ORIGINAL RESEARCH

Association of digital screen exposure with dry eye disease:A retrospective analysis of a north Indian population

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ABSTRACT
Dry eye disease (DED), a widespread multifactorial condition affecting the ocular surface, is characterized by a disruption in tear film homeostasis, leading to ocular symptoms, tear film instability, hyperosmolarity, ocular surface inflammation, damage, and neurosensory abnormalities. Defined by the TFOS DEWS II Definition and Classification Subcommittee, its global prevalence ranges considerably from 5% to 50%, with a notable presence in Southeast Asian countries, spanning 20% to 52.4%. This prevalence can escalate to 75% in adults over the age of 40, with a higher incidence observed in women. The underlying pathophysiology of DED is increasingly recognized as chronic ocular inflammation arising from an imbalance in the tear film. Desiccation of the ocular surface, alterations in tear composition and osmolarity, trigger the release of inflammatory mediators and the recruitment of inflammatory cells. These processes initiate the breakdown of cell junctions, epithelial cell death, and destabilization of the tear film, perpetuating a cycle of inflammation that further sensitizes nociceptors.
This study delved into exploring the association of digital screen time with DED in patients. A prospective comparative study enrolled 105 patients aged 18-75 years with mild to moderate DED, presenting to the outpatient department of a tertiary eye care center. The diagnosis of DED was based on the presence of signs and symptoms, with symptoms assessed using the Ocular Surface Disease Index (OSDI) questionnaire. Signs were evaluated by Tear film breakup time (TBUT), Schirmer's test (ST) and Corneal Fluorescein staining (CFS). Patients with an OSDI score of >13, TBUT of <10 seconds and Schirmer's test of <15mm were diagnosed to have DED. Detailed history was taken, and digital screen time was recorded. A comprehensive ocular examination was done, followed by objective tests for DED assessment.
The results showed the mean age of the patients was 36.66 years, with the maximum number of patients in the 25-50 years age group. Females were slightly more affected than males. The most common symptoms were gritty/burning sensation, light sensitivity and difficulty in screen work/TV watching. Most patients had moderate DED. The study found that maximum patients had a digital screen time of more than 6 hours, followed by 3-6 hours. DED parameters worsened with increasing age and digital screen time.
In conclusion, the study found that mild to moderate DED is common in middle-aged individuals in their 30s and 40s. While factors like increasing age and female gender are known contributors, digital screen time is an emerging risk factor. Higher screen time is more common in younger age groups and is bringing DED to this population. Promoting practices like the 20-20-20 rule and counseling patients about preventative measures and controlling screen time, along with appropriate topical therapy, is important.
Key words: Dry eye disease, digital screen time, ocular surface disease, tear film, inflammation, risk factors

INTRODUCTION
Dry eye disease (DED) is a multifactorial disease of the ocular surface characterized by 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 neurosensoryabnormalities play etiological roles, as defined by the TFOS DEWS II Definition and Classification Subcommittee. Prevalence ranges from 5 to 50% globally, with that in South east Asian countries ranging from 20 to 52.4%. This may go upto 75% in adults over 40 yr age, with women being most affected[1].
Ocular inflammation due to disturbance of the balance of tear film is increasingly being recognized as the underlying pathophysiology resulting in the chronic

nature of the disease[1].Desiccation of the ocular surface, changes in tear composition and osmolarity lead to the activated production of inflammatory mediators and inflammatory cell recruitment. These processes trigger the dissolution of cell junctions, death of epithelial cells and destabilization of the tear film, which creates a cycle of inflammation. Ocular surface inflammation alters the sensitization of nociceptors and causes a sensation of pain and dryness of the eye. Long-term inflammation and nerve injury can cause neuropathic pain on the ocular surface[2].

Computer vision syndrome (CVS) is defined by the American Optometric Association as a complex of eye and vision problems related to the activities which stress the near vision and which are experienced in relation, or during, the use of the computer. This includes ocular complains like eye-strain, headaches, dry and irritated eyes, slow refocusing and sometimes blurred distance or near vision and diplopia. The major contributor to this by far is dry eye disease, and pertaining to the increasing digital screen time nowadays, CVS associated DED has become a major lifestyle problem[3].

This study delves into exploring the association of digital screen time in male and female patients of different age groups, diagnosed with mild to moderate DED.

METHODS

This prospective comparative study enrolled 105 patients aged 18-75 years with mild to moderate DED presenting to the out-patient department of RIO, Pt. B.D Sharma PGIMS Rohtak, Haryana. The patients were recruited from September 2023 over a period of 1 year. The patients presented with various ocular symptoms like light sensitivity, gritty sensation, burning sensation, redness and blurred vision. Ethical clearance was obtained from the institutional review board (Biomedical Research Ethics Committee Pt. B.D Sharma PGIMS/UHS, Rohtak. Written and informed consent was obtained from all patients and the study adhered to the tenets of the declaration of Helsinki.

The diagnosis of DED was based on the presence of signs and symptoms of DED. The presence of symptoms was assessed using Ocular Surface Disease Index (OSDI) questionnaire and the signs were assessed by Tear film breakup time (TBUT), Schirmer's test (ST) and Corneal Fluroscein staining (CFS). Patients with an OSDI score of >13, TBUT of <10 seconds and Schirmer's test of <15mm were diagnosed to have DED. The classification into mild, moderate and severe disease was done on the basis of OSDI score, and only patients with mild to moderate DED (OSDI score of 13-32) were eligible for participation in the study.

The OSDI questionnaire comprises of 12 questions related to symptoms of DED, and with each question a score of 0 (none of the time) to 4 (all of the time) is

given. The patient had to assign a score based on the duration of symptoms experienced over the preceding week. The final score was calculated by multiplying the sum of all the scores by 25 and then dividing by the total number of questions answered. Score ranges from 0-100 with 0-12 suggestive of no disease, 13-22 suggestive of mild DED, 23-32 suggestive of moderate DED and ≥33 suggestive of severe DED. A single examiner administered the questionnaire and was available in both Hindi and English languages as per patient convenience[4].

Patients of age 18-75 years with mild to moderate DED (OSDI score 13-32) along with the presence of one sign amongst TBUT, Schirmer's test and Corneal Fluorescein staining were included in the study. Exclusion criteria were patients with ocular allergies or chronic ocular bacterial or viral infections or any non-dry eye ocular inflammation, history of trauma or ocular surgery in a period of last 6 months, patients with corneal degenerations or dystrophies, uncontrolled systemic disease, pregnant women, nursing women and chronic alcoholics.

Detailed history as taken and the symptoms of DED experienced by the patient were noted. OSDI questionnaire was evaluated as well and score was recorded at baseline. A comprehensive ocular examination was done for all patients, including uncorrected and best corrected visual acuity testing, slit lamp examination and detailed fundus examination to rule out posterior segment pathology. This was followed by objective tests for DED assessment including TBUT, ST and CFS. A gap of 10-15 minutes was given between two consecutive examinations.

RESULTS

The mean age was calculated to be 36.66 years with a standard deviation (SD) of 13.32. It was observed that the maximum number of patients were in the age group of 25-50 years(63.8%), followed by less than 25 years (21%) in our study. Amongst the affected individuals, females (58.1%) were slightly more than males (41.9%) in our study. Patients in our study presented with a variety of symptoms but the most common symptoms noted among patients were gritty/burning sensation (80.9%), light sensitivity (66.6%) and difficulty in screen work/TV watching (93.3%).

In our study out of 105 patients, 96 (91.4%) had an OSDI score between 23-32 suggestive of moderate DED and only 9 (8.6%) had an OSDI score of 13-22 suggestive of mild DED. The average OSDI score at baseline was 27.52 with SD of 4.46. The TBUT was in the range of 5-10 seconds for 99 (94.3%) of patients for right eye (R/E) and 98 (93.3%) for the left eye (L/E), and a TBUT of >/=10 seconds for 6 (5.7%) for R/E and 7 (6.7%) patients for the left eye. The average TBUT at baseline was 6.95 with SD of 1.35.Similarly, the ST was 5-10 mm for 86 (81.9%) patients for the R/E and L/E both, and between 10-15

mm for 19 (18.1%) patients for the R/E and L/E both. The average ST at baseline was 8.19 with SD of 2.40. The CFS test showed no corneal staining for all the patients and thus the test was inconclusive for our study.

Out of total 105 patients, 96 (91.4%) had no other ocular or systemic disease in past or present. Past ocular associations were present in 2 (1.9%) patients who had a history of LASIK eye surgery more than 1 year ago, and 1 (0.95%) post op case of C3R for Keratoconus 5 years ago and now presenting with moderate dry eye disease. Systemic associations were present in 2 (1.9%) patients with Xerostomia out of which 1 (0.95%) had seroactive Rheumatoid Arthritis with secondary Sjogren's syndrome on treatment, 1 (0.95%) patient with Type 2 Diabetes Mellitus, 1 (0.95%) patient with cardiac disease and history of cardiac stenting > 1 year back, 1 (0.95%) had lowermotor neuron Bell's palsy and 1 (0.95%) had a history of CNS tumor resected >1 year ago.

This study also recorded the digital screen time of all the DED patients and its association with DED parameters. It was found that maximum 44 (41.9%) patientshad a digital screen time (DST) of more than 6 hours, followed by 42(40%) patients with screen time of 3-6 hours, and only 19 (18.1%) patients with screen time of less than 3 hours in our study. For patients with a screen time of >6 hours, the mean age was 29.04 years with SD of 12.60, out of which 24 were females and 20 were males. Average OSDI score was 27.20 with SD of 4.08, TBUT of 7.00 with SD of 1.26 and ST of 8.36 with SD of 2.27. For patients with screen time of 3-6 hours, the mean age was 39.71 years with SD of 8.70, out of which 27 were females and 15 were males. Average OSDI score was 27.75 with SD of 4.26, TBUT of 6.93 with SD of 1.35 and ST of 8.12 with SD of 2.33. For patients with screen time of <3 hours, the mean age was 47.53 years with SD of 13.60, out of which 10 were females and 9 were males. Average OSDI score was 27.77 with SD of 5.80, TBUT of 6.89 with SD of 1.63 and ST of 7.95 with SD of 2.91.

	Mean	Standard Deviation
Age	36.66	13.32
OSDI	27.52	4.46
TBUT	6.95	1.35
ST	8.19	2.40

Gender-Age distribution			Sex		Total
			F	M	
Age Categories	<25 years	Count	10	12	22
		% within Sex	16.4%	27.3%	21.0%
	25-50 years	Count	42	25	67
		% within Sex	68.9%	56.8%	63.8%
	>50 years	Count	9	7	16
		% within Sex	14.8%	15.9%	15.2%
Total		Count	61	44	105
		%	58.1%	41.9%	100.0%

DISCUSSION

Dry eye disease (DED) is a very common yet easily overlooked condition, and an emerging health problem which occurs in all age groups and can vary in severity.
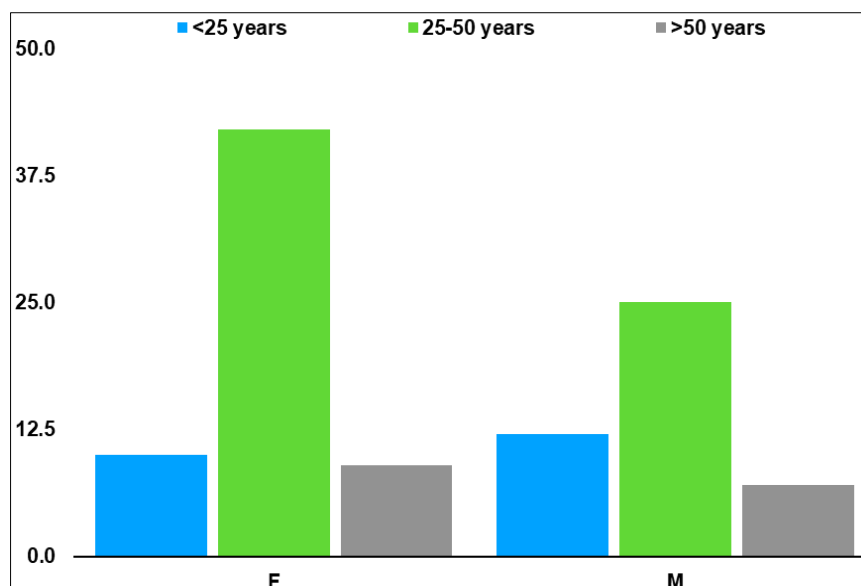
Digiral Screen Time	>6 hours	3-6 hours	<3 hours
Avg. Age	29.04 ± 12.60	39.71 ± 8.70	47.53 ± 13.60
Females	24	27	10
Males	20	15	9
Avg. OSDI	27.20 ± 4.08	27.75 ± 4.26	27.77 ± 5.80
Avg. TBUT	7.00 ± 1.26	6.93 ± 1.35	6.89 ± 1.63
Avg. ST	8.36 ± 2.27	8.12 ± 2.33	7.95 ± 2.91

In this study, the mean age came to be 36.66 years. The age distribution for all the three groups showed that maximum number of patients suffering from dry eye disease were between 25-50 years of age in all three groups, making a cumulative of 63.8% of the total sample size. These findings were comparable to a study conducted by Mullick et al. (2021), where the mean age was 32.67 (SD 11.24). Another study by Singh et al. (2022) had a mean age of 54 years (SD 9.5)[5,6].A cross-sectional study by Titiyal et al. (2018) to study the prevalence of dry eye disease in North India concluded that the age group of 21-40 had the highest prevalence[7].

Another similar study by Donthineni PR et al. (2019) in a North Indian population, among 21,290 patients diagnosed with recent onset DED, the mean age of patients was 46.32 (SD 17.51) years[8].

A study by Shilpy et al. (2019) in a population of western India, out of 578 patients of DED, the mean age of mild DED patients was 44.14 (SD 19.85), for moderate disease was 49.60 (SD 21.17) years and for severe DED patients was 63.25 (SD 6.95) years, which highlights that mild to moderate DED is more common in age group of 30-40 years, while severe DED in more common in geriatric individuals[9].

Regarding gender, out of the 105 patients in our study, 61 (58.1%) were females and 44 (41.9%) were males.In a study conducted by Mullick et al. (2021), the gender distribution was 47% female and 53% male patients. Another study by Singh et al. (2022) had a gender distribution to be 71% females and 29% males[5,6].

However in the study by Donthineni PR et al. (2019), it was noted that incidence was significantly higher in males in 3rd, 4th, 9thdecades, while in females it was greater in the 5thand 6thdecade of life[8].

In another study by Chatterjee et al. (2020) in the population of North India, it was noted that the crude and age adjusted prevalence of DED in males was around 15.2% and 18.4%, and among females was 20.5% and 23.3% respectively[10].

Various predisposing factors include advancing age (associated with Meibomian gland disease), gender (female more common) genetic factors, ethnicity (more common in East Asian countries), systemic conditions like diabetes, androgen deficiency, mental health conditions, drug use associated like antihistamines, antidepressants, anxiolytics, hormone replacement therapy, ocular conditions like blepharitis, chronic use of contact lenses, history of ophthalmic surgery (like keratorefractive surgeries, cataract surgery) and use of topical ophthalmic medications like anti-glaucoma drugs having Benzalkonium chloride preservative, topical NSAIDS. Modifiable risk factors include environmental factors (like avoiding low humidity conditions andpollution), digital screen time, sleep disorders, poor diet.

Various epidemiological studies have consistently demonstrated a positive association between advancing age and the development of dry eye disease, irrespective of ethnicity [11]. A number of population-based cross-sectional studies have found that the prevalence and severity of clinical signs and symptoms of dry eye disease increases with ageing.

Recent studies investigating the natural history of dry eye disease in adults have noted that signs of MGD and evaporative dry eye disease tend to develop at an earlier age than signs of aqueous tear deficiency [12].

Digital screen time is another very important factor in today's era, which has a significant role in bringing DED into the young and middle age groups. Various studies have found that for every one hour per day increase in screen time, the odds of developing DED raises by 1.14 times. The rationale behind this association is possibly related to suppression of the spontaneous blink reflex while performing tasks that require significant visual processing, especially tasks with higher cognitive demands. As a result, reduced blink rate and incomplete blinking causes poor tear lipid layer integrity and tear film instability. Ocular surface symptoms can be further exacerbated by uncorrected refractive error and/or binocular vision anomalies[13].A study done by Hanyuda et al. in 2020 noted that prolonged visual display time had a significantly higher prevalence of DED in both the sexes[14].

Our study compiles the average DED parameters of patients with different ranges of approximate digital screen time per day. It was noted that average age of patients with DST of <3 hours a day had average age of around 47 years and the DED parameters were OSDI average of 27.77, TBUT average of 6.89 and ST average of 7.95. The average age of patients with DST of 3-6 hours decreased to around 39 years, and the DED parameters were OSDI average of 27.75, TBUT average of 6.93 and ST average of 8.12. Whereas the average age of patients with DST of >6 hours further decreased to around 29 years, and the DED parameters were OSDI average of 27.20, TBUT average of 7.00 and ST average of 8.36. It was noted that the DED parameters of patients with higher screen time per day but younger average age were nearly similar to patients with lower screen time but older average age. DED parameters worsen with increasing age as well as digital screen time.

Studies have explored the effects of breaks on digital eye strain induced dry eye using the 20-20-20 rule. This rule involves taking a 20 seconds break every 20 minutes to look at something at 20 feet away. This helps the eye muscles relax and prevent fatigue, while maintaining the tear film stability[15].

CONCLUSION
Our study concluded that the mild to moderate DED is common in middle aged people in their 30's and 40's. Although various factors like increasing age and female gender are known contributing factors, digital screen time per day is an emerging risk factor which should be considered. Higher screen hours per day is more common in younger age group of either gender, and is bringing DED to the younger age group. Promoting and counselling the patients about practices like 20-20-20 rule has shown to have benefits. As ophthalmologists, one should be conscious about counselling these patients with mild to moderate DED who may also present with eye strain and fatigue, to use preventative practices, control screen time per day, apart from prescribing appropriate topical therapy for the DED.

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. Mikalauskiene L, Grzybowski A, Zemaitiene R. Ocular Surface Changes Associated with Ophthalmic Surgery. J Clin Med. 2021;10(8):1642.
3. Kahal F, Al Darra A, Torbey A. Computer vision syndrome: a comprehensive literature review.Future Sci OA.2025;11(1).
4. Ocular Surface Disease Index© (OSDI©)2. Super Eye Care [Internet]. Available from: http://www.supereyecare.com/resources/OSDI.pdf.
5. Mullick R, Annavajjhala S, Thakur P, Mohapatra A, Shetty R, D'Souza S. Efficacy of topical cyclosporine 0.05% and osmoprotective lubricating eye drops in treating dry eye disease and inflammation. Indian J Ophthalmol. 2021 Dec;69(12):3473-7.
6. Singh KK. Prospective, Randomized Comparative Assessment of Efficacy of Chloroquine Phosphate 0.03% And Sodium Carboxymethylcellulose 1% in Dry Eye. Int J Toxicol Pharmacol. 2022;12(4); 159-66.
7. 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.
8. 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.
9. Shilpy N &Patel D. Prevalence of Dry Eye Disease in Western India. Int J Contemp Med Res. 2019;6(7):37.
10. Chatterjee S, Agrawal D, Sharma A. Dry eye disease in India.Indian J Ophthalmol. 2020;68(7):1499-500.
11. Wolffsohn, J.S.; Wang, M.T.M.; Vidal-Rohr, M.; Menduni, F.; Dhallu, S.; Ipek, T.; Acar, D.; Recchioni, A.; France, A.; Kingsnorth, A.; *et al*. Demographic and lifestyle risk factors of dry eye

disease subtypes: A cross-sectional study. Ocul. Surf.**2021**, 21, 58-63.

12. Wang, M.T.M.; Muntz, A.; Lim, J.; Kim, J.S.; Lacerda, L.; Arora, A.; Craig, J.P. Ageing and the natural history of dry eye disease: A prospective registry-based cross-sectional study.Ocul. Surf**2020**,18, 736-741.

13. Wang, M.T.M.; Muntz, A.; Mamidi, B.; Wolffsohn, J.S.; Craig, J.P. Modifiable lifestyle risk factors for dry eye disease.Contact Lens Anterior Eye **2021**, 101409.

14. Hanyuda A, Sawada N, Uchino M, *et al.* Physical inactivity, prolonged sedentary behaviors, and use of visual display terminals as potential risk factors for dry eye disease: JPHC-NEXT study. Ocul Surf. 2020;18(1):56-63.

15. Talens-Estarelles C, Cerviño A, García-Lázaro S, Fogelton A, Sheppard A, Wolffsohn JS. The effects of breaks on digital eye strain, dry eye and binocular vision: Testing the 20-20-20 rule. Cont Lens Anterior Eye. 2023;46(2):101744.