Original Article

Keratoconus characteristics and associations: A cross-sectional keratoconus study in western India (CKSWI)

Zalak Shah, Dipali Purohit, Parul Danayak

Purpose: To study the clinical and tomographic characteristics and associations of keratoconus (KC) patients visiting a tertiary eye care hospital. **Methods:** This was a cross-sectional, observational study that included 242 newly diagnosed clinical KC patients. Detailed ocular and systemic history, visual complaints, habit of eye rubbing, best spectacle-corrected visual acuity (BSCVA), retinoscopy reflex, detailed slit-lamp examination and tomographic findings, and presence of any ocular and systemic associations were documented for the included patients. Severity of KC was further graded into stages 0, 1, 2, 3, and 4 according to the ABCD grading system. **Results:** The most common visual complaint was blurred vision (82.64%), followed by itching (48.76%), tearing (43.80%), and photophobia (41.32%). A total of 44.62% of patients had the habit of eye rubbing and 4.54% had a family history of KC. Most common clinical signs were scissor reflex (94.21%), Rizutti's sign (77.27%), corneal protrusion (69.83%), and Fleischer ring (67.35%). A total of 14.05% of patients had stage 0, 42.15% had stage 1, 19.83% had stage 2, 18.60% had stage 3, and 5.37% had stage 4 KC. Of these patients, 70.25% had a BSCVA visual acuity of ≥6/12 or better; 26.45% had a BSCVA of ≥6/60 to <6/12; and 3.30% had a BSCVA of <6/60. Ocular allergies, atopy, and asthma were found in 32.32%, 4.96%, and 2.48% cases, respectively. **Conclusion:** This study gives an overview of the clinical findings of KC cases in western India. Our results suggest that use of retinoscopy should be promoted in early KC detection in primary eyecare screening programs.

Access this article online

Website: https://journals.lww.com/ijo

DOI: 10.4103/IJO.IJO_1069_23

Quick Response Code:

Key words: Keratoconus, keratoconus association, keratoconus characteristics

Keratoconus (KC) is a bilateral, noninflammatory multifactorial thinning disorder of the cornea, which causes stromal thinning and protrusion, resulting in irregular astigmatism and vision loss.[1] The pathophysiology of KC includes mainly genetic factors. However, biomechanical, biochemical, and environmental factors can also act as disease triggers.[1] Nowadays, KC is not an uncommon disease. The worldwide prevalence of KC is 1.38 per 1000 people.[2]

Various classifications of KC have been developed to define KC severity.[3] In the early stages of KC, patients are often asymptomatic and it is difficult to diagnose the condition only from clinical signs.[3] However, moderate to severe cases can be easily diagnosed on a slit-lamp biomicroscope. Furthermore, the diagnosis of KC is confirmed with the use of corneal imaging techniques (tomographer), which give details of corneal contours (curvature, thickness, anterior and posterior elevation, and aberration data).[3]

KC presents with a wide variety of clinical and topographic characteristics.[4,5] The knowledge of KC characteristics in subjects belonging to a particular region can help to understand the nature of the disease. Many studies have reported KC characteristics[4-11] and its association with various ocular and systemic conditions.[3] Literature search shows that large cross-sectional studies on KC characteristics in India are lacking. This study aims to understand the visual complaints, clinical findings, and ocular and systemic associations of newly diagnosed KC patients who visited a tertiary eye care hospital located in western India.

Methods

This was a cross-sectional, observational study conducted at a tertiary eye care hospital from January 2018 to October 2022. The study protocol was approved by our institutional review board, and it adhered to the tenets of the Declaration of Helsinki.

Our tertiary eye care hospital provides low-cost services to the patients. Many patients are referred to us for corneal imaging from small private sectors and primary and secondary eye health centers where advanced diagnostic facilities are not available. This study included newly diagnosed clinical KC patients who were associated with or without ocular inflammation and other systemic diseases and were willing to participate.

Clinical KC was considered for the patients who showed clinical signs of KC in one or both eyes with central,

Department of Cornea and Refractive Surgery, Shree C.H. Nagri Eye Hospital, Ahmedabad, Gujarat, India

Correspondence to: Zalak Shah, Department of Refractive Surgery, Shree C.H. Nagri Eye Hospital, Ahmedabad, Gujarat - 380 006, India. E-mail: optomzalak@gmail.com

Received: 24-Apr-2023 Revision: 16-Oct-2023
Accepted: 22-Oct-2023 Published: 05-Feb-2024

Cite this article as: Shah Z, Purohit D, Danayak P. Keratoconus characteristics and associations: A cross-sectional keratoconus study in western India (CKSWI). Indian J Ophthalmol 2024;72:704-11.

paracentral, or peripheral steepening on the curvature map and corresponding thinning of the cornea on the thickness map, along with a KC vertex front value of ≥12 μm and a KC vertex back value of ≥24 μm on the tomographer.[5]

After giving informed consent, patients underwent detailed ophthalmic examination of both eyes. In pediatric patients, informed consent was taken from parents. All the measurements were performed by a single qualified and experienced optometrist. Demographic details of the included patients were collected. A detailed ocular and systemic history was taken. Patients were asked about their previous history of using glasses or contact lenses, refractive or any other ocular surgery, and visual complaints (blurred vision, poor vision with glasses, frequent changes of glasses, diplopia, foreign body sensations, pain, redness, tearing, itching, photophobia), and their response was documented. Retinoscopy was performed, and the presence of an irregular reflex on retinoscopy (scissor reflex) was documented. Best spectacle-corrected visual acuity (BSCVA) was measured using Snellen's visual acuity chart.

Corneal tomography was performed using a Sirius tomographer (Costruzione Strumenti Oftalmici, Florence, Italy). Clinical signs of KC[3] [Fig. 1] (corneal protrusion [outward bulging of the cornea], Fleischer ring [dark brown ring in the peripheral cornea, resulting from iron deposition in the basal epithelial cells], Vogt's striae [vertical lines in the posterior stroma of Descemet's membrane of cornea], prominent corneal nerves, Munson's sign [v-shaped protrusion of the lower eyelid on downward gaze], and Rizutti's sign [conical reflection on the nasal cornea if light is shone from the temporal side]) were evaluated by a single cornea specialist using torch light and slit-lamp biomicroscope, and the findings were documented for each eye.

A detailed slit-lamp examination was done for the presence of ocular allergy (conjunctival hyperemia, chemosis, lid eczema, conjunctival cicatrization, presence of papillae, cobblestones, Horner-Trantas dots, pannus, tarsal scarring, superficial punctate epithelial erosion, focal and annular limbal inflammation, limbal stem cell deficiency, marcoerosions, superficial punctate keratitis, and corneal vascularization). The presence of ocular allergy was graded as mild, moderate, severe, or blinding based on the severity grading system classification.[12] The presence of any other specific ocular and systemic associations was documented. Eyes with corneal scars were specifically checked for the presence of any corneal flap to rule out post-refractive surgery ectasia. Patients with previously diagnosed KC, bilateral suspected KC, pellucid-like KC, pellucid marginal degeneration, and post-refractive surgery ectasia were excluded from our study.

Data of BSCVA and tomographic indices (anterior and posterior flat and steep keratometry, symmetry index of anterior and posterior curvature, apical keratoscopy: front and back, KC vertex: front and back, thinnest location, thinnest and apex corneal thickness, anterior chamber depth and volume, mean pupil power, corneal longitudinal spherical aberration, and root mean square value of anterior and posterior surfaces of the cornea) were collected and compared between the two genders.

The severity of KC was graded into stages 0, 1, 2, 3, and 4 according to ABCD grading system,[13] which takes into account the anterior and posterior 3-mm radius of curvature, thinnest corneal thickness, best distance-corrected visual acuity, and presence of corneal scarring.

To avoid any bias in the results, only the right eye of the KC patient was considered for analysis. In cases with a forme fruste or suspected KC in the right eye, clinical and tomographic findings of the other eye were taken for analysis.

Data analysis was performed using IBM Statistical Package for the Social Sciences (SPSS) statistics software (version 20.0; IBM Corp., New York, USA) and Microsoft Excel 2019.

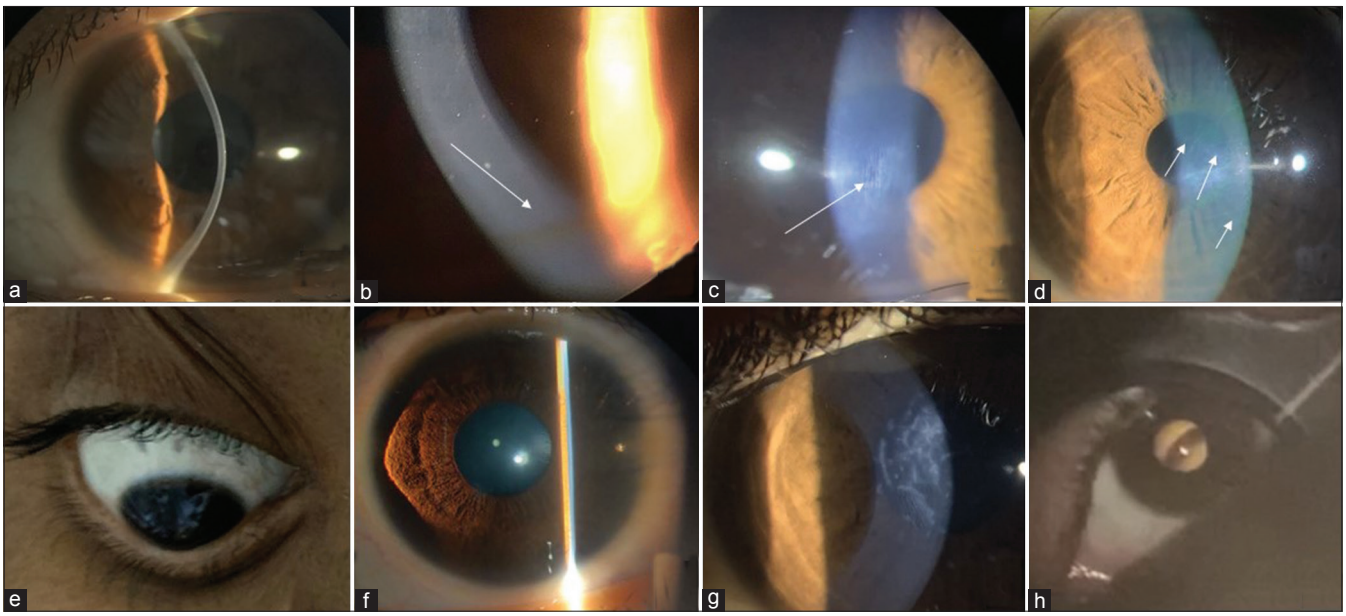

Figure 1: Photographs of the clinical signs of keratoconus: (a) corneal protrusion, (b) Fleischer ring, (c) Vogt's striae, (d) prominent corneal nerves, (e) Munson's sign, (f) Rizutti's sign, (g) corneal scar, and (h) scissor reflex on retinoscopy

Descriptive statistics (means, standard deviations, and percentages) were used to describe variables. Mann–Whitney U tests were used to analyze continuous variables, whereas Chi-square test was applied for categorical variables. A *P* value of <0.05 was considered statistically significant.

Results

A total of 632 newly diagnosed patients with clinical KC were examined from January 2018 to October 2022. Of these patients, 242 were included in the study as the remaining were not willing to participate. The mean age of included patients was 20.09 ± 5.65 (range: 8–41) years. There were 148 males and 94 females. Twenty-five patients had forme fruste KC (10.33%) in their right eye.

A total of 14.05% (34/242) patients had stage 0, 42.15% (102/242) had stage 1, 19.83% (48/242) had stage 2, 18.60% (45/242) had stage 3, and 5.37% (13/242) had stage 4 KC. Of these patients, 70.25% (170/242) had a BSCVA visual acuity of ≥6/12 or better, 26.45% (64/242) had a BSCVA of ≥6/60 to <6/12, and 3.30% (8/242) had a BSCVA of <6/60. Table 1 shows the corneal tomographic indices and BSCVA of male and female KC patients. Our results showed no significant difference in corneal tomographic indices and BSCVA between the two genders.

Visual complaints

The most common visual complaint was blurred vision (82.64%, 200/242), followed by itching (48.76%, 118/242), tearing (43.80%, 106/242), and photophobia (41.32%, 100/242).

Least reported visual complaints were pain (21.07%, 51/242), redness (21.07%, 51/242), foreign body sensations (17.35%, 42/242), and diplopia (15.29%, 37/242).

A total of 61.98% (150/242) patients had a previous history of using glasses. Of these 150 patients, 41.33% (62/150) complained about frequent changes in glasses, while 54.66% (82/150) felt that they had poor vision even after using glasses. Only 2.89% (7/242) gave a previous history of using soft contact lenses. However, none of them gave a history of using rigid gas-permeable lenses at the time of diagnosis.

Table 1: Corneal tomographic indices, severity grades, and best spectacle-corrected visual acuity of included KC patients

	KC patients (*n*=242)	Males KC (*n*=148)	Females KC (*n*=94)	*P*
Flat K (D)	47.57±6.32	46.87±4.53	48.68±8.27	0.073[a]
Steep K (D)	51.34±6.65	50.77±5.44	52.25±8.11	0.232[a]
Posterior flat K (D)	−6.84±1.38	−6.73±1.54	−7.01±1.04	0.114[a]
Posterior steep K (D)	−7.91±1.67	−7.77±1.84	−8.13±1.31	0.125[a]
Thinnest location (mm)	0.68±0.26	0.69±0.28	0.65±0.22	0.303[a]
Thinnest corneal thickness (μm)	447.05±45.90	447.30±43.71	446.67±49.13	0.854[a]
Aqueous depth (mm)	3.37±0.30	3.40±0.31	3.33±0.27	0.160[a]
Anterior chamber volume (mm^3)	178.50±34.47	182.57±37.38	172.27±28.24	0.002*[a]
Apex corneal thickness (μm)	458.25±49.33	459.58±46.0	456.25±53.88	0.684[a]
Mean pupil power (D)	48.76±4.92	48.39±45.71	49.33±5.19	0.072[a]
LSA (D)	-1.08±2.63	-0.85±2.56	-1.43±2.73	0.307[a]
SIF (D)	4.64±3.76	4.41±4.05	4.99±3.24	0.261[a]
SIB (D)	1.31±1.50	1.30±1.78	1.33±0.87	0.272[a]
AKF	57.12±8.09	57.03±8.77	57.28±6.89	0.304[a]
AKB	−9.32±1.80	−9.20±1.86	−9.52±1.85	0.133[a]
KVF	31.11±19.62	31.48±21.24	30.67±16.53	0.693[a]
KVB	67.26±44.27	66.46±44.66	69.56±42.30	0.415[a]
RMS/A	0.28±0.35	0.26±0.27	0.30±0.44	0.739[a]
RMS/B	0.44±0.26	0.44±0.28	0.44±0.25	0.799[a]
KC severity grades				
Stage 0	14.05% (34)	73.53% (25)	26.47% (9)	0.340[b]
Stage 1	42.15% (102)	62.75% (64)	37.25% (38)	
Stage 2	19.83% (48)	60.42% (29)	39.58% (19)	
Stage 3	18.60% (45)	51.11% (23)	48.89% (22)	
Stage 4	5.37% (13)	53.85% (7)	46.15% (6)	
BSCVA				
≥6/12 or better	70.25% (170)	73.65% (109)	64.90% (61)	0.305[b]
≥6/60 to <6/12	26.45% (64)	22.97% (34)	31.91% (30)	
<6/60	3.30% (8)	3.38% (5)	3.19% (3)	

AKB=apical keratoscopy back, AKF=apical keratoscopy front, BSCVA=best spectacle corrected visual acuity, K=keratometry, KC=keratoconus, KVB=keratoconus vertex back, KVF=keratoconus vertex front, LSA=corneal longitudinal spherical aberration, SIB=symmetry index of the posterior curvature, SIF=symmetry index of the anterior curvature, RMS/A=root mean square value of the anterior surface of cornea, RMS/B=root mean square value of the posterior surface of cornea. [a]Mann–Whitney test. [b]Chi-square test

Ocular signs

A scissor reflex on retinoscopy was present in 94.21% (228/242) of patients. Rizutti's sign was appreciable in 77.27% (187/242) of patients. Corneal protrusion was visible in 69.83% (169/242) of cases. Fleischer ring was visible in 67.35% (163/242) of cases.

Munson's sign was present in 66.94% (162/242), prominent corneal nerves in 26.86% (65/242), Vogt's striae in 24.79% (60/242), and corneal scar in 9.91% (24/242) of cases.

Ocular allergy

A total of 44.62% (108/242) cases had the habit of eye rubbing. Ocular allergies were found in 32.32% (78/242) of patients. Vernal keratoconjunctivitis (VKC) was the most common form of ocular allergy. Among 78 patients with ocular allergies, 43.59% (34/78) had mild, 38.46% (30/78) had moderate, and 17.95% (14/78) had severe and blinding eye allergies.

Various ocular associations among the included KC patients are shown in Fig. 2. Various systemic associations among the included KC patients are shown in Fig. 3.

Asthma and atopy were found in 2.48% (6/242) and 4.96% (12/242) of patients, respectively [Fig. 3]. A total of 4.54% (11/242) of patients gave self-reported family history of KC. KC was seen in three pairs of twins.

Discussion

KC starts at puberty and either progresses rapidly to an advanced stage of the disease or progresses slowly and may remain stable in cases of delayed onset.[3] Current understandings of KC suggest that it has a male preponderance.[2] The number of males being more than that of females in our study concurs with the finding that KC has male preponderance.

Our study did not find any significant differences in tomographic indices (except for anterior chamber volume) and BSCVA among males and females [Table 1]. The results of tomographic indices of our KC populations are comparable with previous studies.[14,15] In our study, we found higher anterior chamber volumes in males than females, which can be due to male patients having physiologically larger anterior chamber dimensions than female patients. To the best of our knowledge, no literature has reported a difference in anterior chamber volume between male and female KC.

KC is a bilateral disease, but few cases can have significant asymmetric presentation (so-called unilateral KC). We found 10.33% patients with unilateral KC disease at the time of diagnosis. Previous studies have reported percentages of unilateral KC ranging from 4.3% to 11.4%.[6-8] The discrepancy in the results could be because various studies have used different criteria to define unilateral KC.

Our study used the most recent grading system of KC (the ABCD grading) to define the severity of KC.[13] We found 14.05% had stage 0, 42.15% had stage 1, 19.83% had stage 2, 18.60% had stage 3, and 5.37% had stage 4 KC. Our results are comparable to the findings of Elbedewy *et al*.[8] in Egypt and Naderan *et al*.[9] in Iran, who reported that approximately 40% of patients had stage 1 KC. A study in Palestine by Shanti *et al*.[10] reported that 62% of patients presented with a mild form of disease [Table 2]. The greater number of patients with stage 1 KC in our study could be explained by two facts. First, there is an increasing trend for refractive surgery. As a part of the refractive surgery workup, many asymptomatic patients are being diagnosed at an early stage of the disease. Secondly, improved diagnostic techniques such as Scheimpflug and Oct-based tomography can detect KC earlier.[16]

Table 2: Keratoconus severity grades reported in several studies from different countries

Author (year)	Country	Severity classification	Mild KC	Moderate KC	Advanced KC	Severe KC
Zadnik *et al*.[17] (1998)	USA	Based on keratometry	4.6%	48.7%	46.7%	-
Saini *et al*.[18] (2004)	India	Based on keratometry	0	32.8%	67.2%	-
Sharma *et al*.[19] (2009)	India	Based on keratometry	17.5%	40.4%	42.1%	-
Mahadevan *et al*.[20] (2009)	India	Based on keratometry	26.0	32.6	41.4%	-
Bilgin *et al*.[7] (2009)	Turkey	Based on keratometry	7.40%	55.0%	30%	8%
Fatima *et al*.[21] (2010)	India	Based on keratometry	14.4%	36.7%	32.4%	16.6%
Agrawal *et al*.[22] (2011)	India	Based on keratometry	12.0%	72.3%	15.7%	-
Abu-Ameerh *et al*.[23] (2012)	Jordan	Based on keratometry	6.3%	21.6%	72.1%	-
Naderan *et al*.[4] (2015)	Iran	Based on keratometry	15.2%	43.8%	41%	-
Rashid *et al*.[11] (2016)	Kenya	Based on keratometry	6.2%	22.9%	71%	-
Naderan *et al*.[9] (2017)	Iran	Keratoconus severity score	41.5%	34.0%	24.5%	-
Al-Mahrouqi *et al*.[24] (2018)	Oman	Amsler–Krumeich classification	37%	30%	18%	16%
Shanti *et al*.[10] (2018)	Palestine	Based on keratometry	62%	28.1%	9.9%	-
Elbedewy *et al*.[8] (2019)	Egypt	Amsler–Krumeich classification	38.4%	29.9%	15.3%	16.4%
Rafati *et al*.[25] (2019)	Iran	Based on keratometry	15.2%	56.4%	28.4%	-
Alzahrani *et al*.[26] (2021)	Saudi Arabia	Based on keratometry	30.6%	64.3%	5.1%	-
Alqudah *et al*.[27] (2021)	Jordan	Based on keratometry	63.3%	24.7%	11.9%	-
Present study	India	ABCD classification	42.15% (stage 1)	19.83% (stage 2)	18.60% (stage 3)	5.37% (stage 4)

KC=keratoconus

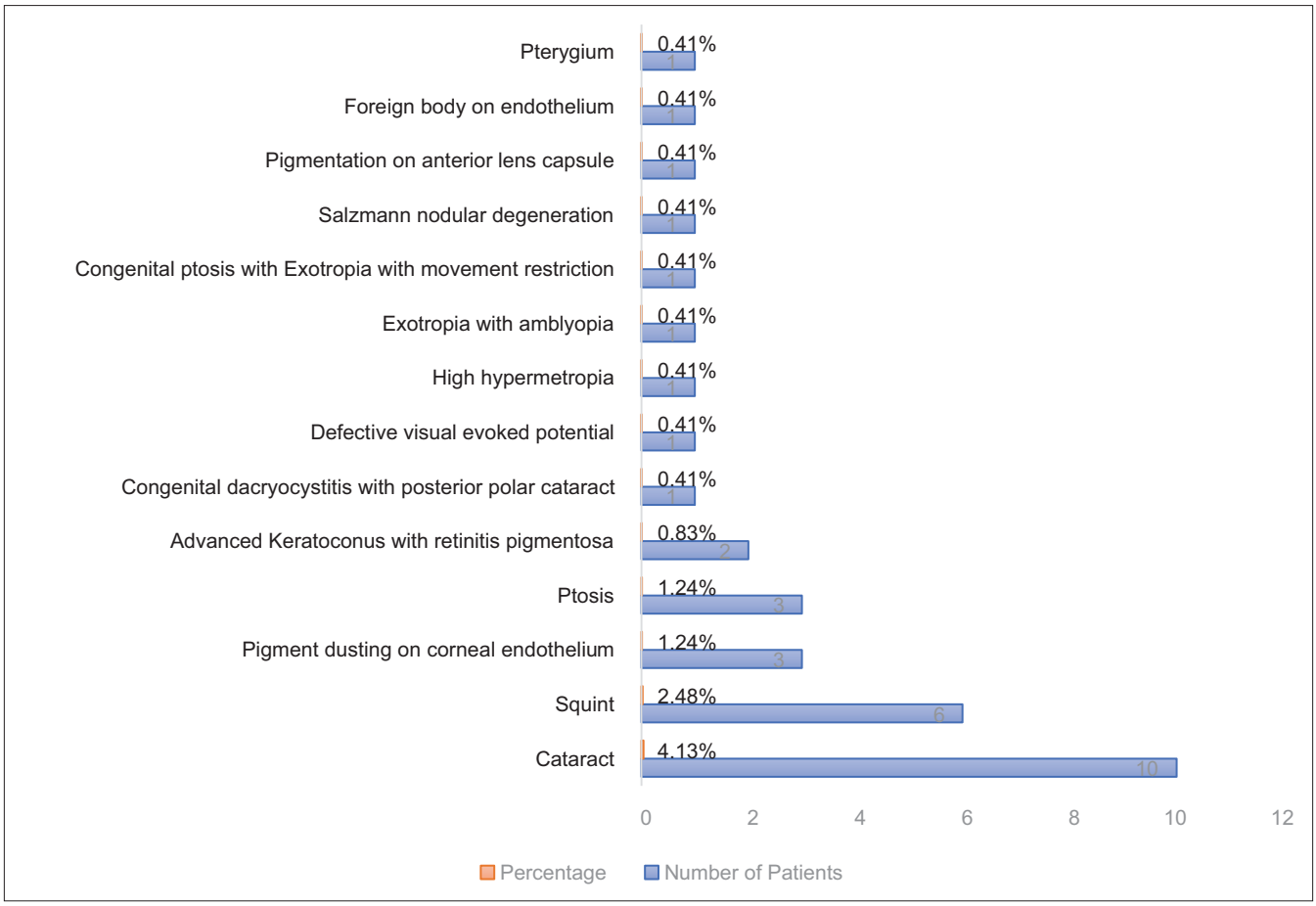

Figure 2: Bar graph of the various ocular associations of the included keratoconus patients

In contrast to our study, other studies[11,18,22,26] have reported slightly higher numbers of patients with KC stages 2 and 3. Of these studies, Alzahrani *et al*.[26] in Saudi Arabia reported that 64.3% of patients had a moderate stage of the disease. In Kenya, 71% of patients reported having a severe stage of the disease.[11] In India, Agrawal[22] reported 72.3% of patients presented with a moderate stage and Saini *et al*.[18] reported 67.2% of patients presented with a severe stage of the disease [Table 2].

The discrepancy in the results among different studies could be because of ethnicity, differences in sample size, different diagnostic criteria and technology, different grading systems used, the inclusion of previously diagnosed KC, and the inclusion of rigid contact lens wearers, resulting in corneal scarring due to poor fitting and presenting with a severe form of disease. In our study, though, it is still strange that 43.8% (stages 2: 19.83%, stage 3: 18.60%, and stage 4: 5.37%) of patients were diagnosed at their moderate to severe stage of disease, and these patients noticed their symptoms after their disease had progressed.

In our study, 70.25% had BSCVA visual acuity of ≥ 6/12 or better. Our result is comparable to the study findings of Fatima *et al*.[21] (70.3% had BSCVA of 6/18 or better) in India, Al-Mahrouqi *et al*.[24] (65% of eyes had BSCVA of >0.5 log of minimum angle of resolution [logMAR]) in Oman, and Shanti *et al*.[10] (71.5% had ≥6/12 in most affected eyes) in Palestine. A CLECK study by Zadnik *et al*.[17] reported best spectacle– or contact lens–corrected visual acuity of 6/12 or better in 95.5% of eyes in the USA, Assiri *et al*.[28] reported 98% in Saudi Arabia, Khor *et al*.[6] reported 94.5% in Singapore, and Rashid *et al*.[11] reported 75% in Kenya. In short, KC rarely causes total blindness.

The most prevalent complaint in our study was blurred vision (82.64%), followed by poor visual acuity with spectacles (54.66%). A similar result was reported by Naderan *et al*.,[4] Weed *et al*.,[29] and Rashid *et al*.,[11] who also found blurred vision to be the most common complaint in their study patients.

Only 2.89% had a previous history of using soft contact lenses and none had worn rigid contact lenses at the time of diagnosis, indicating that our patients had very little awareness of or poor motivation toward contact lenses. However, they will have to depend on contact lenses (as a nonsurgical management option) to improve and enhance the quality of their vision.

Studies have reported that the most common clinical sign of KC is Fleischer ring, with a prevalence of 76%–81%.[22,29] However, a study by Naderan *et al*.[9] stated corneal protrusion as the most common clinical sign in 71.7% of eyes, followed by scissor reflex in 64.2% of eyes. In contrast to this, our study found the presence of the scissor reflex on retinoscopy (94.21%), followed by Rizzuti's sign (77.27%) and corneal protrusion (69.83%) as the common prevailing signs. A study by Al-Mahrouqi *et al*.[24] reported retinoscopy reflex test as a reliable test even in early KC detection, which supports

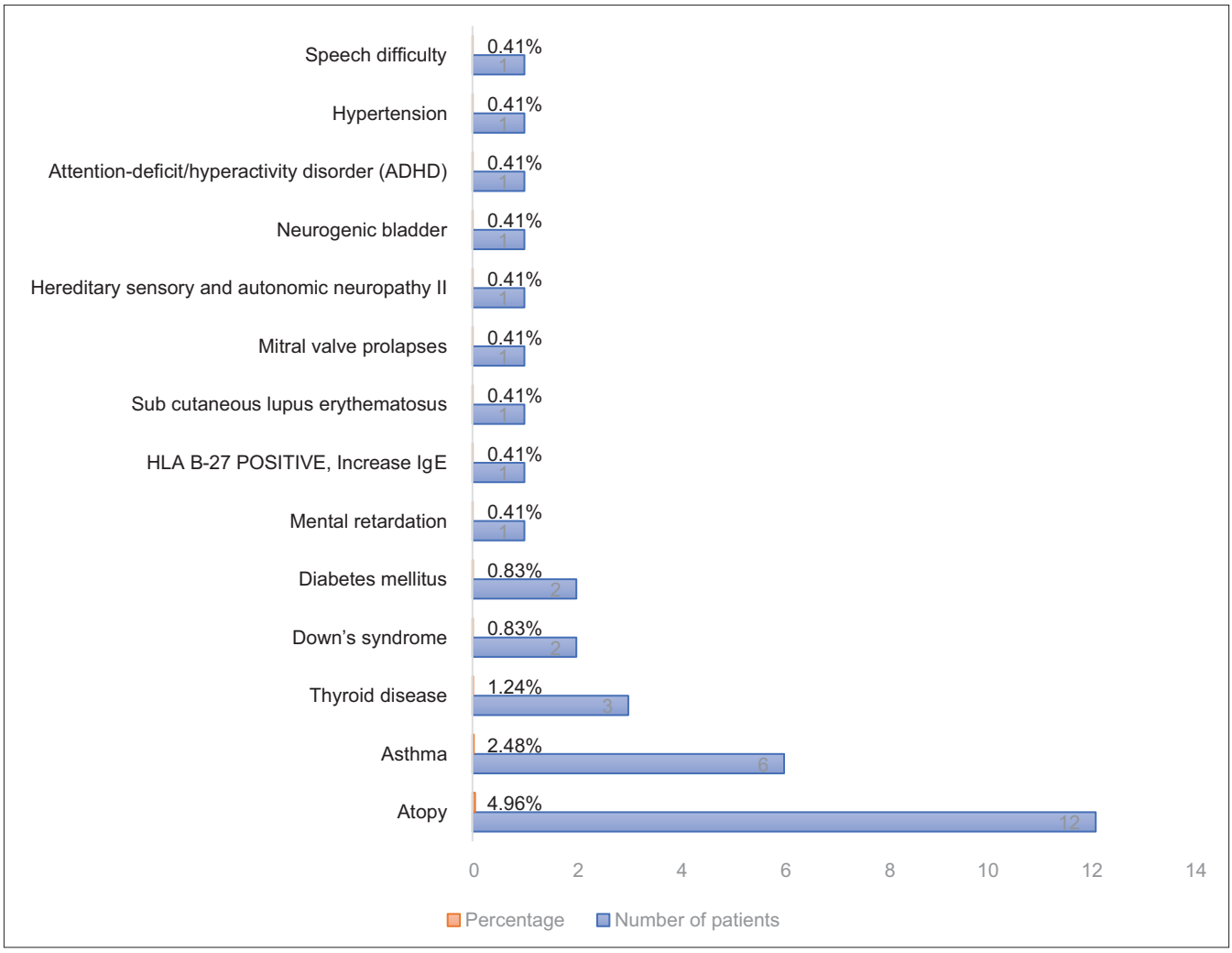

Figure 3: Bar graph of the various systemic associations of the included keratoconus patients

the result of our study. Studies have reported that Vogt's striae ranges from 7.5% to 68%[7,17,18,29] [Table 3]. Vogt's striae were present in 24.79% of our patients. Vogt's striae are generally seen in the moderate-to-advancing stage of the disease. The results might vary in different studies due to differences in severity of the included patients.

In our study, 61.98% of patients had a previous history of wearing glasses. However, these patients became symptomatic only after the disease had progressed, making it mandatory to undergo regular ophthalmic checkups. As a part of routine primary eye care examinations, we should encourage eye care practitioners to check for scissor reflex and Rizutti's sign, especially in vision screening programs or refraction checkup evaluations, for early detection of KC.

Allergic eye diseases include IgE-mediated and non–IgE-mediated ocular allergic disorders.[31] The most common forms of ocular allergies are seasonal conjunctivitis, perennial conjunctivitis, VKC, atopic keratoconjunctivitis, giant papillary conjunctivitis, and contact blepharoconjunctivitis.[31] Of these, VKC is the most persistent and severe form of ocular allergy that affects children and young adults.[31] The most common ocular association of KC is ocular allergy.[32] In our study, we found ocular allergies in 32.32% of patients. Our result is similar to that of Shneor *et al*.,[30] who found it in 34.4% of patients. In our study, 48.76% of patients complained of itching, 43.80% of tearing, and 41.32% of photophobia. Habit of eye rubbing was seen in 44.62% of cases. These symptoms are mostly linked to ocular allergy, which causes corneal stromal keratocyte thinning and may play a role in triggering KC progression.[33]

Most commonly reported systemic associations of KC are atopy, asthma, Down's syndrome, and connective tissue disorders.[3] We found atopy in 4.96% of patients. Studies have reported association of eczema to range from 6.6% to 18.4% in KC.[6,17,30] However, we found little association with asthma and Down's syndrome, which may be due to less number of patients with major systemic diseases visiting our exclusive eye care hospital. Complete systemic evaluation of all KC patients is required to find out the actual systemic associations.

In our cohort, we found KC in three pairs of twins and in association with endothelial dystrophy, which supports the evidence for the role of genetics in KC pathophysiology.[34] Family histories of KC have been reported in 1.1%–27.9% of KC patients[6,28-30] [Table 3]. In our study, only 4.54% of patients gave a self-reported family history of KC. Complete clinical and

Table 3: Clinical findings of keratoconus reported in several studies from different countries

Family history of keratoconus	Agrawal *et al.*[22] (1.1%)	Khor *et al.*[6] (4.3%)	Weed *et al.*[29] (5%)	Sharma *et al.*[19] (5%)	Zadnik *et al.*[17] (13.5%)	Assiri *et al.*[28] (16%)	Alqudah *et al.*[27] (23.5%)	Shneor *et al.*[30] (27.9%)	Present study (4.54%)
History of eye rubbing	Saini *et al.*[18] (44%)	Shneor *et al.*[30] (65.6%)	Khor *et al.*[6] (68%)	-	-	-	-	-	Present study (44.62%)
Fleischer ring	Bilgin *et al.*[7] (1.8%)	Saini *et al.*[18] (50.0%)	Sharma *et al.*[19] (50.8%)	Naderan *et al.*[9] (55.5%)	Zadnik *et al.*[17] (74.6%)	Weed *et al.*[29] (76-79%)	Agrawal *et al.*[22] (81%)	-	Present study (67.35%)
Vogt's striae	Bilgin *et al.*[7] (7.5%)	Elbedewy *et al.*[8] (34.5%)	Zadnik *et al.*[17] (45.5%)	Sharma *et al.*[19] (47.5%)	Naderan *et al.*[9] (47.7%)	Saini *et al.*[18] (50.8%)	Weed *et al.*[29] (67-68%)	-	Present study (24.79%)
Munson's sign	Bilgin *et al.*[7] (6.2%)	Naderan *et al.*[9] (23.2%)	Elbedewy *et al.*[8] (60.5%)	-	-	-	-	-	Present study (66.94%)
Corneal scar	Mahadevan *et al.*[20] (13.9%)	Bilgin *et al.*[7] (14%)	Weed *et al.*[29] (20%–21%)	Naderan *et al.*[9] (30.2%)	Zadnik *et al.*[17] (31% in one eye; 22% in both eyes	Saini *et al.*[18] (32.7%)	Sharma *et al.*[19] (56.2%)	-	Present study (9.91%)
Prominent corneal nerves	Naderan *et al.*[9] (54.7%)	Saini *et al.*[18] (95%)	-	-	-	-	-	-	Present study (26.86%)
Ocular allergy	Sharma *et al.*[19] (12.5%)	Bilgin *et al.*[7] (13.4%)	Alqudah *et al.*[27] (19.7%)	Agrawal *et al.*[22] (24.5%)	Shneor *et al.*[30] (34.4%)	Saini *et al.*[18] (36%)	Assiri *et al.*[28] (56%)	Zadnik *et al.*[17] (59%)	Present study (32.32%)
Asthma	Agrawal *et al.*[22] (11.31%)	Shneor *et al.*[30] (13.2%)	Zadnik *et al.*[17] (14.9%)	Assir *et al.*[28] (16%)	Weed *et al.*[29] (23%)	Khor *et al.*[6] (26.3%)	-	-	Present study (2.48%)
Eczema	Shneor *et al.*[30] (6.6%)	Sharma *et al.*[19] (10%)	Weed *et al.*[29] (14%)	Assir *et al.*[28] (16%)	Khor *et al.*[6] (18.4%)	-	-	-	Present study (4.96%)

tomographic evaluation of eyes of family members with KC can give us an idea about the actual familial association of KC.

Conclusion

KC patients present with a wide variety of ocular and systemic associations. Our study gives an overview of the clinical findings of KC cases in western India. Blurred vision was the most common complaint. The use of retinoscopy should be promoted in early KC detection in primary eyecare screening programs.

Financial support and sponsorship: Nil.

Conflicts of interest: There are no conflicts of interest.

References

1. Rabinowitz YS. Keratoconus. Surv Ophthalmol 1998;42:297–319.
2. Hashemi H, Heydarian S, Hooshmand E, Saatchi M, Yekta A, Aghamirsalim M, *et al.* The prevalence and risk factors for keratoconus: A systematic review and meta-analysis. Cornea 2020;39:263–70.
3. Santodomingo-Rubido J, Carracedo G, Suzaki A, Villa-Collar C, Vincent SJ, Wolffsohn JS. Keratoconus: An updated review. Contact Lens Anterior Eye 2022;45:101559.
4. Naderan M, Shoar S, Rezagholizadeh F, Zolfaghari M, Naderan M. Characteristics and associations of keratoconus patients. Contact Lens Anterior Eye 2015;38:199–205.
5. Shah Z, Singh S, Shilpy N, Purohit D. Prevalence of corneal topographic patterns in ectatic corneal diseases. Optom Vis Sci 2022;99:560–7.
6. Khor W-B, Wei RH, Lim L, Chan CM, Tan DT. Keratoconus in Asians: Demographics, clinical characteristics and visual function in a hospital-based population: Clinical features of keratoconus in Asians. Clin Experiment Ophthalmol 2011;39:299–307.
7. Bilgin LK, Yılmaz Ş, Araz B, Yüksel SB, Sezen T. 30 years of contact lens prescribing for keratoconic patients in Turkey. Contact Lens Anterior Eye 2009;32:16–21.
8. Elbedewy HA, Wasfy TE, Soliman SS, Sabry MM, Awara AM, El Emam SY, *et al.* Prevalence and topographical characteristics of keratoconus in patients with refractive errors in the Egyptian delta. Int Ophthalmol 2019;39:1459–65.
9. Naderan M, Jahanrad A, Farjadnia M. Clinical biomicroscopy and retinoscopy findings of keratoconus in a Middle Eastern population. Clin Exp Optom 2018;101:46–51.
10. Shanti Y, Beshtawi I, Zyoud SH, Abu-Samra A, Abu-Qamar A, Barakat R, *et al.* Characteristics of keratoconic patients at two main eye centres in Palestine: A cross-sectional study. BMC Ophthalmol 2018;18:95.
11. Rashid ZA, Millodot M, Evans KSE. Characteristics of keratoconic patients attending a specialist contact lens clinic in Kenya. Middle East Afr J Ophthalmol 2016;23:283-7.
12. Gokhale NS. Systematic approach to managing vernal keratoconjunctivitis in clinical practice: Severity grading system and a treatment algorithm. Indian J Ophthalmol 2016;64:145-8.
13. Belin M, Duncan J. Keratoconus: The ABCD grading system. Klin Monatsblätter Für Augenheilkd 2016;233:701–7.
14. Tunç U, Akbaş YB, Yıldırım Y, Kepez Yıldız B, Kırgız A, Demirok A. Repeatability and reliability of measurements obtained by the combined Scheimpflug and Placido-disk tomography in different stages of keratoconus. Eye 2021;35:2213–20.
15. Safarzadeh M, Nasiri N. Anterior segment characteristics in normal and keratoconus eyes evaluated with a combined Scheimpflug/Placido corneal imaging device. J Curr Ophthalmol 2016;28:106–11.
16. Abdala-Figuerola A, Navas A, Ramirez-Miranda A, Lichtinger A, Hernandez-Bogantes E, Olivo-Payne A, *et al.* Scheimpflug and optical coherence tomography analysis of posterior keratoconus. Cornea 2016;35:1368–71.

17. Zadnik K, Barr JT, Edrington TB, Everett DF, Jameson M, McMahon TT, *et al.* Baseline findings in the collaborative longitudinal evaluation of keratoconus (CLEK) study. Invest Ophthalmol Vis Sci 1998;39:2537–46.
18. Saini JS, Saroha V, Singh P, Sukhija JS, Jain AK. Keratoconus in Asian eyes at a tertiary eye care facility. Clin Exp Optom 2004;87:97–101.
19. Sharma R, Titiyal JS, Prakash G, Sharma N, Tandon R, Vajpayee RB. Clinical profile and risk factors for keratoplasty and development of hydrops in north Indian patients with keratoconus. Cornea 2009;28:367–70.
20. Mahadevan R, Arumugam AO, Arunachalam V, Kumaresan B. Keratoconus - A review from a tertiary eye-care center. J Optom 2009;2:166–72.
21. Fatima T, Acharya MC, Mathur U, Barua P. Demographic profile and visual rehabilitation of patients with keratoconus attending contact lens clinic at a tertiary eye care centre. Contact Lens Anterior Eye 2010;33:19–22.
22. Agrawal VB. Characteristics of keratoconus patients at a tertiary eye center in India. J Ophthalmic Vis Res 2011;6:87–91.
23. Abu Ameerh MA, Al Refai RM, Al Bdour MD. Keratoconus patients at Jordan University Hospital: A descriptive study. Clin Ophthalmol Auckl NZ 2012;6:1895–9.
24. Al-Mahrouqi H, Al-Shamli N, Mohan N, Oraba S, Panchatcharam S, Al-Saidi R, *et al*. Clinical profile of Omani keratoconus patients: An experience from a tertiary referral centre in Muscat. Oman J Ophthalmol 2018;11:259-64.
25. Rafati S, Hashemi H, Nabovati P, Doostdar A, Yekta A, Aghamirsalim M, *et al*. Demographic profile, clinical, and topographic characteristics of keratoconus patients attending at a tertiary eye center. J Curr Ophthalmol 2019;31:268–74.
26. Alzahrani K, Al-Rashah A, Al-Salem S, Al-Murdif Y, Al-Rashah A, Alrashah A, *et al.* Keratoconus epidemiology presentations at Najran Province, Saudi Arabia. Clin Optom 2021;13:175–9.
27. Alqudah N, Jammal H, Khader Y, Al-dolat W, Alshamarti S, Shannak Z. Characteristics of keratoconus patients in Jordan: Hospital-based population. Clin Ophthalmol 2021;15:881–7.
28. Assiri AA, Yousuf BI, Quantock AJ, Murphy PJ. Incidence and severity of keratoconus in Asir province, Saudi Arabia. Br J Ophthalmol 2005;89:1403–6.
29. Weed KH, MacEwen CJ, Giles T, Low J, McGhee CNJ. The Dundee University Scottish Keratoconus study: Demographics, corneal signs, associated diseases, and eye rubbing. Eye Lond Engl 2008;22:534–41.
30. Shneor E, Millodot M, Blumberg S, Ortenberg I, Behrman S, Gordon-shaag A. Characteristics of 244 patients with keratoconus seen in an optometric contact lens practice. Clin Exp Optom 2013;96:219–24.
31. Vazirani J, Shukla S, Chhawchharia R, Sahu S, Gokhale N, Basu S. Allergic conjunctivitis in children: Current understanding and future perspectives. Curr Opin Allergy Clin Immunol 2020;20:507–15.
32. Ahuja P, Dadachanji Z, Shetty R, Nagarajan SA, Khamar P, Sethu S, *et al.* Relevance of IgE, allergy and eye rubbing in the pathogenesis and management of Keratoconus. Indian J Ophthalmol 2020;68:2067–74.
33. Najmi H. The correlation between keratoconus and eye rubbing: A review. Int J Ophthalmol 2019;12:1775–81.
34. Gordon-Shaag A, Millodot M, Shneor E, Liu Y. The genetic and environmental factors for keratoconus. BioMed Res Int 2015;2015:795738.