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ASSOCIATION OF EYE RUBBING AND ALLERGIC EYE DISEASE WITH KERATOCONUS IN 6 TO 12 YEARS PEDIATRIC POPULATION IN MAHARASHTRA.

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ABSTRACT **Background:** Keratoconus is a progressive corneal ectatic disorder that may progress rapidly in children and lead to visual impairment if not detected early. Allergic eye disease and habitual eye rubbing are considered important modifiable factors associated with keratoconus. **Objectives:** To assess the association of eye rubbing and allergic eye disease with suspected or confirmed keratoconus among children aged 6–12 years. **Methods:** This hospital-based cross-sectional observational study was conducted in the Department of Ophthalmology of a tertiary care teaching hospital in Vidarbha, Maharashtra, from July 2025 to December 2025. A total of 60 children aged 6–12 years attending the ophthalmology outpatient department with allergic eye symptoms, eye rubbing or refractive complaints were included by consecutive sampling. Demographic details, ocular symptoms, history of atopy, eye rubbing and family history were recorded. All children underwent visual acuity assessment, refraction, slit-lamp examination, keratometry and central corneal thickness measurement wherever available. Corneal topography or tomography was performed where available for confirmation. Data were analyzed using SPSS version 26. Chi-square test and $p<0.05$ was considered statistically significant. **Results:** The mean age of children was 9.1 ± 1.8 years. Allergic eye disease was present in 42 (70.0%) children and habitual eye rubbing was reported in 38 (63.3%). Suspected or confirmed keratoconus was observed in 8 (13.3%) children. All children with keratoconus had allergic eye disease, though the association was not statistically significant ($p=0.091$). Habitual eye rubbing showed a significant association with keratoconus ($p=0.022$). Keratoconus was more common among children with vernal keratoconjunctivitis. **Conclusion:** Habitual eye rubbing was significantly associated with suspected or confirmed keratoconus in children. Children with allergic eye disease, especially vernal keratoconjunctivitis and frequent eye rubbing, should be screened for early keratoconus.

KEYWORDS : Keratoconus, Eye rubbing, Allergic eye disease.

INTRODUCTION

Keratoconus (KC) is a progressive, bilateral but often asymmetric corneal ectatic disorder characterized by stromal thinning, apical protrusion and irregular astigmatism, leading to visual impairment. It typically manifests around puberty and can progress rapidly in the pediatric population, often presenting at a more advanced stage compared to adults. Pediatric KC (generally defined as onset before 18 years) is more aggressive, with higher rates of progression (up to 88% within one year of diagnosis in some cohorts) and a greater risk of complications such as corneal hydrops. [1,2]

The global prevalence of KC is approximately 1.38 per 1,000 population, though estimates vary widely by region, ethnicity and diagnostic methods (ranging from 0.3 to 23 per 1,000 or higher in high-risk groups). In India, prevalence appears higher, with reports of 2.3% in certain populations and elevated rates in children (e.g., 1.04% in hospital-based data for ≤16 years). Regional data from rural Maharashtra (Central India Eye and Medical Study) and other Indian studies highlight the burden in young populations, particularly in warmer climates where allergic conditions are prevalent. [3-6]

The etiopathogenesis of KC is multifactorial, involving genetic predisposition, environmental triggers, oxidative stress, enzymatic degradation (e.g., matrix metalloproteinases) and inflammatory pathways. Among modifiable environmental factors, chronic eye rubbing and allergic eye diseases (particularly atopic conditions like vernal keratoconjunctivitis and allergic conjunctivitis) are strongly implicated. Eye rubbing induces mechanical trauma, releasing inflammatory mediators (e.g., IL-6, TNF-α, MMPs) that promote keratocyte apoptosis, collagen degradation and corneal thinning. Allergic eye disease exacerbates this through itching-induced rubbing and direct inflammatory effects; VKC, common in children in tropical regions like Maharashtra, shows a notable association with KC due to chronic ocular surface inflammation.[2,7,8]

Meta-analyses and systematic reviews confirm significant associations: eye rubbing has an odds ratio (OR) around 2–3 or higher (up to 15 in some studies), while atopy/allergies (including allergic conjunctivitis, asthma and eczema) show ORs of 1.4–5 or more. In pediatric cohorts, especially in regions with high VKC prevalence, these factors contribute to earlier onset and faster progression. However, some studies report variable or non-significant independent associations after adjusting for confounders, underscoring the need for context-specific research.

In Maharashtra, where pediatric populations in rural and semi-urban areas face environmental challenges (e.g., dust, allergens, UV exposure), the interplay of eye rubbing and allergic eye disease with KC remains under-explored in the 6–12 years age group. This study aims to investigate these associations in a pediatric cohort, providing insights for early screening, allergy management and preventive strategies to mitigate visual morbidity in this vulnerable population.

METHODOLOGY

This hospital-based cross-sectional observational study was conducted in the Department of Ophthalmology of a tertiary care teaching hospital in the Vidarbha region of Maharashtra, India, over a period of six months from July 2025 to December 2025. A total of 60 children aged 6–12 years attending the Ophthalmology outpatient department with symptoms suggestive of allergic eye disease, eye rubbing, redness, watering, itching or for refractive error evaluation were included by consecutive sampling. Children with systemic

disorders associated with keratoconus, previous ocular trauma or surgery, active corneal infection or opacity, recent contact lens use within four weeks, uncooperative children and those whose parents did not give consent were excluded.

After obtaining written informed consent from parents/guardians and assent from children wherever applicable, demographic details, ocular symptoms, history of eye rubbing, history of atopy, family history of allergy and family history of keratoconus were recorded using a structured proforma. Eye rubbing was considered significant when rubbing of eyes was reported at least once daily on most days. All children underwent visual acuity assessment, refraction, slit-lamp examination, keratometry and central corneal thickness measurement wherever available. Allergic eye disease was diagnosed clinically based on symptoms such as itching, redness and watering along with slit-lamp findings suggestive of allergic conjunctivitis or vernal keratoconjunctivitis. Keratoconus was suspected in the presence of clinical signs, irregular astigmatism or keratometry readings greater than 47.5 D in either meridian. Corneal topography or tomography was performed wherever available for confirmation.

Data were entered in Microsoft Excel and analyzed using IBM SPSS Statistics version 26. Quantitative variables were expressed as mean and standard deviation, while categorical variables were expressed as frequency and percentage. Association between eye rubbing, allergic eye disease and suspected or confirmed keratoconus was assessed using Chi-square test or Fisher's exact test, as appropriate. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 60 children aged 6–12 years were included in the present study. The mean age of the study participants was 9.1 ± 1.8 years. Most children belonged to the 9–12 years age group, accounting for 36 (60.0%) participants, while 24 (40.0%) were in the 6–8 years age group. Males were slightly more common than females, with 34 (56.7%) males and 26 (43.3%) females. Rural residence was noted in 32 (53.3%) children, while 28 (46.7%) were from urban areas. [Table 1]

Ocular itching was the most common presenting symptom, reported by 44 (73.3%) children. Recurrent eye rubbing was present in 38 (63.3%) children, followed by redness in 36 (60.0%), watering in 30 (50.0%), blurring of vision in 18 (30.0%) and frequent change of glasses in 6 (10.0%) children. Allergic eye disease was present in 42 (70.0%) children, while 18 (30.0%) had no allergic eye disease. Among the types of allergic eye disease, allergic conjunctivitis was seen in 28 (46.7%) children and vernal keratoconjunctivitis was seen in 14 (23.3%) children. [Table 2]

Habitual eye rubbing, defined as daily or frequent rubbing of eyes, was reported in 38 (63.3%) children, while absent or occasional eye rubbing was reported in 22 (36.7%) children. Suspected or confirmed keratoconus was observed in 8 (13.3%) children. Among these, 5 (8.3%) were classified as suspected keratoconus and 3 (5.0%) as confirmed keratoconus, while 52 (86.7%) children had no evidence of keratoconus. [Table 3]

All 8 children with suspected or confirmed keratoconus had allergic eye disease. Among children with allergic eye disease, 8 (19.0%) had keratoconus, whereas none of the children without allergic eye disease had keratoconus. However, this association was not statistically significant on Fisher's exact test. [Table 4]

Habitual eye rubbing showed a statistically significant association with suspected or confirmed keratoconus. Among children with daily or frequent eye rubbing, 8 (21.1%) had keratoconus, whereas none of the children with absent or occasional eye rubbing had keratoconus. [Table 4]

Suspected or confirmed keratoconus was more common among children with vernal keratoconjunctivitis compared to those with allergic conjunctivitis. Keratoconus was present in 5 (35.7%) children with vernal keratoconjunctivitis and 3 (10.7%) children with allergic conjunctivitis, while no child without allergic eye disease had keratoconus. This association was statistically significant; however, due to small expected cell counts, the result should be interpreted cautiously. [Table 5]

Children with a history of atopy had a higher proportion of suspected or confirmed keratoconus compared to those without atopy. Keratoconus was present in 5 (25.0%) children with atopy and 3 (7.5%) children without atopy. However, the association was not statistically significant on Fisher's exact test. [Table 5]

Children with suspected or confirmed keratoconus had significantly higher mean visual acuity impairment, higher mean keratometry readings and lower central corneal thickness compared to those without keratoconus. The mean maximum keratometry reading was 50.4 ± 2.6 D among children with keratoconus compared to 44.8 ± 1.9 D among those without keratoconus. The mean central corneal thickness was lower among children with keratoconus, 466.5 ± 28.4 µm, compared to 528.2 ± 34.6 µm among children without keratoconus. [Table 6]

Table 1. Distribution of Children According to Sociodemographic Characteristics

Variable	Category	Frequency (n=60)	Percentage (%)
Age group	6–8 years	24	40.0
	9–12 years	36	60.0
Sex	Male	34	56.7
	Female	26	43.3
Residence	Rural	32	53.3
	Urban	28	46.7

Table 2. Distribution According to Presenting Symptoms and Allergic Eye Disease

Variable	Category	Frequency (n=60)	Percentage (%)
Presenting symptoms*	Ocular itching	44	73.3
	Redness	36	60.0
	Watering	30	50.0
	Recurrent eye rubbing	38	63.3
	Blurring of vision	18	30.0
	Frequent change of glasses	6	10.0
Allergic eye disease	Present	42	70.0
	Absent	18	30.0
Type of allergic eye disease	Allergic conjunctivitis	28	46.7
	Vernal keratoconjunctivitis	14	23.3
	No allergic eye disease	18	30.0

*Multiple responses were present for symptoms.

Table 3. Distribution According to Eye Rubbing and Keratoconus Status

Variable	Category	Frequency (n=60)	Percentage (%)
Eye rubbing status	Absent/ occasional	22	36.7
	Daily/frequent	38	63.3
Keratoconus status	Absent	52	86.7
	Suspected keratoconus	5	8.3
	Confirmed keratoconus	3	5.0
Total suspected/confirmed keratoconus	Present	8	13.3
	Absent	52	86.7

Table 4. Association of Allergic Eye Disease and Eye Rubbing with Suspected/Confirmed Keratoconus

Variable	Category	Kerato-conus present n (%)	Kerato-conus absent n (%)	Total	Test used	p-value
Allergic eye disease	Present	8 (19.0)	34 (81.0)	42	Fisher's exact test	0.091
	Absent	0 (0.0)	18 (100.0)	18		
Eye rubbing	Daily/frequent	8 (21.1)	30 (78.9)	38	Fisher's exact test	0.022
	Absent/ occasional	0 (0.0)	22 (100.0)	22		

Table 5. Association of Type of Allergic Eye Disease and Atopy with Suspected/Confirmed Keratoconus

Variable	Category	Keratoconus present n (%)	Keratoconus absent n (%)	Total	Test used	p-value
Type of allergic eye disease	Allergic conjunctivitis	3 (10.7)	25 (89.3)	28	Chi-square test	0.011
	Vernal keratoconjunctivitis	5 (35.7)	9 (64.3)	14		
	No allergic eye disease	0 (0.0)	18 (100.0)	18		
History of atopy	Present	5 (25.0)	15 (75.0)	20	Fisher's exact test	0.103
	Absent	3 (7.5)	37 (92.5)	40		

Table 6. Comparison of Mean Ocular Parameters Among Children with and Without Suspected/Confirmed Keratoconus

Parameter	Keratoconus present Mean ± SD	Keratoconus absent Mean ± SD	Test used	p-value
Visual acuity, LogMAR	0.32 ± 0.18	0.11 ± 0.09	Independent t-test	0.013
Mean K reading, D	48.9 ± 2.1	43.6 ± 1.8	Independent t-test	<0.001
Maximum K reading, D	50.4 ± 2.6	44.8 ± 1.9	Independent t-test	<0.001
Central corneal thickness, µm	466.5 ± 28.4	528.2 ± 34.6	I	

DISCUSSION

Keratoconus is an important pediatric corneal disorder because it tends to progress more rapidly in children than in adults and may lead to significant visual impairment if not detected early [1,2]. In the present hospital-based study, suspected or confirmed keratoconus was observed in 8 (13.3%) children aged 6–12 years. This proportion appears higher than general population estimates; however, it should be interpreted cautiously because the study included a selected group of children attending the ophthalmology OPD with allergic symptoms, eye rubbing or refractive complaints rather than a community-based sample.

Allergic eye disease was present in 70.0% of children, with allergic conjunctivitis being more common than vernal keratoconjunctivitis. Ocular itching and recurrent eye rubbing were the predominant symptoms. Similar observations have been reported by Balogun and Fashola, who found frequent itching to be the commonest complaint among children with allergic conjunctivitis and emphasized the need for keratoconus screening in children with ocular allergy [3]. Pediatric keratoconus has also been frequently associated with ocular allergy, particularly vernal keratoconjunctivitis, which may accelerate disease progression due to chronic inflammation and eye rubbing [2].

In the present study, all children with suspected or confirmed keratoconus had allergic eye disease, although the association was not statistically significant. This may be due to the small sample size and limited number of keratoconus cases. However, keratoconus was more frequent among children with vernal keratoconjunctivitis than among those with allergic conjunctivitis. This finding supports the existing evidence that severe ocular allergy, especially VKC, is an important associated condition in pediatric keratoconus [2,3].

Habitual eye rubbing showed a statistically significant association with suspected or confirmed keratoconus in the present study. This is consistent with previous literature, which identifies eye rubbing as one of the most important modifiable risk factors for keratoconus [4,9,12]. Najmi et al. concluded that eye rubbing contributes to corneal thinning and that its effect depends on the duration and force of rubbing [4]. Yang et al. also reported that eye rubbing was independently associated with keratoconus and the coexistence of eye rubbing and atopy markedly increased the risk [9]. Mechanically, repeated rubbing may induce corneal epithelial trauma, keratocyte apoptosis, release of inflammatory mediators, stromal weakening and progressive corneal thinning [9,12].

Children with keratoconus in the present study had significantly higher keratometry readings and lower central corneal thickness compared with those without keratoconus. These findings are consistent with the basic clinical features of keratoconus, which include corneal steepening, thinning and irregular astigmatism. Jonas et al., in the Central India Eye and Medical Study, reported that keratoconus was associated with myopic refractive error and thinner central cornea [5]. Similarly, large Indian hospital-based data by Das et al. described keratoconus as commonly affecting young individuals and presenting with corneal ectasia and variable visual impairment [7].

Recent awareness studies have shown poor knowledge regarding keratoconus and the harmful effects of eye rubbing among the general population [10,11]. These findings are relevant because prevention in children depends largely on parental awareness, early recognition of allergic eye disease and avoidance of habitual eye rubbing. The present study highlights the need for counseling children and parents regarding the risks of frequent eye rubbing, along with early treatment of ocular allergy and screening of high-risk children for keratoconus.

The study has some limitations. It was a hospital-based study with a small sample size and therefore the findings cannot be generalized to the community. Corneal topography or tomography was performed only where available, so some cases were classified as suspected rather than confirmed keratoconus. Eye rubbing history was based on parent or child reporting and may be affected by recall bias. Despite these limitations, the study suggests that habitual eye rubbing and allergic eye disease, especially vernal keratoconjunctivitis, are important clinical factors associated with suspected or confirmed keratoconus in children.

CONCLUSION

The present study showed that suspected or confirmed keratoconus was observed among a proportion of children aged 6–12 years attending the ophthalmology outpatient department. Allergic eye disease was common in the study population and keratoconus was more frequent among children with vernal keratoconjunctivitis. Habitual eye rubbing showed a statistically significant association with suspected or confirmed keratoconus. Children with keratoconus had higher keratometry readings and lower central corneal thickness compared with those without keratoconus. These findings suggest that children with allergic eye disease, especially those with frequent eye rubbing, should be screened carefully for early signs of keratoconus. Early diagnosis, control of ocular allergy and counseling to avoid eye rubbing may help in reducing progression and visual morbidity.

Limitations

This study had certain limitations. It was a hospital-based study with a small sample size and therefore the findings may not represent the true community prevalence of keratoconus. The study included children attending the ophthalmology outpatient department, so selection bias cannot be excluded. Corneal topography or tomography was performed only where available; hence, some cases were classified as suspected rather than confirmed keratoconus. History of eye rubbing and atopy was based on reporting by parents or children, which may be affected by recall bias. Further community-based studies with larger sample size and routine corneal tomography are recommended.

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Conflict of Interest

The authors declare that there was no conflict of interest.

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