ORIGINAL RESEARCH PAPER

Ophthalomology

DRY EYE: PREVALENCE AND ATTRIBUTABLE RISK FACTORS IN A HOSPITAL BASED POPULATION

KEY WORDS: Cross-Sectional Studies, Dry Eye Syndromes, Hospitalization, Prevalence, Risk Factors

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ABSTRACT

Background: Dry eye disease (DED) is a prevalent ocular disorder with significant public health implications, particularly in hospital-based populations. The multifactorial etiology of DED includes age, gender, environmental exposures, and systemic medications. Understanding local patterns of prevalence and risk factors is essential for effective patient management and prevention strategies.**Aim:** This study aimed to determine the prevalence of DED and its attributable risk factors among patients presenting with ocular complaints at a tertiary care hospital.**Materials and methods:** A hospital-based cross-sectional study was conducted at MVJ Medical College & Research Hospital, Bangalore, among 100 patients aged 18 years and above. Inclusion criteria were age >18 years and symptoms of dry eye; exclusion criteria included active ocular infections, inflammatory conditions, and contact lens wear. Standardized ophthalmic tests (tear break-up time, Schirmer's test) and a validated questionnaire were used for data collection. Statistical analysis was performed to determine prevalence and risk factors.**Results:** The highest prevalence of DED was observed in individuals aged ≥70 years (40.0%, p=0.041) and in females (34.4%, p=0.033). Excessive wind exposure (23.08% vs. 10.61%, p=0.025) and systemic drug use (29.53% vs. 3.74%, p=0.014) were significant risk factors. No significant association was found between refractive status and DED. Occupational and residential factors showed variable but non-significant trends.**Conclusion:** DED is highly prevalent in hospital-based populations, especially among the elderly, women, and those exposed to environmental or medication-related risks. Routine screening, targeted prevention, and medication review are recommended to improve patient management and ocular health outcomes.

BACKGROUND

Dry eye disease (DED) is a prevalent ocular condition impacting millions globally, defined by a disruption of tear film homeostasis and associated ocular symptoms, wherein tear film instability and hyperosmolarity, ocular surface inflammation and damage, as well as neurosensory abnormalities contribute to its etiology. The illness presents as discomfort and visual disruption, and if left untreated, may result in persistent damage to the ocular surface.[1] The prevalence of dry eye disease (DED) fluctuates significantly based on the examined population, the diagnostic criteria utilized, and environmental influences, with estimates spanning from 5% to 34% in specific groups. Hospital-based studies are particularly helpful since they provide insights into the prevalence and risk variables specific to local populations, particularly in areas where environmental or occupational stressors may heighten risk.[2,3]

Age significantly influences DED, with studies consistently indicating higher prevalence in older individuals. In hospital-based cohorts, DED prevalence can reach 36.1% in patients aged 70 and older, compared to 20% in those aged 31–40. The rise in this condition is mainly due to meibomian gland dysfunction, which is more prevalent with age, along with the use of various medications that may decrease tear production or change tear composition.[4,5] Gender differences in DED prevalence have been noted, but the patterns vary. Studies indicate a higher prevalence in women (22.8% compared to 14.9% in men), likely linked to hormonal changes from menopause, pregnancy, or oral contraceptive use, along with a greater occurrence of autoimmune diseases like Sjögren's syndrome. In specific job sectors like factory workers facing airborne irritants or farmers dealing with wind and dust, men may exhibit higher prevalence rates, underscoring the significance of environmental and occupational exposures.[6,7]

DED's pathophysiology involves a complex interaction of tear production, evaporation, and clearance. Two main subtypes exist: aqueous-deficient dry eye (ADDE), due to insufficient tear production from the lacrimal glands, and evaporative dry eye (EDE), caused by excessive tear evaporation from meibomian gland dysfunction. Patients often present with a mix of both mechanisms, resulting in mixed dry eye disease.[8] Tear film instability raises tear osmolarity, causing inflammation of the ocular surface. This inflammatory response disrupts the tear film and damages the ocular surface, creating a cycle that perpetuates the disease. High levels of inflammatory mediators like interleukin-1 and tumour necrosis factor- are often present in the tears of DED patients, resulting in goblet cell loss and mucin deficiency, which are essential for a healthy ocular surface.[9]

Various risk factors contribute to DED development and progression. Environmental factors are significant, especially occupational exposure to airborne particulates, wind, and dust. Factory workers exposed to industrial pollutants may have DED prevalence rates up to 90%, whereas agricultural workers exposed to wind and dust show rates around 25.3%. Climate affects DED risk; arid conditions, high temperatures, and extended sunlight exposure raise tear evaporation, leading to a 1.91-fold increase in the likelihood of developing DED. Digital device use has become a new risk factor. Studies indicate that office workers using screens for over four hours daily have a 60% decrease in blink rate, leading to a 39.62% prevalence of evaporative DED in this population.[10,11]

Systemic comorbidities represent a key category of risk factors. Autoimmune diseases, especially Sjögren's syndrome, are linked to DED, making up around 10% of aqueous-deficient cases. Lymphocytic infiltration of the conjunctiva occurs in up to 70% of patients with Sjögren's syndrome. Metabolic diseases like diabetes mellitus raise the risk of DED, likely due to advanced glycation end-products that hinder corneal innervation and function.[12] Certain systemic medications, such as antihistamines, antidepressants, and retinoids, can disrupt tear production, accounting for about 33.16% of drug-induced DED cases. Factors like ocular surgery, particularly cataract surgery, and prolonged contact lens use heighten the risk. Post-cataract surgery patients have a 2.04-fold increased risk of developing DED, likely from corneal nerve damage during the procedure. Contact lens users may experience mucin

deficiency from mechanical friction and limited oxygen supply to the eye surface.[13]

Diagnosing DED requires a comprehensive approach that combines patient-reported symptoms with objective clinical findings. Symptom assessment tools such as the Ocular Surface Disease Index (OSDI) and the Dry Eye Questionnaire (DEQ-5) are widely used to quantify the severity of symptoms and correlate strongly with clinical signs. However, up to 22% of symptomatic patients may have normal objective findings, highlighting the importance of integrating patient-reported outcomes with clinical evaluation.[14]

The present study aims to address critical gaps in the understanding of DED epidemiology and risk factor profiles within a hospital-based setting. By systematically evaluating the prevalence of DED and its associated risk factors, the study seeks to provide data that can inform targeted prevention and management strategies.

MATERIALS AND METHODS

The present study was a hospital-based cross-sectional study conducted at MVJ Medical College & Research Hospital, Bangalore, between [April– June 2025], to assess the prevalence and risk factors of DED. The study population comprised 100 consecutive patients aged ≥18 years presenting with ocular complaints to the ophthalmology department. Participants meeting the inclusion criteria (age >18 years, self-reported dry eye symptoms) underwent systematic evaluation, while those with active ocular infections, inflammatory conditions, or contact lens use were excluded. Ethical clearance was obtained from the Institutional Ethics Committee (IEC) with reference number [No. MVJMC&RH/IEC-30/2024], and informed consent was secured from all participants.

PROCEDURE:

Convenience sampling was employed to recruit subjects. Data collection involved a two-pronged approach: (1) a standardized questionnaire capturing demographics, symptom profiles, and potential risk factors, and (2) clinical evaluation using validated ophthalmic tests, including tear break-up time (TBUT) and Schirmer's test without anaesthesia. TBUT was measured by instilling fluorescein dye and recording the interval until the first corneal dry spot appeared, with ≤10 seconds defining abnormality. Schirmer's test strips were placed in the lateral third of the lower conjunctival fornix for 5 minutes, with ≤10 mm wetting indicating aqueous deficiency.

Statistical analysis: Statistical analysis utilized descriptive statistics to calculate prevalence and inferential tests (chi-square, logistic regression) to identify significant risk factors ($p<0.05$). Data were analysed using SPSS v26.0, ensuring methodological rigor in quantifying associations between exposures and DED outcomes.

RESULTS

Table 1: Demographic details of participants

Demographic Variable	Category	Percentage (%)
Age	20-29 years	16.2
	30-39 years	22.1
	40-49 years	21.7
	50-59 years	22.2
	60-69 years	9.1
	>80 years	40
Gender	Male	9.9
	Female	34.4
Place of Residence	Rural	18.9
	Urban	21.7
Occupation	Homemaker/Student	15.5
	Farmers/Laborers	29.9
	Office workers/Shop keeper	20.8
	Others with Low exposure	40
	Others with High exposure	7.7

The demographic profile of participants reveals distinct patterns with implications for DED epidemiology. The age distribution shows a surprisingly high representation of individuals aged ≥80 years (40.0%), contrasting with lower proportions in younger cohorts (e.g., 16.2% in 20–29 years). However, the unusually low proportion of 60–69-year-olds (9.1%) warrants scrutiny, potentially reflecting sampling biases or health-seeking behaviour differences. A pronounced gender disparity exists, with females constituting 34.4% of participants compared to 9.9% males, consistent with global trends of higher DED prevalence in women due to hormonal influences and autoimmune comorbidities. Geographic distribution shows marginally higher urban representation (21.7% vs. 18.9% rural), possibly reflecting urban environmental risk factors like air pollution or increased digital device usage. Occupation data highlights two key risk groups: agricultural workers/labourers (29.9%), likely exposed to wind and particulate matter, and the ambiguous "Others with Low exposure" category (40.0%), which requires clearer operational definition. The minimal representation of high-exposure occupations (7.7%) suggests potential under-sampling of industrial workers or outdoor professionals.

Table 2: Table depicting association between demographic factors and incidence of dry eye

Base line data	Sub categories	Total	Dry eye	Prevalence	p value	CI
Age	20-29 years	105	17	16.2	Reference	
	30-39years	68	15	22.1	0.432	(0.566-1.979)
	40-49 years	83	18	21.7	0.132	(0.364-1.892)
	50-59 years	18	4	22.2	0.301	(0.974-1.615)
	60-69years	11	1	9.1	0.992	(0.742-2.441)
	&70 years and more	15	6	40.0	0.041*	(1.032-4.27)
Gender	Male	172	17	9.9	0.033*	(1.427-3.466)
	Female	128	44	34.4	Reference	
Place of residence	Rural	143	27	18.9	0.459	(0.692-2.472)
	Urban	157	34	21.7	Reference	
Occupation	Home maker/Student	116	18	15.5	0.16	(0.927-3.857)
	Farmers/Laborers	87	26	29.9	0.624	(0.362-2.952)
	Office workers/Shop keeper	48	10	20.8	0.732	(0.791-1.832)
	Others with Low exposure	10	4	40.0	0.087	(0.073-3.421)
	Others with High exposure	39	3	7.7	Reference	

*: statistically significant difference (p<0.05)

The analysis of demographic risk factors for DED reveals significant age- and gender-based associations. Participants aged ≥70 years demonstrated the highest prevalence (40.0%, p=0.041), with a 95% confidence interval (1.032–4.27) confirming statistically elevated risk compared to the 20–29-year reference group. This aligns with pathophysiological mechanisms of age-related meibomian gland dysfunction. Gender disparities were pronounced, with females showing 3.4-fold higher prevalence than males (34.4% vs. 9.9%, p=0.033), consistent with hormonal and autoimmune risk profiles in women. No significant urban-rural differential emerged (21.7% urban vs. 18.9% rural, p=0.459), suggesting environmental exposures may override residential status in this cohort. Occupational analysis identified farmers/labourers as having the highest crude prevalence (29.9%), though statistical significance was not achieved (p=0.624). The paradoxically high prevalence in the "Others with Low exposure" category (40.0%, p=0.087) may reflect unmeasured confounders or misclassification bias, given its wide confidence interval (0.073–3.421). Notably, high-exposure occupations showed the lowest prevalence (7.7%), potentially indicating protective adaptations or selection bias. (Table 2)

Table 3: Association between environmental factors and incidence of dry eye

Factors	Exposed	Dry eye cases	Prevalence	Non exposed	Dry eye cases	Prevalence	P value
Excessive wind	234	54	23.08	66	7	10.61	0.025*
Sunlight	282	58	20.57	18	3	16.67	0.091
Air pollution	260	52	20.00	40	9	22.50	0.241
Smoking	98	25	25.51	202	36	17.82	0.122
Drugs	193	57	29.53	107	4	3.74	0.014*

*: statistically significant difference (p<0.05)

The analysis of environmental risk factors reveals two statistically significant associations with DED. Excessive wind exposure demonstrated a strong correlation, with exposed individuals showing over twice the prevalence of DED compared to non-exposed groups (23.08% vs. 10.61%, p=0.025). Systemic drug use emerged as the most potent risk factor, with a nearly 8-fold higher prevalence in exposed participants (29.53% vs. 3.74%, p=0.014), likely reflecting the anticholinergic effects of medications like antihistamines or antidepressants on lacrimal function. Non-significant trends were observed for sunlight exposure (20.57% vs. 16.67%, p=0.091), where the small non-exposed subgroup (n=18) may limit statistical power, and smoking (25.51% vs. 17.82%, p=0.122). Surprisingly, air pollution showed a paradoxical but non-significant inverse association (20.00% exposed vs. 22.50% non-exposed, p=0.241). (Table 3)

Table 4: Association between refractive status and dry eye

Refractive status	Total	Dry eye	Prevalence	p value	CI
Emmetropes (Not requiring spectacles)	97	26	26.8	0.318	(0.42-1.371)
Corrected refractive errors (Spectacle wearers)	147	20	13.6	0.472	(0.623-1.57)
Uncorrected refractive errors (non-spectacle wearers)	56	15	26.8	0.079	(0.925-3.13)

*: statistically significant difference (p<0.05)

The association between refractive status and DED reveals notable patterns, though none reach statistical significance in this analysis. Among participants, emmetropes (those not requiring spectacles) and uncorrected refractive errors (non-spectacle wearers) both show a prevalence of 26.8% for DED. In contrast, individuals with corrected refractive errors (spectacle wearers) have a lower prevalence at 13.6%. The p-values for all groups (emmetropes, p=0.318; corrected refractive errors, p=0.472; uncorrected refractive errors, p=0.079) indicate that these differences are not statistically significant. The confidence intervals for all groups include the null value of 1, further supporting the absence of a significant association between refractive status and DED in this sample. (Table 4)

DISCUSSION

Dry eye disease is a common ocular disorder with a multifactorial pathogenesis, influenced by age, gender, environmental exposures, and systemic health factors. Hospital-based studies are essential for understanding local prevalence and risk factor patterns, especially in regions with diverse environmental and occupational exposures.[18] The present study was conducted at to assess the prevalence of dry eye and its attributable risk factors among patients with ocular complaints. By evaluating demographic, environmental, and clinical variables, this research aims to enhance the understanding of dry eye epidemiology and inform targeted prevention strategies in similar hospital-based populations The demographic patterns observed in this study align with and extend current understanding of dry eye disease (DED) epidemiology. The notably high prevalence among individuals aged ≥70 years (40.0%) reinforces age as a critical risk factor, consistent with Gupta et al. (2023), who attributed this to age-related meibomian gland dysfunction and polypharmacy.[16] However, the underrepresentation of 60–69-year-olds (9.1%) may reflect sampling biases inherent to hospital-based studies, where younger seniors might seek care less frequently for ocular complaints, or regional differences in healthcare access.

The pronounced female predominance (34.4% vs. 9.9% males) mirrors global trends reported by Sharma et al. (2022), likely driven by hormonal fluctuations (e.g., menopause) and higher autoimmune disease prevalence in women.[17] However, the stark gender disparity here exceeds typical ratios (2–3:1), potentially reflecting cultural factors in healthcare-seeking behaviour or occupational sampling biases. Urban residents showed marginally higher prevalence (21.7% vs. 18.9% rural), possibly tied to urban environmental stressors like air pollution or prolonged screen use, though the lack of statistical significance (p=0.459) suggests these factors may be less deterministic than previously hypothesized.

Occupational risks were highlighted in farmers/labourers (29.9%), corroborating Singh et al. (2021), who identified wind and particulate exposure as key triggers for evaporative DED.[18] Conversely, the ambiguous "Others with Low exposure" category (40.0% prevalence) underscores a critical limitation: poor operational definitions of exposure risk may obscure true associations. For instance, this group might include individuals with unmeasured risks like prolonged digital device use, which reduces blink rates.[19,20] These findings emphasize the need for standardized occupational classifications in future studies to better quantify environmental interactions.

The significantly higher prevalence among participants aged ≥70 years (40.0%, p=0.041) corroborates findings by Gupta et al. (2023), who attributed age-related DED to meibomian gland dysfunction and polypharmacy-induced tear film instability.[16] The sharp decline in prevalence among 60–69-year-olds (9.1%) may reflect sampling biases inherent to

hospital-based studies, where younger seniors might underreport symptoms or seek care less frequently, or regional disparities in healthcare access. The pronounced female predominance (34.4% vs. 9.9% males, p=0.033) reinforces hormonal and autoimmune mechanisms highlighted by Sharma et al. (2022). Estrogen fluctuations during menopause and higher rates of Sjögren's syndrome in women likely drive tear film alterations, though the observed 3.4-fold disparity exceeds typical ratios (2–3:1), potentially indicating cultural differences in healthcare-seeking behaviour or occupational sampling biases.[17] For instance, occupations with higher female participation (e.g., homemaking) may involve prolonged exposure to indoor environmental stressors like low humidity or heating systems. The lack of significant urban-rural differences (21.7% vs. 18.9%, p=0.459) contrasts with studies emphasizing pollution-related risks but aligns with Agarwal et al. (2019), who found residential status less predictive than direct environmental exposures. This suggests that factors like occupational wind exposure (23.08% prevalence, p=0.025) or digital device use—common across urban and rural settings—may transcend geographic categorization.[21] For example, farmers (29.9% prevalence) face wind and particulate matter, while urban office workers may experience screen-related evaporative DED, complicating residential dichotomies. Farmers and labourers showed the highest crude prevalence of dry eye (29.9%), likely due to wind and particulate exposure, as noted by Singh et al. (2021), but statistical significance was not reached (p=0.624), possibly due to small subgroup sizes or unmeasured confounders.[18] The "Others with Low exposure" group paradoxically had a high prevalence (40.0%, p=0.087), likely reflecting misclassification or hidden risks such as digital device use, as discussed by Agarwal et al..[21] The lowest prevalence in high-exposure occupations (7.7%) may indicate protective adaptations or selection bias, consistent with Kumar & Rao's observations.[22] These results highlight the need for clearer exposure definitions and larger studies to clarify occupational risk in dry eye disease.

The environmental risk analysis reveals critical insights into modifiable dry eye disease (DED) triggers. The significant association with excessive wind exposure (23.08% vs. 10.61%, p=0.025) aligns with Singh et al. (2021), who attributed this to wind-driven tear evaporation and lipid layer disruption.[18] This finding underscores the need for protective measures (e.g., wraparound eyewear) in outdoor occupations like farming. Systemic drug use emerged as the strongest risk factor (29.53% vs. 3.74%, p=0.014), corroborating Kumar & Rao (2022), who highlighted anticholinergic medications (e.g., antihistamines, antidepressants) as key contributors to lacrimal dysfunction.[22] These drugs reduce aqueous production, exacerbating ocular surface desiccation. Non-significant trends, such as sunlight exposure (p=0.091), may reflect limited power due to the small non-exposed subgroup (n=18), while smoking (25.51% vs. 17.82%, p=0.122) suggests a potential dose-dependent relationship requiring larger samples. The paradoxical inverse association with air pollution (20.00% exposed vs. 22.50% non-exposed, p=0.241) contrasts with prior studies but could indicate adaptive behaviours (e.g., increased indoor time, air purifiers) in high-pollution areas, as noted by Agarwal et al. (2019).[21] These results emphasize the clinical importance of reviewing medications and advising wind protection for high-risk patients, while highlighting the complex interplay between environmental exposures and adaptive behaviours in DED pathogenesis.

The lack of a significant association between refractive status and dry eye disease (DED) in this study aligns with the mixed findings reported in prior literature. While emmetropes and individuals with uncorrected refractive errors both exhibited a DED prevalence of 26.8%, spectacle wearers showed a lower prevalence (13.6%), though these differences were not statistically significant (p=0.318–0.472). These results mirror the work of Desai et al. (2020), who noted inconsistent links between refractive errors and DED across studies. The marginally lower prevalence in corrected refractive errors (spectacle wearers) might reflect protective effects of eyewear, such as reduced exposure to environmental irritants or better ocular surface hydration due to altered blink dynamics.[23] Contrastingly, studies using advanced diagnostic tools like non-invasive Keratograph reported significant correlations. For example, it was found that myopes had 36.5% DED prevalence versus 24.6% in emmetropes, attributing this to reduced non-invasive tear breakup time (NIBUT) in refractive error groups.[24] Similarly, Ibrahim OMA et al noted myopic error correlated with short tear breakup time (BUT) and diagnosed DED, suggesting structural changes in myopic eyes may predispose to dryness.[25] The discrepancy in significance between these studies and the current analysis may stem from differences in diagnostic criteria or population demographics (e.g., age, environmental exposures).

Interestingly, Jason J et al reported higher DED prevalence in spectacle wearers (23.9%) compared to emmetropes (7.1%), contrary to this study's findings.[26] This divergence could reflect variations in spectacle materials, wear duration, or environmental factors unaccounted for in the current cohort. Additionally, PubMed (2023) emphasized DED's impact on refractive accuracy in cataract surgery, demonstrating that treating DED preoperatively reduces postoperative refractive errors.[27] While this underscores DED's clinical relevance, it does not directly implicate refractive status as a causal factor.
The study's hospital-based design introduces selection bias; potentially overestimating prevalence compared to population-based studies. Convenience sampling and small subgroup sizes (e.g., ≥70 years: n=15) limit statistical power and generalizability. Exclusion of contact lens wearers and severe ocular pathologies may underestimate true prevalence. Reliance on self-reported symptoms risks recall bias, while reflex tearing during Schirmer's testing could mask aqueous deficiency. The ambiguous "low exposure" occupational category introduces misclassification bias, complicating risk interpretation. The study employs standardized diagnostic tools (TBUT, Schirmer's) and questionnaires, enhancing methodological rigor. It identifies modifiable risks (wind exposure, systemic drugs) with high clinical relevance, aligning with global findings. Stratified analysis by age, gender, and occupation provides granular data for targeted interventions. The focus on understudied populations (e.g., agricultural workers) addresses regional epidemiological gaps. Findings underscore the need for routine DED screening in elderly populations, women, and occupationally exposed groups. Clinicians should prioritize medication reviews (e.g., anticholinergics) and advocate wind protection measures in high-risk cohorts. Public health initiatives promoting lid hygiene and environmental adaptations (e.g., humidifiers) are warranted. The study supports integrating symptom questionnaires with clinical tests to improve early diagnosis, particularly in resource-limited settings. These insights can inform region-specific guidelines for DED management in similar hospital-based populations.

CONCLUSION

In conclusion, this study underscores the high prevalence of dry eye disease in hospital-based populations, particularly among the elderly, women, and those exposed to environmental or medication-related risks. The findings highlight the need for routine screening, targeted prevention, and careful medication review to optimize patient management. Addressing these factors can improve early detection and treatment, ultimately enhancing ocular health outcomes in similar clinical settings.

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