

Prevalence and Physiological and Environmental Predictors of Dry Eye Disease Among Outdoor and Indoor Workers: A Community-Based Comparative Study

Muhammad Firdous¹, Saima Tasneem², Rehan Moinuddin Shaikh³, Maftoon Ahmed⁴, Saima Munawar⁵

¹ Assistant Professor, Department of Ophthalmology, Al-Nafees Medical College, Islamabad, Pakistan.

² Assistant Professor, Faculty of Health Sciences, Girne American University, Kyrenia, North Cyprus, via Mersin 10, Türkiye.

³ Associate Professor, Department of Ophthalmology, Red Crescent Medical College, Pakistan.

⁴ Demonstrator, Department of Community Medicine, Quetta Institute of Medical Sciences, Quetta, Pakistan.

⁵ Demonstrator, Department of Physiology, University College of Medicine and Dentistry (UCMD), Pakistan.

ABSTRACT

Background: Dry eye disease (DED) is a prevalent ocular surface disease that is affected by environmental and occupational exposures. Outdoor workers are often more susceptible to exposure to the sun, dust, wind and heat, and indoor workers are often exposed to long periods of digital screen viewing and air conditioning.

Objective: To determine if the prevalence and severity of DED are different between outdoor and indoor workers and to identify occupational and physiological factors associated with DED.

Methods: This was a comparative cross-sectional study and included 150 adults divided equally into 75 outdoor workers and 75 indoor workers which were recruited from the Department of Ophthalmology, Al-Nafees Medical College, Islamabad and Department of Physiology, University College of Medicine and Dentistry, Pakistan in the period of February 2025 to February 2026. DED was evaluated by the Ocular Surface Disease Index (OSDI), tear-film break-up time (TBUT) and Schirmer's test. Occupational exposures were documented and independent associations were determined by multivariable logistic regression.

Results: The overall prevalence of DED was 46.7% and was significantly higher for outdoor workers compared to indoor workers (58.7% vs. 34.7%, $p=0.003$). Outdoor workers had higher OSDI scores (24.6 ± 15.2 vs. 17.1 ± 13.7 ; $p=0.002$), shorter TBUT (7.4 ± 2.6 vs. 9.2 ± 3.0 seconds; $p<0.001$), and lower Schirmer values (11.8 ± 4.9 vs. 14.1 ± 5.2 mm/5 minutes; $p=0.006$). DED was independently associated with outdoor occupation (aOR 2.31), dust/wind exposure (aOR 2.68), and screen exposure ≥ 6 hours/day (aOR 2.14).

Conclusion: DED was prevalent among workers and was much more prevalent among outdoor workers. Diseases were significantly associated with occupational and environmental exposures.

Keywords: dry eye disease; outdoor workers; indoor workers; OSDI; tear-film break-up time; Schirmer test; occupational exposure

How to cite this article: Muhammad Firdous. Prevalence and Physiological and Environmental Predictors of Dry Eye Disease Among Outdoor and Indoor Workers: A Community-Based Comparative Study. *Int J Drug Deliv Technol.* 2026;16(83s):640-646. DOI: 10.25258/ijddt.16.83s.80.

INTRODUCTION

Dry eye disease (DED) is a multifactorial disorder of the ocular surface characterized by disruption of tear-film homeostasis and accompanied by symptoms such as ocular dryness, burning, irritation, foreign-body sensation, visual fluctuation, and ocular fatigue. Its pathophysiology is related to tear-film instability, hyperosmolarity, inflammation of the ocular surface, neurosensory abnormalities, and tear production changes [1]. DED is increasingly recognized as an important public health and occupational health concern because persistent symptoms may impair visual performance, reduce work efficiency, interfere with daily activities, and adversely affect quality of life [2,3].

Physiological and environmental conditions affect the occurrence and severity of DED. Individuals may be more susceptible because of advancing age, sex, systemic diseases, medication use, smoking, decreased

tear secretion, and decreased tear-film stability [4]. Ocular surface dysfunction can also be made worse by environmental conditions which can increase tear evaporation or increase ocular irritation. Low humidity, high temperatures, wind, airborne particulate matter, dust, sunlight, and pollutants have all been linked to the increased instability of the precorneal tear film. As a result, occupational environment could be a significant, potentially modifiable risk factor for DED [5].

Exposure to climatic and environmental factors, including direct sunlight, high temperatures, wind, humidity and dust, is recurring for outdoor workers. Chronic exposure to these conditions could contribute to increased tear evaporation, decreased tear-film break-up time and increased ocular surface irritation [6]. However, indoor workers can have varying risk factors in their work environment, such as excessive

exposure to digital screens, artificial light, air conditioning and lower relative humidity. Continuous visual fixation while viewing a screen can reduce the number of blinks and increase incomplete blinks, leading to poor tear-film redistribution and causing evaporative dry eye. So, DED could be caused by both indoor and outdoor work jobs by different physiological and environmental mechanisms [7,8].

The evidence comparing workers who are subjected to significantly different environments is still scant, especially in Pakistan [8] despite the growing relevance of DED to the occupations. Outdoor workers may also experience additional ocular surface stress due to local climatic conditions such as intense heat, dry air, dust and environmental pollution, and the rapid growth of computer and smartphone use in the workplace could also contribute to the rise of DED in indoor workers. Symptom assessment may not be sufficient to measure the burden of disease, so it is important to complement a validated symptom assessment with objective physiological markers including tear-film break-up time (TBUT) and Schirmer's test for more complete evaluation of ocular surface function [9].

Knowing the relative importance of the occupational environment, behavioral exposure, and abnormalities of the physiological tear film may help in the identification of workers at high risk and the selection of preventive methods or techniques. Accordingly, the present study aimed to determine and compare the prevalence and severity of dry eye disease among outdoor and indoor workers and to identify physiological, occupational, and environmental factors associated with DED. It was hypothesized that outdoor workers would demonstrate a greater burden of DED because of prolonged exposure to sunlight, wind, dust, and heat, while extended digital-screen exposure and air-conditioned environments would represent important risk factors among indoor workers [10,11].

MATERIALS AND METHODS

Study Design and Setting

A community-based comparative cross-sectional study was conducted from February 2025 to February 2026 through the Department of Ophthalmology, Al-Nafees Medical College, Islamabad, Pakistan, in collaboration with the Department of Physiology, University College of Medicine and Dentistry (UCMD), Pakistan. The study aimed to compare the prevalence and severity of dry eye disease (DED) between adults predominantly working in outdoor and indoor environments and to identify physiological, occupational and environmental factors associated with DED.

Study Population and Sample Size

150 adult workers were recruited for the study. The participants were divided into 2 homogeneous groups based on their main occupational setting: 75 outdoor workers and 75 indoor workers. Outdoor workers were workers whose daily work activities were mainly in the outdoor environment and who were regularly exposed to sunlight, wind, dust or heat. Indoor workers were workers whose primary occupation was conducted mostly in indoor workplaces, like offices, educational institutions, laboratories, healthcare facilities, or commercial buildings.

The sample size was deemed sufficient to compare the prevalence of DED between the two occupational groups, and for evaluation of multiple potential predictors. A non-probability sampling method was used for the recruitment of participants until the desired sample size was obtained.

Eligibility Criteria

The study included adults (18-60 years) who had worked in their current occupation for at least one year and had worked at least 6 hours per day regularly. Participants had to sign an informed consent and be able to fill out the symptom questionnaire and have an ocular surface evaluation.

Patients with active conjunctivitis, keratitis, corneal ulceration, significant ocular trauma, recent ocular surgery (within 6 months), known serious corneal disease, or other ocular disorders that could affect tear-film assessment were excluded. Where clinically indicated, participants who used topical ocular medications which could significantly affect tear production were also excluded. Systemic illness, medication history, smoking history and prior ocular disease history were, however, recorded for consideration as potential confounding factors.

Data Collection and Occupational Assessment

Structured interviewer-administered questionnaire and a standardized ophthalmic examination were used to collect the data. Details recorded included age, sex, smoking history, occupational category, average daily hours worked, duration of employment, and medical history and current medications.

Occupational and environmental exposure assessed based on the participants' typical work environment. The number of hours per day on average that they spent in sunlight, dust, wind, heat, air-conditioning, and digital screens were gathered. Participants were also queried regarding use of protective eyewear, occupational breaks and periods of continuous computer use. The time spent in the screen was documented in hours per day and categorized for analyses, with prolonged screen time defined as ≥ 6 hours per day. Likewise, high amounts of sun and dust/wind exposure were classified as exposure of 4 hours or more every day during the work day.

Dry eye symptoms assessment

Subjective dry eye symptoms were determined by the Ocular Surface Disease Index (OSDI). This questionnaire assesses how often people experience ocular symptoms, visual-function limitations, and discomfort due to environmental factors in the week before the survey. The final OSDI score is a score from 0 to 100, with a higher score representing more severe symptoms. Scores were categorized as normal (0–12), mild (13–22), moderate (23–32), and severe (≥ 33). Objective tear film testing was performed last to minimize the chance that examining procedures affected the likelihood of symptoms being reported on the OSDI assessment.

Tear-Film Break-Up Time

The tear-film break-up time (TBUT) test was used to evaluate tear-film stability. A small quantity of fluorescein was placed in the lower conjunctival fornix and the participants were asked to blink several times to ensure a uniform distribution of the fluorescein over the ocular surface. These were then asked to close their eyes and the tear film was viewed with cobalt-blue illumination at slit lamp. The time in seconds from the last blink to the first dark break in the fluorescein stained tear film was recorded. Where possible, measurements were repeated and the representative value used for analysis. TBUT time of less than 10 seconds was defined as indicative of tear-film instability.

Schirmer's Test

The Schirmer's test was used to measure aqueous tear production. A standardised filter paper strip was inserted in the lower conjunctival fornix, which usually coincided with the mid-lateral third of the lower eyelid. All subjects were asked to close their eyes softly during the examination. The strip was removed, after 5 minutes, and the length of wetting was measured in millimeters. Values less than this were thought to be indicative of decreased tear secretion, and the Schirmer measurement was interpreted in conjunction with the clinical symptoms and TBUT findings, but not as a sole diagnostic criterion.

Definition of Dry Eye Disease

DED was diagnosed using a symptom/sign combined approach. DED was defined as the presence of clinically significant dry eye symptoms, Tear Film Break-up Time (TBUT) < 5 s and/or Schirmer < 5 mm. This composite definition was chosen because symptoms alone are not necessarily a good indicator of physiological abnormalities of the ocular surface. Severity was also defined by OSDI class and the severity of abnormality in objective tear-film evaluation. TBUT and Schirmer values were also examined as continuous physiological measures to assess the association between these and symptom burden.

Ophthalmic Examination

A basic ocular examination was performed on all the participants to rule out ocular conditions that may affect the assessment of dry eye. Examination comprised the use of visual inspection of eyelids and conjunctiva, anterior-segment examination and slit-lamp examination (when available). Significant corneal disease and/or features suggestive of active infection and/or another ocular condition that would need to be excluded were documented. Standardized procedures were used to minimize inter-observer variation.

Outcome Measures

The main outcome was the rate of DED in the outdoor and indoor workers. Other secondary outcomes were inter-occupational group differences in OSDI scores, TBUT and Schirmer-test values, and in dry-eye severity. Other findings were linkages of DED with age, sex, smoking, duration of employment, working hours, screen time, exposure to sunlight, dust and wind exposure, heat exposure, air-conditioning and wearing protective eyewear.

Statistical Analysis

The data were entered and analyzed by using the IBM SPSS statistics. Continuous variables were assessed for distribution and presented as mean $\pm$ standard deviation in the case of near normal distribution, and as median with interquartile range for non-normally distributed variables. Categorical data were analyzed in terms of frequencies and percentages.

The independent-samples t-test or Mann-Whitney U test was used to compare continuous variables between the outdoor and indoor workers as per the appropriate test. Chi-square or Fisher's exact test were used for comparison of categorical variables, depending on whether the cell frequencies were small. Pearson's or Spearman's correlation analysis, depending on the distribution of data, was used to assess the associations between OSDI scores and physiological tear film measurements.

Binary logistic regression was employed to find factors associated with the presence of DED. Multivariable models were built for variables that were deemed clinically relevant as well as those that showed association on univariable analysis. Adjusted odds ratios (aORs) and 95% confidence intervals (CIs) are reported. Occupational category was highly correlated with several environmental variables, including sun, dust, wind and heat, and therefore this was carefully evaluated to avoid multicollinearity. A two-sided p-value < 0.05 was considered statistically significant.

Ethical Considerations

The study followed the ethical guidelines of the Declaration of Helsinki. Before data collection, the appropriate institutional ethics/review committee

provided ethical approval. Each participant was provided with information on the aims of the study and the procedures to be followed, and signed informed consent was required for participation. The confidentiality of the participants was respected during the study and no personally identifiable data were analysed.

Results

Participant Characteristics

A total of 150 participants were included, of which 75 were outdoor workers and 75 were indoor workers. The study population comprised 78 males (52.0%) and 72 females (48.0%), with an overall mean age of 36.9 ± 9.1 years. The outdoor group and the indoor group were similar with respect to the age, sex distribution, smoking status, duration of employment and the percentage working more than eight hours per day. There were significant differences between the groups in terms of occupational exposures patterns. There was a significantly higher exposure to sun and dust or wind among outdoor workers and to digital screens and air-conditioned environment among indoor workers. 65.3% of the indoor workers reported screen exposure ≥ 6 hours/day, and 74.7% of the outdoor workers reported sunlight exposure ≥ 4 hours/day. Likewise, outdoor workers were much more likely to experience long-term dust or wind exposure. The detailed demographic and occupational characteristics are given in Table 1.

Table 1. Demographic and Occupational Characteristics of Participants

Variable	Outdoor workers (n=75)	Indoor workers (n=75)	Statistical test	p-value
Age, years	38.0 ± 9.4	35.9 ± 8.8	Independent-samples t-test	0.159
Male sex	40 (53.3%)	38 (50.7%)	Chi-square test	0.744
Female sex	35 (46.7%)	37 (49.3%)	Chi-square test	0.744
Current smoking	17 (22.7%)	12 (16.0%)	Chi-square test	0.302

Employment duration, years	9.2 ± 5.8	8.4 ± 5.1	Independent-samples t-test	0.372
Working >8 hours/day	32 (42.7%)	29 (38.7%)	Chi-square test	0.619
Screen exposure ≥ 6 hours/day	12 (16.0%)	49 (65.3%)	Chi-square test	<0.001
Sunlight exposure ≥ 4 hours/day	56 (74.7%)	5 (6.7%)	Chi-square test	<0.001
Dust/wind exposure ≥ 4 hours/day	50 (66.7%)	10 (13.3%)	Chi-square test	<0.001
Air-conditioning ≥ 6 hours/day	7 (9.3%)	53 (70.7%)	Chi-square test	<0.001
Regular protective eyewear	19 (25.3%)	15 (20.0%)	Chi-square test	0.436

Prevalence and Severity of Dry Eye Disease

In total, 70 of 150 participants (46.7%) met criteria for dry eye disease. There was a significant difference in the prevalence of DED between the outdoor and indoor workers ($p=0.003$), with 58.7% (44/75) of the outdoor workers and 34.7% (26/75) of the indoor workers having DED. Crude odds for DED were thus about 2.7 times higher among outdoor workers as compared to indoor workers.

The severity of the disease was also higher in the outdoor group. Twenty-seven outdoor workers (36.0%) had moderate or severe DED, while 13 indoor workers (17.3%) had the disease. There was a significant difference in overall distribution of normal, mild, moderate and severe disease among the different occupational groups ($p=0.023$).

The same was observed on objective physiological assessment. There was a statistically significant difference in ODI (mean $\pm$ SD) between outdoor and indoor workers (24.6 ± 15.2 vs. 17.1 ± 13.7 ; $p=0.002$). Tear-film break-up time (TBUT) was significantly shorter among outdoor workers (7.4 ± 2.6 vs. 9.2 ± 3.0 seconds; $p<0.001$), while Schirmer's test values were also significantly lower (11.8 ± 4.9 vs. 14.1 ± 5.2 mm/5

minutes; $p=0.006$). The results are presented in Table 2.

Table 2. Dry Eye Disease Prevalence, Severity, and Physiological Parameters

Parameter	Outdoor workers (n=75)	Indoor workers (n=75)	Statistical test	p-value
Dry eye disease	44 (58.7%)	26 (34.7%)	Chi-square test	0.003
No dry eye disease	31 (41.3%)	49 (65.3%)	Chi-square test	0.003
Mild disease	17 (22.7%)	13 (17.3%)	Chi-square test	—
Moderate disease	18 (24.0%)	9 (12.0%)	Chi-square test	—
Severe disease	9 (12.0%)	4 (5.3%)	Chi-square test	—
Overall severity distribution	—	—	Chi-square test	0.023
OSDI score	24.6 ± 15.2	17.1 ± 13.7	Independent-samples t-test	0.002
TBUT, seconds	7.4 ± 2.6	9.2 ± 3.0	Independent-samples t-test	<0.001
Schirmer's test, mm/5 minutes	11.8 ± 4.9	14.1 ± 5.2	Independent-samples t-test	0.006

Relationship Between Symptoms and Tear-Film Physiology

Greater symptom burden was significantly associated with deterioration in objective tear-film parameters. OSDI scores showed a moderate inverse correlation with TBUT ($r=-0.48$, $p<0.001$), indicating that increasing symptom severity was accompanied by reduced tear-film stability. OSDI scores were also

inversely correlated with Schirmer's test values ($r=-0.34$, $p<0.001$). In contrast, TBUT and Schirmer's test values demonstrated a positive correlation ($r=0.39$, $p<0.001$), indicating concordance between tear-film stability and aqueous tear production.

Factors Associated with Dry Eye Disease

On regression analysis, outdoor occupational environment was strongly associated with DED and remained significant after adjustment for demographic and occupational variables. Outdoor workers had more than twice the adjusted odds of DED compared with indoor workers (aOR 2.31, 95% CI 1.15–4.65; $p=0.019$).

Prolonged digital-screen exposure was also independently associated with DED. Participants reporting screen exposure ≥ 6 hours/day had approximately twice the adjusted odds of disease (aOR 2.14, 95% CI 1.06–4.32; $p=0.034$). Among environmental exposures, dust or wind exposure ≥ 4 hours/day demonstrated the strongest independent association with DED (aOR 2.68, 95% CI 1.28–5.61; $p=0.009$).

Female sex was not independently associated with DED (aOR 1.42, 95% CI 0.70–2.88; $p=0.329$), indicating that the higher prevalence among outdoor workers was not attributable to differences in sex distribution. Age, smoking, prolonged working hours, sunlight exposure, air-conditioning, and regular use of protective eyewear also did not retain statistically significant independent associations after adjustment. The complete regression analysis is presented in Table 3.

Table 3. Logistic Regression Analysis of Factors Associated With Dry Eye Disease

Predictor	Crude OR (95% CI)	Adjusted OR (95% CI)	p-value
Outdoor occupational environment	2.67 (1.38–5.18)	2.31 (1.15–4.65)	0.019
Age, per 10-year increase	1.31 (0.97–1.78)	1.28 (0.92–1.77)	0.142
Female sex	1.61 (0.84–3.08)	1.42 (0.70–2.88)	0.329
Current smoking	1.72 (0.77–3.83)	1.59 (0.67–3.76)	0.294

Working hours/day >8	1.64 (0.85–3.17)	1.79 (0.89–3.60)	0.102
Screen exposure ≥6 hours/day	1.96 (1.02–3.78)	2.14 (1.06–4.32)	0.034
Dust/wind exposure hours/day ≥4	3.13 (1.58–6.20)	2.68 (1.28–5.61)	0.009
Sunlight exposure hours/day ≥4	2.32 (1.18–4.56)	1.87 (0.83–4.21)	0.131
Air-conditioning ≥6 hours/day	1.28 (0.66–2.49)	1.42 (0.67–3.01)	0.359
Regular protective eyewear	0.69 (0.32–1.48)	0.72 (0.32–1.62)	0.427

DED was present in 46.7% of the study population, and its prevalence was significantly higher for outdoor workers. Outdoor workers had a higher symptom burden and lower tear production and tear-film stability. Outdoor work environment, exposure to dust/wind for long periods and using digital screens for ≥6 hours/day were the main independent risk factors for DED, but sex did not. Combined, the results in Tables 1–3 suggest the exposures to occupations or environment were associated more strongly with DED than were the measured demographic characteristics.

DISCUSSION

This study revealed that there was a high prevalence of dry eye disease (DED) among working adults, with an overall prevalence of 46.7%. The prevalence of DED was significantly higher in outdoor workers than in indoor workers (58.7% vs. 34.7%) suggesting that the occupational environment might be an important factor in ocular surface health. There was also a higher OSDI score, shorter tear-film break-up time, and lower Schirmer's test in outdoor workers, indicating that the higher symptom scores were associated with measurable physiological tear-film dysfunction [1-3]. This is biologically plausible with more outdoor workers, as the additional tear evaporation and disruption of the tear film as a consequence of dust, wind, sunlight and heat may lead to higher prevalence. In the adjusted analysis, outdoor occupation remained independently associated with DED, while dust/wind exposure ≥4 hours/day showed the strongest environmental association. These results indicate that it may be more useful to look at specific exposures in

the workplace than at occupation alone in determining risk [4-6].

Longer exposure to digital screens was also an independent risk factor for DED. The significance of this finding is that it shows that the occupational risk does not only apply to those who work outdoors. Prolonged exposure to screens can contribute to a decrease in blink rate and incomplete blinks, which can lead to a decrease in tear-film redistribution and facilitate evaporative dry eye. This co-occurrence of environmental exposure outdoors and screen exposure indoors underscore the need for occupation-specific approaches to prevention [7-10].

In this cohort, which included both males and females in almost equal numbers, there was no independent association between female sex and DED. This indicates that the differences among the occupational groups were more closely associated with environment and behavior exposures than sex distribution. The strong negative correlation between OSDI scores and TBUT and Schirmer values also suggests a relationship between subjective symptoms and objective tear film dysfunction [11-13].

The study has a number of strengths, such as the inclusion of both sexes, the direct comparison of indoor and outdoor workers and both symptom severity and physiological tear-film parameters were assessed. But the cross-sectional study design precludes causal inferences and environmental exposures were largely self-reported based on the duration of exposure. There is a need for larger prospective studies using objective environmental monitoring and other ocular surface testing to increase the evidence strength [14-16].

CONCLUSION

Dry eye disease was prevalent in the working population studied and was highly significantly more prevalent in outdoor workers. The main risk factors independently associated with DED were outdoor occupation, long-term dust/wind exposure and long-term digital-screen use; the sex was not an independent risk factor. These results indicate that targeted workplace strategies, such as reducing environmental exposures, use of sufficient protective measures and optimizing screen use could help reduce the workplace burden of dry eye disease.

REFERENCES

1. Duarte B, Xavier E, Nunes HC, Barquilha CN, Risso MA, Alves M. Environmental drivers of dry eye disease: a narrative review of pollutants, climate, and indoor exposures with practice recommendations. *Ophthalmol Ther.* 2026;15(2):547-567. doi: 10.1007/s40123-025-01297-7.
2. Akhtar N, Kausar A, Azeem HF, Shah A, Inam R, Mehmood A. Dry eye disease among young

- Pakistanis: association with digital screen use. *J Coll Physicians Surg Pak*. 2026;36(7):893-897. doi: 10.29271/jcpsp.2026.07.893.
3. Shin D, Ahn H, Cho Y, Rim TH, Liu YC, Sim S, et al. The cumulative impact of air pollution on dry eye disease: evidence from the Korea National Health and Nutrition Examination Survey (2017-2020). *Ocul Surf*. 2026;40:254-263. doi: 10.1016/j.jtos.2026.03.003.
4. Ghimire R, Kaiti R, Shyangbo R, Paudel S, Neupane Y. Predictive analysis of dry eye diagnosis and digital screen usage: a cross-sectional study. *Int J Ophthalmol*. 2025;18(10):1851-1855. doi: 10.18240/ijo.2025.10.05.
5. Luo CK, Tan QQ, Tea Y, Pang Y. The prevalence of dry eye disease symptoms and its association with screen time in young adults aged 21-30 years. *Ophthalmic Physiol Opt*. 2025;45(5):1195-1200. doi: 10.1111/opo.13505.
6. Soltan Dehghan H, Rafiepour A, Hosseinzadeh S. Assessment of dry eye disease and convergence insufficiency symptoms in e-commerce workers using validated questionnaires: a cross-sectional study. *Optom Vis Sci*. 2025;102(10):637-643. doi: 10.1097/OPX.0000000000002295.
7. Allwihan R. The association between dry eye disease symptoms, digital device types, and screen distance among health science students: a survey-based study. *Health Sci Rep*. 2025;8(10):e71138. doi: 10.1002/hsr2.71138.
8. Massa S, Patil SA, Raju LV. Effects of digital screen property modification on symptoms of digital eye strain. *Digit J Ophthalmol*. 2025;31(3):62-67. doi: 10.5693/djo.01.2024.04.001.
9. Shah M, Natarajan SB, Ahmad N. Excessive screen time exposure leads to dry eyes and inflammatory conjunctivitis in children. *Ir J Med Sci*. 2025;194(2):597-602. doi: 10.1007/s11845-025-03920-9.
10. Xu Y, Zhang L, Yang Y, Wang W, Zhao H. Delayed effects of the relative humidity on the outpatient visits of dry eye disease in Shanghai, China: effect modification by green and blue space. *J Glob Health*. 2025;15:04142. doi: 10.7189/jogh.15.04142.
11. Abubaker SK, Samaana SB, Saidi QN, Qaddumi JAS, Abualhasan H, Abusalha SI. Prevalence of dry eye disease among indoor and outdoor workers and the impact on work productivity in the West Bank of Palestine in 2024: a cross-sectional study. *BMC Public Health*. 2025;25:1642. doi: 10.1186/s12889-025-22779-0.
12. Choi YH, Song MS, Lee Y, Paik HJ, Song JS, Choi YH, et al. Adverse effects of meteorological factors and air pollutants on dry eye disease: a hospital-based retrospective cohort study. *Sci Rep*. 2024;14(1):17776. doi: 10.1038/s41598-024-68070-x.
13. Xia M, Yang Y, Sun J, Huang R, Huang Y, Zhang M, et al. Time-series analysis of the association between air pollution exposure and outpatient visits for dry eye disease: a case study in Zhengzhou, China. *Front Public Health*. 2024;12:1352057. doi: 10.3389/fpubh.2024.1352057.
14. Humayun S, Noor M, Shahid M, Naqvi SAH, Ishaq M, Humayun Q. Diagnosis of dry eye syndrome using Ocular Surface Disease Index, tear film break-up time, and Schirmer test. *J Coll Physicians Surg Pak*. 2024;34(3):308-312. doi: 10.29271/jcpsp.2024.03.308.
15. Mamoon I, Ayub F, Sarwat S. Prevalence of dry eye disease among IT students in Pakistan. *Int Ophthalmol*. 2024;44(1):204. doi: 10.1007/s10792-024-03142-5.
16. Al-Dossary SK. Environmental and occupational triggers of dry eye symptoms in the Ahsa region of Saudi Arabia: a cross-sectional study. *Clin Ophthalmol*. 2024;18:2427-2438. doi: 10.2147/OPTH.S474832.