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Prevalence and Risk Factors of Dry Eye Syndrome Among University Students and Its Impact on Visual Performance and Quality of Life

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Abstract

Dry eye syndrome (DES/DED) has emerged as a significant public health concern among university students, with symptomatic prevalence ranging from 60% to 89% across various global cohorts. This review synthesizes the multifactorial pathophysiology centered on tear film instability, meibomian gland dysfunction (MGD), hyperosmolarity, and ocular surface inflammation, driven primarily by prolonged digital screen exposure, reduced blink rate, environmental factors (low humidity, air conditioning), contact lens wear, eye cosmetics, and behavioral habits such as tobacco use and poor ergonomics. Higher prevalence is consistently observed in female students and those in advanced academic years. The condition substantially impairs visual performance (reduced reading speed, fluctuating vision, higher-order aberrations), academic productivity, sleep quality, and psychological well-being, with strong associations to anxiety, depression, and presenteeism. Effective management strategies include the 20-20-20 rule, ergonomic improvements, artificial tears, thermal pulsation therapies, and institutional screening programs. Early recognition and preventive interventions are critical to mitigate the long-term impact on visual function and quality of life in this high-risk young adult population.

Introduction

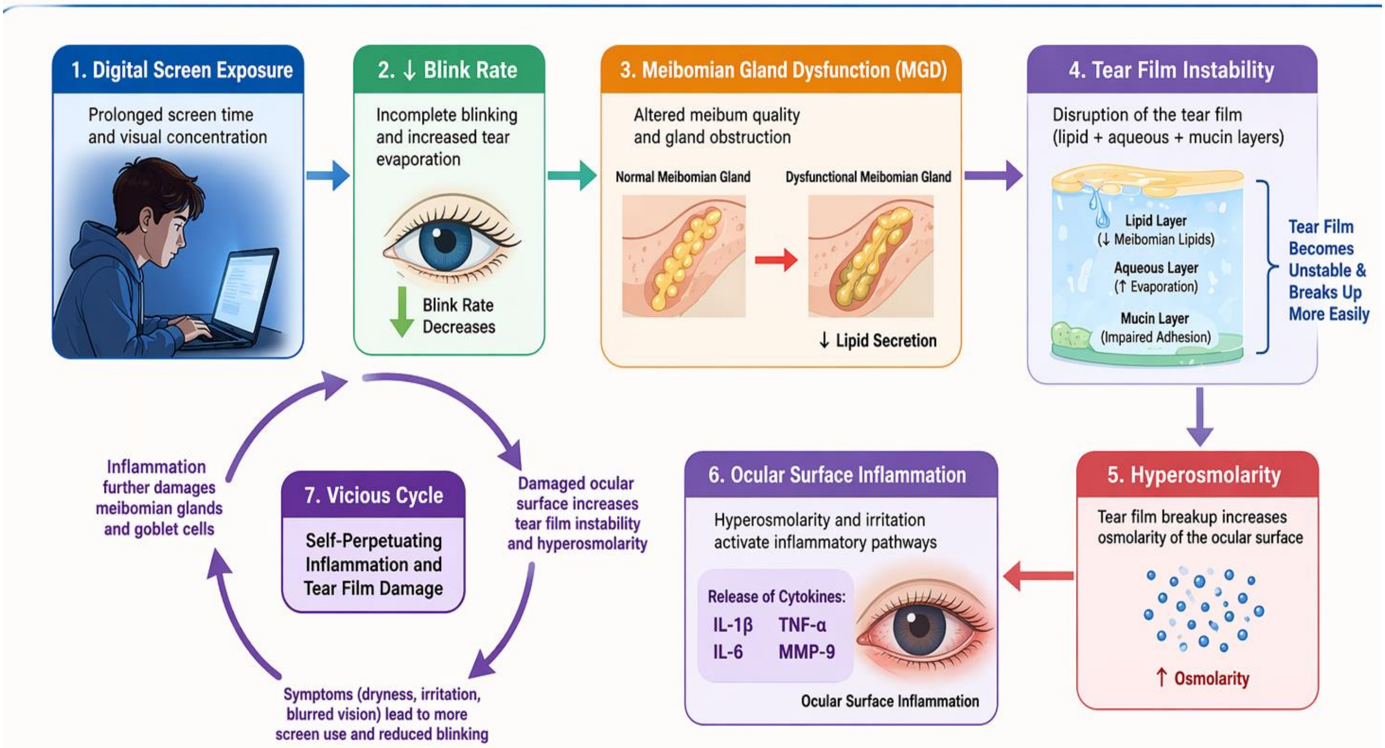
The clinical landscape of ocular surface disorders has undergone a profound transformation over the last decade, transitioning from a condition primarily affecting the geriatric population to a burgeoning epidemic among young adults, particularly those in higher education settings (Zemaitiene et al., 2025). Dry eye syndrome (DES), increasingly referred to as dry eye disease (DED), is defined by the Tear Film and Ocular Surface Society (TFOS) DEWS II report as a multifactorial disease of the ocular surface characterized by a loss of homeostasis of the tear film (Shimazaki, 2018). This condition is accompanied by various ocular symptoms where tear film instability, hyperosmolarity, ocular surface inflammation, and neurosensory abnormalities play central etiological roles (Harrell et al., 2023). For the university student demographic, this disease is no longer a peripheral concern but a central functional impairment that intersects with academic productivity, psychological well-being, and long-term visual health (Smolderen et al., 2023).

Evolutionary Pathophysiology of the Ocular Surface

The fundamental mechanism of dry eye syndrome involves a breakdown in the delicate balance of the precorneal tear film. This film is a complex trilaminar structure consisting of a lipid layer and a muco-aqueous layer (Xu, 2023). The lipid layer, produced by the meibomian glands, serves as a hydrophobic barrier that minimizes evaporation and maintains the structural integrity of the tear film between blinks (Kayal, 2022). Below this lies the muco-aqueous layer, which provides hydration, nutrition, and immunological protection to the corneal and conjunctival epithelia (Croker, 2024). The development of dry eye syndrome in university students can be best understood through an interconnected pathological cascade involving tear film instability and inflammatory amplification.

As illustrated in Figure 1, these processes form a self-perpetuating vicious cycle that progressively worsens ocular surface damage with continued digital exposure. In university students, the primary entry point into ocular surface disease is often

Figure 1. Pathophysiology of Dry Eye Syndrome in University Students



evaporative stress, frequently resulting from environmental challenges and altered behavioral patterns during intense cognitive tasks (Patel et al., 2023). The "vicious circle" of dry eye disease describes a self-perpetuating cycle where initial tear film instability leads to hyperosmolarity of the tear film (Leonardi et al., 2025). This hyperosmolar state triggers a cascade of inflammatory signals, leading to the release of cytokines and chemokines that further damage the goblet cells and epithelial cells of the ocular surface. As goblet cells are lost, the production of mucins which are essential for spreading the aqueous layer over the hydrophobic corneal surface decreases, leading to localized areas of drying and further inflammation (Yang & Yu, 2021).

The Role of Meibomian Gland Dysfunction

Meibomian gland dysfunction (MGD) is identified as the most frequent cause of evaporative dry eye globally (Sheppard & Nichols, 2023). In the student population, MGD is increasingly linked to chronic screen use, which significantly reduces the blink rate and the quality of the blink (Chidi-Egboka et al., 2023). Normal physiological blinking (approximately 22 times per minute) is necessary to mechanically express meibum from the glands and spread it across the eye (Dietrich et al., 2021). When students engage in sustained near-work, the blink rate can plummet to 7 blinks per minute, leading to meibum stagnation, gland duct blockage, and eventually gland dropout (Bannister, 2019). This process establishes a secondary vicious circle where gland blockage reinforces ocular surface inflammation, leading to a state of chronic desiccating stress (van Setten, 2024).

Global Prevalence and Epidemiological Trends

Recent epidemiological data suggest that the prevalence of dry eye syndrome among university students is significantly higher than previously estimated for younger age groups. While general population estimates often range between 5% and 50% depending on the diagnostic criteria, student cohorts frequently report symptomatic prevalence rates exceeding 60% (Supiyaphun et al., 2021).

Comparative Regional Analysis

The prevalence of DES is shaped by a combination of geographic, environmental, and methodological factors. Studies conducted during and after the COVID-19 pandemic have highlighted an upward trend in prevalence, likely due to the shift toward online learning and increased indoor screen exposure (Pranzo et al., 2023).

Table 1. Regional Prevalence of Dry Eye Symptoms and Diagnostic Assessment Tools

Region/Country	Study Population	Prevalence Rate	Assessment Tool	Source
Iraq	University Students	62.0%	WHS Criteria	Aljaberi et al. (2025)
Saudi Arabia (Jazan)	General Population	59.9%	Symptom Survey	Basalaim et al. (2025)
Saudi Arabia (Western)	University Students	74.6%	OSDI	Zarban et al. (2024)
Jordan	Medical Students	74.08%	OSDI	Abu-Ismail et al. (2023)
Palestine	University Students	69.4%	OSDI	Aljarousha et al. (2024)
Pakistan (Islamabad)	Digital Screen Users	89.2%	SPEED Score	Sindhushree et al. (2025)
Global Estimate	All ages	11.59%	Meta-analysis	Papas (2021)

These variations often reflect the diagnostic criteria used. For instance, studies using the Ocular Surface Disease Index (OSDI) tend to report higher prevalence rates compared to those relying on clinical signs like tear break-up time (TBUT) (Starr et al., 2019). In regions like Saudi Arabia and Iraq, the arid environment and high temperatures serve as external desiccating stressors that compound the internal stressors of the academic lifestyle (Adamo et al., 2022).

Gender-Specific Prevalence Patterns

A consistent finding across virtually all epidemiological studies is the higher prevalence of symptomatic dry eye in female students (Wróbel-Dudzińska et al., 2023). In a large Iraqi cohort, female participants had an adjusted odds ratio (aOR) of 2.34 for symptomatic DES. Similarly, in Jordan, females showed significantly higher odds (OR = 2.1) (Alsajri et al., 2025). This disparity is attributed to several factors, including the synthesis and interaction of sex steroids on the lacrimal apparatus and meibomian glands (Kaštelan et al., 2025). Furthermore, cultural behaviors, such as the more frequent use of eye cosmetics among female students, provide an additional pathway for ocular surface irritation (Ahmad Najmee et al., 2022).

Multi-Dimensional Risk Factors in the Student Population

The emergence of DES in university students is driven by a complex interplay of demographic, behavioral, and environmental variables (Rizwan et al., 2024).

Digital Device Integration and Screen Time

The ubiquitous use of smartphones, tablets, and laptops has fundamentally altered the ocular surface homeostasis of young adults. A dose-response relationship has been observed between daily screen time and OSDI severity (Gajewski et al., 2025). Students reporting more than 7 hours of daily screen exposure face the highest risk burden. Prolonged screen exposure reduces the blink rate and increases the frequency of incomplete blinks (Pardhan et al., 2022).

Table 2. Association Between Digital Device Use Parameters and Symptom Burden

Device Use Parameter	Impact/Association	Statistical Measure	Source
Screen Time > 7 hours/day	Highest Symptom Burden	aOR 2.25	Aljaberi et al. (2025)
Digital device use at bedtime	90.8% of students	High incidence factor	Zarban et al. (2024)
Smartphone use before bed	Severe DED symptoms	73.01% of users	Abu-Ismail et al. (2023)
TikTok/Social Media use	Most frequent app (35.6%)	Behavioral risk	Zarban et al. (2024)

The Influence of Academic Standing and Level

Academic progress appears to be an independent predictor of dry eye symptoms. Students in their fourth academic year showed significantly higher odds of symptoms (aOR 1.75), possibly reflecting the cumulative effect of years of digital eye strain (Preoteasa & Preoteasa, 2024). Studies among medical students often find that those in their basic science years are at a higher risk than those in clinical years (OR = 0.564 for clinical years), suggesting that the intensive, stationary reading of the early years is more taxing than clinical rotations (Tang et al., 2019).

Vision Correction and Contact Lens Wear

The use of glasses or contact lenses is a well-established risk factor for dry eye. Among Iraqi university students, the use of corrective lenses was a significant predictor of symptomatic DES (aOR 1.45) (Berthold-Lindstedt, 2021). Contact lenses can disrupt the tear film by splitting it into pre-lens and post-lens layers, increasing evaporation. In Saudi Arabia, wearing soft contact lenses was significantly associated with DED compared to non-wearers (17.8% vs. 5.4%) (Yokoi et al., 2023).

Environmental and Behavioral Determinants

Beyond the digital screen, the physical and cultural environments provide numerous catalysts for tear film instability (Georgiev et al., 2019).

Atmospheric Conditions and Ergonomics

Students spend significant time in air-conditioned environments, such as libraries and lecture halls, which reduces humidity and increases airflow, accelerating tear evaporation (Nair et al., 2025). Poor ergonomic setups such as screens positioned too high increase the ocular surface area exposed to air (Rahman et al., 2024).

Tobacco Use and Cultural Habits

Behavioral factors such as smoking have been identified as potent irritants to the ocular surface. In Jordanian student populations, specific types of tobacco were found to have a severe impact on the ocular surface (Bakkar et al., 2025).

Table 3. Impact of Specific Tobacco Types on Dry Eye Symptom Severity (OSDI)

Tobacco Type	DE Symptom Incidence	Mean OSDI Score	Severity Classification	Source
Dokha (Medwakh)	100%	48.13	High Severity	Bakkar et al. (2025)
Ajami Waterpipe	90%	38.08	High Severity	Bakkar et al. (2025)
Daily Smokers	97.3%	36.67	High Severity	Bakkar et al. (2025)
Indoor Smoking	86.7%	36.94	High Severity	Bakkar et al. (2025)

Eye Cosmetics and Hygiene Practices

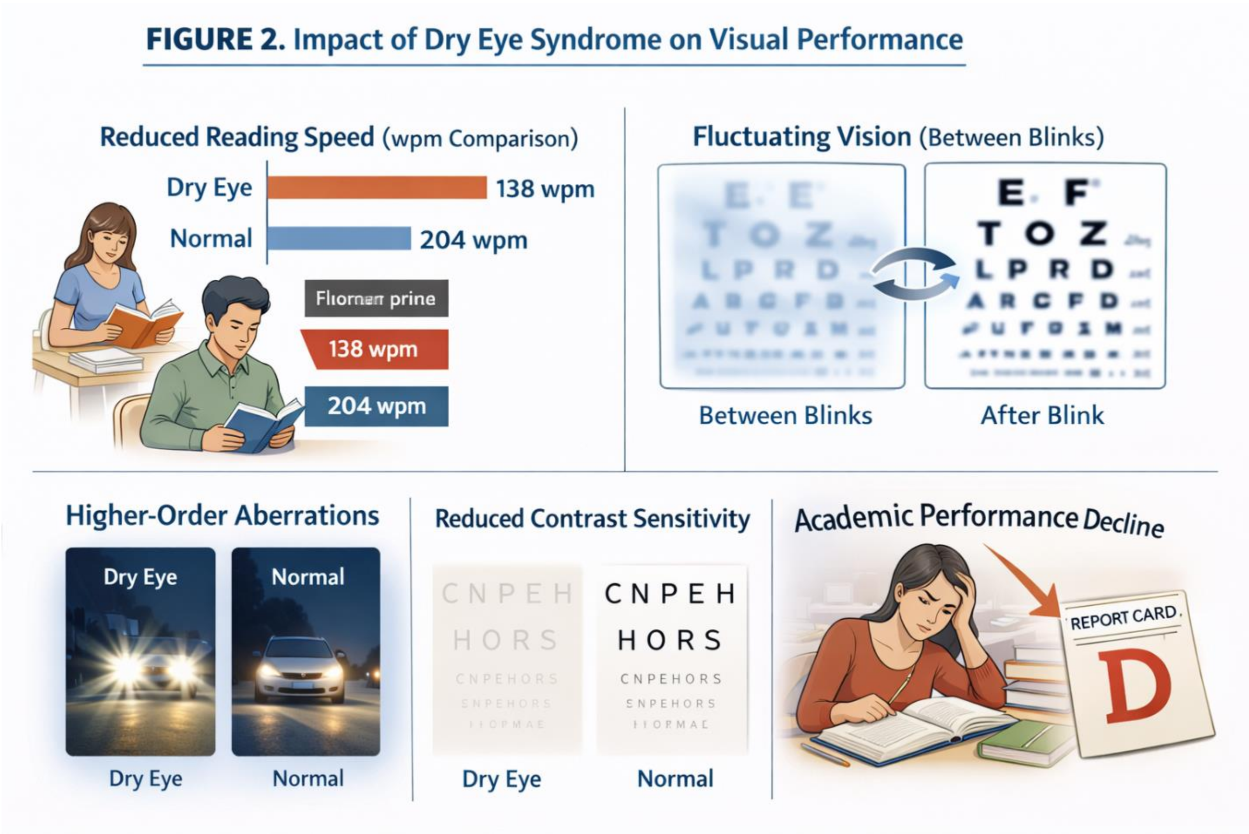
The application of eye cosmetics can significantly exacerbate dry eye symptoms. Products like mascara and internal eyeliner are often applied near the meibomian gland orifices, leading to physical blockage (Cheraqpour, 2025). Daily users of internal eyeliner and false eyelashes exhibit the highest OSDI severity scores (Han et al., 2024). Furthermore, using soapy water for makeup removal is associated with a 90.2% incidence of symptoms, likely due to the alkaline nature (pH $\geq$ 8) of many soaps (Nieradko-Iwanicka et al., 2020).

Caffeine Consumption

University students are frequent consumers of caffeinated beverages. While some studies indicate caffeine may stimulate the lacrimal glands and increase the tear meniscus height (Sajid et al., 2025), high intake combined with stress can contribute to systemic dehydration. In medical students in Jordan, caffeine consumption only marginally affected DED incidence ($p = 0.095$) (Qasem et al., 2024).

Impact on Visual Performance and Academic Efficiency

Dry eye syndrome significantly affects multiple components of visual function that are essential for academic performance. Figure 5 highlights the measurable decline in visual efficiency associated with tear film instability.



Sustained Reading Speed and Functional Vision

Reading is a critical skill for academic success. Chronic dry eye significantly slows reading rates, particularly during sustained tasks (Karakus et al., 2018).

Table 4. Comparison of Reading Speeds Between Control and Dry Eye Groups

Reading Parameter	Control Group	Dry Eye Group	Statistical Difference	Source
Out-loud Reading	163 wpm	148 wpm	p = 0.006	Mathews et al. (2013)
Silent Reading	226 wpm	199 wpm	p = 0.03	Mathews et al. (2013)
Sustained Silent (30 min)	272 wpm	240 wpm	p = 0.04	Akpek (2018)
Impact of Corneal Staining	-	-10 wpm/unit	p = 0.01	Akpek (2018)

Fluctuating Vision and Higher-Order Aberrations

In a healthy eye, the tear film provides the first refractive surface for light. In DES, the irregularity of the tear film results in "fluctuating vision," where the image becomes blurry between blinks (Kaštelan et al., 2024). This condition is associated with increased higher-order visual aberrations, which degrade contrast sensitivity and precision (Shneor et al., 2021).

Psychological Correlates and Quality of Life

Anxiety, Depression, and Stress

There is a robust relationship between dry eye disease and mental health disorders. Large-scale studies show that dry eye prevalence is significantly higher in patients suffering from depression and anxiety (Lin et al., 2026).

Table 5. Prevalence of Psychological Symptoms in the DED Population

Psychological Metric	DED Population Prevalence	Correlation with OSDI	Source
Anxiety Symptoms	26.79% - 39%	Positive ($p < 0.01$)	Wu et al. (2024)
Depression Symptoms	13.7% - 26.48%	Positive ($p < 0.01$)	Wu et al. (2024)
Both Anxiety/Depression	16.82%	Positive ($p < 0.01$)	Wu et al. (2024)

The Vicious Cycle of Sleep and Ocular Health

Sleep quality is a critical mediator in the relationship between dry eye and mental health. Approximately 83.8% of students with DED report poor sleep quality (Jongkhajornpong et al., 2025). Dry eye symptoms cause discomfort that disrupts sleep, while poor sleep increases stress hormones like cortisol and reduces the parasympathetic activity needed for tear production (Li et al., 2022).

Academic Productivity and "Presenteeism"

The impact of dry eye on work and academic productivity is substantial. Patients with severe dry eye report an average productivity impairment of 28.8%. This manifests as "presenteeism," where the student is in attendance but cannot concentrate due to constant eye irritation (Greco et al., 2021).

Management and Preventative Strategies

Behavioral and Ergonomic Interventions

The 20-20-20 rule taking a 20-second break every 20 minutes to look at an object 20 feet away is widely recommended (Johnson & Rosenfield, 2023).

Table 6. Ergonomic Strategies and Desired Outcomes for Digital Screen Users

Ergonomic Strategy	Action/Recommendation	Desired Outcome	Source
20-20-20 Rule	20s break / 20min / 20ft	Reduced strain and burning	Rangari et al. (2024)
Screen Height	Slightly below eye level	Reduced ocular exposure	Pucker (2023)
Room Humidity	Use a humidifier	Reduced tear evaporation	Pucker (2023)

Clinical and Advanced Therapies

Artificial Tears: Mainstay of initial treatment (Mani & Shah, 2020).
Thermal Pulsation (TearCare/LipiFlow): Office-based procedures to soften meibum (Rocha et al., 2024).
Exosomes: Recent research explores the use of exosomes as innate immunomodulators to target inflammatory cascades (Gangadaran et al., 2023).

The Role of Institutional Campus Health Programs

Universities are uniquely positioned to address the dry eye epidemic through campus-level prevention. Programs at institutions like UAB and Ketchum Health provide specialized care, integrating dry eye screening into routine health visits to identify high-risk groups before symptoms become debilitating (Aljaberi et al., 2025).

Conclusion

Dry eye syndrome has transitioned from a condition predominantly affecting older adults to a prevalent and impactful disorder among university students, fueled by modern academic lifestyles characterized by prolonged digital device use, reduced blink rates, and environmental stressors. High prevalence rates, often exceeding 60–89% in student populations, combined with its multifactorial nature including meibomian gland dysfunction, tear film instability, and inflammatory cascades result in significant impairments in visual performance, reading efficiency, academic productivity, sleep quality, and mental health. The strong bidirectional links with anxiety, depression, and reduced quality of life underscore the need for proactive screening and intervention within higher education settings.

Simple behavioral modifications such as the 20-20-20 rule, proper ergonomics, humidification, and reduced screen time before bed, alongside clinical treatments like artificial tears and thermal pulsation, can effectively break the vicious cycle of dry eye disease. Universities should integrate routine ocular surface assessments into student health programs and promote awareness campaigns. Future research should focus on longitudinal studies and tailored interventions for this demographic. Addressing dry eye syndrome comprehensively will not only preserve visual health but also enhance overall academic performance, psychological well-being, and long-term quality of life for university students worldwide.

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