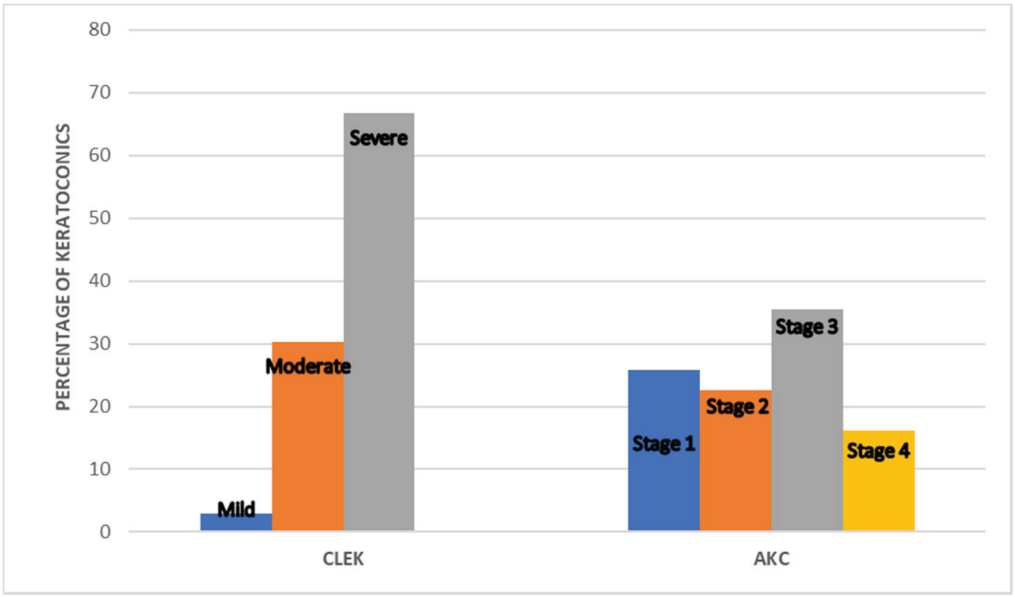

Figure 2. Comparison of stage of keratoconus based on the Amsler-Krumeich (AKC) and CLEK classification systems.

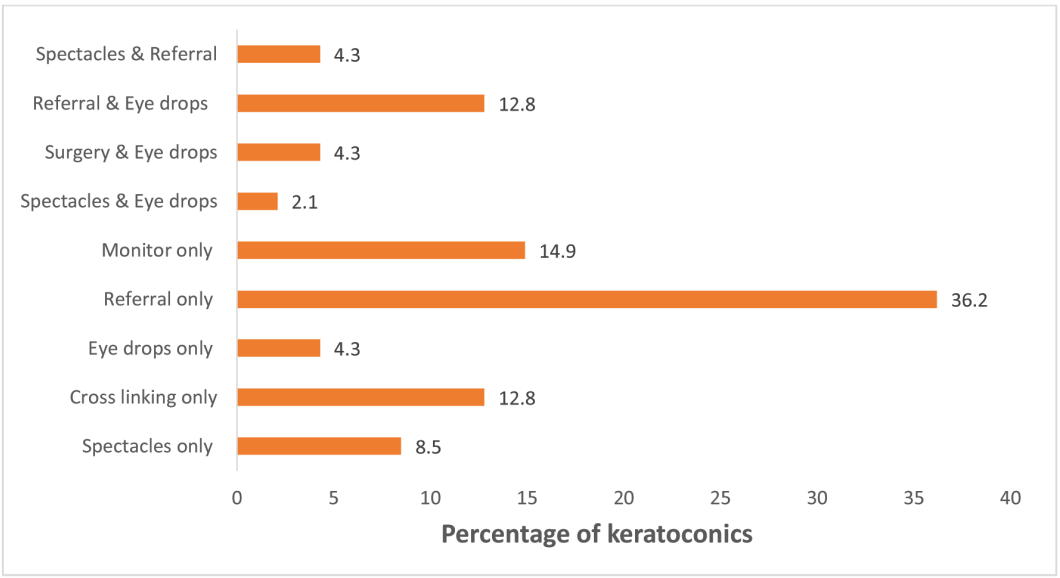

Figure 3. Treatment options considered for patients with KC at MPEH.

clinical records, even though randomly selected, were mainly of Black (72.8%) participants followed by Indians (14.6%), Mixed race (3.3%) and Whites (1.7%). Moreover, both the study by Chetty and Rubin (2019) and the current study were conducted at public health care facilities. The 2018 general household survey (GHS) in South Africa highlighted that only 9.9% of Black African households had access to medical insurance thereby limiting access to private health care by this racial group and promoting the seeking of health care in the public sector which is where MPEH currently lies. Similarly, the survey noted that 72.9% of the White population (72.9%) had access to health care privately, through health insurance, and thus they do not frequent public health facilities; which may account for the low percentage of that racial group attending the site of the current study (50).

The mean age of the patients with KC in this study was 24.7±7.94 years, which is similar to that reported by Weed *et al* (2008) of a mean age of 25.05±8.97 years in a keratoconic population in Scotland (3). The mean age of the current study is, however higher than that found in other African countries namely Kenya and Sudan (40,51). Two clinic-based studies in South Africa reported that the mean age of patients that visit their KC clinic were 25.2±9.9 years and 26.1±7.5 years, respectively, which is also similar to the mean age noted in the current study. Studies in Asia have also reported similar age profiles whereby the mean age of the patients was 21.46±6.17 years in Malaysia and 29.5±9.40 years in Singapore (43,44). The age profile of keratoconics generally being in their twenties could be related to the finding that even though KC tends to progress until the third or fourth decade of

life, patients with KC appear to only present for medical care in hospitals or clinics in their second decade of life (39). In the current study, the keratoconic patients were categorized into four age groups with the finding of the majority (76.3%) being in the 19-34 year age group. A study by Millodot *et al* (2016) reported that the onset of KC in their participants was at the age of 18.4±3.8 years (52). In the current study the onset of KC was not investigated, however, this aspect may be complicated by keratoconics possibly presenting to another health facility before subsequent referral to MPEH.

Most of the keratoconic patients in the current study were classified with Stage 3 (35.3%), or severe KC (66.7%) based on the Amsler-Krumeich and CLEK classifications, respectively. Previous studies have reported a high percentage of patients presenting with severe KC based on the CLEK classification to specialized eyecare clinics or hospitals (52,53). Serdarogullari *et al* (2013) using Pentacam-derived parameters reported that the mean corneal curvature of patients with KC was 57.7±9.0 D, which is similar to this finding in the current study (52). Mahadevan *et al* (2009) revealed that most KC patients presenting to a tertiary eye care hospital had advanced KC with corneal curvatures of greater than 52D (53). Similarly, a university clinic-based study in Durban, SA found the mean corneal curvature for patients with KC to be 54.16±7.65D. A possible reason why the patients may be seeking medical intervention in the advanced or in the later stages of KC also noted in the current study, could be that spectacles no longer provide adequate functional vision at that stage. The avoidance or the delay in seeking medical help by patients could also be due to factors such as the fear of the diagnosis, denial of the diagnosis and financial constraints (54,55). Access to cost-effective treatment may also be a factor as highlighted in a study conducted within the same district by Maake and Moodley (2018) (56). The authors stated that financial constraints was one of the reasons that the patients did not seek medical care.

Keratoconus causes thinning and protrusion of the cornea and the current study revealed Munson's sign and central corneal thinning, with a mean corneal thickness of 413±80.1 μm, to be the most noted clinical signs. Munson's sign was mostly reported in keratoconics in the severe stage (33.3%) and Stage 3 (45.5%), while the central corneal thinning was more frequently noted in moderate stage 2 (66.7%) and Stage 3 (45.5%) according to the CLEK and Amsler Krumeich classification, respectively. This finding further highlights the late-stage presentation of the disease by patients, which potentially enhances the treatment challenges and costs to the facility. Similar percentages of keratoconics with corneal thinning were noted in Stages 1, 2 and 4 of KC when applying the Amsler-Krumeich classification. A hospital-based study conducted in Turkey by Serdarogullari *et al* (2013) also reported that the patients with KC showed clinical signs such as stromal thinning, bulging of the cornea, Fleischer ring, and Vogt's striae (57). Similarly, Salooti and Amir (2001) found that 35.5% of patients presented with central or paracentral thinning, 40% with Fleisher rings, and 31.4% with Vogt's striae (58). Elmassry *et al* (2021) focused on corneal endothelial cell changes in the different stages of KC as classified using Amsler-Krumeich classification, and found no significant endothelial changes in Stages 1 and 2 (59). However, Stage 3 showed significant changes, often exhibiting polymegathism and pleomorphism. Therefore, KC does cause physiological changes in the different layers of corneal tissue which subsequently manifest as clinical signs depending on the severity of the disease.

The management strategy for keratoconics presenting to MPEH was most often a referral to the local university-based clinic followed by cross-linking, with contact lenses not offered as a treatment modality. Previous hospital and clinic-based studies have reported a different hierarchy of treatment options used for patients with KC, in order of highest to lowest frequency, being contact lenses, spectacles and surgery (4,46,56). A hospital-based study in London by Lim and Vogt (2002) reported that 78.5% of the patients were treated with binocular contact lenses, 18.5% with monocular contact lenses and only 3% had received no intervention (59). A similar trend was observed in a study in Sudan, Africa which reported that 60.8% of patients were treated with contact lenses while 24.5% were treated with spectacles (41). Contact lenses were a treatment of choice because it allows the best possible vision for the patients requiring optical correction and somehow delays the need for surgery. The reason for most patients being referred in the current study could be related to the facility, despite having the equipment for a correct diagnosis of KC, not having the necessary equipment for the fitting of contact lenses and supplies, such as fitting sets. Furthermore, those patients that are still in the early stages of KC are treated by crosslinking to delay the progression of KC, which will have positive long-term benefits to the patient and reduce treatment costs at the health care facility. The Health Professions Council of South Africa (HPCSA) has a guideline for the minimum tests to be conducted for any person that presents for a basic eye examination. A study by Gcabashe *et al* (2022) revealed that none of the eye care facilities in their study, including MPEH had contact lens fitting sets, contact lenses, suction holders among other instruments needed for management of . Thus, a possible negative impact on the quality of life in the keratoconic patients represented in the current study may be expected, as many did not receive the required care when they were first diagnosed and were subsequently not treated at the public sector facility to which they were referred (60). The deficiency in care of keratoconic patients at the facility should be addressed by the relevant stakeholders to provide patients with the expected minimum standards of eye health care.

The current study has provided epidemiological data on the prevalence of keratoconus and a clinical profile of keratoconic patients presenting to a public eye hospital in KZN which has not been determined by any previous study. This information is key to effective strategies for the delivery of equitable and adequate eye care for the diagnosis and management of KC in the public sector in South Africa. The study however is not without limitations. The information presented following this retrospective study may not be complete as the instruments or clinical tests used to detect KC were not always documented in the clinical records. There was also no standardization of record keeping amongst the large number of eye care personnel employed at any one time. Furthermore, the clinical

records did not have any imaging data (tomography or topography) from which more data regarding KC could have been retrieved. As this was a hospital-based study, the prevalence determined cannot be assumed to represent the larger population in KwaZulu-Natal. Moreover, screening for the optometry department is done by a team of primary health caregivers that does not include an optometrist hence leading to possible referrals of keratoconics. Furthermore, as the current study was cross-sectional, the age of onset of keratoconus cannot be commented on.

Conclusions

The World Health Organization (WHO) in its strategic plan for 2009-2013 emphasized the need for population-based data on the frequency of VI. One of the causes of VI is uncorrected refractive error which may, in turn, be related to ocular disease including KC. It is therefore important that countries have access to clinical data that can inform policies and strategies for the management of the ocular disease. The prevalence of KC in the study was similar to that reported by previous studies. Many patients that presented at the facility in the current study were at the severe stage 4 of KC highlighting the need for screening programs at lower levels of care, efficiency in diagnostic protocols and patient education programmes on KC. The screening team at hospitals, which should include optometrists, should be trained to identify patients at risk, or those with early signs of KC. Vernal keratoconjunctivitis and sinusitis were the most noted ocular disease and medical conditions present in the participants. As previous studies highlight the strong link with these conditions, it is important that all patients that present with VKC be screened for KC. The prevalence of KC in the current study can be utilized to guide proper implementation of appropriate diagnosis and management strategies and also assist in early diagnosis. This will help to reduce the likelihood of the affected patients becoming visually impaired due to KC.

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Ethical approval and consent to participate

The study commenced after ethical clearance and relevant gatekeeper permissions were obtained from the Biomedical Research Ethics Committee (BE332/19), Department of Health in KZN, and MPEH, respectively.

Availability of data and material

New and original data were collected, analyzed, and available upon request from the corresponding author, NMG.

Contributions

NMG, VRM, RH conceptualized the project and designed the methodology; NG, drafted the initial manuscript and wrote the manuscript; VRM, RH supervised the project, guided and reviewed drafts up to the final article. All the authors approved the final version to be published.

Conflict of interest

The authors declare no potential conflict of interest.

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