

A STUDY ON THE PREVALENCE AND DETERMINANTS OF OCULAR DRYNESS WITH EMPHASIS ON ENVIRONMENTAL, BEHAVIOURAL, AND PHYSIOLOGICAL RISK FACTORS

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ABSTRACT

Background:

Ocular dryness, or dry eye disease (DED), is a chronic and multifactorial condition impacting tear film stability and ocular surface health. The increasing use of digital devices among young adults has been identified as a significant risk factor, alongside behavioural and environmental contributions, but the magnitude of these risks and their interaction in student populations is underexplored.

Methods:

A cross-sectional study was conducted over six months among 400 college students aged 18–25 years at Rajan Eye Care. Participants underwent comprehensive ocular assessment, including Schirmer's test for tear production and Tear Break-Up Time (TBUT) for tear film stability. They also completed the Ocular Surface Disease Index (OSDI) questionnaire, which evaluated dry eye symptoms, screen usage habits, and exposure to environmental risk factors. Statistical analysis included descriptive and inferential statistics, with significance set at $p < 0.05$.

Results:

Among the participants (58% female), 88% exhibited normal tear production, and 55% had normal TBUT, while 48% reported dry eye symptoms on the OSDI. The prevalence of ocular dryness symptoms correlated strongly with prolonged daily digital screen exposure and was higher among females. The most commonly reported symptoms were light sensitivity, eye strain, and dryness. Environmental factors such as air conditioning and suboptimal lighting further increased risk. Behavioural patterns like prolonged computer use and nighttime device usage were significant contributors.

Conclusion:

Nearly half of young digital device users experience symptoms of ocular dryness, with a substantial contribution from screen exposure and modifiable behavioural and environmental factors. Targeted awareness and preventive strategies are urgently needed to reduce the burden of dry eye disease in this population.

Keywords: Ocular dryness, Ocular Surface Disease Index, Tear Break-Up Time, Ocular irritation

INTRODUCTION

Dry eye disease (DED) is a chronic, multifactorial disorder of the ocular surface and tear film, characterized by a deficiency in tear production and/or excessive tear evaporation (1). Symptoms include ocular irritation, pain, visual fluctuations, and inflammation. DED can be associated with autoimmune diseases such as Sjögren's syndrome and lupus, as well as other conditions including Stevens-Johnson syndrome. In young adults and students, the prevalence is alarmingly high due in

part to environmental factors and altered behavioral habits, especially the heavy use of digital devices leading to decreased blink rates and increased tear evaporation(2).

The impact of environmental exposures (air conditioning, wind, low humidity), contact lens usage, ocular allergies, and pollutants further destabilizes the tear film structure, increasing the risk and severity of DED(3). Extended exposure to visual display terminals (VDTs) such as computers, tablets, and smartphones has become commonplace, greatly affecting the ocular surface by increasing evaporative loss and promoting dry eye symptoms (4). The symptoms of DED frequently interfere with everyday life, affecting activities like reading, driving, and screen-based work.

Prevalence rates vary from 5% to 50% globally, depending on geographic region, age group, diagnostic criteria, and environmental conditions. Recent studies have found particularly high DED rates in university student populations: 60.4% in Thailand (3); 60% in India (5); and between 23%–44% in population-based studies across Europe and Asia (1)(6). In central India, Sabarwal et al(7). reported a prevalence of 25%, with the highest rates in the elderly and students; major risk factors included occupation, smoking, uncorrected refractive status, ocular allergies, and extensive digital device usage.

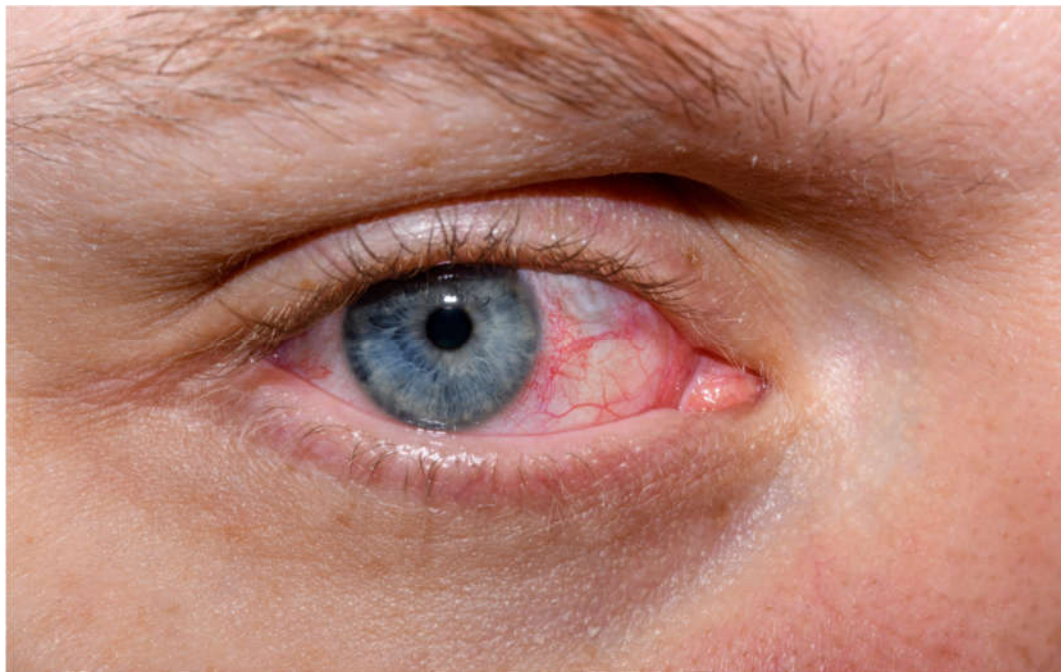


Fig – 1 Dry Eye Diseases

Diagnosis of DED is often achieved through combined subjective and objective assessments, including the Ocular Surface Disease Index (OSDI) questionnaire, Schirmer 1 test for tear production, and Tear Break-Up Time (TBUT) for tear film stability. The OSDI questionnaire evaluates both symptoms and their effect on daily functioning, while clinical tests quantify severity, enabling targeted management strategies.

Given the complex and individualized nature of DED, especially among students and screen users, both underlying risk factors and patient complaints must be holistically addressed. The significant burden of dry eye on comfort, productivity, and quality of life underscores the importance of robust diagnostic protocols and personalized care in modern ophthalmology (4).

METHODS AND METHODOLOGY

This cross-sectional study was conducted at Rajan Eye Care, Puducherry, over a six-month period

from December 2024 to May 2025. Participants aged 18 to 25 years, regular users of digital screens for academic, professional, or recreational purposes, and without prior history of dry eye diagnosis or treatment, were recruited through simple random sampling. Exclusion criteria included ocular surgery, use of contact lenses, existing eye conditions (infections, inflammation, scars), systemic disorders affecting ocular health (diabetes, rheumatoid arthritis, thyroid disease), unwillingness to consent, or use of medications known to affect tear production.

Each participant completed a detailed questionnaire capturing demographic data, digital device usage habits, behavioral patterns, illumination settings during visual tasks, and self-reported symptoms. The Ocular Surface Disease Index (OSDI) was employed to measure subjective dry eye symptoms over the preceding seven days, categorizing frequency and severity of discomforts like photophobia, soreness, grittiness, dryness, blurred vision, and difficulties in daily activities.

Objective assessment of tear function included two standardized clinical tests. First, the Schirmer 1 test was performed using Whatman filter paper strips (5 mm x 35 mm): after instillation of paracaine 1% drops in both eyes to suppress reflex tearing, the strip was positioned at the junction of lateral and mid-thirds of the lower eyelid. Participants maintained gentle eyelid closure for five minutes, after which the wetting length in millimeters was measured. Wetting <10 mm was considered abnormal and further classified into moderate (5–9 mm) or severe (<5 mm) tear deficit.

Second, the Tear Break-Up Time (TBUT) test involved instilling fluorescein dye into the inferior conjunctival fornix and using a slit-lamp biomicroscope with cobalt blue filter to observe the time interval between last blink and emergence of a dry spot on the corneal surface. TBUT <10 seconds indicated abnormal tear film stability, with further grading for mild (11–15 s), moderate (6–10 s), and severe (≤ 5 s) instability.

All tests and questionnaires were administered with full explanation and written informed consent from participants. Data from both eyes were recorded, and results were analyzed using descriptive statistics in SPSS software (version 28.0), establishing prevalence and identifying contributing factors for ocular dryness in the study population.

STATISTICAL ANALYSIS

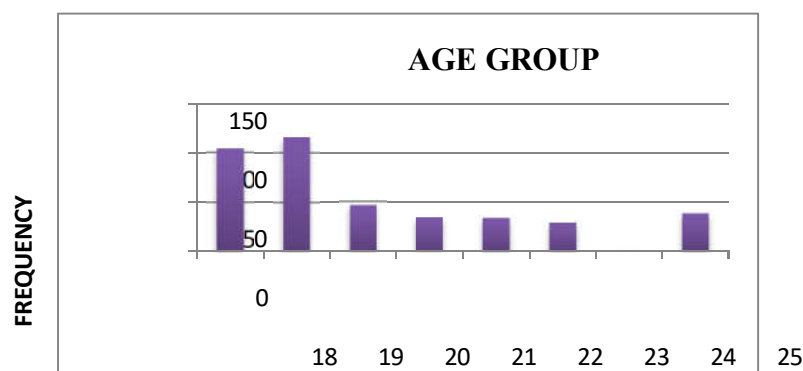
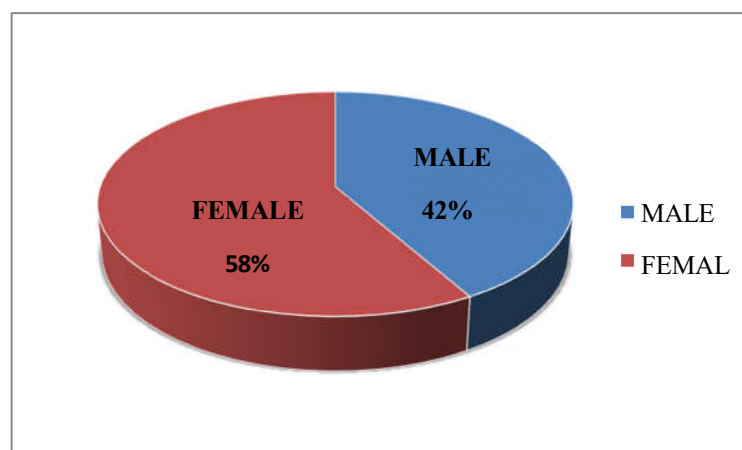
The collected data were analyzed using SPSS Statistics Software, version 28.0. Descriptive statistics—means and standard deviations—were calculated for continuous variables, while frequency and percentage analyses were used for categorical variables such as age, gender, and levels of symptom severity. Normality of data distribution was assessed before statistical test selection. For comparisons between groups (e.g., by gender, age group, Schirmer or TBUT results), appropriate parametric (such as independent t-test or ANOVA) or nonparametric tests were applied, depending on the data's distribution characteristics. Associations between variables, such as digital device usage and dry eye measures, were explored using chi-square tests for categorical data and correlation analysis for continuous variables. A p-value less than 0.05 was considered to indicate statistical significance throughout the analysis, ensuring rigor in determining meaningful differences and associations in the study cohort.

RESULT:

The study enrolled 400 participants aged 18 to 25 years, comprising 167 males (41.8%) and 233 females (58.3%). The majority fell within the 18-19 year age group, reflecting the university student demographic.

Table – 1 AGE GROUP OF THE PARTICIPANTS

AGE (VALID)	FREQUENCY	PERCENT	VALID PERCENT	CUMULATIVE PERCENT
18	104	26	26	26
19	116	29	29	55
20	46	11.5	11.5	66.5
21	34	8.5	8.5	75
22	33	8.3	8.3	83.3
23	28	7	7	90.3
24	1	0.3	0.3	90.5
25	38	9.5	9.5	100
TOTAL	400	100	100	

**Fig - 2 Age group of the participants****Fig - 3 Gender of the participants**

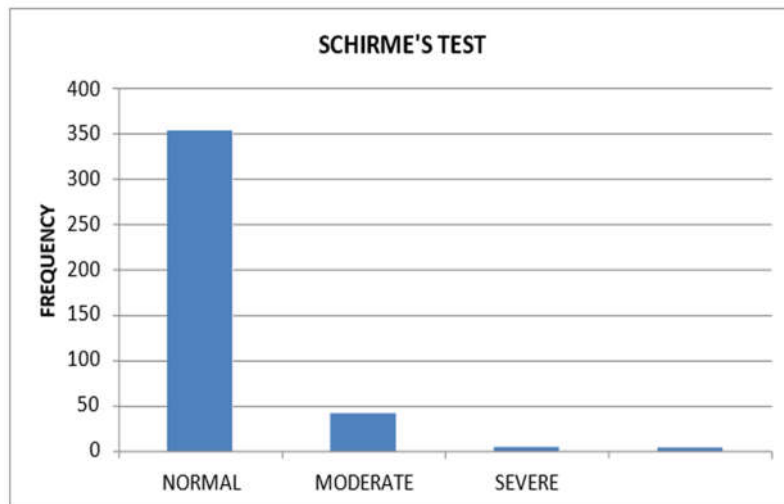


Fig – 4 Tear Production (Schirmer Test): The Schirmer test revealed that 353 participants (88.3%) had normal tear production with wetting greater than 10 mm. Forty-two subjects (10.5%) demonstrated moderate tear insufficiency (wetting 5-10 mm), while only 5 participants (1.3%) displayed severe deficiency with less than 5 mm of wetting. A significant association was found between lower Schirmer values and the presence of dry eye symptoms ($p=0.004$). The test demonstrated a sensitivity of approximately 73.9% and specificity of 96.1% for detecting dry eye.

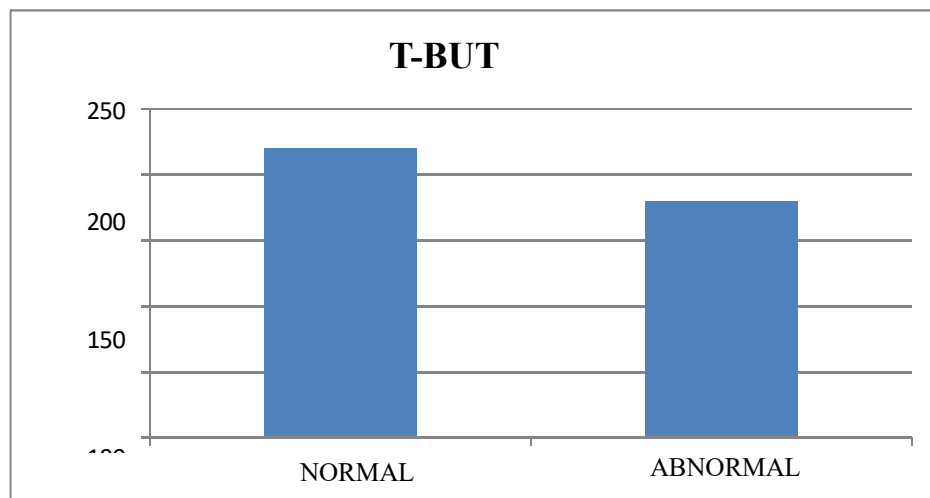


Fig – 5 Tear Film Stability (Tear Break-Up Time - TBUT): Fifty-five percent of subjects showed normal tear film stability (TBUT >10 seconds), whereas 45% had abnormal TBUT (<10 seconds). A majority of those with abnormal TBUT presented moderate or severe instability, correlating strongly with reported symptoms ($p=0.000$).

Symptom Assessment (Ocular Surface Disease Index - OSDI): Participants completed the OSDI questionnaire assessing subjective symptoms such as ocular dryness, burning, foreign body sensation, visual disturbance, and discomfort during daily activities. Analysis revealed a substantial prevalence of dry eye symptoms, with many classified within mild to severe categories of the OSDI scale. Females reported higher symptom burden, paralleling the gender distribution of dry eye in other studies.

Table – 2 THE PROFILE OF PRECIPITATING FACTORS BY OSDI-QUESTIONNAIRES

FACTORS	GENDER		FREQUENCY	PERCENTAGE	VALID PERCENTAGE	CUMULATIVE PERCENTAGE	P VALUE
	MALE	FEMALE					
Light Sensitivity	8	10	18	4.5	4.5	4.5	<0.028
Gritty Sensation	1	2	3	0.8	0.8	0.8	
Soreness	4	8	12	3	3	3	
Reading	3	8	11	2.8	2.8	2.8	
Night Drive	4	5	9	2.3	2.3	2.3	
Computer Usage	6	8	14	3.5	3.5	3.5	
Watching Television	5	6	11	2.8	2.8	2.8	
Air Conditioned	3	6	9	2.3	2.3	2.3	
Blureness	4	6	10	2.5	2.5	2.5	
Irritation	5	8	13	3.3	3.3	3.3	
Burning Sensation	3	3	6	1.5	1.5	1.5	
Dryness Sensation	6	9	15	3.8	3.8	3.8	
Eye Strain	9	9	18	4.5	4.5	4.5	
Foreign Body Sensation	4	3	7	1.8	1.8	1.8	

Precipitating Factors and Exposure: Detailed examination of environmental and behavioral factors indicated that prolonged digital screen use (>4 hours daily), exposure to air-conditioned environments, suboptimal lighting, and continuous rather than intermittent digital device use were significantly correlated with increased ocular discomfort and dry eye symptoms. Commonly reported sensations included eye strain (18%), irritation (13%), and dryness-related burning (15%). Clinical Signs: Clinical findings included conjunctival hyperemia, superficial punctate keratitis, and lid margin abnormalities, which were more frequent in symptomatic participants. Fluorescein and rose bengal staining further supported ocular surface compromise in a subset of subjects.

Overall, the findings underscore a considerable burden of dry eye amongst young adults with high digital device usage, with environmental and behavioral factors substantially contributing to the condition's prevalence and severity.

DISCUSSION

The findings of this study reveal a significant prevalence of dry eye symptoms among the young adult population, particularly university students exposed to prolonged digital screen time and adverse environmental factors. The elevated rates of abnormal Schirmer test and TBUT results align with prior research indicating that extensive use of digital devices, coupled with behaviors such as reduced blink rate, precipitates ocular surface dryness and tear film instability(1) (2)(Zou et al., 2025; Benítez-del-Castillo et al., 2025).

The pronounced presence of symptoms like eye strain, irritation, burning, and foreign body sensation corresponds to the multifactorial nature of dry eye disease (DED), where external environmental stressors synergize with physiological inadequacies of tear production and quality (3)(Kunboon et al., 2024). The higher symptom burden reported among females is consistent with global epidemiological trends suggesting hormonal influences and differential exposure patterns contribute to sex-based susceptibility (4)(Mondiguin et al., 2025).

Moreover, the association between environmental conditions such as air conditioning and suboptimal lighting with worsening of dry eye symptoms underscores the importance of holistic management strategies that address not only ocular surface pathology but also behavioral and environmental modifications. These findings are corroborated by a broad spectrum of contemporary studies emphasizing the impact of modern lifestyles on ocular health in young populations, including university students who represent a vulnerable group due to their intensive reliance on digital technology (8).

The study employed validated clinical and subjective assessment tools—Schirmer test, TBUT, and Ocular Surface Disease Index (OSDI) questionnaire—providing a comprehensive evaluation of physiological tear function alongside patient-reported symptomatology. This multi-modal assessment is crucial for accurate diagnosis and grading of DED severity, facilitating targeted interventions.

Limitations of the study include its cross-sectional design, which precludes causal inferences, and potential bias due to self-reporting in questionnaires. Future longitudinal research is warranted to elucidate the temporal dynamics of DED progression and response to interventions. Nonetheless, the robust sample size and careful analytical approach lend credence to the observed associations and emphasize the pressing need for increased awareness and proactive management of dry eye disease within young, digitally engaged demographics.

In conclusion, the study highlights that dry eye disease is a significant and growing public health concern among students, influenced heavily by digital device use and environmental factors. Comprehensive diagnostic protocols and preventative strategies incorporating behavioral and lifestyle modifications are essential to mitigate the individual and societal impact of this condition (1,2).

CONCLUSION

The study reveals a growing concern about ocular dryness among college students, primarily driven by extended digital device usage. Despite normal tear production in most participants, nearly half experienced tear film instability, indicating a heightened risk of dry eye symptoms. Screen time was found to be a more influential factor than lifestyle or environmental causes, with women commonly reporting discomfort like soreness and grittiness, while men experienced more light sensitivity and strain.

These findings highlight the urgent need to raise awareness about digital eye strain and promote preventive habits, especially in an age dominated by screens. Simple yet effective strategies—such as taking regular screen breaks, adjusting lighting, and practicing proper eye hygiene—can significantly reduce discomfort and help preserve visual health and overall well-being.

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