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FREQUENCY OF ANTERIOR SEGMENT DISEASES ASSOCIATED WITH ENVIRONMENTAL FACTORS IN AGE GROUP 12 TO 60 YEARS IN LRBT QUETTA

Original Research

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ABSTRACT

Background: Anterior segment diseases of the eye are highly prevalent and often influenced by environmental factors such as dust, UV radiation, and occupational exposure. These conditions can significantly impair vision and quality of life if left unrecognized or untreated. Despite their burden, the environmental associations of these diseases remain underexplored, particularly in underserved regions. This study was conducted to determine the frequency of anterior segment disorders and their relationship with environmental exposures among patients presenting to a tertiary eye care facility.

Objective: To determine the frequency of anterior segment diseases and evaluate their association with environmental risk factors in patients attending LRBT Hospital Quetta.

Methods: A descriptive cross-sectional quantitative study was conducted at LRBT Hospital Quetta between 10 August and 10 September 2024. A total of 211 participants were selected through non-probability purposive sampling. Inclusion criteria involved patients aged 12 years and older who consented to participate. Data were collected using a structured close-ended questionnaire and clinical eye examination. Environmental exposure variables included sunlight, dust, and occupational setting. Data were analyzed using SPSS version 25 for descriptive statistics.

Results: Among the 211 participants, 156 (74%) were male and 55 (26%) were female, with a mean age of 33.64 years. The most frequently diagnosed anterior segment disease was conjunctivitis, affecting 70 individuals (33.2%), followed by cataract in 41 (19.5%), and both VKC and pterygium in 40 patients each (19%). Notably, 195 participants (92.42%) reported no use of eye protection, while 116 (54.9%) had daily dust exposure exceeding six hours. A majority of cases were linked to outdoor work environments.

Conclusion: Conjunctivitis emerged as the most common anterior segment disease. The findings underscore a strong association between environmental exposures and disease occurrence, highlighting the urgent need for preventive public health interventions.

Keywords: Cataract, Conjunctivitis, Environment, Frequency, Keratitis, Pterygium, VKC.

INTRODUCTION

The human eye, a complex and delicate organ, is vulnerable to a range of external and internal influences that can compromise its structure and function. While genetics and advancing age are well-established risk factors for ocular degeneration, a growing body of evidence suggests that environmental exposures play a substantial role in the onset and progression of anterior segment diseases. The increasing reliance on digital screens, poor indoor air quality, ultraviolet (UV) radiation, exposure to air pollutants, artificial lighting, and climate extremes are becoming prominent contributors to visual fatigue and pathological ocular changes. These environmental stressors, when unaddressed, not only exacerbate discomfort such as dry eyes and photophobia but also increase the burden of more severe conditions including conjunctivitis, keratitis, vernal keratoconjunctivitis, trachoma, pterygium, and dry eye disease (1). Conjunctivitis, characterized by inflammation of the conjunctiva with redness, discharge, and discomfort, is among the most frequently diagnosed ocular disorders globally and is often exacerbated by poor hygiene, allergen exposure, and crowded living conditions (2). Bacterial conjunctivitis, although less common than viral types, is notably prevalent in pediatric populations and is linked with direct contact transmission and compromised ocular defenses (3). In more severe cases, infection extends deeper into the eye, as seen in bacterial keratitis—an acute, vision-threatening condition heavily associated with environmental trauma, contact lens use, and pathogen virulence (4). Another environmentally aggravated anterior segment disease is vernal keratoconjunctivitis, a chronic and recurrent allergic disorder seen predominantly in young males living in hot, arid climates. This condition presents with intense ocular itching, photophobia, and characteristic cobblestone papillae, underscoring the significant role of seasonal and climatic factors (5).

In low-resource settings, the bacterial infection trachoma remains a leading cause of preventable blindness, driven primarily by inadequate sanitation, poor water access, and socioeconomic deprivation. Transmission of *Chlamydia trachomatis* is facilitated by close contact and shared personal items, reflecting the disease's strong link to environmental and hygienic deficits (6). Similarly, pterygium, a fibrovascular growth on the ocular surface, is increasingly recognized as a UV-related degenerative disorder. The condition, often asymptomatic in its early stages, may progress to cause irritation, vision distortion, and ocular surface instability in advanced forms (7). Visual display units and cognitively demanding screen-based activities have introduced new dimensions of environmental exposure, particularly in urban, indoor settings. Symptoms such as dry, irritated eyes are now among the top complaints in ophthalmology clinics, especially in women and older adults. The pathogenesis of dry eye disease involves tear film instability, meibomian gland dysfunction, and inflammatory cascades, often worsened by air-conditioned environments and screen overuse (8,9). Ethnic and gender-based disparities in disease susceptibility further emphasize the need to understand the intricate interactions between systemic health, hormonal milieu, and environmental triggers.

Other environmentally and systemically influenced anterior segment conditions include keratoconus—an ectatic disorder often aggravated by eye rubbing, contact lens misuse, and endocrine fluctuations (10)—and congenital cataracts, which exhibit a higher prevalence in regions with increased exposure to infections and environmental toxins (11). Uveitis, particularly anterior uveitis, also warrants mention as a multifactorial inflammatory disease that may be triggered by trauma, medications, infections, or systemic autoimmune responses. Although not always directly environmental in origin, the exacerbating role of pollutants and ambient triggers cannot be overlooked (12,13). Given the broad spectrum and increasing incidence of environmentally linked anterior segment diseases, it becomes imperative to investigate these associations comprehensively. Raising awareness, implementing preventive strategies, and recognizing modifiable risk factors can significantly reduce the burden of ocular morbidity. Therefore, this study aims to determine the frequency of anterior segment diseases associated with environmental exposures, with a focus on identifying the most commonly observed conditions in clinical practice.

METHODS

The study was designed as a descriptive cross-sectional analysis aimed at identifying the frequency of anterior segment eye diseases associated with environmental factors. Data were collected using a non-probability purposive sampling technique from patients presenting to the outpatient department (OPD) of LRBT Hospital, Quetta. Prior to data collection, ethical approval was obtained from the Ethical Review Committee of the Pakistan Institute of Rehabilitation Sciences (PIRS), and institutional permission was granted by the hospital administration. Written informed consent was obtained from all study participants in accordance with ethical research

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guidelines. Patients were recruited consecutively during OPD hours, which operated six days a week. The schedule varied slightly, with operating hours from 8:00 AM to 10:00 AM on Mondays, 8:00 AM to 12:00 PM on Fridays, and 8:00 AM to 2:30 PM on other weekdays. Upon arrival, each patient underwent a standardized ophthalmic assessment beginning with measurement of visual acuity, followed by intraocular pressure evaluation using a non-contact (air puff) tonometer. Anterior segment evaluation was then conducted using a slit lamp biomicroscope. Where clinically necessary, a direct ophthalmoscope was also used to aid in diagnosis. Dry eye disease was diagnosed using fluorescein staining and the cobalt blue filter of the slit lamp, with assessment of tear film stability and corneal integrity. Patients diagnosed with anterior segment pathology were then interviewed by a trained research team member using a structured questionnaire to document demographic, occupational, and environmental exposure data.

To ensure methodological clarity and enhance generalizability, this revised version of the methodology now includes clearly defined inclusion and exclusion criteria. Participants were included if they were aged 12 years or older, presented to the OPD with anterior segment complaints or diagnoses, and consented to participate. Exclusion criteria comprised individuals with posterior segment eye diseases only, non-consenting individuals, and patients with systemic conditions affecting vision who were unable to participate in ocular examinations. Data analysis was conducted using SPSS version 25. Descriptive statistics were used to analyze demographic data, frequencies, and distributions of disease types. Cross-tabulations were employed to explore associations between environmental exposures and specific anterior segment pathologies.

RESULTS

A total of 211 participants were included in the study, comprising 156 males (74%) and 55 females (26%). Most female participants fell within the 12–20 years age group, whereas the majority of males were aged 31–40 years. Regarding occupational classification, 28.5% of participants were students, 14.3% were laborers, and the remaining 57.2% were engaged in a variety of other professions. Conjunctivitis was identified as the most prevalent anterior segment disease, affecting 70 participants (33.2%). This was followed by vernal keratoconjunctivitis (VKC) and pterygium, each diagnosed in 40 participants (18.9%). Cataract was found in 41 participants (19.4%), while the remaining 20 participants (9.5%) were diagnosed with dry eye disease, keratitis, or uveitis. VKC was predominantly observed among individuals aged 12–20 years, with only three cases occurring in those over 20. Conjunctivitis was most commonly seen in the 21–40 years age group, whereas cataracts were primarily diagnosed in the 41–60 years age group. Pterygium was distributed largely among individuals aged 20–40 years. Analysis of laterality revealed that conjunctivitis, VKC, and dry eye disease tended to affect both eyes equally, while conditions such as pterygium, keratitis, cataract, and uveitis were more frequently unilateral. Regarding workplace exposure, a majority of participants diagnosed with cataract, conjunctivitis, and pterygium reported spending most of their work hours outdoors. In contrast, those affected by other conditions typically split their time between indoor and outdoor environments.

Dust exposure emerged as a notable environmental risk factor, with 116 participants (54.9%) reporting daily exposure for more than six hours. Smoke exposure was relatively lower; 118 participants (55.9%) indicated rare exposure, while 34 (16.1%) were occasionally exposed, 41 (19.4%) frequently exposed, and 18 (8.5%) were constantly exposed to smoke. Despite this, a significant number of participants across exposure categories presented with various anterior segment pathologies. Eye protection practices were found to be suboptimal. A total of 195 participants (92.4%) reported not using any form of protective eyewear in sunny or dusty environments, while only 16 participants (7.6%) reported regular or situational use of protective glasses. In terms of transportation, 107 participants (50.7%) used motorbikes, followed by 49 (23.2%) who walked, 30 (14.2%) who used buses, and 25 (11.8%) who commuted by car. Conjunctivitis and pterygium were most prevalent among motorbike users, while car users showed relatively lower incidences of pterygium. Symptomatically, 160 participants (75.8%) reported eye itching in the previous two months, followed by 141 (66.8%) with redness, 125 (59.2%) with excessive watering, 90 (42.7%) with blurred vision, and 43 (20.4%) with other ocular complaints. To further explore potential associations between environmental exposures and disease prevalence, a stratified analysis of outcome variables was conducted. Conjunctivitis showed a higher frequency among individuals exposed to dust for more than six hours daily (40 vs. 30 cases), as did pterygium (30 vs. 10 cases), suggesting a strong correlation between prolonged dust exposure and ocular surface disease. Cataracts were more prevalent in those with lower dust exposure (27 vs. 14), indicating an alternative set of risk factors. In terms of workplace environment, conjunctivitis and pterygium were more common among participants working predominantly outdoors, while VKC showed a more balanced distribution between mixed (indoor and outdoor) environments. Transportation mode also revealed interesting trends; motorbike users had the highest number of conjunctivitis cases (47), followed by pterygium and VKC, supporting the role of wind and particulate exposure in disease development. Smoke exposure, while reported as rare by most, still showed a gradient effect—participants with frequent or constant exposure had a greater incidence of cataract and pterygium compared to those rarely exposed.

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Table 1: Demographics Table

Variable	Count	Percentage
Total Participants	211	100
Male	156	74
Female	55	26
Students	60	28.5
Laborers	30	14.3
Other Occupations	121	57.2

Table 2: Disease Distribution by Dust Exposure

Disease	> 6 hrs. Exposure	≤ 6 hrs. Exposure
Conjunctivitis	40	30
VKC	22	18
Pterygium	30	10
Cataract	14	27
Others	10	10

Table 3: Disease Distribution by Work Area

Disease	Outdoor	Indoor + Outdoor	Indoor
Conjunctivitis	35	25	10
VKC	10	20	10
Pterygium	25	10	5
Cataract	22	10	9
Others	5	8	7

Table 4: Disease Distribution by Transport Mode

Disease	Motorbike	Walk	Car	Bus
Conjunctivitis	47	9	5	9
VKC	22	13	3	2
Pterygium	19	9	0	12
Cataract	11	14	13	3
Others	8	8	4	4

Table 5: Disease Distribution by Smoke Exposure

Exposure Level	Conjunctivitis	Cataract	VKC	Pterygium	Others
Rarely	38	20	24	20	16
Occasionally	15	7	4	5	3
Frequently	10	6	6	9	10
Always	7	8	6	6	5

Table 6: Environmental Exposure and Disease Prevalence

Disease	Dust Exposure > 6 hrs.	Dust Exposure ≤ 6 hrs.	Outdoor Workers	Mixed Environment Workers
Conjunctivitis	40	30	35	25
Pterygium	30	10	25	10
Cataract	14	27	22	10
VKC	22	18	10	20

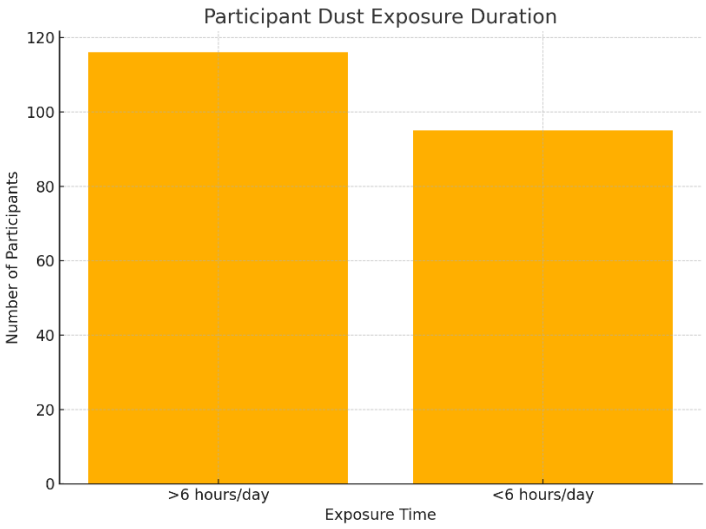

Figure 1 Participant Dust Exposure Duration

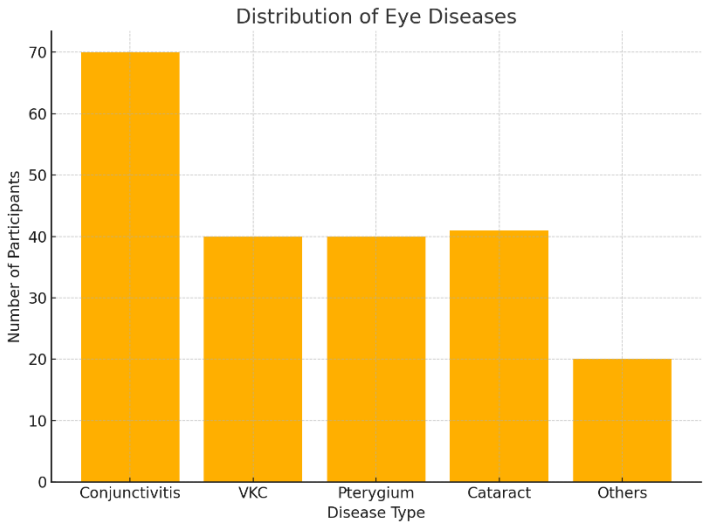

Figure 2 Distribution of Eye Diseases

DISCUSSION

This study aimed to assess the frequency of anterior segment diseases associated with environmental exposures, and the findings provide valuable insight into the epidemiological patterns of common ocular surface conditions in a specific regional context. Over a one-month period, seven anterior segment diseases were identified among 211 participants, with conjunctivitis emerging as the most prevalent diagnosis, followed by vernal keratoconjunctivitis (VKC), pterygium, and cataract. The predominance of conjunctivitis is consistent with global trends, where it remains a leading cause of outpatient ophthalmic visits due to its contagious nature and association with poor environmental hygiene. The current analysis showed that VKC affected 40 participants, with a slight male predominance (55% male vs. 45% female). These findings are comparable to those reported in earlier literature, which has consistently shown a higher prevalence of VKC among males. The most affected age group in this study was 12–16 years, accounting for 85% of VKC cases, while only 2.5% of cases were reported in individuals above 20 years (14). The absence of younger children in the sample likely explains the age-related shift in VKC distribution compared to other studies that typically report a peak incidence in younger age brackets. Nevertheless, the trend aligns with established knowledge that VKC incidence diminishes with increasing age, reflecting the self-limiting nature of the disease as children grow older (15).

Pterygium was diagnosed in 40 participants, with a marked gender disparity—75% were male and 25% female. The majority of cases (70%) were found in the 18–40 years age group. This is in contrast with some literature which suggests a more balanced gender ratio but supports the notion that outdoor occupational exposure is a key driver. The current findings revealed that 72.5% of participants with pterygium had daily exposure to dust, and 45% reported sun exposure exceeding five hours (16). These exposure rates are significantly higher than those noted in previous studies, possibly due to widespread use of motorcycles and inadequate eye protection in the region studied. Only 5% of those affected with pterygium reported using any form of protective eyewear, underscoring a major public health gap in awareness and preventive behavior (17). The cumulative evidence strongly supports the hypothesis that environmental exposures, especially UV radiation and dust, are modifiable risk factors for pterygium in occupationally exposed populations. Cataract was the fourth most commonly diagnosed condition, affecting 41 participants. The gender distribution in the present study showed a male

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predominance (61% male vs. 39% female), differing from international literature which often reports higher prevalence among females (18,19). However, this discrepancy may reflect regional sampling variation and the exclusion of individuals above 60 years in this study, which is typically the age group most affected by cataract. The most affected age range here was 40–60 years, whereas other studies have cited a peak between 53–68 years. The observed difference likely stems from the age limitation in the current sample. Despite this, the overall frequency of cataract (19%) aligns with similar studies in the region, reaffirming its significance as a major cause of visual impairment (20).

One of the strengths of this study lies in its real-world assessment of environmental factors and their correlation with anterior segment diseases, particularly in underserved regions. The inclusion of occupational exposure, transportation mode, and use of protective eyewear offers practical insight into modifiable lifestyle factors contributing to disease burden. However, several limitations warrant consideration. The use of non-probability purposive sampling may limit the generalizability of the findings. Moreover, the absence of participants under the age of 12 and over the age of 60 restricts age-based disease pattern analysis. Another notable limitation is the lack of inferential statistical testing, which could have quantified associations between exposures and disease prevalence more robustly. Future studies should aim to adopt probability sampling methods to enhance representativeness and include broader age groups for comprehensive disease mapping. Incorporating multivariate statistical analysis, such as logistic regression, would enable a more detailed exploration of causative links between environmental exposures and anterior segment pathologies. Educational interventions promoting the use of protective eyewear and public health campaigns addressing occupational risks could also be investigated for their effectiveness in reducing disease incidence. Overall, this study contributes meaningful data to the understanding of environmental ophthalmology and provides a foundation for preventive strategies in similar high-risk settings.

CONCLUSION

This study concluded that anterior segment diseases, particularly conjunctivitis, are strongly influenced by environmental exposures such as dust, sunlight, and poor ocular hygiene. The findings highlight a clear gap in public awareness and preventive practices regarding eye health. A significant association was observed between environmental factors and the development of anterior segment conditions, emphasizing the need for targeted education and accessible preventive strategies. The research underscores the importance of environmental eye health awareness in reducing disease burden and encourages proactive measures to protect vision, especially in high-risk populations exposed to environmental hazards.

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AUTHOR CONTRIBUTION

Author	Contribution
Malak Zohaib Khan	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Sanaullah	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Muslim Ameer	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Kinza Sajjad	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Hina Said	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Muhammad Jameel	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Saima Ghufran*	Contributed to study concept and Data collection Has given Final Approval of the version to be published

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