

Original Research Article

PREVALENCE OF DRY EYE DISEASE AMONG OFFICE WORKERS OF 25 TO 50 YEAR OF AGE

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Received : 15/08/2026
Received in revised form : 12/09/2026
Accepted : 24/09/2026

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DOI: 10.70034/ijmedph.2026.4.18

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2026; 16 (4); 110-117

ABSTRACT

Background: Dry eye disease is a common ocular-surface disorder among office workers because of prolonged digital-screen exposure, reduced and incomplete blinking, air-conditioned environments and inappropriate workstation ergonomics. It may cause ocular discomfort, visual disturbance and reduced occupational productivity. **Aim:** To determine the prevalence of dry eye disease among office workers aged 25-50 years. Materials and

Materials and Methods: This cross-sectional study included 180 office workers aged 25-50 years. Sociodemographic, behavioural, ocular, systemic, occupational and workplace information was collected using a structured questionnaire. Dry-eye symptoms were assessed using the Ocular Surface Disease Index. Clinical assessment included tear-film break-up time, Schirmer I test, ocular-surface staining and evaluation for meibomian gland dysfunction. Continuous variables were compared using the independent-samples t test or analysis of variance, and categorical variables were analysed using the chi-square test. Multivariable binary logistic regression was performed to identify independent predictors. Adjusted odds ratios with 95% confidence intervals were calculated, and $p < 0.05$ was considered statistically significant.

Results: The mean age of the participants was 38.2 ± 7.1 years. DED was diagnosed in 103 participants, giving a prevalence of 57.2% (95% CI: 49.9%-64.2%). OSDI-positive symptoms, abnormal TBUT, reduced Schirmer values and positive ocular-surface staining were observed in 62.2%, 60.6%, 46.7% and 37.8%, respectively. Mild, moderate and severe DED were present in 14.4%, 17.2% and 25.6% of all participants. OSDI scores increased, whereas TBUT and Schirmer values decreased significantly with increasing severity (all $p < 0.001$). Participants with DED had greater daily screen exposure than those without DED (7.1 ± 2.0 versus 5.2 ± 1.8 hours; $p < 0.001$). Age (aOR=1.06 per year; $p = 0.020$), female sex (aOR=2.08; $p = 0.033$), meibomian gland dysfunction (aOR=3.67; $p = 0.001$), screen exposure exceeding six hours (aOR=2.89; $p = 0.003$), irregular screen breaks (aOR=2.76; $p = 0.006$) and low workplace humidity (aOR=2.31; $p = 0.020$) were independent predictors.

Conclusion: DED was highly prevalent among office workers and was strongly associated with prolonged screen exposure, irregular breaks, meibomian gland dysfunction and low workplace humidity. Periodic ocular screening and workplace interventions targeting screen-use behaviour and environmental conditions are recommended.

Keywords: Dry eye disease; office workers; digital-screen exposure.

INTRODUCTION

Dry eye disease (DED) is a common, multifactorial disorder of the ocular surface characterized by a loss

of tear-film homeostasis and accompanied by ocular symptoms. Tear-film instability, hyperosmolarity, ocular surface inflammation and damage, and neurosensory abnormalities contribute to its development.^[1] Patients commonly experience

dryness, burning, grittiness, foreign-body sensation, redness, excessive watering, blurred vision and ocular fatigue. These symptoms may interfere with reading, driving, computer work and other routine activities, thereby reducing quality of life and occupational productivity. The reported prevalence of DED varies widely because of differences in study populations, environmental conditions, diagnostic criteria and assessment instruments. The TFOS DEWS II Epidemiology Report documented prevalence estimates ranging from approximately 5% to 50%, with an increasing burden associated with age, female sex, Asian ethnicity, contact-lens use, environmental exposure and prolonged digital-device use.^[2]

Office workers represent a particularly vulnerable occupational group because their work frequently requires prolonged viewing of computers, laptops and smartphones. Concentrated screen viewing reduces spontaneous blink rate and increases the proportion of incomplete blinks. This accelerates tear evaporation, destabilizes the tear film and increases ocular surface exposure. Screen-related dry eye may be aggravated by air-conditioned rooms, low humidity, excessive airflow, glare, poor illumination, improper screen position and inadequate breaks. Prolonged digital-device exposure has consequently emerged as an important modifiable risk factor for ocular discomfort and DED.^[3] The prevalence of DED among digital-screen workers has varied substantially across studies, ranging from 9.5% to 87.5%, partly because investigators used different symptom questionnaires and clinical tests.^[3]

Office workers aged 25-50 years constitute an economically productive population in whom persistent ocular symptoms may reduce concentration, work efficiency and productivity and may increase absenteeism and healthcare utilization. Although DED has traditionally been associated with older age, increasing digital exposure has resulted in dry-eye symptoms being frequently observed among younger and middle-aged adults. The effect of the digital environment on the ocular surface is influenced not only by screen duration but also by viewing distance, blink pattern, font size, contrast, ambient illumination, workstation ergonomics and environmental humidity.^[4] Other contributing factors include smoking, contact-lens use, refractive errors, systemic diseases, ocular surgery and the use of medications that interfere with tear secretion.

Because symptoms and clinical signs of DED may not always correlate, assessment should include a validated symptom questionnaire together with objective evaluation of tear-film stability, tear secretion and ocular surface integrity. The Ocular Surface Disease Index (OSDI), tear-film break-up time (TBUT), Schirmer's test and ocular surface staining are commonly used for this purpose.^[1,5] Early identification of DED and its modifiable occupational risk factors can facilitate timely counselling regarding screen breaks, conscious blinking, appropriate screen positioning, workplace

humidity and ophthalmological treatment. Therefore, the present study was undertaken to estimate the prevalence of dry eye disease and identify its associated factors among office workers aged 25-50 years.

AIM: To determine the prevalence of dry eye disease among office workers aged 25-50 years.

Objectives:

1. To estimate the prevalence and severity of dry eye disease among office workers aged 25-50 years.
2. To assess the association of dry eye disease with the duration of digital-screen exposure and workplace-related factors.
3. To identify sociodemographic, behavioural, ocular and systemic factors associated with dry eye disease.

MATERIALS AND METHODS

Source of Data: The study population consisted of office workers aged 25-50 years employed in selected government and/or private offices located within the study area. Eligible workers who were available during the data-collection period and provided written informed consent constituted the source of data. Information was obtained through participant interviews, a structured questionnaire, the OSDI questionnaire and a standardized ophthalmological examination.

Study Design: A descriptive cross-sectional study was conducted to estimate the prevalence of dry eye disease and assess its associated factors among office workers.

Study Location: The study was carried out in selected government and private. Participant interviews and preliminary examinations were conducted in a designated room with adequate privacy. Detailed ocular examinations were performed in the Department of Ophthalmology.

Study Duration: The study was conducted over a period of six months. This period included participant recruitment, data collection, ophthalmological assessment, data entry, statistical analysis and preparation of the study report.

Sample Size: A total of 180 office workers aged 25-50 years were included in the study. The sample size was estimated using the formula for a single population proportion:

$$n = (Z_{(1-\alpha/2)}^2 \times p \times (1-p)) / d^2$$

where:

n= required sample size

$Z_{(1-\alpha/2)}$ = 1.96 at a 95% confidence level

p= anticipated prevalence of dry eye disease among office workers

d= allowable absolute error

After accounting for the anticipated prevalence, desired precision, feasibility and possible incomplete responses, the final sample size was fixed at 180 participants.

Sampling Technique: A list of eligible office workers was obtained from the administrative departments of the selected offices. Participants were recruited using a simple random or systematic random sampling method. When more than one office was included, the sample was allocated proportionately according to the number of eligible employees in each office. Recruitment continued until the required sample size of 180 was achieved.

Inclusion Criteria

Participants were included when they:

1. Were aged between 25 and 50 years.
2. Had been employed as office workers for at least six months.
3. Performed desk-based, computer-based or other office-related work.
4. Used a computer, laptop, tablet or smartphone for occupational activities.
5. Were willing to participate and provided written informed consent.

Exclusion Criteria

Participants were excluded when they:

1. Had an active ocular infection, corneal ulcer, allergic conjunctivitis or acute ocular inflammation at the time of examination.
2. Had undergone ocular surgery, refractive surgery or ocular trauma during the preceding six months.
3. Were using topical ocular medications, except preservative-free lubricating eye drops, that could substantially alter tear-film measurements.
4. Had severe eyelid abnormalities, lacrimal drainage disorders or corneal diseases that interfered with dry-eye assessment.
5. Had systemic autoimmune diseases, such as Sjögren syndrome or rheumatoid arthritis, already known to cause severe dry eye.
6. Were unable to complete the questionnaire or cooperate with the ocular examination.
7. Declined to provide informed consent.

Procedure and Methodology: Approval was obtained from the Institutional Ethics Committee before commencement of the study. Permission was also obtained from the administrative authorities of the participating offices. Eligible workers were informed about the purpose, procedure, benefits and minimal risks of the study. Written informed consent was obtained before enrolment.

Each participant was interviewed using a predesigned, pretested, structured questionnaire. Information regarding age, sex, educational level, occupation, duration of employment, working hours, smoking, contact-lens use, spectacle use, medical history, medication history and previous ocular conditions was recorded. Details of daily digital-screen exposure, uninterrupted screen-use duration, frequency of breaks, viewing distance, screen position, use of multiple digital devices, air-conditioner exposure, airflow, lighting and perceived workplace humidity were collected.

Symptoms of dry eye were assessed using the Ocular Surface Disease Index. The questionnaire evaluated

ocular symptoms, vision-related functional limitations and environmental triggers during the preceding week. The OSDI score was calculated as: "OSDI score"=(("sum of scores for answered items" ×25)/"number of items answered")

The final score ranged from 0 to 100. Scores were interpreted as normal (0-12), mild (13-22), moderate (23-32) and severe dry-eye symptoms (33-100).

Visual acuity was assessed separately for each eye using a standard Snellen chart. Anterior-segment examination was performed using a slit lamp to identify eyelid abnormalities, meibomian gland dysfunction, conjunctival congestion, reduced tear meniscus and corneal abnormalities.

Tear-film stability was measured using fluorescein TBUT. A fluorescein strip moistened with sterile normal saline was gently applied to the inferior conjunctival fornix. Participants were instructed to blink several times and then keep their eyes open. The interval between the last complete blink and the appearance of the first dark spot in the fluorescent tear film was recorded in seconds. Three readings were obtained, and their mean was calculated. A TBUT of less than 10 seconds was considered abnormal.

A Schirmer I test was performed without topical anaesthesia. A standardized Schirmer strip was placed at the junction of the middle and lateral thirds of the lower eyelid. The length of wetting after five minutes was recorded in millimetres. Wetting of 10 mm or less in five minutes was considered suggestive of reduced tear secretion.

Fluorescein or lissamine-green staining was used, when available, to assess corneal and conjunctival epithelial damage. The same sequence of tests was followed for every participant to reduce measurement variation. Dry eye disease was diagnosed when a participant had clinically significant symptoms, such as an OSDI score of at least 13, together with at least one abnormal tear-film or ocular-surface test.

Participants diagnosed with DED or another ocular disorder were counselled and referred to the Ophthalmology outpatient department for further evaluation and appropriate management.

Sample Processing: No blood, urine or tissue sample was collected because the study was based on questionnaire assessment and non-invasive or minimally invasive ocular-surface tests. The completed questionnaires and clinical examination forms were checked daily for completeness and consistency. Each participant was assigned a unique identification number. Data were coded, anonymized and entered into an electronic database. Any incomplete or inconsistent entry was verified against the original data-collection form before final analysis.

Data Collection: Data were collected using:

1. A predesigned and pretested sociodemographic and occupational questionnaire.
2. The validated OSDI questionnaire.
3. A workplace and digital-screen exposure assessment form.

4. A standardized ophthalmological examination form.
5. TBUT, Schirmer I test and ocular surface staining findings.

The questionnaire was pilot-tested among a small group of office workers who were not included in the final study. Necessary changes were made for clarity and feasibility. All examinations were conducted by a trained investigator using uniform procedures and calibrated equipment. Privacy and confidentiality were maintained throughout the study.

Outcome Measures: The primary outcome was the prevalence of dry eye disease, calculated as: "Prevalence of DED"="number of participants diagnosed with DED" /180×100

Secondary outcomes included the severity of dry-eye symptoms and their association with screen time, continuous work without breaks, air-conditioner exposure, smoking, contact-lens use, refractive errors and other participant characteristics.

Statistical Methods: Data were entered into Microsoft Excel and analysed using IBM SPSS

Statistics version 26.0. Continuous variables were presented as mean with standard deviation or median with interquartile range, according to their distribution. Categorical variables were summarized as frequencies and percentages.

The prevalence of DED was reported as a percentage with a 95% confidence interval. The chi-square test or Fisher's exact test was used to examine associations between DED and categorical variables. The independent-samples t test was used to compare normally distributed continuous variables between participants with and without DED; the Mann-Whitney U test was used for non-normally distributed data.

Variables with clinical relevance or a univariable p value below 0.20 were entered into a multivariable binary logistic-regression model. Adjusted odds ratios with 95% confidence intervals were calculated to identify independent factors associated with DED. Model fit and multicollinearity were assessed. All tests were two-tailed, and p <0.05 was considered statistically significant.

RESULTS

Table 1: Prevalence of dry eye disease among office workers aged 25-50 years (N=180)

Study finding	n (%) or mean (SD)	95% CI	Test of significance	p value
Age, years	38.2 (7.1)	37.2-39.2	One-sample t=72.20	<0.001
OSDI-positive symptoms (score ≥13)	112 (62.2)	55.0%-69.0%	$\chi^2=10.76$	0.001
Abnormal TBUT (<10 seconds)	109 (60.6)	53.3%-67.4%	$\chi^2=8.02$	0.005
Reduced Schirmer I test (≤10 mm/5 min)	84 (46.7)	39.5%-53.9%	$\chi^2=0.80$	0.371
Positive ocular-surface staining	68 (37.8)	31.0%-45.0%	$\chi^2=10.76$	0.001
Dry eye disease present	103 (57.2)	49.9%-64.2%	$\chi^2=3.76$	0.052
Dry eye disease absent	77 (42.8)	35.8%-50.1%		

Table 1 shows that the mean age of the 180 office workers was 38.2±7.1 years (95% CI: 37.2-39.2). OSDI-positive symptoms were observed in 112 (62.2%) participants, while 109 (60.6%) had an abnormal tear-film break-up time. Both findings were statistically significant (OSDI: $\chi^2=10.76$, p=0.001; TBUT: $\chi^2=8.02$, p=0.005). Reduced tear secretion on the Schirmer I test was recorded in 84 (46.7%) participants and was not statistically significant

compared with the reference proportion ($\chi^2=0.80$, p=0.371). Positive ocular-surface staining was found in 68 (37.8%) participants ($\chi^2=10.76$, p=0.001). Overall, dry eye disease was diagnosed in 103 (57.2%) office workers, with a 95% CI of 49.9%-64.2%, whereas 77 (42.8%) did not have DED. The difference from the reference prevalence of 50% was marginally nonsignificant ($\chi^2=3.76$, p=0.052).

Table 2: Prevalence, severity and clinical characteristics of dry eye disease (N=180)

A. Prevalence and severity

DED category	n (%)	95% CI	Test of significance	p value
No dry eye	77 (42.8)	35.8%-50.1%		
Mild DED	26 (14.4)*	10.1%-20.3%		
Moderate DED	31 (17.2)*	12.4%-23.4%	$\chi^2=6.31†$	0.043
Severe DED	46 (25.6)*	19.7%-32.4%		
Any DED	103 (57.2)	49.9%-64.2%	$\chi^2=3.76‡$	0.052

*Percentage calculated using the complete sample of 180. Among the 103 participants with DED, mild, moderate and severe disease accounted for 25.2%, 30.1% and 44.7%, respectively.

†Chi-square goodness-of-fit test comparing the distribution of the three severity categories among participants with DED.

‡Comparison of DED present versus absent against an expected proportion of 50%.

B. Clinical parameters according to DED severity

Clinical parameter	Mild DED (n=26)	Moderate DED (n=31)	Severe DED (n=46)	Effect estimate (95% CI)	Test statistic	p value
OSDI score, mean (SD)	17.8 (2.7)	27.4 (2.8)	44.6 (8.1)	Severe-mild MD: 26.8 (23.9-29.7)	ANOVA F=188.42	<0.001
TBUT, seconds, mean (SD)	8.4 (1.3)	6.7 (1.6)	5.1 (1.8)	Severe-mild MD: -3.3 (-4.1 to -2.5)	ANOVA F=38.67	<0.001
Schirmer I test, mm/5 min, mean (SD)	11.1 (3.2)	8.8 (3.1)	7.2 (2.9)	Severe-mild MD: -3.9 (-5.4 to -2.4)	ANOVA F=13.91	<0.001
Ocular-surface staining present	7 (26.9)	16 (51.6)	37 (80.4)	Severe vs mild OR: 11.15 (3.54-35.13)	$\chi^2=20.36$	<0.001
Meibomian gland dysfunction	9 (34.6)	17 (54.8)	34 (73.9)	Severe vs mild OR: 5.36 (1.91-15.06)	$\chi^2=10.78$	0.005

Table 2 demonstrates the prevalence and severity of DED among the participants. Of the 180 office workers, 26 (14.4%) had mild DED, 31 (17.2%) had moderate DED and 46 (25.6%) had severe DED. Among the 103 participants diagnosed with DED, these categories represented 25.2%, 30.1% and 44.7%, respectively. The distribution across the three severity categories was statistically significant ($\chi^2=6.31$, $p=0.043$), with severe DED being the most frequent category. The mean OSDI score increased progressively from 17.8±2.7 in mild disease to 27.4±2.8 in moderate disease and 44.6±8.1 in severe disease ($F=188.42$, $p<0.001$). In contrast, mean

TBUT decreased from 8.4±1.3 seconds in mild DED to 5.1±1.8 seconds in severe DED ($F=38.67$, $p<0.001$), while the mean Schirmer I value decreased from 11.1±3.2 to 7.2±2.9 mm/5 minutes ($F=13.91$, $p<0.001$). Ocular-surface staining increased from 26.9% in mild DED to 80.4% in severe DED; severe cases had 11.15 times greater odds of staining than mild cases (95% CI: 3.54-35.13; $\chi^2=20.36$, $p<0.001$). Similarly, meibomian gland dysfunction increased from 34.6% to 73.9%, with 5.36 times higher odds in severe than mild DED (95% CI: 1.91-15.06; $\chi^2=10.78$, $p=0.005$).

Table 3: Association of digital-screen exposure and workplace factors with dry eye disease (N=180)

Exposure factor	DED present (n=103)	DED absent (n=77)	Effect estimate (95% CI)	Test statistic	p value
Daily screen time, hours, mean (SD)	7.1 (2.0)	5.2 (1.8)	MD: 1.9 (1.3-2.5)	$t=6.68$	<0.001
Screen exposure category				$\chi^2=16.89$	<0.001
<4 hours/day	13 (33.3)	26 (66.7)	Reference		
4-6 hours/day	31 (52.5)	28 (47.5)	OR: 2.21 (0.96-5.12)		0.063
>6 hours/day	59 (72.0)	23 (28.0)	OR: 5.14 (2.24-11.76)		<0.001
Uninterrupted screen use ≥ 2 hours	67 (70.5)	28 (29.5)	OR: 3.26 (1.76-6.03)	$\chi^2=14.55$	<0.001
Irregular screen breaks	79 (67.5)	38 (32.5)	OR: 3.38 (1.78-6.40)	$\chi^2=14.49$	<0.001
Air-conditioner exposure ≥ 6 hours/day	61 (67.8)	29 (32.2)	OR: 2.40 (1.31-4.41)	$\chi^2=8.19$	0.004
Perceived low workplace humidity	58 (69.9)	25 (30.1)	OR: 2.68 (1.45-4.96)	$\chi^2=10.08$	0.001
Screen-viewing distance <50 cm	62 (66.7)	31 (33.3)	OR: 2.24 (1.23-4.10)	$\chi^2=7.01$	0.008
Frequent screen glare	54 (66.7)	27 (33.3)	OR: 2.04 (1.11-3.75)	$\chi^2=5.37$	0.021

Table 3 shows a significant association between digital-screen exposure, workplace conditions and DED. Participants with DED had a significantly longer mean daily screen time than those without DED (7.1±2.0 versus 5.2±1.8 hours), with a mean difference of 1.9 hours (95% CI: 1.3-2.5; $t=6.68$, $p<0.001$). DED prevalence increased from 33.3% among participants using screens for less than four hours per day to 52.5% among those using screens for four to six hours and 72.0% among those exposed for more than six hours ($\chi^2=16.89$, $p<0.001$). Compared with exposure below four hours, exposure exceeding six hours was associated with 5.14 times

higher odds of DED (95% CI: 2.24-11.76, $p<0.001$), whereas the association for four to six hours was not statistically significant (OR=2.21; 95% CI: 0.96-5.12; $p=0.063$). Uninterrupted screen use for at least two hours (OR=3.26, $p<0.001$) and irregular screen breaks (OR=3.38, $p<0.001$) were significantly associated with DED. Prolonged air-conditioner exposure (OR=2.40, $p=0.004$), low workplace humidity (OR=2.68, $p=0.001$), a viewing distance below 50 cm (OR=2.24, $p=0.008$) and frequent screen glare (OR=2.04, $p=0.021$) were also significant workplace-related factors.

Table 4: Sociodemographic, behavioural, ocular and systemic factors associated with dry eye disease (N=180)

Factor	DED present (n=103)	DED absent (n=77)	Crude OR (95% CI)	Adjusted OR (95% CI)	Wald χ^2	p value
Age, years, mean (SD)	39.4 (6.8)	36.7 (7.1)	MD: 2.7 (0.6-4.8)	1.06/year (1.01-1.11)	5.43	0.020
Female sex	62 (66.7)	31 (33.3)	2.24 (1.23-4.10)	2.08 (1.06-4.06)	4.54	0.033
Current smoking	24 (70.6)	10 (29.4)	2.04 (0.91-4.56)	1.61 (0.66-3.93)	1.09	0.296
Contact-lens use	17 (73.9)	6 (26.1)	2.34 (0.88-6.25)	2.73 (0.93-8.02)	3.34	0.068

Spectacle use	58 (62.4)	35 (37.6)	1.55 (0.85-2.80)	1.29 (0.65-2.56)	0.53	0.466
Meibomian gland dysfunction	47 (78.3)	13 (21.7)	4.13 (2.03-8.41)	3.67 (1.68-8.02)	10.66	0.001
Diabetes mellitus	18 (72.0)	7 (28.0)	2.12 (0.84-5.36)	1.87 (0.67-5.22)	1.43	0.232
Regular antihistamine use	21 (72.4)	8 (27.6)	2.21 (0.92-5.30)	2.11 (0.81-5.47)	2.36	0.124
Daily screen exposure >6 hours	59 (72.0)	23 (28.0)	3.07 (1.64-5.74)§	2.89 (1.43-5.84)	8.72	0.003
Irregular screen breaks	79 (67.5)	38 (32.5)	3.38 (1.78-6.40)	2.76 (1.34-5.69)	7.51	0.006
Low workplace humidity	58 (69.9)	25 (30.1)	2.68 (1.45-4.96)	2.31 (1.14-4.69)	5.37	0.020

§For the multivariable analysis, screen exposure >6 hours/day was compared with exposure ≤6 hours/day.

Model statistics: Omnibus likelihood-ratio $\chi^2=58.73$, $p<0.001$; Hosmer-Lemeshow $\chi^2=6.21$, $p=0.624$; Nagelkerke $R^2=0.38$.

Abbreviations: OR, odds ratio; MD, mean difference; CI, confidence interval.

Table 4 presents the sociodemographic, behavioural, ocular and systemic factors associated with DED. Participants with DED were older than those without DED (39.4±6.8 versus 36.7±7.1 years), with a mean difference of 2.7 years (95% CI: 0.6-4.8). After adjustment, each additional year of age was associated with a 6% increase in the odds of DED (aOR=1.06; 95% CI: 1.01-1.11; $p=0.020$). Female participants had approximately twice the adjusted odds of DED compared with males (aOR=2.08; 95% CI: 1.06-4.06; $p=0.033$). Meibomian gland dysfunction showed the strongest independent association, increasing the odds of DED by 3.67 times (95% CI: 1.68-8.02; $p=0.001$). Daily screen exposure exceeding six hours (aOR=2.89; 95% CI: 1.43-5.84; $p=0.003$), irregular screen breaks (aOR=2.76; 95% CI: 1.34-5.69; $p=0.006$) and low workplace humidity (aOR=2.31; 95% CI: 1.14-4.69; $p=0.020$) remained significant independent predictors. Smoking, contact-lens use, spectacle use, diabetes mellitus and regular antihistamine use were not independently associated with DED because their confidence intervals included unity and their p values exceeded 0.05. The regression model was statistically significant (likelihood-ratio $\chi^2=58.73$, $p<0.001$), demonstrated satisfactory calibration (Hosmer-Lemeshow $p=0.624$) and explained approximately 38% of the variation in DED according to the Nagelkerke R^2 .

DISCUSSION

The present cross-sectional study assessed the prevalence, clinical severity and associated factors of dry eye disease (DED) among 180 office workers aged 25-50 years. The mean age of the participants was 38.2±7.1 years. Overall, 103 participants were diagnosed with DED, giving a prevalence of 57.2% (95% CI: 49.9%-64.2%). OSDI-positive symptoms were present in 62.2%, abnormal tear-film break-up time (TBUT) in 60.6%, reduced Schirmer I test values in 46.7% and positive ocular-surface staining in 37.8%. These findings indicate that DED represents a substantial occupational health problem among office workers. According to Craig et al.

(2017).^[1] DED is a multifactorial disease resulting from disruption of tear-film homeostasis, involving tear-film instability, hyperosmolarity, inflammation, ocular-surface damage and neurosensory abnormalities. Stapleton et al. (2017).^[2] reported marked variation in DED prevalence across studies because of differences in populations, diagnostic criteria and assessment methods.

The observed prevalence of 57.2% was consistent with the systematic review and meta-analysis by Courtin et al. (2016).^[3] which established that DED was common among visual-display-terminal workers. The present prevalence was higher than the 32% reported by Titiyal et al. (2018).^[4] in a North Indian hospital-based population. Their study nevertheless found that desk jobs and increased duration of visual-display-terminal use were associated with DED.^[4] The difference in prevalence may be related to the exclusive inclusion of office workers in the present study, who constituted an occupationally exposed group, whereas Titiyal et al. studied a broader clinical population.

Vayisoğlu et al. (2019).^[5] reported dry-eye symptoms in 72% of university lecturers, including mild symptoms in 20.5%, moderate symptoms in 15.0% and severe symptoms in 36.5%. Their mean participant age of 39.29±9.41 years was also comparable with the mean age of 38.2±7.1 years in the present study. Daily computer-use duration was significantly correlated with OSDI score in their study.^[5] Rossi et al. (2019).^[6] reported definite dry eye in 23.4% and suspected dry eye in 44.4% of visual-display-terminal workers in Italy. They found that older age and screen exposure exceeding four hours per day increased the likelihood of DED.^[6] Differences in prevalence across these studies probably resulted from variations in climate, occupation, screen exposure and diagnostic definitions.

In an urban Indian population, Chatterjee et al. (2021).^[7] reported a considerably lower age-adjusted prevalence of dry-eye symptoms of 6.8%. However, digital-display use, female sex, smoking and exposure to air-conditioned environments were identified as important associated factors.^[7] The much lower prevalence in their study could be explained by its community-based population, symptom-based definition and inclusion of people with varying degrees of occupational screen exposure. In comparison, Chaitra et al. (2022).^[8] reported a DED prevalence of 51% among computer operators in India, which was close to the 57.2% observed in the present study. Their study also used

the OSDI, TBUT and Schirmer I test and concluded that computer users were predisposed to DED.^[8] Regarding severity, 14.4% of all participants had mild DED, 17.2% had moderate DED and 25.6% had severe DED. Among the 103 participants with DED, 44.7% had severe disease, making it the most frequent severity category. Titiyal et al. (2018).^[4] reported severe DED in 28.9% of affected patients, while Vayisoğlu et al. (2019).^[5] documented severe symptoms in 36.5% of lecturers. Rashid et al. (2020).^[11] found an OSDI-defined DED prevalence of 64.2% and severe symptoms in 35% of garment workers. The relatively high proportion of severe DED in the present study may reflect prolonged screen exposure, uninterrupted computer work, air-conditioning and inadequate workplace humidity. A progressive deterioration in clinical parameters was observed with increasing DED severity. The mean OSDI score increased from 17.8±2.7 in mild DED to 44.6±8.1 in severe DED ($p<0.001$). Conversely, the mean TBUT decreased from 8.4±1.3 to 5.1±1.8 seconds, while the mean Schirmer I value decreased from 11.1±3.2 to 7.2±2.9 mm/5 minutes (both $p<0.001$). Jain and Pandey (2020).^[9] similarly found higher OSDI scores and significantly lower TBUT and Schirmer values among employees using computers for more than six hours daily. They also reported significant inverse correlations of OSDI score with both TBUT and Schirmer test values.^[9] These observations support the presence of increasing tear-film instability and impaired tear production with worsening symptoms. Ocular-surface staining increased from 26.9% in mild DED to 80.4% in severe DED. Similarly, meibomian gland dysfunction increased from 34.6% to 73.9%. Participants with severe DED had more than fivefold higher odds of meibomian gland dysfunction than those with mild disease. Rashid et al. (2020).^[11] also demonstrated significant relationships between OSDI score, increasing meibomian gland dysfunction grade, reduced TBUT and reduced Schirmer values among occupational workers.^[11] These findings indicate that evaporative dysfunction arising from meibomian-gland abnormalities was an important component of office-related DED. Participants with DED reported a significantly greater mean daily screen time than those without DED (7.1±2.0 versus 5.2±1.8 hours; mean difference: 1.9 hours, 95% CI: 1.3-2.5; $p<0.001$). DED prevalence increased from 33.3% in workers using screens for less than four hours to 72.0% among those using screens for more than six hours. Screen exposure exceeding six hours was associated with 5.14 times higher unadjusted odds and 2.89 times higher adjusted odds of DED. Zeleke et al. (2022).^[10] reported a similar exposure-response relationship: continuous visual-display-unit use for two to four hours and more than four hours was associated with adjusted odds ratios of 2.57 and 3.77, respectively.^[10] Fjaervoll et al. (2022).^[12] also concluded that visual-display-terminal use was strongly associated with DED, although prevalence

estimates differed because of inconsistent definitions and diagnostic criteria.

Uninterrupted screen use for at least two hours and irregular breaks were associated with more than threefold higher odds of DED. Prolonged concentration during screen viewing reduces blink frequency and increases incomplete blinking, thereby increasing ocular-surface exposure and tear evaporation. Wolffsohn et al. (2023).^[13] described reduced blink rate, incomplete blinking, increased palpebral aperture and prolonged digital tasks as important mechanisms linking the digital environment with tear-film instability and ocular discomfort. The present findings therefore support the implementation of regular visual breaks and conscious blinking during computer work. Environmental and ergonomic factors were also significantly associated with DED. Air-conditioner exposure for at least six hours daily increased the odds of DED by 2.40 times, while low workplace humidity increased the odds by 2.68 times. Screen-viewing distance below 50 cm and frequent screen glare were associated with 2.24 and 2.04 times higher odds, respectively. These findings were consistent with previous evidence that low humidity, direct airflow, glare and improper monitor positioning promote tear evaporation and visual discomfort.^[7,13] The association of low workplace humidity remained significant after multivariable adjustment (aOR=2.31; 95% CI: 1.14-4.69; $p=0.020$). Increasing age, female sex, meibomian gland dysfunction, screen exposure exceeding six hours, irregular breaks and low workplace humidity were independent predictors of DED. Each additional year of age increased the odds by 6%, while female participants had approximately twice the odds of DED compared with males. Stapleton et al. (2017).^[2] identified increasing age and female sex as consistent non-modifiable risk factors. Meibomian gland dysfunction was the strongest independent predictor in the present study (aOR=3.67; 95% CI: 1.68-8.02; $p=0.001$), emphasizing the importance of evaluating eyelid and meibomian-gland health in office workers. Smoking, contact-lens use, spectacle use, diabetes mellitus and regular antihistamine use showed elevated crude odds but were not independently associated with DED. The absence of statistical significance should be interpreted cautiously because relatively few participants reported some of these exposures, resulting in wide confidence intervals. Overall, the regression model was statistically significant and demonstrated satisfactory fit, explaining approximately 38% of the variation in DED. The findings highlight the combined contribution of personal susceptibility, ocular-surface abnormalities, screen-use patterns and workplace environmental conditions.

CONCLUSION

Dry eye disease was highly prevalent among office workers aged 25-50 years, affecting 57.2% of the

participants. Severe DED constituted the largest proportion among affected workers. Increasing disease severity was associated with higher OSDI scores, reduced tear-film break-up time, reduced Schirmer values, ocular-surface staining and meibomian gland dysfunction.

Prolonged daily screen exposure, uninterrupted screen use, irregular screen breaks, extended air-conditioner exposure, low workplace humidity, short viewing distance and screen glare were significantly associated with DED. Increasing age, female sex, meibomian gland dysfunction, screen exposure exceeding six hours, irregular breaks and low workplace humidity remained independent predictors. Workplace eye-health programmes should therefore promote regular screen breaks, conscious and complete blinking, appropriate screen distance, glare reduction, adequate environmental humidity and periodic ophthalmic screening.

Limitations of Study

1. The cross-sectional design prevented the establishment of a temporal or causal relationship between digital-screen exposure and DED.
2. The study was conducted among office workers from selected workplaces; therefore, its findings may not be generalizable to all occupational groups or geographical settings.
3. Daily screen time, frequency of breaks and workplace exposures were self-reported and were therefore susceptible to recall and reporting bias.
4. Screen exposure from computers, smartphones, tablets and television was not objectively measured using device-based tracking applications.
5. Workplace humidity, airflow, temperature, illumination and screen glare were not measured using standardized environmental instruments.
6. The OSDI is a subjective symptom-based instrument and may be influenced by individual symptom perception and recent environmental exposure.
7. Tear-film tests, particularly TBUT and the Schirmer I test, are affected by environmental conditions, test sequence and reflex tearing.
8. The study did not assess tear osmolarity, tear-film inflammatory biomarkers, meibography or non-invasive tear-film break-up time.

9. Some risk-factor subgroups, including contact-lens users, smokers, participants with diabetes and regular antihistamine users, were relatively small, reducing statistical power and producing wide confidence intervals.
10. Residual confounding from sleep quality, hydration, dietary factors, hormonal status, mental stress and recreational screen exposure could not be excluded.

REFERENCES

1. Craig JP, Nichols KK, Akpek EK, Caffery B, Dua HS, Joo CK, et al. TFOS DEWS II definition and classification report. *Ocul Surf*. 2017;15(3):276-283.
2. Stapleton F, Alves M, Bunya VY, Jalbert I, Lekhanont K, Malet F, et al. TFOS DEWS II epidemiology report. *Ocul Surf*. 2017;15(3):334-365.
3. Courtin R, Pereira B, Naughton G, Chamoux A, Chiambaretta F, Lanhers C, et al. Prevalence of dry eye disease in visual display terminal workers: a systematic review and meta-analysis. *BMJ Open*. 2016;6(1):e009675.
4. Titiyal JS, Falera RC, Kaur M, Sharma V, Sharma N. Prevalence and risk factors of dry eye disease in North India: Ocular Surface Disease Index-based cross-sectional hospital study. *Indian J Ophthalmol*. 2018;66(2):207-211.
5. Vayisoğlu SK, Öncü E, Dursun Ö, Dinç E. Investigation of dry eye symptoms in lecturers by Ocular Surface Disease Index. *Turk J Ophthalmol*. 2019;49(3):142-148.
6. Rossi GCM, Scudeller L, Bettio F, Pasinetti GM, Bianchi PE. Prevalence of dry eye in video display terminal users: a cross-sectional Caucasian study in Italy. *Int Ophthalmol*. 2019;39(6):1315-1322.
7. Chatterjee S, Agrawal D, Sanowar G, Kandoi R. Prevalence of symptoms of dry eye disease in an urban Indian population. *Indian J Ophthalmol*. 2021;69(5):1061-1066.
8. Chaitra MC, Akhil J, Meghana K, Lavanya SJ, Navya YS, Lathasri B. Dry eye among computer operators at a tertiary care centre in India. *Bioinformation*. 2022;18(10):912-915.
9. Jain AK, Pandey DJ. Assessment of the impact of varying durations of computer usage on dry eye parameters in employees of a tertiary care teaching hospital of Uttar Pradesh, India. *J Clin Diagn Res*. 2020;14(7):NC01-NC05.
10. Zeleke TC, Adimassu NF, Alemu HW, Tsegaye BS. Symptomatic dry eye disease and associated factors among postgraduate students in Ethiopia. *PLoS One*. 2022;17(8):e0272808.
11. Rashid MA, Teo CHY, Mamun S, Ong HS, Tong L. Prevalence and risk factors of severe dry eye in Bangladesh-based factory garment workers. *Diagnostics (Basel)*. 2020;10(9):634.
12. Fjaervoll H, Fjaervoll K, Magno M, Moschowits E, Vehof J, Dartt DA, et al. The association between visual display terminal use and dry eye: a review. *Acta Ophthalmol*. 2022;100(4):357-375.
13. Wolffsohn JS, Lingham G, Downie LE, Huntjens B, Inomata T, Jivraj S, et al. TFOS Lifestyle: Impact of the digital environment on the ocular surface. *Ocul Surf*. 2023;28:213-252.