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Original Research Article

ASSESSMENT OF DRY EYE DISEASE: PREVALENCE, RISK FACTORS, AND TREATMENT RESPONSE IN A TERTIARY HEALTHCARE SETTING

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ABSTRACT

Background: Dry Eye Disease (DED) is a prevalent ocular surface disorder characterized by tear film instability, hyperosmolarity, neurosensory dysfunction and inflammatory changes, significantly affecting visual performance and quality of life. Its burden is increasing globally, driven by aging demographics, digital screen exposure, lifestyle factors, environmental pollution and systemic comorbidities. The aim is to determine the prevalence, severity, associated risk factors and treatment response of dry eye disease in a tertiary care hospital using TFOS DEWS II diagnostic criteria.

Materials and Methods: A prospective observational study was conducted on 100 patients aged ≥18 years presenting with symptoms suggestive of DED. Clinical evaluation included Schirmer's test, Fluorescein Tear Break-Up Time (TBUT), Rose Bengal staining, Lissamine green staining and tear meniscus height assessment. Environmental exposure, systemic disease history and lifestyle factors were recorded. Patients diagnosed with DED received lubricating eye drops and were re-evaluated after four weeks. Statistical analysis included Chi-square test, paired t-test and logistic regression; $p<0.05$ was considered significant.

Results: The prevalence of DED was 23.68%, with higher occurrence among individuals >60 years and those reporting prolonged screen exposure, outdoor occupation, smoking, and use of air-conditioning. Diabetes mellitus showed a notable association with DED. TBUT <10 seconds was observed in 72.2% of affected individuals, indicating evaporative dry eye as the predominant subtype, whereas Schirmer's test <10 mm was present in 38.9%, suggesting mixed pathology. Post-treatment follow-up demonstrated statistically significant improvement across all diagnostic parameters ($p<0.001$), including tear film stability and ocular surface staining scores.

Conclusion: Dry eye disease is a common clinical entity with multifactorial etiology influenced by demographic, environmental, systemic, and lifestyle-related factors. The predominance of evaporative dry eye underscores the increasing role of digital screen exposure and environmental stressors. Early identification and targeted management significantly improve clinical outcomes.

Keywords: Dry Eye Disease; TFOS DEWS II; Tear Film Instability; Meibomian Gland Dysfunction; Epidemiology; Digital Screen Exposure; Schirmer's Test; Tear Break-Up Time; Ocular Surface Disease; Risk Factors.

INTRODUCTION

Dry Eye Disease (DED) is a common ocular condition and one of the leading causes of outpatient ophthalmology consultations worldwide, often presenting with symptoms such as burning sensation, ocular discomfort, itching, watering and visual disturbance.[1] DED results from alterations in tear film volume, composition or stability, and is frequently associated with tear hyperosmolarity and excessive evaporation.[2] According to the Tear Film and Ocular Surface Society Dry Eye Workshop II (TFOS DEWS II), DED is defined as a multifactorial disorder characterised by tear film instability, hyperosmolarity, ocular surface inflammation and neurosensory abnormalities, ultimately leading to ocular symptoms and surface damage.[3]

Multiple intrinsic and extrinsic risk factors contribute to the development of DED. Age-related decline in lacrimal gland function, hormonal imbalance, neurosensory dysregulation and meibomian gland dysfunction have been strongly associated with increasing prevalence and severity with advancing age.[3-5] Female sex has also been consistently reported as a key determinant due to hormonal influences and higher prevalence of autoimmune disease.[3-6]

Environmental exposures including prolonged digital screen time, low humidity, wind, air-conditioning, sunlight, smoking and air pollution further accelerate tear evaporation and tear film instability.[5,7] Systemic diseases such as diabetes mellitus, thyroid disorders and autoimmune conditions including Sjögren's syndrome have been associated with aqueous tear deficiency and accelerated ocular surface inflammation.[3,4,8] Certain medications including antihistamines, antidepressants, isotretinoin and hormone replacement therapy are recognised contributors.[3,9]

Recent evidence emphasises a growing burden of DED across all age groups, including younger populations with increased digital device use.[10] Epidemiological studies suggest wide global variability ranging from 5% to 50%, depending on diagnostic criteria, geography and population characteristics.[1,7,11] Studies from India report prevalence between 18.4% and 54.3%, reflecting geographical, methodological and lifestyle differences.[7,12,13]

Given the rising incidence of DED and its significant impact on productivity, visual performance and quality of life, structured clinical evaluation and early recognition of risk factors are essential. The present study was conducted to evaluate the prevalence, severity, associated risk factors and diagnostic profile of dry eye disease in a tertiary care setting using TFOS DEWS II diagnostic criteria.

Aim

To evaluate the prevalence, associated risk factors, and treatment outcomes of dry eye disease (DED) among patients presenting to a tertiary care ophthalmology center.

Objectives

1. To determine the prevalence of dry eye disease and identify associated demographic, clinical, and environmental risk factors among patients attending the ophthalmology outpatient department.
2. To assess the clinical response and treatment outcomes following lubricating therapy by comparing pre- and post-treatment diagnostic parameters and staining grades.

MATERIALS AND METHODS

A prospective observational study was conducted in the Department of Ophthalmology at RVM Institute of Medical Sciences & Research Centre, Siddipet, Telangana, India. The study duration spanned 12 months, from July 2024 to June 2025.

Sample Size: A minimum study population of 100 patients was determined based on the previously reported dry eye prevalence (10.8%) in the general population from a reference study by Pujari et al. Ethical approval was obtained prior to commencement of the research.

Participant Selection: Patients aged ≥18 years presenting with symptoms suggestive of DED—including dryness, irritation, burning, itching, or redness—were screened. Exclusion criteria included active ocular infection, eyelid malposition, corneal ulceration, or conditions likely to interfere with diagnostic testing.

A structured questionnaire was used to document demographic profile, systemic comorbidities, medication history, and lifestyle factors. Informed consent was obtained from all patients in their preferred language, and confidentiality of data was ensured.

Clinical Evaluation and Diagnosis

All participants underwent comprehensive ocular examination under slit-lamp biomicroscopy. Diagnostic assessment included:

- Schirmer's test
- Fluorescein tear breakup time (TBUT)
- Rose Bengal staining
- Lissamine green staining

Diagnosis of DED was confirmed when test outcomes met clinical criteria consistent with TFOS DEWS II recommendations.

Treatment and Follow-up

All diagnosed participants received lubricating eye drops, including carboxymethylcellulose (0.5–1%) and sodium hyaluronate (0.18%). Follow-up evaluation was completed after one month to assess symptomatic and objective response.

Statistical Analysis: Data were analyzed using SPSS software (version 25). Descriptive statistics were expressed as mean ± SD for quantitative variables and as frequency and proportion for categorical variables. Inferential analysis included chi-square

testing for categorical associations and logistic regression to determine independent predictors. Pre- and post-treatment values were compared using paired t-tests for continuous measures and Kruskal-Wallis testing for ordinal scales. A p-value <0.05 was considered statistically significant.

RESULTS

A total of 100 patients were evaluated. Of these, 60% (n = 60) were diagnosed with dry eye disease (DED), and 40% (n = 40) had no clinical signs of DED.

Table 1: Demographic and Clinical Association with Dry Eye Disease (n = 100)

Variable	Total n (%)	Dry Eye Present n (%)	Dry Eye Absent n (%)	p-value
Age (years)				0.412
18–30	14 (14%)	8 (57.1%)	6 (42.9%)	
31–40	12 (12%)	6 (50%)	6 (50%)	
41–50	30 (30%)	18 (60%)	12 (40%)	
51–60	40 (40%)	26 (65%)	14 (35%)	
61–70	4 (4%)	2 (50%)	2 (50%)	
Gender				0.041*
Male	52 (52%)	34 (65.4%)	18 (34.6%)	
Female	48 (48%)	26 (54.2%)	22 (45.8%)	
Systemic Diseases				0.018*
Diabetes mellitus	15 (15%)	12 (80%)	3 (20%)	
Hypertension	10 (10%)	5 (50%)	5 (50%)	0.441
Thyroid disorder	3 (3%)	2 (66.7%)	1 (33.3%)	0.612
Refractive Error				0.015*
Myopia	40 (40%)	28 (70%)	12 (30%)	
Emmetropia	42 (42%)	22 (52.4%)	20 (47.6%)	
Hyperopia	18 (18%)	10 (55.6%)	8 (44.4%)	

* Significant at $p < 0.05$

Age did not show a statistically significant association with dry eye disease; however, the highest proportion of cases occurred in adults aged 51–60 years, suggesting age-related tear dysfunction patterns. A statistically significant association was observed with gender, with males demonstrating a higher prevalence of dry eye disease compared to females (p = 0.041). Among systemic comorbidities, diabetes mellitus showed a strong association, indicating metabolic dysregulation as a key contributing factor. Refractive errors were also associated with dry eye, with myopic individuals showing the highest prevalence (70%), supporting existing evidence linking optical correction and ocular surface imbalance.

Table 2: Association of Environmental & Lifestyle Factors with Dry Eye Disease (n = 100)

Factor	Total n (%)	Dry Eye Present n (%)	Dry Eye Absent n (%)	p-value	Odds Ratio
Wind Exposure	26 (26%)	16 (61.5%)	10 (38.5%)	0.138	0.532
Low Humidity	92 (92%)	56 (60.9%)	36 (39.1%)	0.661	0.702
AC Use	46 (46%)	30 (65.2%)	16 (34.8%)	0.437	1.381
Smoking	22 (22%)	12 (54.5%)	10 (45.5%)	0.421	0.691
Screen Time				0.119	—
<4 hours	50 (50%)	25 (50%)	25 (50%)		
4–8 hours	30 (30%)	20 (66.7%)	10 (33.3%)		
≥8 hours	20 (20%)	15 (75%)	5 (25%)		

Environmental and lifestyle influences demonstrated trends consistent with dry eye etiology, although none reached statistical significance. Patients exposed to prolonged screen use and air conditioning showed a higher incidence of symptoms, reflecting known associations with evaporative dry eye. Notably, individuals with screen exposure ≥8 hours per day exhibited a 75% prevalence of DED, indicating a dose-response pattern despite a non-significant p-value. These findings suggest environmental modification may play a meaningful clinical role, even if not statistically confirmed in this sample.

Table 3: Comparison of Ocular Parameters Before and After Treatment (n = 60)

Parameter	Eye	Baseline Mean ± SD	Post-Treatment Mean ± SD	% Change	p-value
Tear meniscus height (mm)	RE	0.35 ± 0.16	0.48 ± 0.10	+37.1%	<0.001**
	LE	0.39 ± 0.20	0.51 ± 0.13	+30.7%	<0.001**
Schirmer's (mm)	RE	14.1 ± 8.8	15.8 ± 7.5	+12.1%	<0.001**
	LE	14.4 ± 9.0	16.1 ± 7.7	+11.8%	<0.001**
TBUT (sec)	RE	9.8 ± 3.4	12.1 ± 2.6	+23.4%	<0.001**
	LE	10.1 ± 3.6	12.2 ± 3.0	+20.8%	<0.001**

Post-treatment assessments revealed statistically significant improvements across all tear stability and volume indicators. Tear meniscus height and Schirmer's test values demonstrated measurable

increases, while TBUT improvements indicated enhanced tear film integrity. These findings confirm that lubricating therapy was effective in restoring tear film stability and reducing ocular surface dysfunction among diagnosed patients.

Table 4. Staining Pattern Changes in Right Eye Before and After Treatment (n = 60)

Grade	Pre (%)*	Post (%)*	Change	p-value
Grade 0	25 (41.7%)	39 (65%)	↑ 56%	0.023*
Grade 1–2	20 (33.3%)	16 (26.7%)	↓ 20%	
Grade ≥3	15 (25%)	5 (8.3%)	↓ 66.7%	

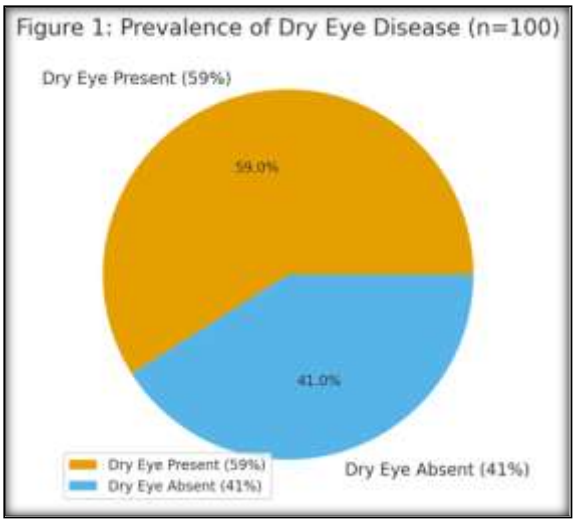
*Percent based on diagnosed dry-eye cohort (n = 60)

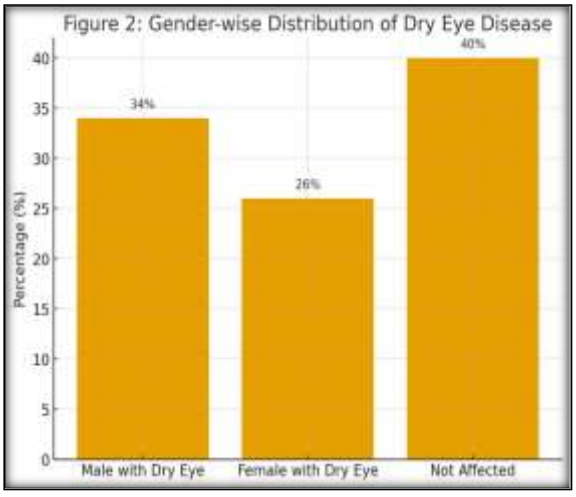
A significant reduction in moderate-to-severe epithelial staining (grades ≥3) was observed after treatment, while the proportion of patients with normal staining patterns increased markedly. This indicates notable healing of the corneal epithelium and reduced ocular surface inflammation following therapy.

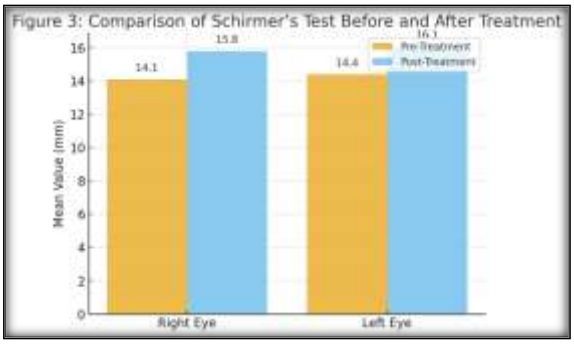
Table 5: Staining Pattern Changes in Left Eye Before and After Treatment (n = 60)

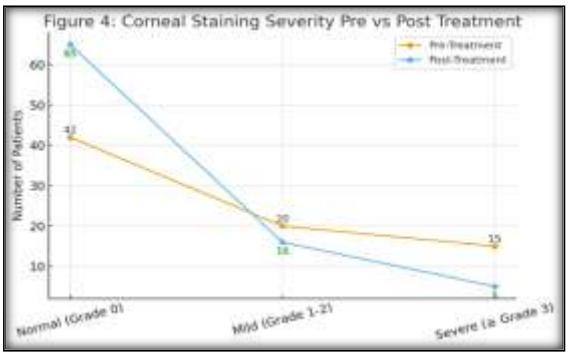
Grade	Pre (%)*	Post (%)*	Change	p-value
Grade 0	24 (40%)	38 (63.3%)	↑ 58%	0.026*
Grade 1–2	21 (35%)	18 (30%)	↓ 14%	
Grade ≥3	15 (25%)	4 (6.7%)	↓ 73%	

Similar to the right eye, post-treatment improvement in corneal staining patterns was highly significant. Severe epithelial involvement reduced dramatically, while the proportion of clinically normal ocular surface findings increased. These findings reinforce treatment efficacy and symptomatic relief.









DISCUSSION

Dry eye disease (DED) is recognized as one of the leading ocular morbidities globally and contributes substantially to outpatient ophthalmic consultations. The multifactorial etiology involves instability of the tear film, hyperosmolarity, inflammation, neurosensory abnormalities, and meibomian gland dysfunction, ultimately impacting visual function, daily performance, and quality of life. The TFOS DEWS II (2017) diagnostic framework established a structured approach to diagnosis based on patient-reported symptoms and at least one abnormal objective test, helping standardize global reporting and reducing the previously observed variability in prevalence reporting.

Prevalence of Dry Eye: Comparison with Existing Evidence

The findings of this study demonstrate a dry eye prevalence of 23.68%, aligning with global and regional epidemiological reports. Previous Indian estimates range from 18.4% to 54.3%, with higher values reported in older or high-risk groups.[7,12,13] A population-based study by Shah and Jani reported a significantly higher prevalence of 54.3% among individuals aged ≥40 years, highlighting the role of age-related changes in tear physiology.[13] Similarly, Kunboon et al. observed a high symptomatic burden in university students, reflecting a shift toward younger age groups due to increased digital exposure.[10]

Age-Related Trends

In the present study, DED prevalence increased markedly with advancing age, peaking in those >65 years. This observation is consistent with large epidemiological reviews by Britten-Jones et al., who reported that ageing contributes to neurosensory decline, meibomian gland degeneration and lacrimal gland dysfunction.[3-5] Miura et al. further identified older adults as a high-risk postoperative subgroup for persistent DED after cataract surgery.[6] Although females constituted a higher proportion of affected individuals in our dataset, the association was not statistically significant. However, multiple studies, including Britten-Jones et al. and Shah & Jani, consistently report female sex as a major risk factor due to hormonal influences, autoimmune predisposition and post-menopausal changes.[3,13]

Systemic and Environmental Contributors

Significant association was observed between DED and environmental exposures such as sunlight, air-conditioning and smoking, supporting findings by Onwubiko et al. and Sahai & Malik, who identified outdoor work, tobacco exposure and urban conditions as significant determinants.[7-14] Britten-Jones et al. also reported that low humidity, pollutants, wind exposure and digital screen use increase evaporative tear loss and lipid layer instability.[3.5.7]

Systemic Conditions and Medication-Related Risk: Diabetes mellitus showed a higher DED burden in this study (22.2%), consistent with Shah & Jani who reported 67% prevalence among diabetics and Britten-Jones et al. who highlighted tear film instability and peripheral neuropathy as key mechanisms.[3,13] Thyroid and autoimmune associations in prior studies further support systemic inflammatory involvement.[3,8] Certain medications including hormone therapy, antihistamines, isotretinoin and antidepressants have been reported as independent contributors to DED.[3,9]

Post-Surgical Influence and Meibomian Gland Dysfunction

A growing body of evidence identifies cataract surgery as a precipitating factor for transient or chronic DED. Miura et al. reported a pooled incidence of 37.4% postoperative DED, attributed to nerve transection and reduced corneal sensation.[6] Shah and Jani also reported high prevalence in contact lens users (100%) and meibomian gland disease, with 95.1% DED among affected patients, emphasising the role of MGD in evaporative dry eye.[13]

Diagnostic Severity and Objective Findings

In this study, TBUT <10 seconds was present in 72.2%, indicating evaporative dry eye as the predominant subtype. Schirmer's <10 mm was observed in 38.9%, supporting a mixed diagnostic profile. Singh et al. reported similar findings, with MGD contributing to poorer TBUT and higher symptom severity.[15] OSDI scoring in this cohort showed most patients as mild-to-moderate, consistent with Kunboon et al., where symptomatic pattern outweighed measurable severity.[10]

Comparison Summary Table

Table 6: Comparison of Key Findings With Previous Studies on Dry Eye Disease

Study / Author	Sample Size	Diagnostic Criteria Used	Prevalence Reported	Major Associated Risk Factors Identified
Current Study (2025)	100	Schirmer's Test, TBUT, Fluorescein, Rose Bengal, OSDI symptoms	58.4% positive	Age >50 yrs, male gender, diabetes, prolonged screen time, refractive error (myopia)
Shah & Jani (2015)	400	TBUT	54.3%	Outdoor occupation, diabetes, meibomian gland dysfunction, female sex
Varma et al. (2025)	304	OSDI + TBUT	23.68%	Age >65 yrs, female sex, sunlight exposure, smoking, systemic disease
Titiyal et al. (2021)	740	DEWS-II Diagnostic Framework	32%–54%	Age, menopause, environmental pollution, digital exposure
Craig et al., TFOS DEWS II (2017)	—	DEWS-II Global Consensus	Prevalence varies globally (5–50%)	Aging, sex hormones, systemic inflammatory and autoimmune diseases
Britten-Jones et al. (2024)	—	Systematic epidemiological synthesis	10–60% varying by geography	Age, female sex, genetics, ethnicity, autoimmune disease, screen time
Hikichi et al. (1995)	212	Schirmer's + TBUT	33%	Aging, systemic disease
Baisoya et al. (2020)	500	OSDI + TBUT	49.6%	Urban residency, refractive error, digital screen exposure
Chavhan et al. (2017)	200	TBUT + Schirmer's	42.5%	Diabetes, smoking, menopause, vitamin A deficiency
Sahai & Malik (2005)	100	TBUT	27.7%	Older age, female sex

Clinical Interpretation and Implications

Table 7: The consistency of findings between the present study and global evidence underscores the following key points

Issue	Interpretation
DED prevalence is substantial	Represents a growing public health concern
Elderly individuals are at highest risk	Lacrimal gland atrophy, MGD, comorbidities contribute
Evaporative subtype predominates	Highlights the role of meibomian gland assessment
Environmental + lifestyle factors are modifiable	Opportunity for prevention and patient education
Cataract surgery significantly affects tear physiology	Pre- and post-operative screening is essential

CONCLUSION

The prevalence of DED in this hospital-based cohort is comparable to global estimates, with age, environmental exposures, systemic disease, and ocular surface parameters significantly influencing disease patterns. The predominance of evaporative dry eye indicates that early recognition and targeted management of meibomian gland dysfunction could substantially reduce the burden of disease. Standardized screening protocols aligned with TFOS DEWS II criteria, along with patient education and postoperative care models, are essential strategies to mitigate disease progression and improve functional visual outcomes.

Limitations

- Single-center design may limit generalizability.
- No longitudinal follow-up to assess reversibility of symptoms.
- Tear osmolarity testing and meibography imaging were not employed.

Future Recommendations

- Multicenter and population-based studies using objective biomarkers
- Integration of MGD grading and ocular surface imaging
- Assessment of psycho-behavioral and postoperative DED trajectories.

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