REVIEW ARTICLE

Dry Eye Disease and Its Impact on Tear Film Stability, Contrast Sensitivity, and Quality of Life: A Narrative Review

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ABSTRACT

Dry eye disease (DED) is a multifactorial ocular surface disorder characterized by tear film instability, inflammation, and visual disturbances. It significantly affects visual performance, including contrast sensitivity, and has notable consequences for quality of life (QoL). This narrative review synthesizes current knowledge on tear physiology, tear film structure, DED classification, diagnostic investigations, contrast sensitivity impairment, and the associated impact on QoL. A literature search was conducted in PubMed, Google Scholar, ResearchGate, and Web of Science using the terms "Tear," "Tear film," "Dry eye disease/DED," "Quality of life/QoL," "Contrast sensitivity," "Prevalence of dry eye disease," "Schirmer Test," "Non-invasive break-up time (NIBUT)," "Invasive break-up time (BUT)." English-language articles published between 2017 and 2025 were included. DED adversely affects tear film stability and integrity of the ocular surface, resulting in optical aberrations, reduced contrast sensitivity, visual fluctuations, and discomfort. These limitations contribute to impaired daily functioning, diminished productivity, and decreased QoL. Prevalence data show wide variability globally and in India, with higher rates in older adults and females. DED remains a major cause of visual and functional disability. Tear film instability significantly reduces contrast sensitivity and subsequently affects QoL. Early diagnosis, detailed evaluation, and timely management are crucial to reduce the burden of DED on visual function and daily life.

KEY WORDS: Dry eye disease (DED), Quality of life (QoL), Contrast sensitivity (CS), Tear film, Tear break up time (BUT)

Introduction

Tears play a fundamental role in maintaining ocular surface health, ensuring clear vision, and facilitating emotional expression. They are classified into four major types: basal tears, which provide continuous lubrication and protection of the ocular surface; reflex tears, produced in response to external irritants; emotional tears, triggered by strong emotional states; and closed-eye tears, secreted during sleep to remove debris and support ocular homeostasis[1, 2].

The tear film is uniformly spread over the cornea through blinking and ocular movements and comprises four anatomical regions: (1) the marginal tear film along the moist eyelid margin posterior to the lipid strip, (2) the portion overlying the palpebral conjunctiva, (3) the portion covering the bulbar conjunctiva, and (4) the precorneal tear film directly covering the cornea. Total tear volume ranges from 5–10 µl with a secretion rate of 1–2 µl/min, of which approximately 95% is produced by the lacrimal gland, with additional contributions from conjunctival goblet cells and accessory lacrimal glands[3].

Structurally, the precorneal tear film consists of three layers:

1. **Lipid layer** – produced by the meibomian glands, it reduces evaporation and facilitates smooth eyelid movements. Dysfunction leads to evaporative dry eye.

2. **Aqueous layer** – secreted by the lacrimal glands, containing electrolytes, proteins (including IgA, lysozyme, lactoferrin, and betalysin), and water. It provides oxygen to the avascular cornea, removes debris, and enhances antimicrobial defense.

Access this article online

Quick Response Code:

Website: jmsh.ac.in

Doi: 10.46347/jmsh.v12.i3.26.143

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Aqueous deficiency results in hyperosmolarity and dry eye symptoms.

3. **Mucin layer** – produced by conjunctival goblet cells, crypts of Henle, and glands of Manz, converting the hydrophobic corneal epithelium into a hydrophilic surface and ensuring adequate lubrication. Mucin abnormalities contribute to both evaporative and hypersecretory dry eye[4, 5].

According to the TFOS DEWS II Definition and Classification Report (2017), dry eye disease (DED) is a multifactorial disease of the ocular surface characterized by a loss of homeostasis of the tear film, accompanied by ocular symptoms, in which tear film instability, hyperosmolarity, ocular surface inflammation and damage, and neurosensory abnormalities play etiological roles. DED is broadly classified into aqueous-deficient dry eye (ADDE), evaporative dry eye (EDE), or a mixed form[6, 7]. DED is defined as a multifactorial disorder of the tears and ocular surface characterized by tear film instability, visual disturbance, discomfort, elevated tear osmolarity, and ocular surface inflammation. Patients commonly experience irritation, burning, itching, fluctuating vision, foreign-body sensation, redness, and excessive tearing, all of which contribute to impaired visual performance and reduced quality of life[8-10].

This review aims to consolidate current knowledge on tear physiology, dry eye disease, contrast sensitivity impairment, and their collective impact on quality of life, providing an updated and comprehensive understanding of these interrelated concepts.

Methodology

Study Design

This study was conducted as a narrative review to provide a comprehensive and up-to-date overview of dry eye disease (DED), focusing on tear film stability, contrast sensitivity, and quality of life (QoL). The review aimed to synthesize current evidence regarding the physiology of the tear film, pathophysiology and classification of DED, diagnostic investigations, epidemiology, visual function impairment, and their clinical implications.

Literature Search Strategy

A comprehensive literature search was performed using four electronic databases: PubMed, Web of Science, Google Scholar, and ResearchGate. The search included articles published between January 2017 and March 2025, corresponding to the publication of the Tear Film and Ocular Surface Society Dry Eye Workshop II (TFOS DEWS II) reports and subsequent advances in dry eye research.

The search strategy combined Medical Subject Headings (MeSH) and free-text terms using Boolean operators. The primary search terms included "Dry Eye Disease" OR "DED", "Tear Film", "Tear Film Stability", "TFOS DEWS II", "Contrast Sensitivity", "Visual Function", "Quality of Life" OR "QoL", "Schirmer Test", "Tear Break-Up Time" OR "TBUT", "Non-Invasive Tear Break-Up Time" OR "NIBUT", "Tear Osmolarity", "Ocular Surface Disease", "Dry Eye Epidemiology", "Dry Eye Diagnosis", and "Dry Eye Management".

A representative PubMed search strategy was:

("Dry Eye Disease" OR DED) AND ("Tear Film" OR "Tear Film Stability") AND ("Contrast Sensitivity" OR "Visual Function") AND ("Quality of Life" OR QoL).

Manual screening of the reference lists of selected articles was also performed to identify additional relevant studies that were not retrieved through the electronic database search.

Eligibility Criteria

Inclusion Criteria:

Studies were included if they met the following criteria:

- Published in the English language.
- Published between January 2017 and March 2025.
- Conducted in human participants.
- Addressed one or more of the following topics: tear film physiology, tear film stability, dry eye disease definition and classification, epidemiology, diagnosis, management, contrast sensitivity, visual function, or quality of life.
- Original research articles, systematic reviews, meta-analyses, narrative reviews, consensus reports, and clinical practice guidelines published in peer-reviewed journals.

Exclusion Criteria:

The following publications were excluded:

- Articles published before 2017 unless considered landmark references.
- Non-English publications.
- Conference abstracts without full-text availability.
- Editorials, commentaries, letters to the editor, and expert opinions without original data.
- Animal studies and laboratory-based studies not directly related to clinical dry eye disease.
- Duplicate publications.
- Studies unrelated to the objectives of this review.

Study Selection

The electronic database search identified 268 records. After removing duplicate records, 214 unique articles remained for title and abstract screening. Following the initial screening, 92 full-text articles were assessed for eligibility based on the predefined inclusion and exclusion criteria. After full-text evaluation, 54 studies met the eligibility criteria and were included in the final narrative review. Reference lists of the included studies were also manually searched to identify additional relevant publications.

Data Extraction

The following information was extracted from each included study:

- First author
- Year of publication
- Country
- Study design
- Sample size
- Study objectives
- Diagnostic methods
- Major findings
- Clinical significance

The extracted data were organized and summarized to facilitate comparison of study characteristics and outcomes.

Data Synthesis

As this was a narrative review, no quantitative meta-analysis or statistical pooling of results was performed. Instead, the evidence was synthesized descriptively under the following themes:

- Tear physiology and tear film structure
- Definition and classification of dry eye disease
- Pathophysiology of dry eye disease
- Clinical investigations and diagnostic methods
- Contrast sensitivity and visual function
- Quality of life
- Epidemiology and prevalence
- Clinical implications and future perspectives

Priority was given to high-quality evidence, including the TFOS DEWS II reports, systematic reviews, meta-analyses, multicenter studies, and recent peer-reviewed clinical research to ensure scientific accuracy and clinical relevance.

Quality Assessment

Since this study was designed as a narrative review, a formal methodological quality assessment or risk-of-bias evaluation of the included studies was not undertaken. However, preference was given to evidence derived from internationally recognized consensus reports, systematic reviews, meta-analyses, and well-designed observational and clinical studies.

Literature Selection Flow

To improve methodological transparency, the study selection process followed the general principles of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). The literature identification, screening, eligibility assessment, and final inclusion of studies are illustrated in [Fig. 1].

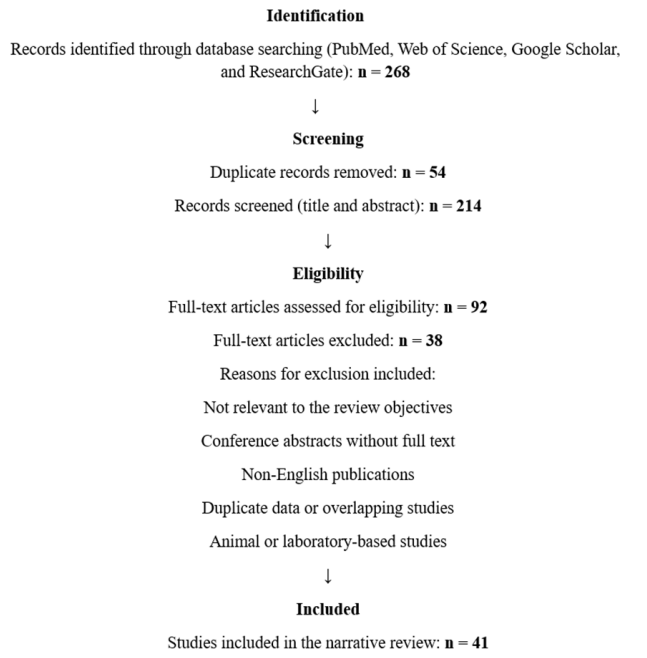


Fig. 1: PRISMA Flow Diagram of Literature Selection

Results

Tear Physiology and Tear Film Structure

The tear film is essential for maintaining ocular surface homeostasis, providing lubrication, protecting against environmental insults, and maintaining optical quality of the eye. Tears are broadly classified into basal, reflex, emotional, and closed-eye tears, each contributing to ocular surface protection and physiological regulation[1].

Basal tears provide continuous lubrication and nourishment to the corneal epithelium, whereas reflex tears are produced in response to external stimuli such as irritants or foreign bodies and contain increased concentrations of antimicrobial components. Emotional

tears are associated with psychological responses, while closed-eye tears contribute to ocular surface maintenance during sleep.

The tear film is distributed over the ocular surface through blinking and consists of marginal tear film, palpebral conjunctival tear film, bulbar conjunctival tear film, and precorneal tear film. The precorneal tear film maintains corneal transparency and consists of three interacting components.

The **lipid component**, secreted primarily by the meibomian glands, reduces tear evaporation, improves tear film stability, and facilitates smooth eyelid movement. Dysfunction of the meibomian glands contributes significantly to evaporative dry eye disease.

The **aqueous component**, produced mainly by the lacrimal glands, contains water, electrolytes, proteins, immunoglobulins, lysozyme, lactoferrin, and other protective molecules. Reduced aqueous secretion results in increased tear osmolarity, inflammation, and ocular surface damage.

The **mucin component**, secreted mainly by conjunctival goblet cells, crypts of Henle, and glands of Manz, transforms the hydrophobic corneal epithelial surface into a hydrophilic surface, allowing uniform tear distribution and lubrication. Alterations in mucin expression contribute to tear film instability and ocular surface disease[1, 3].

Definition and Classification of Dry Eye Disease

According to the TFOS DEWS II Definition and Classification Report (2017), dry eye disease (DED) is defined as a multifactorial disease of the ocular surface characterized by loss of tear film homeostasis, accompanied by ocular symptoms. Tear film instability, hyperosmolarity, ocular surface inflammation and damage, and neurosensory abnormalities are important mechanisms involved in DED development[2].

DED is broadly classified into:

1. **Aqueous-deficient dry eye (ADDE):** Characterized by reduced lacrimal gland secretion resulting in decreased tear volume and increased tear osmolarity.
2. **Evaporative dry eye (EDE):** Primarily associated with excessive tear evaporation, commonly due to meibomian gland dysfunction and lipid layer abnormalities.

Many patients demonstrate overlapping features of both subtypes. Clinical manifestations include dryness, burning, foreign body sensation, redness, photophobia, fluctuating vision, and excessive tearing. These symptoms may significantly affect visual performance and daily activities such as reading, driving, and digital device use[2, 9, 10].

Clinical Investigations of Dry Eye Disease

Diagnosis of DED requires assessment of both symptoms and objective signs because clinical findings may not always correlate with patient-reported severity.

Tear Film Stability Assessment

Tear film stability is commonly evaluated using Tear Break-Up Time (TBUT) and Non-Invasive Tear Break-Up Time (NIBUT).

Fluorescein-based TBUT measures the interval between a complete blink and the appearance of the first dry spot on the ocular surface. A value of less than 10 seconds generally indicates tear film instability.

NIBUT provides a dye-free assessment of tear stability using technologies such as corneal topography and interferometry. It minimizes the influence of fluorescein application and provides a more physiological assessment of tear dynamics[14].

Tear Secretion Assessment

The Schirmer test remains one of the commonly used methods for evaluating aqueous tear production[27].

Schirmer I measures combined basal and reflex tear secretion, whereas Schirmer II evaluates reflex tearing following nasal stimulation. Schirmer testing with anesthesia primarily assesses basal secretion. Lower Schirmer values indicate reduced aqueous tear production and are associated with aqueous-deficient DED[27, 28].

Ocular Surface Integrity Assessment

Ocular surface damage is assessed using vital dyes including fluorescein, rose bengal, and lissamine green. These tests detect epithelial disruption, punctate epithelial erosions, and areas of increased ocular surface staining, providing important information regarding disease severity[3].

Accurate diagnosis of dry eye disease requires assessment of both patient-reported symptoms and objective clinical signs, as symptoms alone may not always correlate with ocular surface changes. Various diagnostic modalities are used to evaluate tear film stability, aqueous tear production, ocular surface integrity, tear homeostasis, and functional visual impairment. [Table. 1] summarizes the commonly used

diagnostic tests for dry eye disease and their clinical significance.

Table 1: Diagnostic Evaluation Methods for Dry Eye Disease and Their Clinical Significance

Diagnostic Test	Principle/Assessment	Major Findings	Clinical Significance
Tear Break-Up Time (TBUT)	Measures time between complete blink and appearance of first dry spot after fluorescein application	Reduced TBUT indicates tear film instability	Common clinical test for assessment of tear film stability and evaporative dry eye
Non-Invasive Tear Break-Up Time (NIBUT)	Evaluates tear film disruption without fluorescein using topography/interferometry-based methods	Provides physiological assessment of tear stability	Useful for detecting early tear film abnormalities and minimizing dye-related variability
Schirmer Test	Measures aqueous tear secretion using filter paper strip placed in lower fornix	Reduced wetting indicates decreased aqueous tear production	Helps identify aqueous-deficient dry eye
Ocular Surface Staining (Fluorescein)	Detects corneal epithelial defects and punctate epithelial erosions	Increased staining indicates ocular surface damage	Useful for grading severity of epithelial involvement
Rose Bengal/Lissamine Green Staining	Evaluates devitalized epithelial cells and mucin deficiency	Highlights areas of ocular surface compromise	Helps assess conjunctival and corneal surface abnormalities
Tear Osmolarity Assessment	Measures concentration of dissolved particles in tears	Increased osmolarity indicates loss of tear homeostasis	Considered an important objective marker of DED severity
Meibomian Gland Evaluation	Assesses gland structure and function using meibography and expression tests	Detects meibomian gland dysfunction and lipid abnormalities	Important for diagnosis of evaporative dry eye
Ocular Surface Disease Index (OSDI) Questionnaire	Patient-reported assessment of symptoms and functional impact	Higher scores indicate greater symptom burden	Evaluates disease impact on quality of life and daily activities
Contrast Sensitivity Testing	Measures ability to detect differences in luminance between objects and background	Reduced contrast sensitivity reflects functional visual impairment	Detects visual disability not captured by standard visual acuity testing

Impact of Dry Eye Disease on Quality of Life

DED affects multiple domains of quality of life, including physical functioning, psychological well-being, independence, and social functioning. The impact of DED extends beyond ocular discomfort and influences daily activities, occupational performance, and emotional health[22].

Patients with DED commonly experience ocular discomfort, burning, foreign body sensation, photophobia, blurred vision, visual fluctuation, eye fatigue, and contact lens intolerance. These symptoms interfere with reading ability, computer use, driving, and other visually demanding activities[11, 22].

Persistent symptoms and visual disturbances associated with DED contribute to psychological stress, frustration, anxiety, and reduced emotional well-being. The chronic nature of the disease and incomplete symptom relief may further increase the emotional burden among affected individuals[23].

DED requires long-term management involving artificial tears, medications, follow-up visits, and lifestyle modifications. Healthcare costs and reduced work productivity contribute to a significant socioeconomic burden. Studies indicate that DED negatively affects vision-related mental health and overall quality of life[9, 20, 23, 31].

Contrast Sensitivity and Visual Function in Dry Eye Disease

Contrast sensitivity (CS) represents the ability of the visual system to distinguish differences in luminance between an object and its background. It is essential for functional vision, particularly under low illumination conditions and during activities such as night driving and navigation[25, 26].

DED reduces contrast sensitivity through several mechanisms, including tear film instability causing transient optical degradation, increased higher-order aberrations, and irregular corneal surfaces due to epithelial damage and superficial punctate keratopathy (SPK).

Patients with central corneal staining demonstrate greater reduction in contrast sensitivity due to increased light scattering and optical irregularity. These findings indicate that visual impairment in DED extends beyond

conventional visual acuity measurements and contributes to reduced functional vision and quality of life[10, 15, 30, 35].

Prevalence of Dry Eye Disease

The prevalence of dry eye disease (DED) varies widely worldwide, ranging approximately from 5% to 50%, depending on diagnostic criteria, population characteristics, environmental exposure, and study methodology[32-35].

Global estimates suggest considerable variation, with pooled prevalence reported around 11.59% in population-based analyses[36].

Studies from India demonstrate substantial regional variation:

- National and multicentric studies have reported prevalence rates ranging from approximately 18% to 54%[37-39].
- North Indian populations have demonstrated prevalence rates of approximately 32%[38].
- Studies from Uttar Pradesh reported prevalence rates ranging from 19.2% in rural populations to approximately 40.9% in urban and tertiary care settings[40, 41].

The variability in prevalence reflects differences in diagnostic methods, age distribution, environmental factors, lifestyle patterns, and population characteristics.

Summary of Reviewed Studies

A summary of the included studies is presented in [Table. 2]. The table provides an overview of the key characteristics of the selected literature, including author, year of publication, country, study design, major findings, and clinical significance. The included studies represent evidence related to dry eye disease classification, epidemiology, diagnostic evaluation, contrast sensitivity changes, tear film alterations, and quality-of-life outcomes. This summary facilitates comparison of findings across different populations and highlights the clinical relevance of dry eye disease in terms of visual function and patient-reported outcomes.

Table 2: Summary of Selected Studies Included in the Narrative Review

Author	Year	Country/Region	Study Design	Major Findings	Clinical Significance
Willcox *et al*.[1]	2017	International	TFOS DEWS II Tear Film Report	Described tear film composition, structure, and role in maintaining ocular surface homeostasis	Provided updated scientific understanding of tear physiology
Craig *et al*.[2]	2017	International	TFOS DEWS II Definition and Classification Report	Updated DED definition emphasizing loss of tear film homeostasis, instability, inflammation, and neurosensory abnormalities	Established current international classification criteria for DED
Bron *et al*.[3]	2017	International	TFOS DEWS II Pathophysiology Report	Explained mechanisms involving tear instability, inflammation, epithelial damage, and immune responses	Improved understanding of DED pathogenesis
Nelson *et al*.[4]	2017	International	TFOS DEWS II Introduction Report	Summarized advances in understanding and management of DED	Provided framework for modern DED research
Stapleton *et al*.[5]	2017	International	Epidemiological Review	Reported global variation in DED prevalence and associated risk factors	Highlighted DED as a global health concern
Sullivan *et al*.[6]	2017	International	Consensus Report	Evaluated influence of sex, gender, and hormonal factors on DED	Explained increased prevalence among females
Benítez-del-Castillo *et al*.[9]	2017	International	Expert Review	Demonstrated impact of DED on visual acuity and quality of life	Supported inclusion of patient-reported outcomes in DED evaluation
Koh *et al*.[10]	2017	Japan	Clinical Study	Found that ocular surface irregularity affects contrast sensitivity and increases straylight	Demonstrated optical consequences of tear film disruption
Karakus *et al*.[11]	2018	USA	Clinical Study	Reported reduced reading performance and visual discomfort in DED patients	Highlighted effect of DED on near visual tasks
Titiyal *et al*.[12]	2018	North India	Cross-sectional Study	Evaluated prevalence and risk factors of DED using OSDI questionnaire	Provided regional epidemiological data from India
Inomata *et al*.[13]	2018	Japan	Screening Study	Demonstrated association between maximum blink interval and tear film break-up time	Suggested blink interval as a simple screening parameter

Author	Year	Country/Region	Study Design	Major Findings	Clinical Significance
Pauk *et al*. [14]	2019	Croatia	Diagnostic Study	Evaluated non-invasive tear film break-up time measurement using lipid layer assessment	Supported objective assessment of tear film stability
Szczotka-Flynn *et al*. [15]	2019	USA	Clinical Study (DEAM Study)	Demonstrated association between DED severity and reduced contrast sensitivity	Supported assessment of functional vision in DED
Attri *et al*. [16]	2019	Meerut, India	Cross-sectional Study	Investigated prevalence, symptoms, and risk factors of DED	Added epidemiological evidence from North India
Shilpy and Patel[17]	2019	Western India	Cross-sectional Study	Reported prevalence of DED in Western Indian population	Contributed regional prevalence information
Wang *et al*. [20]	2020	Australia	Registry-based Study	Evaluated age-related changes and progression patterns of DED	Identified aging as an important risk factor
Tandon *et al*.[21]	2020	India	Population-based Study (SEED Study)	Reported association between sun exposure and DED occurrence	Highlighted environmental contributors to DED
Guo and Akpek[22]	2020	International	Review Article	Reviewed negative effects of DED on visual function and quality of life	Demonstrated broader functional burden of DED
D'Souza *et al*.[18]	2020	India	Clinical Study	Evaluated tear film optics and relationship with quality of vision	Linked tear film abnormalities with visual quality impairment
Tsubota *et al*.[19]	2020	International	Review Article	Discussed clinical definition and mechanisms of DED	Provided modern clinical perspective
Wang *et al*. [23]	2021	Australia	Cross-sectional Study	Found association between DED, psychological stress, and self-perceived health status	Demonstrated psychological impact of DED
Global Prevalence Study[24]	2021	International	Bayesian Analysis	Estimated global prevalence of DED and geographical differences	Provided updated epidemiological estimates
Erdinest *et al*.[25]	2021	International	Review Article	Discussed changes in visual function with aging	Supported importance of contrast sensitivity assessment
Zhuang[26]	2022	—	Review Article	Explained contrast sensitivity function and its role beyond visual acuity	Supported functional vision testing
Ekici *et al*. [27]	2022	Turkey	Comparative Clinical Study	Evaluated repeatability and reproducibility of Schirmer testing	Highlighted limitations of tear secretion measurement
Singh *et al*. [28]	2023	India	Mini Review	Reviewed lacrimal and meibomian gland evaluation in DED	Supported comprehensive ocular surface examination
Drozdova *et al*.[29]	2023	Russia	Clinical Study	Evaluated risk factors and clinical characteristics of DED in young patients	Highlighted increasing occurrence of DED in younger populations
Talens-Estarelles *et al*.[30]	2023	Spain	Observational Study	Reported changes in visual function, optical quality, and tear film parameters in computer users	Demonstrated impact of digital device exposure
Tan and Tong[31]	2023	—	Clinical Study	Demonstrated association between DED, functional visual acuity, and quality of life	Confirmed effect on daily visual activities
Ren *et al*. [32]	2023	China	Clinical Study	Evaluated binocular dynamic visual acuity changes in DED patients	Demonstrated visual performance impairment
Bhatt *et al*. [33]	2023	India	Cross-sectional Study	Studied prevalence and TFOS DEWS II categorization of DED	Provided updated Indian clinical evidence
Govila *et al*.[34]	2023	North Central India	Hospital-based Study	Assessed incidence and risk factors of DED	Added regional prevalence data
Khirat *et al*.[35]	2024	Egypt	Clinical Study	Demonstrated reduction in visual acuity and contrast sensitivity in DED patients	Supported contrast sensitivity as an important outcome measure
Kaštelan *et al*.[36]	2024	Croatia	Review Article	Evaluated relationship between tear film quality and visual function	Reinforced role of tear film stability in vision

Author	Year	Country/Region	Study Design	Major Findings	Clinical Significance
Misra *et al.* [37]	2024	Shahjahanpur, Uttar Pradesh, India	Prospective Study	Reported prevalence and associated risk factors of DED in rural population	Provided rural Indian epidemiological data

Discussion

Dry eye disease (DED) is a multifactorial ocular surface disorder characterized by disruption of tear film homeostasis, ocular surface inflammation, tear hyperosmolarity, and neurosensory abnormalities. The current understanding of DED has evolved from the traditional classification of aqueous-deficient and evaporative dry eye to a more comprehensive concept described by the TFOS DEWS II report, which emphasizes loss of tear film homeostasis as the central mechanism of disease development and progression[7, 24]. The present narrative review highlights the complex interaction between tear film alterations, visual function impairment, particularly contrast sensitivity reduction, and deterioration in quality of life (QoL).

The tear film plays an essential role in maintaining corneal transparency, lubrication, and optical quality. Alterations in the lipid, aqueous, or mucin components of the tear film can compromise tear distribution and stability, resulting in ocular surface damage and visual disturbances[1, 4, 5]. Tear film instability produces an irregular optical surface that increases light scatter and optical aberrations, leading to fluctuating vision and reduced visual quality[30, 37]. Therefore, patients with DED may experience significant functional visual impairment despite having relatively preserved conventional visual acuity[10, 28].

According to the TFOS DEWS II pathophysiology report, tear hyperosmolarity and inflammation contribute to a self-perpetuating cycle of epithelial damage and further tear film instability[24]. Reduced aqueous secretion, increased evaporation, and meibomian gland dysfunction may initiate this cycle, resulting in inflammatory mediator release, goblet cell dysfunction, and ocular surface compromise[15, 24]. This explains why DED symptoms and clinical signs may persist even when individual diagnostic parameters show variable results.

Tear film instability has a direct influence on optical performance. Studies have demonstrated that ocular surface irregularity in DED patients is associated with increased straylight, reduced contrast sensitivity, and impaired visual quality[34, 37]. Contrast sensitivity represents the ability to detect differences in luminance between objects and their background and is essential for practical visual tasks such as driving, reading, and navigating under low illumination[32, 33]. Reduction in contrast sensitivity has been reported in DED patients and correlates with ocular surface damage severity, particularly in individuals with corneal epithelial abnormalities[34-36].

The effect of DED extends beyond ocular discomfort and significantly influences quality of life. Patients commonly report pain, burning sensation, foreign-body sensation, photophobia, fluctuating vision, and difficulty performing daily activities[16, 18]. Chronic symptoms may contribute to psychological stress, frustration, anxiety, and reduced emotional well-being[19]. Previous studies have demonstrated associations between DED, reduced work productivity, impaired reading ability, and decreased vision-related quality of life[20, 22, 23]. These findings indicate that DED should be considered a functional disorder affecting multiple aspects of daily living rather than merely a tear deficiency condition.

The epidemiological burden of DED varies considerably worldwide due to differences in diagnostic criteria, environmental exposure, lifestyle factors, and population characteristics. Age and female sex are consistently identified as important risk factors, possibly due to age-related lacrimal gland dysfunction and hormonal influences on ocular surface homeostasis. Indian studies have reported variable prevalence across different geographical regions, including North India and Western India, suggesting the contribution of environmental conditions, occupational exposure, and lifestyle-related factors.

Diagnosis of DED requires integration of symptoms, clinical signs, and objective investigations. Tear break-up time (TBUT), non-invasive tear break-up time (NIBUT), Schirmer testing, ocular surface staining, and meibomian gland evaluation are commonly used methods for assessing tear film stability and ocular surface status[11, 13, 15]. However, because DED is a heterogeneous disease, no single diagnostic test is sufficient to represent the complete disease profile. A combination of structural, functional, and patient-reported assessments provides a more comprehensive evaluation[7, 21].

Management strategies for DED should be individualized according to underlying mechanisms and disease severity. Current approaches include tear supplementation, lipid-based lubricants, anti-inflammatory therapy, meibomian gland-directed treatments, punctal occlusion, and lifestyle modification[15, 24]. Assessment of functional outcomes

such as contrast sensitivity and QoL may provide additional information regarding treatment effectiveness beyond improvement in clinical signs alone[10, 23, 28].

Despite advances in understanding DED, several challenges remain, including variability in diagnostic criteria, limited availability of objective biomarkers, and differences in treatment response among patients. Future research should focus on molecular biomarkers, advanced ocular surface imaging, and long-term evaluation of treatment effects on visual function and quality of life[2, 15]. Large-scale studies using standardized TFOS DEWS II criteria are required to better define disease burden and improve preventive and therapeutic strategies.

Overall, DED represents a complex ocular surface disorder affecting tear film stability, visual performance, and patient well-being. Integration of tear film evaluation, contrast sensitivity assessment, and QoL measurement provide a more complete understanding of disease severity and supports a patient-centered approach to diagnosis and management.

Conclusion

Dry eye disease (DED) is a multifactorial ocular surface disorder involving loss of tear film homeostasis, ocular surface inflammation, tear instability, and visual dysfunction. The present review highlights that DED affects not only ocular comfort but also functional vision, particularly contrast sensitivity, which plays an important role in real-world visual activities despite relatively preserved conventional visual acuity.

Tear film instability, increased tear evaporation, ocular surface irregularity, and inflammatory changes contribute to optical degradation and reduced visual performance. These alterations significantly influence daily activities such as reading, computer use, driving, and occupational tasks, ultimately reducing quality of life. The burden of DED is further increased by psychological stress, reduced productivity, and limitations in daily functioning.

Accurate diagnosis requires a comprehensive approach integrating symptom evaluation, tear film stability assessment, ocular surface examination, and functional visual tests. Early identification and appropriate management targeting tear film stabilization, inflammation control, and modification of risk factors are essential to improve clinical outcomes.

Future research focusing on objective biomarkers, advanced diagnostic technologies, and long-term evaluation of treatment outcomes will further improve understanding and management of DED. Considering its impact on visual function and overall well-being, DED should be recognized as a significant ocular and public health concern requiring a holistic, patient-centered approach.

Disclosure

Authors' Contributions: Ms. Rashmi conceptualized the study, Dr. R.K. conducted the literature review, drafted the manuscript, and approved the final version Mr. Singh supported during all works.

Funding and Financial Support: No funding was received for this work.

Conflict of Interest: The author declares no conflict of interest.

Informed Consent: Not applicable.

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How to cite this article: Rashmi, Kumari R, Singh J. Dry Eye Disease and Its Impact on Tear Film Stability, Contrast Sensitivity, and Quality of Life: A Narrative Review. Journal of Medical Sciences and Health 2026; 12(3):332-342

Date of submission: 09.04.2026
Date of review: 22.05.2026
Date of acceptance: 17.07.2026
Date of publication: 19.08.2026