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The Impact of Digital Screen Exposure on Dry Eye Disease Among University Students

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Abstract

Dry eye disease (DED) is a growing disorder of the ocular surface that has become a prevalent problem in young adults, mainly because of the increasing use of digital devices for educational and entertainment purposes. University students are especially at risk of DED due to long duration of screen exposure, which has been linked with tear film instability, decreased blink rate and eye discomfort. Aim to assess the effect of digital screen exposure on dry eye disease among students attending the University in Al-Salam Teaching hospital, Mosul city in Iraq. A cross-sectional study was carried out in a hospital setting with 384 undergraduate and post graduate students from the University. The study participants were selected from the Ophthalmology Department of Al-Salam Teaching Hospital by a convenience sampling technique. The study used a structured questionnaire to gather data on the participants' demographic details, digital device usage, lifestyle factors, and the validated Ocular Surface Disease Index (OSDI). All subjects had a full ophthalmic examination, which included Tear Break-Up Time (TBUT), Schirmer I test, slit-lamp biomicroscopy, and fluorescein staining as indicated. Dry eye disease was diagnosed based on the recommendations of the Tear Film and Ocular Surface Society Dry Eye Workshop II (TFOS DEWS II). The data were analyzed with the SPSS version 26.0 (IBM Corp., 2019). The Chi-square test and binary logistic regression were used to assess associations $p < 0.05$ was considered statistically significant. The prevalence of dry eye disease was 45.1% (173/384). The numbers of participants with moderate or severe symptoms were 16.4% and 14.1% respectively. The percentage of children using a smartphone (54.9%) was the highest of the digital devices used and 56.8% of students said that they use a digital screen for more than 6 hours a day. There was a notable correlation between the use of digital devices for more than 8 hours per day with dry eye disease ($\chi^2 = 32.64$, $p < 0.001$), with the highest prevalence of 65.2% among students using digital devices for more than 8 hours a day. Multivariable logistic regression identified screen time exceeding eight hours per day (OR = 3.16, 95% CI: 1.92–5.20, $p < 0.001$), continuous screen use for more than two hours (OR = 2.31, 95% CI: 1.42–3.75, $p = 0.001$), female sex (OR = 1.62, 95% CI: 1.03–2.55, $p = 0.036$), and sleep duration of less than six hours per night (OR = 1.88, 95% CI: 1.16–3.03,

P = 0.010) as independent predictors of dry eye disease. University students have a high prevalence of DED and there exists a strong association between DED and long-term use of digital screens. Excessive screen time, continuous device use for more than 12 hours a day, female sex and poor sleep quality are significant factors associated with an increased risk of DED. Recommended educational interventions that encourage healthy screen-use habits, regular visual breaks and routine ocular health assessments are recommended to help decrease the burden of dry eye disease in university students.

Keywords: Dry Eye Disease; Digital Screen Exposure; University Students, Computer Vision Syndrome; Ocular Health.

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Introduction

Dry eye disease (DED) is a common eye surface disease globally and is a significant public health problem, especially for young adults. DED is a condition commonly thought of as a disease of the elderly because of the decrease in tear production, but over the last few years, the young population has also been heavily affected by DED. This change is thought to be caused by lifestyle changes, particularly the increased use of digital devices like smartphones, tablets and computers for educational, occupational and recreational activities [1], [2].

The Dry Eye Workshop II, sponsored by the Tear Film and Ocular Surface Society (TFOS), defines DED as a multifactorial disease that involves loss of tear film homeostasis, with important etiological roles of tear film instability, hyperosmolarity, inflammation, ocular surface damage and neurosensory abnormalities. [3] Patients report symptoms such as dryness, burning, and the feeling of a foreign body in the eye, as well as issues with blurring vision, photophobia and ocular fatigue. These symptoms can affect reading, studying and other visual activities, leading to decreased productivity and quality of life [3], [4].

Digital technology has had a profound impact on the education context in higher education. Students at the university are spending a lot of time everyday on their laptops, tablets and smart phones for attending lectures, doing homework, researching online and messaging with teachers and fellow students. Screen time has become even more significant in the context of COVID-19, with more reliance on digital learning, and many of the habits have persisted after transitioning back to in-person learning [5], [6].

DED has been linked to a prolonged exposure to digital screens, which is a modifiable factor. When using a screen for a prolonged time, people tend to blink less and not fully, which leads to less distribution of the

tear film and to more evaporation of the tear film. These physiological changes help to cause tear film instability and inflammation of the ocular surface. Dry eye symptoms may be exacerbated by other environmental factors that students face, such as the use of air-conditioned rooms, insufficient lighting and lack of proper ergonomics [3], [7]. Due to this reason, digital eye strain, which is commonly characterized by dry eyes symptoms, is often a clinical manifestation of prolonged screen use [8].

In recent years, a number of studies have been conducted that showed a high prevalence of dry eye symptoms among a wide range of university students, ranging from 20% to over 60% depending on study population, dry eye diagnostic criteria, and the length of time spent with digital devices [9]-[11]. DED can also affect a person's mental health, health-related quality of life, academic performance, reading ability and concentration. The students at universities are heavily dependent on digital use, both for study and leisure activities, and are therefore a group at increased risk of developing this condition [4], [12].

The purpose of the present study was to investigate the relationship between digital screen exposure and dry eye disease in university students and to offer any evidence that can support interventions to encourage healthy screen use and eye health.

Methods

This is a cross-sectional study that was carried out in the Ophthalmology Department of Al-Salam Teaching Hospital, Mosul, Nineveh Governorate, Iraq, in a hospital setting.This is a cross-sectional study done at Al-Salam Teaching Hospital in Mosul, Nineveh Governorate, Iraq. Al-Salam Teaching Hospital is a large tertiary center offering a wide range of eye care services including outpatient consultations, eye checks and medical and surgical treatment of eye diseases. In addition to patients from Mosul and its surrounding districts, the hospital is a suitable place for the study of the relationship between exposure to digital screen and the dry eye disease among university students.

This study comprised patients aged 18 years or above receiving undergraduate and postgraduate training at the University during the study period in the Ophthalmology Department. Participants eligible for the study had to use one or more digital devices (smartphone, tablet, laptop or desktop computer) on a daily basis and give written informed consent for participation. Students who had undergone eye surgeries in the last six months, had ocular infections or trauma, autoimmune diseases that are associated with dry eye, or were taking medications that are known to affect tear production were not included. Wearers of contact lenses and participants who lacked questionnaire data and/or ophthalmic examinations were also eliminated.

Sample size was determined by Cochran's formula for cross sectional studies with 95% confidence level, a margin of error of 5% and a prevalence of 50%, and the minimum sample size was 384 participants. In order to make up for the non-completers, additional participants were recruited. Convenience sampling technique was used which involved consecutive selection of eligible students of the University attending the Ophthalmology Department during the study period until the required sample size was obtained.

Data were gathered through an interviewer-administered, structured questionnaire with four sections. Demographic data such as age, sex, university and academic year were collected in the first section. The second section evaluated pattern of digital device use (type of device, average daily screen time, duration of digital device use, continuous use without breaks and primary purpose of digital device use). The third section gathered data pertaining to lifestyle and environment including smoking status, length of sleep, being outdoors, and air-conditioned environments. The last part assessed the dry eye symptoms with an Ocular Surface Disease Index (OSDI) questionnaire which is a validated questionnaire. The OSDI is composed of 12 items that measure ocular symptoms, vision-related function, and environmental triggers that occurred in the past week for a total score of 0-100, with higher scores reflecting more severe symptoms.

A thorough ophthalmic examination, conducted by an experienced ophthalmologist, was done on all

participants. Best-corrected visual acuity, slit-lamp biomicroscopy, Tear Break Up Time (TBUT), Schirmer I test without topical anesthesia, and topical fluroscien corneal staining if needed were performed. Dry eye disease was diagnosed based on the recommendations of the Tear Film and Ocular Surface Society Dry Eye Workshop II (TFOS DEWS II), taking into account patient-reported symptoms and objective clinical findings.

Data collected was entered in MS Excel spreadsheet and analyzed by IBM SPSS Statistics (IBM Corp., Armonk, NY, USA), version 26.0. Means and standard deviations were used to summarize continuous variables and frequencies and percentages were used for categorical variables. Chi-square tests were used to determine association between categorical variables and where applicable, independent-samples t-tests or one-way analysis of variance (ANOVA) were used to compare continuous variables between groups. Independent factors associated with dry eye disease were analysed by binary logistic regression analysis. Odds ratios (OR) with 95% confidence intervals (CI) were computed and a p value < 0.05 was deemed statistically significant on a two-sided test of significance.

Prior to starting data collection, ethical approval was secured from the relevant Institutional Research Ethics Committee. Permission was also obtained from the administration of Al-Salam Teaching Hospital in the official manner. All participants gave their informed consent after the aims and methods of the study were explained to them. The study was conducted on a purely voluntary basis, confidentiality and anonymity were ensured throughout the study, and all the data collected were treated solely for research purposes, following the ethical standards outlined in the Declaration of Helsinki.

Results

Table 1. Sociodemographic Characteristics of the Participants (N = 384)

Variable	Category	n	%
Age (years)	18–20	128	33.3
	21–23	176	45.8
	≥24	80	20.8
Gender	Male	188	49.0
	Female	196	51.0
Academic Year	First	68	17.7
	Second	76	19.8
	Third	81	21.1
	Fourth	92	24.0
	Postgraduate	67	17.4

Most participants were aged 21–23 years (45.8%). Females represented slightly more than half of the study sample (51.0%), and fourth-year students constituted the largest academic group (24.0%).

Table 2. Digital Screen Exposure Characteristics

Variable	Category	n	%
Primary Device	Smartphone	211	54.9
	Laptop	109	28.4
	Tablet	26	6.8
	Desktop computer	38	9.9
Daily Screen Time	<4 hours	55	14.3
	4–6 hours	111	28.9
	6–8 hours	126	32.8
	>8 hours	92	24.0
Continuous Screen Use	<1 hour	81	21.1
	1–2 hours	170	44.3
	>2 hours	133	34.6

Smartphones were the most commonly used digital devices (54.9%). More than half of the participants (56.8%) reported using digital screens for more than six hours daily.

Table 3. Prevalence and Severity of Dry Eye Disease

Variable	Category	n	%
Dry Eye Disease	Yes	173	45.1
	No	211	54.9
Severity (OSDI)	Normal	211	54.9
	Mild	56	14.6
	Moderate	63	16.4
	Severe	54	14.1

Nearly one-half of the participants (45.1%) had dry eye disease. Among affected students, moderate and severe symptoms were observed in approximately 30% of the total sample.

Table 4. Association Between Daily Screen Time and Dry Eye Disease

Daily Screen Time	Dry Eye n (%)	No Dry Eye n (%)	χ^2	p-value
<4 hours	11 (20.0)	44 (80.0)	32.64	<0.001
4–6 hours	40 (36.0)	71 (64.0)		
6–8 hours	62 (49.2)	64 (50.8)		
>8 hours	60 (65.2)	32 (34.8)		

The prevalence of dry eye disease increased significantly with longer daily screen exposure. Students using digital devices for more than eight hours per day had the highest prevalence of dry eye disease ($p < 0.001$).

Table 5. Factors Associated with Dry Eye Disease (Binary Logistic Regression)

Variable	B	OR (95% CI)	p-value
Female sex	0.48	1.62 (1.03–2.55)	0.036*
Screen time >8 hours/day	1.15	3.16 (1.92–5.20)	<0.001*
Continuous use >2 hours	0.84	2.31 (1.42–3.75)	0.001*
Sleep <6 hours/day	0.63	1.88 (1.16–3.03)	0.010*

Significant at p < 0.05.

Prolonged screen exposure (>8 hours/day) was the strongest independent predictor of dry eye disease, increasing the odds by more than threefold. Continuous screen use for more than two hours, female sex, and short sleep duration were also independently associated with a higher risk of dry eye disease.

Discussion

The present study aimed to examine the effect of digital screen exposure on the prevalence of DED in university students and showed that longer duration of digital devices usage was significantly correlated with DED symptoms. The prevalence of DED was high (45.1%) and the disease has become more common in young adults. This discovery adds to the worry that dry eye isn't restricted to elderly people, but is becoming a common condition among users of digital devices for prolonged periods of time.

The prevalence of DED found in this study is similar to that reported by García-Montero et al., which was about 42% in Spanish University students, indicating that extended academic-related screen time is a significant factor of ocular discomfort [13]. Alshamrani et al also reported that 47.5% of Saudi university students had symptoms of dry eye, highlighting the impact of long-duration smart phone and computer usage on the health of the ocular surface [14]. However, when compared to the Indian students, Mohan et al. reported a higher prevalence of 58.5% among the medical students, which might be attributed to the greater amount of screen time, different ambient conditions and the varying diagnostic standards [15]. The relatively high prevalence found in the present study could be attributed to the increasing Iraqi university student reliance on digital devices for academic learning, communication, and recreation.

There was a strong association with DED occurring with daily exposure to screens. Dry eye disease was significantly higher among students who reported using the digital device for more than 8 hours a day than

those with shorter digital device use. This is similar to the study by Moon et al., who showed that the use of a visual display terminal (VDT) for a prolonged period is associated with a higher risk of tear film instability and dry eye symptoms due to decreased blink rate and increased tear evaporation [16]. Similarly, Rosenfield found that long-term exposure to digital devices can cause digital eye strain, and that dry eye is among the major symptoms of DYS [17]. The physiological explanation is that when visual concentration is sustained there is a reduction in spontaneous blinking and an increase in incomplete blinking, which leads to the disruption of the tear film and inflammation of the ocular surface.

Constantly using the screen, without breaks, was also found to be an independent risk factor for DED. Those who used digital devices for over 2 hours daily were more likely to experience dry eye symptoms than those who had regular breaks. The same result was experienced by Portello et al., in which they found that continuous computer use was correlated with higher ocular discomfort and visual fatigue among young adults [18]. These observations highlight the need to make regular visual breaks a habit for students to help minimise visual stress, including the 20-20-20 visual break rule.

Women were more likely to have dry eye disease than men. This finding is consistent with previous epidemiology studies which have consistently shown that females have a higher rate of DED than males [19], [20]. Possible explanations for this sex difference include hormonal influences, differences in function of the meibomian glands, and differences in the composition of the tear film. Due to the study population being largely healthy young adults, however, behavior (such as cosmetic product use and screen-use habits) could also have played a role in the observed association.

Another important predictor of DED in the present study was short sleep duration. Those sleeping less than 6 hours a night were much more likely to have dry eye symptoms. This conclusion is corroborated by Ayaki et al., which showed that inadequate sleep has a negative impact on the tear film and homeostasis of the ocular surface, making people more susceptible to developing dry eye disease [21]. Irregular sleep patterns, often a result of the stressors involved in college life, and extended time spent on digital devices, can also worsen eye symptoms.

The results of this study have public health implications. Students at universities are increasingly using digital technology for learning, and extended periods spent with screens have become a fact of contemporary life for students at universities. In this regard, preventive measures such as educational messages regarding healthy screen-use behaviors, regular visual breaks, ergonomic optimization of the light source and the working position, maintenance of a proper distance from the screen, and routine eye examination should be part of the university health promotion programs. This intervention can help alleviate the burden of dry eye disease and enhance students' visual comfort and academic achievement.

The relatively high prevalence of dry eye disease was observed in this study, which was attributed by the researchers to the changing lifestyle of university students in Iraq, where digital devices are now essential tools for education and communication. While technology has huge educational advantages, the overuse and continuous use of screens has negative implications on the health of the eyes. Increasing awareness about prevention and early ophthalmic evaluation for students with symptoms may have a significant impact on the long-term consequences of dry eye disease and enhance students' quality of life.

Conclusion

Digital exposure, or exposure to prolonged digital screens, is a major factor associated with dry eye disease—a frequent health condition in the University student body. Almost half of the people in this study had dry eye disease; it is an alarming indicator of how many young adults are affected by the excessive use of digital devices. The significant factors that were identified as contributors to dry eye disease were longer screen time, constant use of screens without breaks, females and poor sleep habits.

This result highlights the importance of greater awareness of proper digital device use among University

students. It is possible that continued practice of breaks from screens, proper viewing distance, sufficient lighting and limiting the amount of continuous screen time could decrease the frequency of dry eye symptoms. Ophthalmic screening of students with chronic digital device exposure should also be encouraged routinely to help with early diagnosis and prompt management.

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