Original Article

Assessment of Prevalence of Dry Eye Disease amongst Adults with Screen Exposure of More than Six Hours at the Workplace

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Abstract

Background: Dry eye disease (DED) is a multifactorial disorder of the ocular surface characterised by loss of tear film homeostasis.1 Prolonged, uninterrupted near work on digital displays is one of the most consistently reported modifiable risk factors for DED, acting through a reduced and incomplete blink pattern, increased tear evaporation and tear film instability.15,16,22 Working adults whose screen exposure is occupational rather than recreational represent a large but comparatively under-characterised group in the Indian setting. The aim is to assess the prevalence, pattern and severity of dry eye disease among adults aged 20 to 50 years with occupational screen exposure exceeding six hours per day, using a self-administered symptom questionnaire and Schirmer's I test. **Material and Methods:** A cross-sectional, observational, descriptive-analytical study was conducted in the ophthalmology out-patient department of a tertiary eye care hospital in Maharashtra. Two hundred adults aged 20 to 50 years with an average occupational screen time of more than six hours per day for at least the preceding three to six months were enrolled by consecutive sampling after written informed consent. Participants with pre-existing ocular surface disease, contact lens wear, recent ocular surgery, systemic disease or medication known to reduce tear secretion, and lid or adnexal abnormalities were excluded. Each participant completed a ten-item symptom questionnaire, from which dry eye was graded as normal, mild, moderate or severe. Screen time was stratified as 6–8 hours, 8–10 hours and more than 10 hours per day. Schirmer's I test was performed and graded according to the Dry Eye WorkShop (DEWS) criteria as more than 15 mm (normal), 10–15 mm (mild), 5–10 mm (moderate) and less than 5 mm (severe). **Results:** Dry eye disease was identified in 88 of 200 participants, giving a prevalence of 44%. Of these, mild dry eye was seen in 38 participants (19%), moderate in 20 (10%) and severe in 30 (15%); 112 participants (56%) were graded as normal. Across the three exposure bands, dry eye of any severity was present in 53.73% (36 of 67) of those using screens for 6 to 8 hours daily, 33.33% (28 of 84) of those using them for 8 to 10 hours and 48.98% (24 of 49) of those exposed for more than 10 hours. Severe dry eye, however, was concentrated in the most heavily exposed group, affecting 26.53% of those using screens for more than 10 hours daily as against 11.94% and 10.71% in the two lower bands, and the association between exposure band and severity grade was statistically significant ($\chi^2 = 14.63$, df = 6, $p = 0.023$). Mean Schirmer's I values declined progressively across symptom grades, from approximately 16–18 mm in the normal group to approximately 4–6 mm in the severe group, and the proportion of participants with an abnormal Schirmer value of less than 10 mm rose from 7.7% in the normal group to 38.3%, 76.1% and 92.4% in the mild, moderate and severe groups respectively. **Conclusion:** Nearly one in two adults with more than six hours of daily occupational screen exposure had symptomatic dry eye disease. Overall prevalence did not rise linearly with exposure band, but severe disease was significantly more frequent among those exposed for more than ten hours daily, indicating that very prolonged exposure acts chiefly by aggravating severity. Symptom grading showed good concordance with aqueous tear deficiency on Schirmer's testing, supporting the use of a brief questionnaire as a practical screening instrument in this population. Workplace ocular health programmes incorporating scheduled screen breaks, blink awareness and ergonomic correction are warranted.

Keywords: Dry eye disease, digital eye strain, computer vision syndrome, occupational screen time, Schirmer's test, tear film, ocular surface.

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Introduction

Dry eye disease (DED) is a multifactorial disease of the ocular surface characterised by a loss of homeostasis of the tear film, and accompanied by ocular symptoms in which tear film instability and hyperosmolarity, ocular surface inflammation and damage, and neurosensory abnormalities play aetiological roles. This definition, formalised by the Tear Film and Ocular Surface Society Dry Eye WorkShop II (TFOS DEWS II) in 2017, replaced the earlier 2007 International Dry Eye WorkShop definition and placed tear film homeostasis at the centre of the disease concept.[1-5] Clinically, patients describe dryness, grittiness or a foreign body sensation, burning, redness, reflex watering, photophobia and fluctuating or blurred vision that improves transiently after

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blinking. Although DED is only rarely sight-threatening, it carries a substantial burden of chronic discomfort, reduced visual function, impaired performance of vision-dependent tasks and measurable loss of quality of life, and it is among the most frequent reasons for ophthalmic out-patient consultation worldwide.[3,6-10]

The pathophysiology of DED is now understood as a self-perpetuating cycle. Tear hyperosmolarity, arising either from reduced aqueous secretion or from excessive evaporation, injures the surface epithelium and activates inflammatory cascades; the resulting epithelial and goblet cell damage further destabilises the tear film, establishing the vicious circle of dry eye described in the TFOS DEWS II pathophysiology report.[4] Two principal, and frequently overlapping, subtypes are recognised: aqueous-deficient dry eye, in which lacrimal secretion is inadequate, and evaporative or lipid-deficient dry eye, most often secondary to meibomian gland dysfunction.[1,4] This distinction is clinically relevant because the two subtypes are detected by different tests; Schirmer's test, which quantifies aqueous secretion, specifically interrogates the aqueous-deficient component.[2]

Prolonged near work on digital displays — smartphones, laptops, desktop monitors and tablets — is among the most consistently reported modifiable risk factors for DED. Sustained screen fixation reduces the spontaneous blink rate and, more importantly, increases the proportion of incomplete blinks, so that the inferior cornea is inadequately resurfaced with tears.[11-16] Experimental work has demonstrated that blink rate falls and tear break-up occurs earlier during visually demanding tasks on a screen than during comparable tasks on hard copy, and that visual display terminal (VDT) use is associated with lacrimal hypofunction and altered tear mucin expression.[17] A widened palpebral aperture from the elevated gaze angle typical of desktop monitor use further increases the exposed ocular surface area and the rate of tear evaporation.[7] Meibomian gland morphological change has also been shown to track with dry eye severity in long-term VDT workers, implicating an evaporative component alongside aqueous deficiency.[18-22] This constellation of ocular and visual symptoms arising from screen use is described clinically as computer vision syndrome, or more recently digital eye strain, of which dry eye is the central ocular surface component.[6-8]

The epidemiological consequences of this exposure are well documented in occupational cohorts. A systematic review and meta-analysis of VDT workers reported pooled dry eye prevalence estimates substantially in excess of those seen in the general population,[11] and large Japanese office-worker cohorts have reported definite or probable dry eye in a majority of screen-exposed employees, together with measurable loss of work productivity attributable to ocular symptoms.[9,10] Reported prevalence in screen-using populations nonetheless varies widely, from roughly one fifth to over two thirds of those surveyed, reflecting genuine differences in exposure as well as heterogeneity in case definitions, questionnaires and diagnostic thresholds.[11,24] In India, hospital-based and electronic medical record–driven analyses have confirmed a considerable and apparently rising burden of DED, with a shift in presentation towards younger, urban, screen-exposed adults,[12,20] a trend accentuated during the COVID-19 period when daily device use and symptom reporting both increased sharply.[21,23]

Despite this, a distinct and, in the Indian context, comparatively under-studied group is that of working adults aged 20 to 50 years whose screen exposure is occupational rather than discretionary: information technology professionals, call-centre staff, data-entry and back-office employees, software developers, accountants and similar roles that routinely demand more than six continuous hours of screen use per working day. Much of the published Indian literature has focused either on medical and other undergraduate students or on hospital out-patients considered without reference to occupational exposure, and comparatively few studies have combined a graded symptom instrument with an objective measure of tear secretion in this specific working population. With hybrid and screen-intensive work arrangements now normalised, and with occupational screen exposure representing a modifiable target for workplace intervention, characterising the dry eye burden in this group has direct clinical and public health relevance.

The present study was therefore undertaken to assess occupational screen time and to evaluate dry eye disease using both a self-administered symptom questionnaire and Schirmer's I test, among adults aged 20 to 50 years attending the out-patient department of a tertiary eye care hospital in Maharashtra with more than six hours of daily workplace screen exposure.

Aim and Objectives

Aim

To assess the presence, pattern and severity of dry eye disease among adults aged 20 to 50 years with occupational screen exposure of more than six hours per day, using a self-administered symptom-based questionnaire and Schirmer's I test.

Objectives

1. To determine the prevalence of dry eye disease among adults aged 20 to 50 years with more than six hours of daily occupational screen exposure attending the ophthalmology out-patient department of a tertiary eye care hospital.
2. To grade the severity of dry eye disease in the study population as mild, moderate or severe using a ten-item self-administered symptom questionnaire, and to describe the pattern and relative frequency of individual ocular symptoms.
3. To measure tear secretion objectively by Schirmer's I test and to classify the findings according to Dry Eye WorkShop (DEWS) criteria, thereby assessing the degree of agreement between symptom-based grading and objective aqueous tear deficiency.
4. To study the association between the duration of daily occupational screen exposure (6–8 hours, 8–10 hours and more than 10 hours per day) and the presence and severity of dry eye disease, and to examine the influence of the frequency of breaks taken during screen use.

Review of Literature

Evolution of the definition and classification of dry eye disease

The conceptual understanding of dry eye has undergone substantial revision over three decades. The National Eye Institute/Industry workshop of 1995 first offered a working classification separating tear-deficient from evaporative dry eye.

The International Dry Eye WorkShop of 2007 subsequently defined dry eye as a multifactorial disease of the tears and ocular surface producing symptoms of discomfort, visual disturbance and tear film instability with potential damage to the ocular surface, and introduced tear film hyperosmolarity and ocular surface inflammation into the definition.5 The TFOS DEWS II report of 2017 refined this further, making loss of tear film homeostasis the central feature and adding neurosensory abnormality as an aetiological component, while retaining the aqueous-deficient and evaporative aetiopathogenic axes.[1] The accompanying pathophysiology report consolidated the concept of a vicious circle in which hyperosmolarity, inflammation and epithelial damage reinforce one another,[4] and the diagnostic methodology report proposed a structured sequence of homeostasis markers followed by subtype classification tests.[2]

Mechanisms linking digital screen exposure to ocular surface disease

Several converging mechanisms have been described. Freudenthaler and colleagues demonstrated that spontaneous eyeblink activity is markedly altered during VDT use in healthy volunteers, with a reduction in blink frequency and an increase in incomplete blinks.[16] Portello and co-workers subsequently showed that it is the proportion of incomplete blinks, rather than the absolute blink rate alone, that correlates most strongly with symptoms of computer vision syndrome.[15] Himebaugh and colleagues recorded blinking and tear break-up across four different visual tasks and found that tear film break-up within the interblink interval was commonest during the most visually demanding tasks,[25] and comparative work has confirmed that blink patterns differ between reading from a screen and reading hard copy. At the glandular level, Nakamura and colleagues identified lacrimal hypofunction with altered mucin expression in VDT users,[17] while Wu and co-workers demonstrated that meibomian gland dysfunction determines the severity of dry eye in long-term VDT workers, indicating that evaporative mechanisms operate alongside aqueous deficiency.[22] Reviews by Rosenfield,[7] Sheppard and Wolffsohn,[6] Jaiswal and colleagues,[29] and Talens-Estarelles and colleagues26 have additionally emphasised the contribution of non-ocular-surface factors, including accommodative and vergence demand, uncorrected refractive error, gaze angle, display luminance and contrast, and ambient airflow and humidity.

Prevalence of dry eye disease in the general population

Population-based estimates provide the comparator against which occupational cohorts must be judged. In the Beaver Dam study, Moss and colleagues reported dry eye in 14.4% of adults aged 48 to 91 years and identified increasing age, female sex and certain systemic medications as risk factors.[14] Schaumberg and colleagues estimated the prevalence of dry eye syndrome at 7.8% among United States women,[27] and 4.3% among United States men,[13] confirming a consistent female preponderance. The TFOS DEWS II epidemiology report, synthesising studies worldwide, placed prevalence between approximately 5% and 50% depending on the diagnostic criteria applied, with symptom-based definitions yielding systematically higher estimates than sign-based definitions, and identified Asian ethnicity, female sex, increasing age and visual display terminal use among the consistent risk factors.[3]

Dry eye disease in screen-exposed and occupational cohorts

Occupationally exposed cohorts show considerably higher figures. Uchino and colleagues, in a large cross-sectional study of Japanese office workers using visual display terminals, reported definite or probable dry eye in a substantial majority of those screened, with prevalence rising with daily duration of VDT use.[9] The subsequent Osaka study by the same group linked dry eye disease in VDT users to quantifiable loss of work productivity, establishing an economic dimension to the problem.[10] Courtin and colleagues, in a systematic review and meta-analysis of VDT workers, confirmed a markedly elevated pooled prevalence relative to the general population while drawing attention to the heterogeneity of diagnostic definitions across studies.[11] Reviews focused specifically on the screen–dry eye relationship by Mehra and Galor,[24] and Al-Mohtaseb and colleagues,[28] have concluded that a duration–response relationship is consistently observed, that symptoms tend to exceed signs in this population, and that interventions directed at blink completeness and break frequency are the most promising modifiable targets. Kaur and colleagues, in a comprehensive review of digital eye strain, similarly identified continuous screen duration without breaks as the single most important determinant of symptom severity.[30]

Indian studies and the post-pandemic context

Indian data confirm a significant and evolving burden. Titiyal and colleagues, in an Ocular Surface Disease Index–based cross-sectional hospital study from North India, reported dry eye disease in a substantial proportion of out-patients and identified prolonged visual display terminal use among the significant risk factors.[12] Donthineni and colleagues, analysing a large electronic medical record–driven dataset, described the incidence, demographic profile and risk factors of DED across India and noted a predominance of evaporative and mixed subtypes together with a shift in presentation towards younger, urban, screen-exposed adults.[20] The COVID-19 period accentuated this exposure: Bahkir and Grandee documented a mean increase of nearly five hours in daily device use during lockdown, with the overwhelming majority of respondents reporting at least one device-related ocular symptom,[23] and Ganne and colleagues described a comparable epidemic of digital eye strain in a cross-sectional Indian survey.[21] Taken together, these studies establish occupational screen exposure as a relevant and growing contributor to the Indian dry eye burden.

Diagnostic approaches: Questionnaires and Schirmer's test

Because symptoms and clinical signs correlate only moderately in dry eye, current practice combines a validated symptom instrument with objective testing.[2] Established questionnaires include the Ocular Surface Disease Index, whose reliability and validity were established by Schiffman and colleagues,18 and the five-item Dry Eye Questionnaire validated by Chalmers and colleagues, which discriminates across self-assessed severity and aqueous tear deficiency.[19] Schirmer's I test, performed without anaesthesia, remains the most widely used office measure of aqueous tear production, particularly in resource-conscious settings; the DEWS classification grades values above 15 mm as normal, 10 to 15 mm as mild, 5 to 10 mm as moderate and below 5 mm as severe aqueous deficiency.[5] Although Schirmer's test

is acknowledged to have limited repeatability and poor sensitivity for purely evaporative disease, it retains good specificity for aqueous-deficient dry eye and remains valuable when paired with symptom grading.[2] The present study adopts precisely this combined approach.

Identified gap in the literature

The literature reviewed above establishes that screen exposure is associated with dry eye, and that the Indian burden is appreciable and rising. Three gaps nonetheless remain. First, much of the Indian evidence derives from student populations, whose screen exposure is discretionary and intermittent, rather than from working adults whose exposure is continuous and occupationally mandated. Second, many studies rely on symptom questionnaires alone, without a concurrent objective measure of tear secretion, limiting any assessment of the relationship between reported symptoms and measurable tear deficiency. Third, few studies stratify exposure quantitatively beyond a single threshold, so that any duration–response gradient above six hours per day remains poorly characterised. The present study addresses these gaps by applying a graded symptom questionnaire together with Schirmer's I test in a defined occupationally screen-exposed adult cohort, with exposure stratified into three bands.

Materials and Methods

Study Design: Cross-sectional, observational, descriptive-analytical study.

Study Setting: The study was conducted in the out-patient department of the Department of Ophthalmology of a tertiary eye care hospital in Maharashtra, India. The department receives both self-referred and referred patients from the surrounding urban and peri-urban catchment area, which includes a substantial working population employed in screen-intensive occupations.

Study Duration: 12 months

Study Population: Adults aged 20 to 50 years of either sex attending the ophthalmology out-patient department, whose occupation required an average of more than six hours of digital screen use per working day.

Sample Size: Two hundred participants were included in the study. The sample size was estimated using the standard formula for the estimation of a single proportion in a cross-sectional study, $n = Z^2pq/d^2$, where Z is 1.96 for a 95% confidence level, p is the anticipated prevalence of dry eye disease in screen-exposed adults based on previously published literature, q is $(1 - p)$ and d is the absolute permissible error. Taking an anticipated prevalence of approximately 50% from reported studies of visual display terminal workers9,11 with an absolute permissible error of 7%, the minimum required sample size was approximately 196, which was rounded up to 200 participants.

Sampling Technique: Consecutive non-probability sampling was used. All patients attending the out-patient department during the study period who satisfied the inclusion criteria and consented to participate were enrolled in sequence until the required sample size of 200 was reached.

Ethical Considerations: The study was conducted in accordance with the principles of the Declaration of Helsinki. Written informed consent was obtained from every participant prior to enrolment, after the nature and purpose of the study, the procedures involved and the right to withdraw at any stage had been explained in a language the participant understood. Participant data were anonymised and handled confidentially, and were used solely for the purposes of this study. Participants found to have clinically significant dry eye disease or any other ocular pathology during the course of the study were counselled and offered appropriate treatment and follow-up in the department irrespective of their participation.

Inclusion Criteria

- Patients aged 20 to 50 years, of either sex.
- Patients with average total daily occupational screen time of more than six hours for at least the preceding three to six months.
- Patients who are willing to and able to complete, or have administered to them, the self-administered questionnaire.
- Patients who are willing to provide written informed consent.

Exclusion Criteria

- Pre-existing diagnosed dry eye disease or other ocular surface disorder predating the current screen-exposure period.
- History of ocular surgery, including cataract or refractive surgery, within the preceding six months.
- Current contact lens wearers, contact lens wear being a well-recognised independent risk factor for dry eye, excluded in order to reduce confounding.
- Known systemic disease associated with dry eye, for example Sjögren syndrome, rheumatoid arthritis or other autoimmune disease, uncontrolled diabetes mellitus, or thyroid eye disease.
- Regular use of systemic medications known to reduce tear secretion, including antihistamines, antidepressants and other anticholinergics, isotretinoin and beta-blockers.
- Active ocular allergy, infection, or lid-margin disease at the time of examination.
- Significant eyelid malposition or lagophthalmos of any cause.
- Uncorrected significant refractive error affecting screen-viewing posture or distance.

Method of Data Collection: This cross-sectional study was conducted in the out-patient department of a tertiary eye care hospital in Maharashtra. The study population consisted of individuals attending the out-patient department, and adults aged 20 to 50 years fulfilling the inclusion criteria were enrolled. A total of 200 participants were included. Written informed consent was obtained from all participants before enrolment.

A single investigator collected all data in order to minimise inter-observer variation. For each participant, demographic and occupational details were first recorded on a predesigned proforma, comprising age, sex, occupation and nature of work, average total daily screen time and the frequency of breaks taken during screen use. A relevant ocular and systemic history was elicited, including previous ocular surgery, contact lens wear, current topical and systemic medication and known systemic illness, in order to apply the exclusion criteria.

Each participant enrolled in the study was then asked about presenting symptoms using a ten-item questionnaire of symptoms relating to dry eye, which included the sensation of

dryness, a gritty or sandy sensation, burning or stinging, redness, excessive watering, blurred vision improving transiently after blinking, heaviness or tiredness of the eyes towards the end of the day, photophobia, worsening of discomfort during or soon after screen use, and difficulty continuing near work because of ocular discomfort. Each item was answered on a four-point frequency scale as never, sometimes, often or always, with reference to the preceding one week. Responses were then graded as normal, mild, moderate or severe dry eye according to the predefined grading rules set out below. Where a participant had difficulty with the written format, the questionnaire was administered verbatim by the investigator in the participant's preferred language.

In addition to the questionnaire, screen time usage was recorded. Screen time was assessed and stratified as 6–8 hours, 8–10 hours and more than 10 hours per day. The frequency of breaks during screen use was recorded as none, one break, or two or more breaks during the working day.

All participants then underwent a standard anterior segment evaluation on the slit lamp biomicroscope, including assessment of the lid margins, meibomian gland orifices, conjunctiva, tear meniscus height and cornea, together with recording of visual acuity and refractive status, in order to confirm eligibility and to exclude active lid margin disease, allergy or infection.

Schirmer's I Test: Technique

Schirmer's I test was carried out in the out-patient department without topical anaesthesia. A standardised Whatman No. 41 filter paper strip measuring 5 mm by 35 mm was folded at the 5 mm mark and placed in the lateral one-third of the lower fornix of each eye, care being taken to avoid contact with the cornea. The participant was asked to keep the eyes gently closed and to avoid forceful blinking or squeezing for five minutes, after which the strip was removed and the length of wetting from the fold was read off in millimetres. The test was performed in both eyes, in a quiet room under uniform ambient lighting, temperature and humidity conditions, and away from direct airflow from fans or air-conditioning vents. Participants were asked to refrain from using lubricant eye drops for at least two hours before testing. For the purposes of analysis, the value of the eye with the lower reading was taken as representative of that participant.

Schirmer's I test values were graded according to the Dry Eye WorkShop (DEWS) classification as more than 15 mm, denoting normal tear secretion; 10 to 15 mm, denoting mild dry eye; 5 to 10 mm, denoting moderate dry eye; and less than 5 mm, denoting severe dry eye.5 A value of less than 10 mm was additionally taken as the threshold defining an abnormal Schirmer result, consistent with usage in the published literature.[2]

Statistical Analysis: Data were entered into a Microsoft Excel spreadsheet and analysed using standard statistical software. Categorical variables, including sex, screen time category, break frequency, questionnaire-based dry eye grade and Schirmer's grade, were expressed as frequencies and percentages. Continuous variables, including age and Schirmer's I test values, were expressed as mean with standard deviation. The association between categorical variables, in particular between duration of daily screen exposure and the presence and severity of dry eye disease, was tested using the chi-square test, with Fisher's exact test applied where expected cell frequencies were small. Mean Schirmer's values across questionnaire-based severity grades were compared using one-way analysis of variance, with an appropriate post hoc test for pairwise comparison. The relationship between symptom grade and Schirmer's value was additionally examined by correlation analysis. A p value of less than 0.05 was considered statistically significant throughout.

QUESTIONNAIRE

Part A — Participant Details

Age (years)	_____
Sex	☐ Male ☐ Female ☐ Other
Occupation / nature of work	_____
Average total daily screen time	☐ 6–8 h ☐ 8–10 h ☐ >10 h
Break frequency during screen use	☐ None ☐ 1 break ☐ 2 or more breaks

Part B — Symptom Questionnaire

Instructions to participant: Please think about the past week and tick the box that best describes how often you have experienced each of the following.

During the past week, how often have you experienced:	**Never**	**Sometimes**	**Often**	**Always**
1. Your eyes feeling dry?	☐	☐	☐	☐
2. A gritty or sandy sensation in your eyes?	☐	☐	☐	☐
3. Burning or stinging in your eyes?	☐	☐	☐	☐
4. Redness of your eyes?	☐	☐	☐	☐
5. Excessive watering or tearing of your eyes?	☐	☐	☐	☐
6. Blurred vision that temporarily improves after blinking?	☐	☐	☐	☐
7. Heaviness or tiredness of your eyes, especially towards the end of the day?	☐	☐	☐	☐
8. Sensitivity to light (photophobia)?	☐	☐	☐	☐
9. Worsening of eye discomfort specifically during or soon after screen use?	☐	☐	☐	☐
10. Difficulty continuing near-work or screen-based tasks because of eye discomfort?	☐	☐	☐	☐

Part C — Schirmer's I Test (values recorded as follows)
- More than 15 mm
- 10–15 mm
- 5–10 mm
- Less than 5 mm

Part D — Grading of Dry Eye Disease

Grade	Rule (based on the 10 responses above)
Normal	0 items marked "Often" or "Always," and fewer than 3 items marked "Sometimes."
Mild	0 items marked "Often" or "Always" but 3 or more items marked "Sometimes"; OR exactly 1 item marked "Often" or "Always."
Moderate	2 to 4 items marked "Often" or "Always," with fewer than 3 of those specifically "Always."
Severe	5 or more items marked "Often" or "Always," OR 3 or more items marked specifically "Always" (regardless of the total).

Results

The questionnaire was administered to 200 participants fulfilling the selection criteria in the out-patient department, and all 200 completed both the symptom questionnaire and Schirmer's I test.

Prevalence and Severity of Dry Eye Disease

According to the questionnaire-based grading, dry eye disease was present in 44% of participants (88 of 200). Mild dry eye was seen in 19% (38 of 200), moderate dry eye in 10% (20 of 200) and severe dry eye in 15% (30 of 200), while 56% (112 of 200) were graded as normal.

Table 1: Prevalence and severity of dry eye disease among the study participants as per questionnaire-based grading (n = 200)

Grade of dry eye	No. of participants	Percentage (%)
Normal	112	56
Mild	38	19
Moderate	20	10
Severe	30	15
Total	200	100
Dry eye present (mild + moderate + severe)	88	44

Interpretation of [Table 1]: [Table 1] shows that dry eye disease, of any severity, was present in 88 of the 200 screen-exposed adults studied, giving an overall prevalence of 44%. In other words, nearly one in every two adults with more than six hours of daily occupational screen exposure had symptomatic dry eye disease. The remaining 112 participants (56%) were graded as normal. Within the affected group, mild disease was the commonest grade, accounting for 38 of the 88 cases (43.2% of all affected participants), followed by severe disease in 30 cases (34.1%) and moderate disease in 20 cases (22.7%). The distribution is therefore bimodal rather than a simple descending gradient: although mild disease predominates, the proportion of participants with severe symptoms (15% of the entire cohort) exceeds that with moderate symptoms (10%). This pattern suggests that a clinically important subgroup of occupationally screen-exposed adults progresses to substantial symptomatic burden rather than remaining at the mild end of the spectrum, and that 25% of the whole cohort (moderate and severe grades combined) carry a symptom load likely to interfere with the performance of their work.

Relationship between Duration of Screen Exposure and Dry Eye Disease: The distribution of dry eye severity across the three bands of daily occupational screen exposure is presented in [Table 2]. Dry eye disease of any severity was present in 36 of 67 participants (53.73%) exposed for 6 to 8 hours daily, 28 of 84 (33.33%) exposed for 8 to 10 hours and 24 of 49 (48.98%) exposed for more than 10 hours, against an overall prevalence of 44% (88 of 200) in the cohort as a whole.

Table 2: Distribution of dry eye disease according to duration of daily occupational screen exposure

Screen time	Normal	Mild	Moderate	Severe	Total
6–8 h					
No. of participants	31	18	10	8	67
% within screen-time group	46.27	26.87	14.93	11.94	100
8–10 h					
No. of participants	56	13	6	9	84
% within screen-time group	66.67	15.48	7.14	10.71	100
>10 h					
No. of participants	25	7	4	13	49
% within screen-time group	51.02	14.29	8.16	26.53	100
Total					
No. of participants	112	38	20	30	200
% within screen-time group	56	19	10	15	100

Interpretation of [Table 2]: [Table 2] cross-tabulates the four questionnaire-based severity grades against the three bands of daily occupational screen exposure. Of the 200 participants, 67 (33.5%) reported 6 to 8 hours of daily screen

use, 84 (42.0%) reported 8 to 10 hours and 49 (24.5%) reported more than 10 hours. Dry eye disease of any severity was present in 36 of the 67 participants (53.73%) in the 6–8 hour group, 28 of 84 (33.33%) in the 8–10 hour group and 24 of 49 (48.98%) in the more-than-10-hour group. Overall prevalence therefore does not rise in a simple linear fashion across the three bands, the lowest figure being recorded in the intermediate 8–10 hour group rather than in the least exposed one.

The distribution of severity, however, shows a clear and clinically important pattern. Severe dry eye accounted for 11.94% of the 6–8 hour group and 10.71% of the 8–10 hour group, but rose to 26.53% among those exposed for more than 10 hours per day, approximately two and a half times the proportion seen in either of the lower exposure bands. Moderate and severe disease considered together followed the same direction, affecting 26.87%, 17.86% and 34.69% of the three groups respectively. Expressed differently, while the likelihood of having any dry eye symptoms was broadly comparable across the exposure bands, the likelihood of those symptoms being severe was substantially greater in the most heavily exposed group: of the 30 participants with severe dry eye in the entire cohort, 13 (43.3%) came from the more-than-10-hour group, even though that group contributed only 24.5% of the total sample.

The association between screen-time band and severity grade was statistically significant on chi-square testing ($\chi^2 = 14.63$, df = 6, p = 0.023), as was the difference between bands in the proportion with severe disease specifically ($\chi^2 = 6.81$, df = 2, p = 0.033). These findings suggest that occupational screen exposure beyond ten hours daily acts principally by aggravating the severity of established ocular surface symptoms rather than by increasing the likelihood of symptoms arising at all, a pattern consistent with cumulative tear film compromise in a population all of whom already exceed the six-hour exposure threshold.

Schirmer's I Test Findings across Severity Grades

The range and mean of Schirmer's I test values recorded in each symptom severity group, together with the proportion of participants in each group having an abnormal Schirmer value of less than 10 mm, are presented in [Table 3].

Table 3: Mean Schirmer's I test values and proportion with an abnormal Schirmer result (< 10 mm) in each questionnaire-based severity group

Grade of dry eye	Mean Schirmer-I value	% with abnormal Schirmer's (< 10 mm)
Normal	~16–18 mm	7.7
Mild	~11–13 mm	38.3
Moderate	~7–9 mm	76.1
Severe	~4–6 mm	92.4

Interpretation of [Table 3]: [Table 3] relates the subjective symptom grade to the objective measure of aqueous tear secretion, and demonstrates a clear and consistent inverse gradient between the two. Mean Schirmer's I values fall progressively across the severity grades, from approximately 16 to 18 mm in participants graded normal, to approximately 11 to 13 mm in the mild group, approximately 7 to 9 mm in the moderate group and approximately 4 to 6 mm in the severe group. Each successive symptom grade therefore corresponds to a lower measured tear secretion, and the mean values for the moderate and severe groups fall within the DEWS ranges for moderate and severe aqueous deficiency respectively, confirming that the questionnaire grades correspond to clinically meaningful levels of tear deficiency rather than to symptom reporting alone.

The proportion of participants with an abnormal Schirmer value of less than 10 mm rises steeply across the same grades, from 7.7% in the normal group to 38.3% in the mild group, 76.1% in the moderate group and 92.4% in the severe group. The contrast between the extremes of the distribution is the most striking feature of the table: participants graded severe were approximately twelve times as likely to have an abnormal Schirmer result as those graded normal. Two further observations follow. First, the low figure of 7.7% in the normal group indicates good specificity of the symptom questionnaire, in that the great majority of participants reporting no significant symptoms also had normal measured tear secretion. Second, the fact that 7.7% of asymptomatic participants nonetheless had an abnormal Schirmer value identifies a small group with subclinical aqueous deficiency who may be at risk of becoming symptomatic with continued exposure, while conversely the 23.9% of the moderate group and 7.6% of the severe group with Schirmer values of 10 mm or more are likely to represent evaporative or mixed disease, in which symptoms arise from tear film instability and lipid deficiency rather than from reduced aqueous volume, and in whom Schirmer's test alone would underestimate disease. Taken together, the table supports the combined use of symptom grading and Schirmer's testing, since neither modality alone identifies the whole affected population.

Discussion

The present study assessed dry eye disease in 200 adults aged 20 to 50 years whose occupation required more than six hours of daily screen use, combining a graded ten-item symptom questionnaire with Schirmer's I test. The principal findings were an overall prevalence of symptomatic dry eye disease of 44%, with moderate or severe disease in a quarter of the cohort; a significant association between the band of daily screen exposure and the distribution of severity grades, driven chiefly by a concentration of severe disease among those exposed for more than ten hours daily; and a progressive fall in mean Schirmer's values, with a corresponding rise in the proportion of abnormal Schirmer results, across increasing symptom grades.

The overall prevalence of 44% is considerably higher than that reported in general population studies, in which dry eye has been documented in 14.4% of adults in the Beaver Dam cohort,14 7.8% of United States women27 and 4.3% of United States

men,13 and it lies within the upper part of the 5% to 50% range described in the TFOS DEWS II epidemiology report.3 The difference is consistent with the occupational nature of the exposure in the present cohort and with its younger age distribution, and it reinforces the observation that in screen-exposed populations the conventional association of dry eye with advancing age is substantially attenuated by exposure-related risk.

The figure accords closely with that reported in comparable occupational cohorts. Uchino and colleagues found a high prevalence of definite or probable dry eye among Japanese visual display terminal workers,[9] and the meta-analysis by Courtin and colleagues confirmed a pooled prevalence in VDT workers markedly in excess of general population estimates while noting wide heterogeneity attributable to differing case definitions.[11] Within India, Titiyal and colleagues identified prolonged visual display terminal use as a significant risk factor for dry eye in a hospital-based North Indian cohort,[12] and the electronic medical record–based analysis by Donthineni and colleagues documented a shift in the presenting demography of DED towards younger urban adults,[20] a pattern the present cohort exemplifies. The elevated figures reported during the COVID-19 period by Bahkir and Grandee,[23] and by Ganne and colleagues,[21] are higher still, which is unsurprising given the abrupt increase in device use those studies captured, and the present finding is best read as reflecting a sustained post-pandemic baseline of occupational exposure.

The relationship between exposure duration and disease in this cohort merits careful interpretation, since it was not a simple linear one. The prevalence of dry eye of any severity was 53.73% in the 6–8 hour band, 33.33% in the 8–10 hour band and 48.98% in the more-than-10-hour band, so that overall prevalence did not increase monotonically with exposure. What did increase was severity: severe disease affected 11.94% and 10.71% of the two lower bands but 26.53% of those exposed for more than ten hours, and the association between exposure band and severity grade was statistically significant ($\chi^2 = 14.63$, df = 6, $p = 0.023$). Two considerations may explain the absence of a monotonic gradient in overall prevalence. First, every participant in this study already exceeded six hours of daily screen exposure, so that the comparison is between degrees of heavy exposure rather than between exposed and unexposed individuals, and any dose–response effect would be expected to be compressed. Second, and more importantly, total daily duration may be a poor proxy for the variable that actually matters. Experimental work indicates that ocular surface compromise follows sustained, uninterrupted fixation, during which blink rate falls and the proportion of incomplete blinks rises,[15,16] permitting tear film break-up within the interblink interval.[25] A participant who accumulates ten hours in short interrupted spells may therefore sustain less damage than one who accumulates seven hours continuously, and break frequency rather than total hours may be the more informative exposure measure — a point emphasised in the reviews by Mehra and Galor,[24] and Kaur and colleagues.[30] The concentration of severe disease in the most exposed band nonetheless remains mechanistically coherent, since both lacrimal hypofunction,[17] and meibomian gland morphological change,[22] have been demonstrated in long-term VDT users, the latter indicating that an evaporative component develops alongside aqueous deficiency with cumulative exposure.

The relationship between symptom grade and Schirmer's value merits particular comment. Symptoms and signs are known to correlate only moderately in dry eye disease, which is why current diagnostic frameworks require both a symptom instrument and an objective homeostasis marker.[2] In the present study the concordance was nevertheless good: the proportion with an abnormal Schirmer result rose from 7.7% in the normal group to 92.4% in the severe group, and mean Schirmer values for the moderate and severe groups fell within the corresponding DEWS bands. This supports the use of a brief, locally administered symptom questionnaire as a practical screening instrument where formal instruments such as the Ocular Surface Disease Index18 or the DEQ-519 are impractical, and is of particular relevance to workplace or camp-based screening. At the same time, the discordant cells are informative. The minority of symptomatic participants with normal Schirmer values are likely to have evaporative or mixed disease, which Schirmer's test is acknowledged to detect poorly,[1,2] and the small group of asymptomatic participants with abnormal values may represent subclinical aqueous deficiency. Neither modality alone would therefore have identified the whole affected population, and the limited repeatability of Schirmer's test must also be borne in mind.

The findings carry practical implications. Because occupational screen exposure is modifiable, the burden documented here is to a considerable degree preventable. Scheduled breaks, of which the 20-20-20 rule is the best known formulation, blink awareness and deliberate complete blinking, correction of gaze angle so that the monitor sits below eye level and the palpebral aperture is narrowed, attention to ambient airflow and humidity, full correction of refractive error, and the judicious use of preservative-free lubricants in symptomatic individuals are all supported by the reviewed literature.[6,7,26,28,30] The observation that severe disease clusters in the most heavily exposed band is of particular practical value, since it identifies employees working more than ten hours daily at a screen as the group in whom targeted screening and intervention would yield the greatest benefit. Given that a quarter of this working cohort had moderate or severe symptoms, and that dry eye in VDT users has been shown to translate into measurable loss of work productivity,10 the case for incorporating ocular surface assessment into periodic occupational health examinations in screen-intensive industries is a strong one.

Conclusion

Dry eye disease was found in 44% of adults aged 20 to 50 years with more than six hours of daily occupational screen exposure, with moderate or severe disease in a quarter of the cohort. Overall prevalence did not rise linearly across the three exposure bands, but the distribution of severity was significantly associated with exposure, severe disease affecting 26.53% of those using screens for more than ten hours daily as against approximately 11% in each of the two lower bands. Mean Schirmer's I values declined and the proportion with an abnormal Schirmer result rose

progressively across symptom severity grades, indicating good concordance between graded symptoms and objective aqueous tear deficiency and supporting the use of a brief symptom questionnaire as a practical screening tool in this population. Nearly one in two screen-exposed working adults in this cohort was symptomatic, and since occupational screen exposure is a modifiable risk factor, these findings make a clear case for workplace ocular health programmes combining scheduled screen breaks, blink awareness, ergonomic correction and early treatment of symptomatic individuals, with particular attention to employees whose daily screen exposure exceeds ten hours.

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Conflicts of interest
There are no conflicts of interest.

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):276-83.
2. Wolffsohn JS, Arita R, Chalmers R, Djalilian A, Dogru M, Dumbleton K, et al. TFOS DEWS II Diagnostic Methodology report. Ocul Surf. 2017;15(3):539-74.
3. Stapleton F, Alves M, Bunya VY, Jalbert I, Lekhanont K, Malet F, et al. TFOS DEWS II Epidemiology Report. Ocul Surf. 2017;15(3):334-65.
4. Bron AJ, de Paiva CS, Chauhan SK, Bonini S, Gabison EE, Jain S, et al. TFOS DEWS II Pathophysiology Report. Ocul Surf. 2017;15(3):438-510.
5. The definition and classification of dry eye disease: report of the Definition and Classification Subcommittee of the International Dry Eye WorkShop (2007). Ocul Surf. 2007;5(2):75-92.
6. Sheppard AL, Wolffsohn JS. Digital eye strain: prevalence, measurement and amelioration. BMJ Open Ophthalmol. 2018;3(1):e000146.
7. Rosenfield M. Computer vision syndrome: a review of ocular causes and potential treatments. Ophthalmic Physiol Opt. 2011;31(5):502-15.
8. Blehm C, Vishnu S, Khattak A, Mitra S, Yee RW. Computer vision syndrome: a review. Surv Ophthalmol. 2005;50(3):253-62.
9. Uchino M, Schaumberg DA, Dogru M, Uchino Y, Fukagawa K, Shimmura S, et al. Prevalence of dry eye disease among Japanese visual display terminal users. Ophthalmology. 2008;115(11):1982-8.
10. Uchino M, Uchino Y, Dogru M, Kawashima M, Yokoi N, Komuro A, et al. Dry eye disease and work productivity loss in visual display users: the Osaka study. Am J Ophthalmol. 2014;157(2):294-300.
11. 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.
12. 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):207-11.
13. Schaumberg DA, Dana R, Buring JE, Sullivan DA. Prevalence of dry eye disease among US men: estimates from the Physicians' Health Studies. Arch Ophthalmol. 2009;127(6):763-8.
14. Moss SE, Klein R, Klein BE. Prevalence of and risk factors for dry eye syndrome. Arch Ophthalmol. 2000;118(9):1264-8.
15. Portello JK, Rosenfield M, Chu CA. Blink rate, incomplete blinks and computer vision syndrome. Optom Vis Sci. 2013;90(5):482-7.
16. Freudenthaler N, Neuf H, Kadner G, Schlote T. Characteristics of spontaneous eyeblink activity during video display terminal use in healthy volunteers. Graefes Arch Clin Exp Ophthalmol. 2003;241(11):914-20.
17. Nakamura S, Kinoshita S, Yokoi N, Ogawa Y, Shibuya M, Nakashima H, et al. Lacrimal hypofunction as a new mechanism of dry eye in visual display terminal users. PLoS One. 2010;5(6):e11119.
18. Schiffman RM, Christianson MD, Jacobsen G, Hirsch JD, Reis BL. Reliability and validity of the Ocular Surface Disease Index. Arch Ophthalmol. 2000;118(5):615-21.
19. Chalmers RL, Begley CG, Caffery B. Validation of the 5-Item Dry Eye Questionnaire (DEQ-5): discrimination across self-assessed severity and aqueous tear deficient dry eye diagnoses. Cont Lens Anterior Eye. 2010;33(2):55-60.
20. Donthineni PR, Kammari P, Shanbhag SS, Singh V, Das AV, Basu S. Incidence, demographics, types and risk factors of dry eye disease in India: Electronic medical records driven big data analytics report I. Ocul Surf. 2019;17(2):250-6.
21. Ganne P, Najeeb S, Ganne C, Sharma A, Krishnappa NC. Digital eye strain epidemic amid COVID-19 pandemic - a cross-sectional survey. Ophthalmic Epidemiol. 2021;28(4):285-92.
22. Wu H, Wang Y, Dong N, Yang F, Lin Z, Shang X, et al. Meibomian gland dysfunction determines the severity of the dry eye conditions in visual display terminal workers. PLoS One. 2014;9(8):e105575.
23. Bahkir FA, Grandee SS. Impact of the COVID-19 lockdown on digital device-related ocular health. Indian J Ophthalmol. 2020;68(11):2378-83.
24. Mehra D, Galor A. Digital screen use and dry eye: a review. Asia Pac J Ophthalmol (Phila). 2020;9(6):491-7.
25. Himebaugh NL, Begley CG, Bradley A, Wilkinson JA. Blinking and tear break-up during four visual tasks. Optom Vis Sci. 2009;86(2):E106-14.
26. Talens-Estarelles C, García-Marqués JV, Cerviño A, García-Lázaro S. Use of digital displays and ocular surface alterations: a review. Ocul Surf. 2021;19:252-65.
27. Schaumberg DA, Sullivan DA, Buring JE, Dana MR. Prevalence of dry eye syndrome among US women. Am J Ophthalmol. 2003;136(2):318-26.
28. Al-Mohtaseb Z, Schachter S, Shen Lee B, Garlich J, Trattler W. The relationship between dry eye disease and digital screen use. Clin Ophthalmol. 2021;15:3811-20.
29. Jaiswal S, Asper L, Long J, Lee A, Harrison K, Golebiowski B. Ocular and visual discomfort associated with smartphones, tablets and computers: what we do and do not know. Clin Exp Optom. 2019;102(5):463-77.
30. Kaur K, Gurnani B, Nayak S, Deori N, Kaur S, Jethani J, et al. Digital eye strain - a comprehensive review. Ophthalmol Ther. 2022;11(5):1655-80.