

Dry Eye Morbidity and Its Associated Occupational Risk Factors Among Factory Workers of Medcraft Pharmaceutical Industry Peshawar

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Abstract

Background: Dry eye disease (DED) is a common, multifactorial ocular surface disorder that impairs quality of life and work productivity. Industrial workers face elevated risk due to occupational exposures such as dust, chemicals, low humidity, and prolonged screen time, but its burden among industrial workers in Pakistan has received little attention, especially in Khyber Pakhtunkhwa where data remain limited.

Objective: This study aimed to determine the prevalence of DED and its associated occupational risk factors among workers at a pharmaceutical manufacturing factory in KPK.

Methodology: A descriptive-analytical cross-sectional study was conducted using a total population (census) sampling approach across all departments of the factory. A structured, self-administered questionnaire covering socio-demographics, occupational exposure history, and a modified Ocular Surface Disease Index (OSDI) was used, with workers scoring ≥ 13 classified as having DED; data were analyzed in SPSS v20.0 using chi-square tests.

Result: Among 135 participants (65.9% male, 34.1% female), the overall prevalence of DED was 60.0%. Prevalence rose significantly with age (34% in 18–28 years to 100% in 49–58 years, $p < 0.001$) and with duration of employment (23.8% for < 1 year to 96.8% for > 10 years, $p < 0.001$), while gender showed no significant association ($p = 0.374$). Prevalence varied by department, ranging from 37.5% in Quality Control to 100% in Quality Assurance and Regulatory Affairs, and poor ventilation was the only occupational exposure factor significantly associated with DED, while chemical dust, fumes, low humidity, and screen time showed non-significant directional trends.

Conclusion: DED prevalence among these factory workers (60.0%) substantially exceeds global (34.6%) and regional estimates, driven largely by age, cumulative occupational tenure, and poor ventilation, highlighting DED as a significant, preventable occupational health issue warranting targeted workplace interventions, routine OSDI screening, and policy integration into occupational health practices.

Key Words: Dry eye disease, Occupational health, OSDI, Industrial workers, Ventilation

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Introduction:

One of the most prevalent eye disorders in the

world is dry eye disease (DED). DED significantly increases morbidity and healthcare costs worldwide (1). Dry eye disease is a prevalent, multifactorial, inflammatory ocular surface condition that affects 5% to 50% of people worldwide and lowers their quality of life. Because of the range of symptoms, DED poses a diagnostic challenge in primary care practice (2).

The Tear Film & Ocular Surface Society (TFOS) Dry Eye Workshop (DEWS) II defines DED as a multifactorial disease of the ocular surface characterized by tear film instability and hyperosmolarity, ocular surface inflammation and damage, and neurosensory abnormalities (3). Dry eye (DED) is a multifactorial disease with symptoms caused by an imbalance in the ocular surface and tear film. There are two types of dry eyes: evaporative (EDE) and aqueous deficient (ADDE) (4). Evaporative dry eye is characterized by excessive evaporation from the tear film, whereas aqueous-deficient dry eye is characterized by decreased lacrimal secretion. DED presents with dryness, grittiness, burning, stinging, photophobia, pain, visual fatigue, and blurred vision, with reduced tear production, tear film instability, and ocular surface damage (5). DED can impair ocular comfort, visual function, work productivity, and quality of life (6).

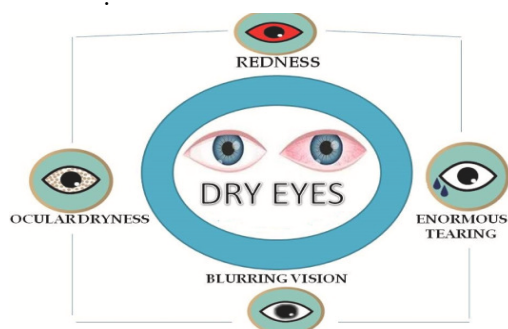


Fig 1.2. Dry Eye Symptoms...(7)

DED has a complicated etiology that includes both physiological and environmental factors. Reduced tear production and excessive evaporation are common causes. Workplace environments are crucial in determining the risk of DED; outdoor workers are more vulnerable because of their extended exposure to wind and dust. These variations in occupation highlight the importance of taking workplace conditions into account when comprehending and reducing DED (8).

Risk factors for DED include reduced tear production, excessive tear evaporation, wind exposure, and dust exposure (8). Other risk factors include high temperature, cold temperature, low humidity, air pollution, smoke, smog, vehicle exhaust, chemical

irritants, industrial chemicals, cleaning products, high altitude, and seasonal variations (7). Low humidity, smoke, nitrogen oxide, and temperature variations are also associated with DED (9,10,11). Air-conditioned environments and strong winds may further contribute to tear evaporation (6).

Globally, the prevalence of Dry Eye Disease (DED) is 34.6%, with the highest prevalence reported in Africa (43.9%) and the lowest in North America (20.9%). Females (39.1%) have a higher prevalence than males (30.8%) (12). In the Middle East, the pooled prevalence of DED is 28.33% (13), while the prevalence among Asian populations is 20.1%, with prevalence generally increasing with age and being higher among women (14).

Methodology

This study used a descriptive-analytical cross-sectional design to determine the prevalence of dry eye disease (DED) and its associated occupational risk factors. Data were collected over six months, from February 2026 to July 2026. The research was conducted at Medicraft pharmaceutical manufacturing factory. A complete list of employees was obtained from the Human Resources (HR) department before data collection began. Every worker who was present during the data collection period and fulfilled the eligibility criteria was approached individually and invited to participate. This ensured all departments and job roles were equally represented.

A total population (census) sampling method was applied. The total population consists of approximately 145 workers. Therefore, all eligible workers were included in the study. However, the final sample size may vary depending on inclusion and exclusion criteria, participant availability and consent. Inclusion criteria included adults aged ≥ 18 years and ≤ 58 years, currently employed as a factory worker for at least 3 months in the same industrial unit, working a minimum of 5 to 8 hours per day for at least 5 days per week and workers who gave consent to participate in the study. Exclusion criteria included known pre-existing ocular surface disease other than dry eye, history of any ocular surgery in the past 12 months and current use of topical ophthalmic medications (except artificial tears) within the past 3 months.

For data collection, a structured self-administered questionnaire as the primary data collection instrument. The questionnaire was adapted from validated instruments and organized into three main sections: Socio-demographic information, Occupational history and exposure risk factors and Dry eye

symptom assessment using Ocular Surface Disease Index (OSDI). Data were analyzed using IBM SPSS Statistics 20.0. DED was assessed using the OSDI score, with ≥ 13 classified as DED. Frequencies, percentages, and prevalence were calculated. Chi-square and Fisher's exact tests were used to assess associations, with statistical significance set at $p < 0.05$.

Result

Table 4.1. shows the prevalence of dry eye among the study participants. Out of the 135 factory workers who participated in the study, 81 (60.0%) were classified as having dry eye disease (OSDI ≥ 13), while 54 (40.0%) were classified as normal (OSDI < 13).

Table 4.1. Frequency and Percentage Distribution of Dry Eye Status (n = 135)

Dry eye presence	Frequency n	Percent %
Dry Eye (No)	54	40.0%
Dry Eye (Yes)	81	60.0%
Total	135	100.0%

DED prevalence increased significantly with age, from 34% in 18–28 years to 100% in 49–58 years ($p < 0.001$). Prevalence was slightly higher in females (65.2%) than males (57.3%), but the association was not statistically significant ($p = 0.374$). DED prevalence increased significantly with duration of employment, from 23.8% in < 1 year to 96.8% in > 10 years ($p < 0.001$). (Table 4.2)

Table 4.2: Association between Dry Eye and Sociodemographic Factors

Chi-Square Tests

Age Group	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	30.107 ^a	3	.000
Gender			
Pearson Chi-Square	.791 ^a	1	.374
Duration of Current Job			
Pearson Chi-Square	34.862 ^a	3	.000

The association between environmental/work-related factors and dry eye disease was

assessed using the Pearson Chi-square test. Chemical dust exposure was not significantly associated with dry eye disease ($\chi^2 = 0.987$, $df = 1$, $p = 0.321$), with 72.84% of participants with dry eye reporting no exposure and 27.16% reporting exposure, compared with 64.81% and 35.19%, respectively, among those without dry eye. Similarly, chemical fumes exposure showed no significant association ($\chi^2 = 2.571$, $df = 1$, $p = 0.109$), with 79.01% versus 20.99% among those with dry eye and 66.67% versus 33.33% among those without dry eye. Low humidity also showed no significant association ($\chi^2 = 0.000$, $df = 1$, $p = 1.000$), with identical distributions of 77.78% exposure and 22.22% no exposure in both groups. Strong airflow was not significantly associated with dry eye ($\chi^2 = 0.171$, $df = 1$, $p = 0.679$), with 87.65% no exposure and 12.35% exposure among those with dry eye, compared with 85.19% and 14.81% among those without dry eye. Eye protection use was also not significant ($\chi^2 = 0.769$, $df = 1$, $p = 0.381$), with 66.67% not wearing protection and 33.33% wearing it among those with dry eye, compared with 59.26% and 40.74% among those without dry eye. In contrast, ventilation showed a statistically significant association with dry eye disease ($\chi^2 = 16.621$, $df = 1$, $p < 0.001$), with 65.43% of those with dry eye reporting no ventilation and 34.57% reporting ventilation, compared with 29.63% and 70.37%, respectively, among those without dry eye. (Table 4.3)

Table 4.3: Association between Dry Eye Disease and Occupational Risk Factors

Chi-Square Test

Ventilation	Value	df	Asymptotic Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	16.621 ^a	1	.000		
Fisher's Exact Test				.000	.000
Chemical Dust					
Pearson Chi-Square	.987 ^a	1	.321		

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Fisher's					
Exact				.344	.211
Test					
Chemical Fumes					
Pearson					
Chi-Square	2.571 ^a	1	.109		
Fisher's					
Exact				.115	.081
Test					
Low Humidity					
Pearson					
Chi-Square	.000 ^a	1	1.000		
Fisher's					
Exact				1.00	.586
Test				0	
Strong Airflow					
Pearson					
Chi-Square	.171 ^a	1	.679		
Fisher's					
Exact				.797	.434
Test					
Eye Wear During Work					
Pearson					
Chi-Square	.769 ^a	1	.381		
Fisher's					
Exact				.465	.243
Test					
N of					
Valid	135				
Cases					

Discussion

Overall DED prevalence was 60.0% (81/135), higher than the global pooled estimate of 34.6% (12), though close to the 53.8% figure from the same review using the same OSDI ≥ 13 threshold, suggesting the gap largely reflects diagnostic criteria. It closely matches other occupational cohorts, including Palestinian factory workers 61.4% (8) and Egyptian marble-dust workers 60.4% (15), and exceeds Chinese coal miners 50.7% (16) and Turkish industrial workers 27.5% (17), placing this workforce among the more heavily

affected industrial groups reported internationally. DED prevalence rose sharply with age, from 34% in workers aged 18–28 to 100% in those aged 49–58 ($\chi^2 = 30.107$, $p < 0.001$), consistent with age as a key determinant of DED reported globally and in meta-analytic evidence (12, 18), reflecting progressive lacrimal and meibomian gland decline. use clustered among the highest-exposure workers. **Ventilation** was the only occupational factor significantly associated with DED ($\chi^2 = 16.621$, $p < 0.001$), with prevalence far higher where ventilation was inadequate. This aligns closely with evidence that air exchange and micro-climate control are key determinants of tear film stability (6,9,10), making it the single most actionable finding of this study

In contrast, chemical dust, chemical fumes, low humidity, and eye protection showed no significant associations with DED ($p > 0.05$), despite some previous studies reporting these factors as potential risks. Overall, age, employment duration, and ventilation were the most important factors identified in the present study, with ventilation being the key modifiable occupational factor.

Conclusion

This study found a high prevalence of DED among Medcraft pharmaceutical factory workers, with 60.0% (81/135) affected. Age and duration of employment were significantly associated with DED, with prevalence increasing from 34% to 100% with age and from 23.8% to 96.8% with longer employment. Gender was not significantly associated with DED. Among occupational factors, poor ventilation was the only significant factor ($\chi^2 = 16.621$, $p < 0.001$). Overall, the findings highlight the importance of improved workplace ventilation and regular eye screening

Recommendation

The factory should upgrade ventilation systems and regularly monitor humidity and air quality, particularly in Production and Packaging departments. Consistent use of appropriate protective eyewear should be ensured through proper provision and staff training. Routine OSDI screening should be included in annual health check-ups, with more frequent monitoring for workers aged over 40 years or employed for more than 5 years. Ergonomic measures, including regular breaks during visual tasks and humidifiers in low-humidity areas, should also be introduced. Ocular health guidelines should be incorporated into occupational health and GMP policies, along with regular staff awareness sessions on DED symptoms, risks, and prevention. Future

research should include larger multi-site and longitudinal studies, combining subjective OSDI assessment with objective clinical tests to improve generalizability and evaluate long-term outcomes.

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