

Association of vitamin D and digital screen time with dry eye syndrome among Duhok health science students

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Abstract

Background: Dry eye disease (DED) is a growing issue, especially in younger groups that use digital devices extensively and among those with vitamin deficiencies. The purpose of this study was to evaluate the relationship between DED among health science students and their digital device use and vitamin D levels.

Methods: A cross-sectional study was performed with ninety health science students in Duhok. Participants filled out a standardized questionnaire that asked about their screen time, how they used devices, and their Ocular Surface Disease Index (OSDI) scores. We checked the levels of vitamin D in the blood. Statistical analyses encompassed t-tests, one-way ANOVA, chi-square tests, and Pearson correlation coefficients.

Results: Many participants had sustained severe DED (61.1%). The majority of participants (69%) used digital devices for more than 6 hours daily. The average OSDI scores were significantly higher in prolonged users (>6 hours/day: 51.94 ± 20.273) compared to moderate and light users ($p = 0.001$). Almost 80% of participants had a low level of vitamin D (deficient or insufficient). Vitamin D levels and OSDI scores were strongly negatively correlated ($r = -0.622$, $p < 0.001$), while screen time and OSDI scores were positively correlated ($r = 0.573$, $p < 0.001$), accounting for 32.8% of the variance. There was a strong link between OSDI intensity and device type ($\chi^2 = 19.69$, $p = 0.02$), with people who used more than one device reporting the worst symptoms. There were no strong links between gender ($p = 0.146$) or educational stress ($p = 0.462$).

Conclusion: Health science students who use digital devices for long periods of time and don't get enough vitamin D have higher OSDI scores. Interventions should concentrate on regulating screen time, enhancing blink efficiency, and tackling nutritional aspects such as vitamin D supplementation.

Keywords: Dry Eye Disease, Ocular Surface Disease Index, Digital Device, Screen Time, Vitamin D, Students, Iraq

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instability, hyperosmolarity, inflammation, and problems with the nerves that sense touch and pain [1]. It can also cause irritation, dryness, discomfort, the feeling of having something in the eye, and changes in the vision [2]. DED is one of the most common eye diseases, affecting millions of people all over the world [3]. It impacts approximately one in eleven individuals globally, with prevalence rates varying from 5% to 50% in epidemiological studies [3]. The likelihood of DED escalates with advancing age, with prevalence increasing from 2.7% in adults aged 18 to 34 years to 18.6% in individuals over 75 years [4]. There has been a significant increase in DES among younger generations, particularly college students, due to environmental and lifestyle issues [5, 6]. This is a change from earlier generations, when it was more common. Using screens for a long time is linked to a lower blink rate and more incomplete blinks. This makes the tear film less stable and makes tears evaporate more quickly [7]. Furthermore, the prolonged visual concentration necessitated by computer usage can induce fatigue and increase vulnerability to Digital eye strain (DES), collectively referred to as "digital eye strain" or "computer vision syndrome" [8]. The incidence of DES among university students nationally ranges from 25% to over 70%, frequently associated with extended screen exposure, female sex, contact lens usage, and disrupted sleep patterns [9, 10]. The prevalence of DES increased from 41.5% before the pandemic to 55.2% during the pandemic among medical students, with those reporting over five hours of screen time daily facing a 1.7-fold higher risk [11]. The risk and severity of DES are also affected by several factors, including distance from the screen, the type of device used, the

Background

Dry eye disease (DED), or Dry eye syndrome (DES), is a complex condition of the eye surface that causes tear film

frequency of use (whether continuous or intermittent), and the duration of use. Using computers, laptops, tablets, and smartphones is one of the leading causes of DED because it changes how often you blink [1]. For instance, using smartphones is linked to shorter blink duration and greater visual fatigue because they are smaller and you have to look at them from a shorter distance [12]. Physiological and demographic risk factors also affect how likely someone is to get DES. Hormonal, anatomical, and tear film quality differences put women, students with refractive errors, and people who wear contact lenses at a higher risk [13]. Environmental elements, including air-conditioned classrooms, arid dormitory conditions, and urban pollution, exacerbate tear film instability and ocular surface inflammation [14]. Despite these risks, many college students are unaware of DES symptoms or don't consider them important. Uncontrolled DES disrupts learning and diminishes quality of life, potentially progressing to advanced ocular surface disease. Insidious progression is facilitated by underdiagnosis and insufficient preventive measures, particularly in visually demanding populations [15]. The current evidence robustly indicates that vitamin D deficiency constitutes a significant and independent risk factor for dry eye disease [16]. The mechanisms are based on the importance of vitamin D in controlling the immune system on the surface of the eyes, lowering inflammation, helping the body make tears, and keeping glands healthy [17]. These findings were reported in a 2021 meta-analysis involving more than ten thousand participants, which found that individuals with DED exhibited markedly lower serum vitamin D levels compared to healthy controls. Moreover, diminished vitamin D levels correlated with an elevated risk of developing DED [16]. Furthermore, the Korean National Health and Nutrition Examination Survey (KNHANES VII) revealed a definitive inverse correlation; the incidence of DED diminished as serum vitamin D quartiles ascended, even after controlling for confounding variables such as age, sex, and screen time [17]. Given that universities currently extensively utilize digital technology and DES has long-term effects, it's crucial to investigate the behavioral risk factors associated with DES among college students. This study seeks to evaluate the prevalence and severity of dry eye disease, as quantified by the Ocular Surface Disease Index (OSDI), among health science students in Duhok, Iraq, and to ascertain its relationship with digital device usage patterns and serum vitamin D levels.

Methods

Study Design and Setting

A cross-sectional study was conducted among health science students at the University of Duhok, Iraq, between November 2024 and March 2025. The study was designed to evaluate the association between dry eye disease (DED), digital screen exposure, and serum vitamin D levels.

Study Population and Sampling

The study participants were students aged 18–30 years from the Colleges of Medicine and Pharmacy. Participants were eligible if they had no history of chronic ocular disease (e.g., glaucoma, uveitis), refractive errors requiring corrective eyeglasses, or systemic diseases known to affect the eyes or vitamin D metabolism (e.g., diabetes mellitus, rheumatoid arthritis). Individuals who declined to participate were excluded. A

convenience sampling method was used to recruit participants. The sample size was calculated using G*Power software based on an anticipated correlation coefficient of 0.3, an alpha error of 0.05, and a power of 80% [18], yielding a target sample size of 90 participants. To account for potential non-response and missing data, the target sample size was increased to 120. A final total of 90 participants were enrolled and completed the study.

Data collection tools and techniques

Data were collected using a structured, self-administered questionnaire composed of three sections: Demographic and Behavioral Data: This section captured age, gender, college affiliation, and detailed digital device usage behavior (average daily screen time, types of devices used, and purpose of their use). Ocular Surface Disease Index (OSDI): The OSDI is a validated, 12-item questionnaire used to assess the presence and severity of dry eye symptoms over the preceding week [19, 20]. It evaluates symptoms related to ocular discomfort, vision-related function, and environmental triggers. Responses are recorded on a 0–4 Likert scale. The total score ranges from 0 to 100 and is calculated as follows: $OSDI = [(sum\ of\ scores) \times 100] / (total\ number\ of\ questions\ answered)$. Scores were categorized as normal (0–12), mild (13–22), moderate (23–32), or severe (33–100) DED [21]. Vitamin D Measurement: A 5 mL blood sample was drawn from each participant by a trained phlebotomist. Serum was separated and analyzed for 25-hydroxyvitamin D [25(OH)D] levels using an automated immunoassay analyzer (Cobas e411 analyzer, Roche Diagnostics, Basel, Switzerland). Vitamin D status was defined as deficient (<20 ng/mL), insufficient (20–29 ng/mL), or sufficient (≥ 30 ng/mL) according to Endocrine Society guidelines.

Data analysis

Data analysis was performed using the Statistical Package for the Social Sciences (SPSS) version 26 (IBM Corp., Armonk, NY, USA). Descriptive statistics were presented as means $\pm$ standard deviation (SD) for continuous variables and frequencies (percentages) for categorical variables. The prevalence of DED was reported as a percentage. Inferential analyses included independent samples t-tests, one-way ANOVA, Chi-square tests, and Pearson correlation analysis to examine relationships between variables. A p-value of less than 0.05 was considered statistically significant. Statistical significance was identified using superscripts following the data (*P < 0.05, **P < 0.01).

Results

Participant Demographics and Characteristics

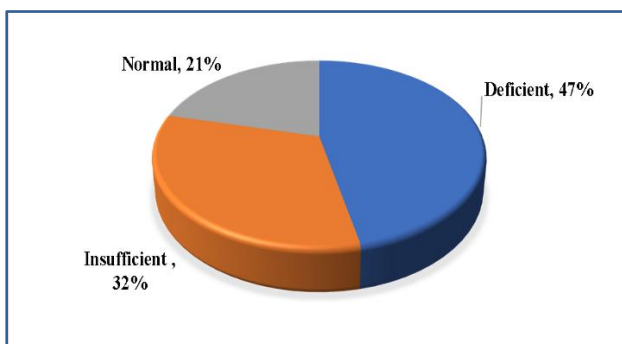
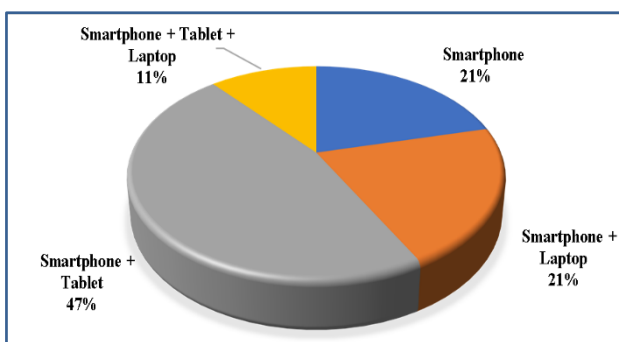
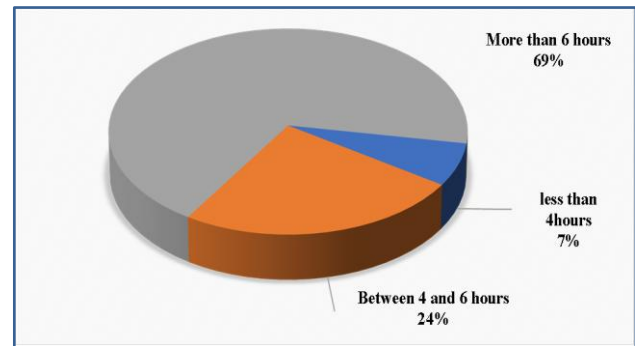
The initial study sample comprised 120 health science students. Ninety participants completed the study, yielding a response rate of 75%. The demographic and health characteristics of the participants are summarized in Table 1. The cohort had a nearly equal gender distribution (54.4% male and 45.6% female). The vast majority of participants (94.4%) were aged 18–24 years. Most participants were from the College of Medicine (64.4%) and were in their third academic year (65.6%). The sample was predominantly free from chronic diseases (95.56%), were non-smokers (93.34%), and were non-drinkers of alcohol (95.56%). However, a majority (61.1%) reported experiencing sleeping problems.

Table 1: Demographic and Health Characteristics of Participants (n=90)

Variable	Category	n (%)
Gender	Male	49 (54.4)
	Female	41(45.6)
Age Group	18-24	85(94.4)
	25-29	5(5.6)
Affiliation	Medicine	58(64.4)
	Pharmacy	32(35.6)
Educational level	Third	59(65.6)
	Fourth	7(7.8)
	Fifth	24(26.7)
Chronic Diseases	Yes	4(4.4)
	No	86(95.6)
Smoking	Yes	6(6.7)
	No	84(93.3)
Alcohol	Yes	4(4.4)
	No	86(95.6)
Sleeping problems	Yes	55(61.1)
	No	35(38.9)

Vitamin D status and digital device usage patterns

The assessment of serum vitamin D levels revealed a high prevalence of deficiency and insufficiency. Nearly 80% of participants had suboptimal levels: 47% were deficient (<12 ng/mL) and 32% were insufficient (12-20 ng/mL). Only 21% had sufficient levels (≥ 20 ng/mL) (Fig. 1). Analysis of digital device usage showed that the most common combination was smartphones and tablets, used by 47% of participants. A smaller proportion (21%) used only smartphones or smartphones with laptops, while 11% used a combination of smartphones, tablets, and laptops (Fig. 2). In terms of duration, the vast majority of participants (69%) reported using digital devices for more than 6 hours per day for both academic and non-academic purposes (Fig. 3).

**Figure 1:** serum level of vitamin D**Figure 2:** Types of digital devices used by participants**Figure 3:** Distribution of participants by daily digital device usage

Prevalence and severity of dry eye disease

The distribution of Ocular Surface Disease Index (OSDI) scores indicated a high burden of symptoms. The majority of participants (61.1%) had severe dry eye disease, while 15.6% had moderate symptoms, 12.2% had mild symptoms, and 11.1% were classified as normal (Table 2).

Associations with OSDI scores

A one-way ANOVA revealed a significant association between daily screen time and OSDI scores ($p < 0.001$). Participants with more than 6 hours of screen time had the highest mean OSDI score (51.94 ± 20.27), followed by those with 4-6 hours (34.58 ± 20.29) and less than 4 hours (12.00 ± 3.03) (Table 3). Comparative analysis between genders is shown in Table 4. While there was no significant difference in total OSDI scores ($p = 0.544$), female students reported significantly longer screen time for academic purposes (3.61 ± 1.16 vs. 2.92 ± 1.10 hours; $p = 0.005$) and total daily device usage (8.26 ± 2.60 vs. 6.96 ± 2.60 hours; $p = 0.020$). Chi-square tests (Table 5) indicated that academic stress was significantly associated with OSDI severity category ($\chi^2 = 21.99$, $df=12$, $p = 0.038$). No significant associations were found for gender or device type.

Correlational Analysis

Pearson correlation analysis (Table 6) demonstrated a strong, statistically significant inverse correlation between serum vitamin D levels and OSDI scores ($r = -0.622$, $p < 0.001$). A strong positive correlation was observed between total screen time and OSDI scores ($r = 0.573$, $p < 0.001$).

Discussion

This cross-sectional study identified an alarmingly high prevalence (88.9%) of dry eye disease (DED) among health science students in Duhok, Iraq, with the majority of cases (61.1%) classified as severe. The findings demonstrate a strong positive correlation between prolonged daily screen time and DED severity and an equally strong negative correlation between serum vitamin D levels and DED symptoms. These results highlight a significant public health issue affecting a young, visually demanding demographic, driven by modern academic and lifestyle factors. The prevalence of DED in our cohort is notably higher than the 33.4% reported among Iraqi and Jordanian students by Abdulmannan et al. [22]. Still, it is consistent with the high burden observed in other regional studies from Palestine (78.4%) [23], Jordan (74.2%) [24], and Saudi Arabia [25]. Globally, our findings are supported by reports from Thailand [26], Poland [27], and Serbia [28]. This disparity with

earlier Iraqi studies may be attributed to the cumulative increase in digital device dependency, particularly following the COVID-19 pandemic, which accelerated the shift towards online learning and increased daily screen exposure. Our finding that 69% of participants used screens for more than 6 hours daily—a higher rate than reported in other regional studies [23] likely explains the elevated prevalence and severity observed. The robust correlation ($r = 0.573$, $p < 0.001$) between screen time and OSDI scores is a central finding of this study.

Table 2. Ocular surface disease index severity distribution.

OSDI Category	Frequency (n)	Percentage (%)	Mean OSDI Score ($\pm$ SD)
Normal	10	11.1%	11.00 ($\pm$ 2.98)
Mild	11	12.2%	18.63 ($\pm$ 1.621)
Moderate	14	15.6%	29.78 ($\pm$ 1.453)
Severe	55	61.1%	60.38 ($\pm$ 13.711)

Table 3. Mean ocular surface disease index by screen time.

Screen Time (hrs/day)	Mean OSDI	SD	p-value; (ANOVA)
Less than 4 hours	12.00	3.033	<0.001*
Between 4 and 6 hours	34.58	20.293	
More than 6 hours	51.94	20.273	

*P < 0.001 vs. other groups (One-way ANOVA) *

Table 4: Comparison of dry eye symptom severity and screen time by gender

Variable	Category	Mean $\pm$ SD	p-value
Total OSDI score indicating the severity of dry eye	Male	36.26 $\pm$ 20.08	0.544
	Female	38.72 $\pm$ 17.64	
Hours spent using digital devices for academic purposes/day.	Male	2.92 $\pm$ 1.096	0.005*
	Female	3.61 $\pm$ 1.159	
Hours spent using digital devices for non-academic purposes/day	Male	3.06 $\pm$ 1.265	0.618
	Female	3.07 $\pm$ 0.932	
Total hours/day of using digital devices	Male	6.959 $\pm$ 2.597	0.02*
	Female	8.256 $\pm$ 2.595	

*P < 0.05 (Independent samples t-test). *

This is mechanistically supported by extensive literature demonstrating that sustained screen use reduces blink rate and promotes incomplete blinks, leading to tear film instability and evaporation [7, 29]. This phenomenon is a hallmark of computer vision syndrome, a condition closely intertwined with DED [8, 30]. Furthermore, participants using a combination of multiple devices (smartphone, tablet, and laptop) reported more severe symptoms, potentially due to increased visual demand and constant screen switching, which exacerbates ocular surface

stress [31]. A novel and significant contribution of this study is the strong inverse correlation ($r = -0.622$, $p < 0.001$) between serum vitamin D levels and DED severity. This finding aligns with growing evidence that vitamin D deficiency is a risk factor for DED [18, 32]. The high prevalence of vitamin D deficiency and insufficiency (79%) in our sample suggests it is a major contributing factor.

Table 5. Associations of gender, device type, and academic stress with OSDI severity

Variable	χ^2 Value (df)	p-value
Gender	1.388 (3)	0.708
Device Type	2.714 (9)	0.975
Academic Stress	21.99 (12)	0.038*

*P < 0.05.

Table 6: Correlations of vitamin d and screen time with OSDI scores

Variable Pair	R	p-value
Vit. D level vs OSDI Score	- 0.622	<0.001*
Total Hours vs. OSDI Score	0.573	<0.001*

*P < 0.001.

The immunoregulatory and anti-inflammatory properties of vitamin D are believed to play a protective role on the ocular surface [33]. Its deficiency may therefore predispose individuals to the inflammatory component of DED, which is exacerbated by prolonged screen use. Contrary to much of the existing literature [24, 26, 27, 28, 30], we found no significant association between gender and DED severity ($p = 0.708$), despite female students reporting significantly longer total screen time. This suggests that in this specific cohort of health science students, the overwhelming environmental and behavioral risk factor of extreme screen exposure may have superseded the well-documented biological and hormonal susceptibilities that typically place females at higher risk [36]. Similarly, while academic stress was significantly associated with OSDI severity in chi-square analysis ($p = 0.038$), its subjective measurement may account for the complex and inconsistent relationship reported in the literature [37]. This study has several limitations. The cross-sectional design precludes the establishment of causality between the identified risk factors and DED. The use of convenience sampling may limit the generalizability of the findings to all student populations. Data on digital device use and academic stress were self-reported, which is subject to recall bias. Furthermore, we did not objectively measure blink rate or meibomian gland function, which are key mechanistic factors in screen-associated DED.

Conclusion

In conclusion, this study reveals a critical health issue among health science students, characterized by a high prevalence of severe dry eye disease strongly linked to excessive digital device use and vitamin D deficiency. These findings call for targeted institutional interventions, including educational programs on ocular ergonomics (e.g., promoting the 20-20-20 rule), routine screening for vitamin D deficiency, and environmental modifications in learning spaces. Future longitudinal research is warranted to confirm these associations and explore the efficacy of interventional strategies, such as vitamin D supplementation

and blink-retraining exercises, in mitigating DED in this vulnerable population.

Abbreviation

DED: Drey Eye Disease; KNHANES VII: Korean National Health and Nutrition Examination Survey; OSDI: Ocular Surface Disease Index

Declaration

Mohammed Ghareeb conducted this research as part of a Master of Science (MSc) thesis, supervised by Hishyar MS Garmavy.

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Availability of data and materials

Data will be available by emailing hishyar.salih@uod.ac

Authors' contributions

All authors contributed equally in the conceptualization, manuscript writing, and interpretation of the findings. The authors read and approved the final manuscript.

Ethics approval and consent to participate

We conducted the research following the declaration of Helsinki. Ethical approval for this study was granted by the Ethics Committee of the College of Medicine, University of Duhok (Reference number: 25092024-8-20). The study's purpose and procedures were explained to all potential participants. Written informed consent was obtained from each individual prior to enrollment. All data were anonymized and stored securely, ensuring confidentiality.

Consent for publication

Not applicable

Competing interest

The authors declare that they have no competing interests.

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