

## ORIGINAL ARTICLE

# Evaluation of Prevalence and Associated Factors of Dry Eye Syndrome among Medical Students Exposed to Visual Display Terminal in Health Campus, Universiti Sains Malaysia

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## ABSTRACT

**Introduction:** Dry eye syndrome (DES) has become a public health concern, especially during the COVID-19 pandemic. Medical students are at risk due to an increase in visual display terminal (VDT) exposure given the transition to full-time online lectures. The presence of reduced blink rate and tear film instability in VDT users causes an increase in tear evaporation leading to symptoms of DES. This study helps us to learn about the associated factors of VDT use and DES among the young generation. This study aims to determine the prevalence and associated factors of DES among medical students exposed to VDT at the health campus, Universiti Sains Malaysia (USM). **Methods:** A cross-sectional study involving 140 undergraduate medical students aged 22 to 29 years old who were VDT users. Factors analysed are age, gender, race and duration of VDT usage. Data collection included both subjective assessment (OSDI questionnaire) and objective assessment (TBUT and Schirmer's test). Statistical analysis was conducted using Statistical Package for the Social Science (SPSS Inc Version 24). Results were analysed using descriptive analysis and multivariate logistic regression. **Results:** Most of the medical student cohort was female and Malay. Most of the students use VDT for less than 8 hours. A high incidence of DES was noted among medical students (92.1%). None of the factors showed significant association with positive findings DES by subjective and objective assessment and duration of VDT usage. **Conclusion:** DES is common among VDT users. This study showed a high prevalence of DES among medical students in USM. The factors analysed did not show a significant association between DES and duration of VDT usage. This study may help to recognize the problem and will raise awareness of their daily practice and implement preventive measures to avoid VDT-related DES.

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## INTRODUCTION

Dry eye syndrome (DES) has become a public health worriment initiating ocular signs and symptoms that may cause a visual disturbance that impedes daily activities. It is one of the most prevailing ocular surface diseases in the universe (1). DES comprises about 20 million in the United States (2). In Malaysia, a study conducted in Kuala Lumpur by Mohd-Ali et al estimated that around 15% of the sample population in Kuala Lumpur has dry eyes (1). The prevalence of DES among medical students during the Covid pandemic was 70.8% (3). Apart from DES, technology has been evolving and has become an important part of life. It has been proven to have a positive and negative impact on education, the workplace and

quality of life. During the COVID-19 pandemic, medical students are at risk due to an increase in both digital screen time for online lectures and stress (3).

According to the Definition and Classification Subcommittee of the International Dry Eye Workshop, "Dry eye is a multifactorial disease of the ocular surface characterized 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 etiological roles" (4). The pathophysiology involves, a breakdown in the tear film which coats in front of the eye. In normal condition, this layer of tears is a stable, homogenous layer which consists of electrolytes, anti-inflammatory elements and enzymes that helps in the maintenance of healthy cornea and conjunctiva (2). The tear film may be affected by an autoimmune disease such as Rheumatoid arthritis, Systemic Lupus erythematosus or Sjogren syndrome (5).

Apart from that, it is postulated that the pathogenetic triggering mechanism stress to the ocular surface environmental factors also contributes to DES, such as due to infection, endogenous stress, antigens and genetic factors (5). Proinflammatory cytokines, chemokines, and matrix metalloproteinases leading to the expansion of autoreactive T helper cells which infiltrate the ocular surface and lacrimal gland (5). The result is a vicious circle of damage to the ocular surface and inflammation leading to damage to the tear film and dry eye symptoms. People with stress have emotional dysregulation, lack of confidence, and social support (6). These alterations generate a state of psychological stress that through the release of inflammatory cytokines such as IL-1 $\beta$ , IL-6 and IL-8 generate the instability of the tear film, as well as the suppression of tear production leading to DES (6). Wang et al. have reported that patients with DED were more likely to have depression (7). The main explanations for this phenomenon are that dry eye symptoms may increase depression symptoms or that antidepressant medications affect anticholinergic activity (6). This study showed that stress is an important risk factor for DED. Apart from that, eyelid abnormalities such as blepharitis, entropion, and trichiasis can cause dry eyes to develop (2). Refractive eye surgeries, such as LASIK, can decrease tear production and contribute to dry eyes (2). Environmental conditions also play an important role. Exposure to smoke, wind and dry climates can increase tear evaporation resulting in dry eye symptoms (2).

Clinical symptoms of DES include burning sensation, itching, tearing, foreign-body sensation, discharge, frequent blinking, redness, blurring of vision, fluctuating vision, light sensitivity, eye pain, eyelid fatigue and or headache (2). These clinical symptoms are made worse when reading, computer, watching television, driving, or playing video games (2). A study conducted in America reported over 2000 American children between eight and eighteen years of age, spend approximately seven and half hours using entertainment media in a day (6). Lockdown during the COVID-19 pandemic has shown a great impact in an increase in screen time in many countries. Majumdar et al studied the use of cell phones and computers among office workers and students before and during the lockdown period (7). They found the significant result of greater duration of time on VDT usage approximately nine hours per day before and eleven hours during the lockdown (7).

Usage of VDT has caused impacts such as ocular symptoms, musculoskeletal, dermatological as well as psychological adverse effects. Though VDT use is associated with a large number of extraocular symptoms, eye symptoms are the most frequently encountered complaint among its users (8). People experience eye discomfort and disturbance in vision problems when viewing digital screens for extended periods. Increased corneal exposure occurs due to the viewing angle of

the visual display screen. This leads to an increase in tear evaporation leading to symptoms of dry eye (8). There is also the presence of reduced blink rate in visual display terminal users which causes an increase in tear evaporation leading to symptoms of dry eye (8). Muniraju et al reported that when viewing electronic material, blinking reduces to 5 to 6 times per minute due to continuous staring at a screen (9).

VDT screens emit short-wavelength blue light which may reduce tear film stability leading to increased tear evaporation and DES (10). This was reported by Xu et al, that blue light from VDTs causes visual disturbance and is a risk factor for ocular surface conditions (11). The blue light emits reactive oxygen which causes oxidative damage to the cornea cells impeding lipid metabolism. This ocular surface damage is reversible (11). Therefore, wearing protective eyewear helps to eliminate screen-related blue light and may help to reduce tear instability in patients with DES (12). The Australian 24-hour movement guideline recommended no more than two hours of sedentary recreational screen time per day for the aged five to seventeen years (13).

Ocular surface disorder plays an important role in VDT-related DES. Meibomian gland secretions, contributing toward the lipid layer of the tear film, are mandatory for deterring evaporative influence on it by ambient air (14). Wu et al. studied the effect of meibomian gland dysfunction (MGD) on the severity of dry eye disorder in VDT users and found that lid margin abnormality, meibum expression and meibomian gland dropout were positively correlated with VDT working time of more than four hours per day (14). The effect of contact lens wear together with VDT use has been identified to have an additive effect on the development of dry eye conditions and ocular symptoms. Tauste et al. reviewed over a hundred articles and found contact lens users are four times more susceptible for developing dry eyes (15). Contact lens users were also found associated with meibomian gland atrophy, tear film instability and decreased cornea sensation leading to a decrease in the reflex arc to secrete tears contributing to the dry eye condition (15).

Usage of VDT has become very influential in our daily lives. Especially during the COVID-19 pandemic, medical students are at risk due to an increase in VDT exposure given the transition to full-time online lectures. Exposure to VDT has been known to cause a reduction in blink rate, visual disturbance due to bright light from the screen, increased cornea exposure due to increased viewing angle of the screen and transient myopia. This has encouraged us to study the effects of the duration of VDT usage and DES among the young generation. These parameters may guide our ophthalmology team in the detection of undiagnosed DES among VDT users. Undiagnosed DES may lead to severe ocular surface disease. This study may elucidate the requirement

for routine eye assessment and further improvise our management and prevention of VDT-related DES. The first objective of this study is to determine the prevalence of dry eye syndrome among medical students exposed to visual display terminal on health campus, USM. The second objective is to determine factors affecting dry eye syndrome among medical students exposed to visual display terminal on health campus, USM.

## MATERIALS AND METHODS

### Patient recruitment

A cross-sectional study was conducted in the Ophthalmology Clinic, Hospital Universiti Sains Malaysia (HUSM), Kelantan, Malaysia between November 2019, and November 2021. Undergraduate medical students from years three, four and five who use visual display terminal (VDT) were selected for this study by convenient sampling. Students with any underlying ocular pathology such as ocular surface disease, contact lens wearer, history of any ocular procedures or known case of chronic systemic diseases were excluded from this study. A thorough ocular examination which included visual acuity, refraction, anterior segment and posterior segment examination and intraocular pressure was conducted. The recruited students will undergo a subjective and objective DES assessment which comprises a questionnaire and ocular examination recorded on the data collection sheet.

### Sample Size Calculation

The sample size done was based on each specific objective. For objective one the sample size was calculated using the single proportion formula. For objective two, sample size calculation was determined using PS (Power and Sample size) Software 2010. A sample size of hundred thirty-eight was used in this study

The calculation for Objective 1 was executed based on two mean formulas (independent). The sample size was determined as the following formula shown below.  $Z = 1.96$  for 95% confidence (5% error), and  $P$  is estimated as 0.1 (16). For Objective 2, the sample size was calculated using an independent, case-control design (8). Calculated sample size obtained is  $57 + 57 = 114$ .

$$n = \left( \frac{Z}{\Delta} \right)^2 p (1 - p)$$

$Z : 1.96$   
 $\Delta : 0.05$   
 $P : 0.1$

### VDT Exposure

A video display terminal is defined as a computer terminal consisting of a screen on which data or graphics can be displayed (17). Examples, a flat panel display, computer, mobile terminal, game devices, and a portable game display (17). The duration of exposure is the average hours of screen time spent on any VDT per day within the recent week. The duration of VDT was calculated by the medical students. Data on the

usage of screen protective eyewear during VDT usage was not included in this study. The duration of exposure was categorized as less than nine hours and more than equal to nine hours as students were attending online classes for about five to seven hours due to the Covid-19 pandemic. The mean duration was nine hours in this study. Therefore, a cut-off point of nine hours was used to group the students for VDT exposure.

## DES assessment

### Subjective assessment

An established Ocular Surface Disease Index (OSDI) questionnaire was used as the subjective assessment in this study. This questionnaire can distinguish between normal students and students with DES. A hard copy of the questionnaire was self-administered by the students before the ocular examination on the same day. OSDI questionnaire consists of twelve items. Each item was graded based on a five-point Likert scale where 0=none of the time; 1=some of the time; 2=half the time; 3=most of the time; and 4=all the time. The final score is calculated by multiplying the sum of all the scores by 25 and then dividing the total by the number of questions. A final score is calculated which ranges from zero to hundred with scores zero to twelve representing normal, score thirteen and above as DES.

### Objective assessment

Schirmer's test and Tear break-up time (TBUT) were performed as this study's objective assessment. Schirmer's test was performed in a confined room with the fan or air-conditioner switched off. Topical anaesthesia was not applied during the test. The round bend of the sterile Schirmer's paper strip was placed in the lower cul-de-sac over the junction of the temporal and central one-third of the lower lid margin. The subjects were then asked to gently close their eyelids for 5 minutes before the removal of the strip. The amount of wetting was measured by reading the calibrated scale printed on the paper strip. Abnormal Schirmer's test is defined as less than 10 mm of wetting after 5 minutes (19).

TBUT is performed to measure the distribution of tears on the ocular surface and tear film stability. It is the time measured from when the eyelid is opened to the appearance of the first dry spot formation after the installation of the fluorescein stain into the inferior cul-de-sac. A sterile fluorescein strip was used in this clinical test, and a sterile normal saline solution was used to wet the fluorescein at the tip of the strip. TBUT was then assessed using a slit lamp at 10X magnification, using cobalt blue illumination. The first appearance of a dry spot was considered TBUT. The normal cut-off value designated in this study was more than equal to ten seconds (19).

Subjects were examined by only one researcher to

maintain consistency in the evaluation of examination findings. The ocular examination was done in a specific room for all subjects. This was to maintain a controlled environment to avoid variation in humidity. The diagnosis of DES was determined by the researcher. The student was diagnosed as having DES if either one or both the subjective and objective assessment is abnormal. If both objective and subjective assessment of the student is normal, the student is considered as not having DES.

**Statistical analysis**

All relevant data such as age, sex, race, duration of VDT use and OSDI scores were consolidated from the data collection sheet and keyed into Microsoft excel. The data were visually checked for correct and missing entries before performing the statistical analysis. Data from Microsoft Excel was analysed using Statistical Package for Social Science (SPSS) Incorporated Version 24. Numerical data were analysed by descriptive analysis and presented as either frequency (percentage) or mean ± standard deviation. The normality of the numerical data was assessed using a histogram normal distribution curve. Demographic data and incidence of DES among medical students exposed to VDT were analysed using Descriptive analysis. The relationships among the individual and dependent variables were assessed using multivariate logistic regression, wherein the results were presented as an adjusted odds ratio (95% confidence interval). A p-value less than 0.05 is utilised as significant findings and the null hypothesis was rejected.

**Ethical Clearance**

The study followed the tenets of the declaration of Helsinki and was approved by the Research and Ethical Committee, School of Medical Sciences, Universiti Sains Malaysia (USM/JEPeM/20010075). Written informed consent for participation was obtained from each patient before conducting the study .

**RESULTS**

A total of hundred forty medical students were recruited for the present study. Their mean age was 23.16±0.93 years old. There was more female preponderance (78.6%) and a majority of them were Malays (72.1%). A slightly higher (53.6%) number of medical students used a VDT for less than 9 hours per day (Table I). Based on the incidence of DES by subjective and objective assessments, 92.1% of them had DES. Subjective assessment based on the OSDI questionnaire showed about 53.6% of them had normal Schirmer’s results. Whereas objective assessment showed a greater percentage (80.7%) of abnormal results. 77.9% of students were noted to have abnormal TBUT in contrast, 85.7% had normal Schirmer’s test (Table II).

Multivariate logistic regression was used to determine

**Table I: Demographic data of medical students**

Variables (N = 140)	Values
Mean age (years)	23.16±0.93
Gender	
Male	30 (21.4%)
Female	110 (78.6%)
Race	
Malay	101 (72.1%)
Chinese	14 (10%)
Indians	20 (14.3%)
Others	5 (3.6%)
Duration of VDT use per day	
<9 hours	75 (53.6%)
≥9 hours	65 (46.4%)

VDT: Visual Display Terminal

**Table II: Incidence of DES among medical students exposed to VDT**

Variables (N = 140)	n (%)
DES Assessment (Subjective and objective assessments)	
No	11 (7.9%)
Yes	129 (92.1%)
Subjective (OSDI Assessment)	
No	75 (53.6%)
Yes	65 (46.4%)
Objective (TBUT and Schirmer’s Test)	
No	27 (19.3%)
Yes	113 (80.7%)
TBUT (seconds)	
No	31 (22.1%)
Yes	109 (77.9%)
Schirmer’s Test	
No	120 (85.7%)
Yes	20 (14.3%)

DES: Dry Eye Syndrome, VDT: Visual Display Terminal, TBUT: Tear Break Up Time, OSDI: Ocular Surface Disease Index

the relationship between independent variables (age, gender, race and VDT duration) and positive findings DES by objective and subjective assessment. According to the analysis, none of the variables showed a significant relationship with the DES positive findings. Duration of VDT less than or higher than 9 hours had a larger percentage of DES (53.49% and 46.51%) (Table III). Multivariate logistic regression was used to determine the relationship between independent variables (age, gender, race, objective and subjective assessments) and VDT duration (Table IV). According to the analysis, all the variables except Schirmer’s test showed no significant relationship Of 0.014 with the DES positive

**Table III. Factors affecting DED among medical students**

Variables	Positive Finding DES by Objective and Subjective Assessments		Adjusted Odds ratio (95% CI)	P-value
	No	Yes		
Age	23±0.63	23.18±0.96	1.186 (0.477, 2.946)	0.714
Gender				
Male	0 (0%)	30 (23.26%)	1	
Female	11 (100%)	99 (76.74%)	0 (0, 0)	0.998
Race				
Malay	9 (81.82%)	92 (71.32%)	1	
Non-Malay	2 (18.18%)	37 (28.68%)	1.784 (0.353, 9.025)	0.484
Duration of VDT use per day, hour				
<9 hours	6 (54.55%)	69 (53.49%)	1	
≥9 hours	5 (45.45%)	60 (46.51%)	1.12 (0.312, 4.016)	0.862

Note: Multivariate logistic regression, \*A P value less than 0.05 indicates a statistically significant difference.

**Table IV: Factors affecting the duration of exposure to VDT**

Variables	Duration of exposure to VDT		Adjusted Odds ratio (95% CI)	P-value
	<9 hours	≥9 hours		
Age	23.15±1.02	23.18±0.83	1.02 (0.701, 1.484)	0.918
Gender				
Male	3 (50%)	27 (20.15%)	1	
Female	3 (50%)	107 (79.85%)	0.968 (0.412, 2.275)	0.941
Race				
Malay	6 (100%)	95 (70.9%)	1	
Non-Malay	0 (0%)	39 (29.1%)	0.906 (0.409, 2.008)	0.808
Subjective assessment				
Negative	4 (66.67%)	71 (52.99%)	1	
Positive	2 (33.33%)	63 (47.01%)	0.619 (0.306, 1.253)	0.182
Objective assessment				
Negative	2 (33.33%)	25 (18.66%)	1	
Positive	4 (66.67%)	109 (81.34%)	9.115 (0.727, 114.23)	0.087
Tear Break Up Time				
No	14 (18.67%)	17 (26.15%)	0.262 (0.025, 2.755)	0.265
Yes	61 (81.33%)	48 (73.85%)		
Schirmer's test				
No	64 (85.33%)	56 (86.15%)		
Yes	11 (14.67%)	9 (13.85%)	0.188 (0.049, 0.714)	0.014*

Note: Multivariate logistic regression, \*A P value less than 0.05 indicates a statistically significant difference.

findings. Most students who had negative subjective assessments used VDT for more than or equal to 9 hours (52.99%). Most students who had a positive objective DES assessment used VDT longer or equal to 9 hours (81.34%) (Table IV).

## DISCUSSION

In this era, we are surrounded by technological products. Technology has been evolving and has become an important part of life. It has been proven to have a positive and negative impact on education, the workplace and quality of life. Eyes are always used to view these gadgets and excessive use has affected the eyes in many ways. Additionally, during the COVID-19 pandemic, medical students are at risk due to an increase in both digital screen time for online lectures and stress (3). OSDI that was used in this study is an established questionnaire which is easily available online. OSDI is a valid and reliable instrument for measuring dry eye syndrome and it is also able to evaluate the effect on vision-related function (4). It can demonstrate sensitivity and specificity in distinguishing between normal subjects and patients with dry eye syndrome with a good specificity of 83% and a moderate sensitivity of 60% (18). Tear Film and Ocular Surface Society (TFOS) Dry Eye Workshop (DEWS) II recommend the use of DES questionnaires such as OSDI to determine the subjective severity of the symptoms and their sequelae on quality of life (19). Additionally, the presence of at least one clinical sign of abnormal tear film homeostasis is required for the diagnosis such as Schirmer < 10 mm in 5 minutes, TBUT < 10 seconds and positive staining (19).

The mean age in our study was 23.16 and mostly female. This was comparable with a study among medical

students by Tangmonkongvoragu et al with a mean age of 20.73 and mostly female (52.3%) (3). VDT usage of fewer than nine hours per day. This was comparable with one large-scale population-based Japanese study among young and middle-aged office workers using VDTs who used VDT for more than four hours daily (80.3%) (8). There was a high prevalence (92.1%) of DES-based signs and symptoms of DES among medical students exposed to VDT. Our study showed a higher prevalence compared to a study by Thatte et al which reported 24.41% and a study by Basnet et al had also shown DES in 61.8% of VDT users in Nepal (20,21) This may be due to the increasing usage of VDT during the covid-19 pandemic which led to an increased incidence of DES among medical students. The prevalence of DED among medical students exposed to VDT during the Covid pandemic in Chiang Mai was 70.8% and explained that this may be due to more stressful situations during the COVID-19 pandemic among medical students (3).

Although the majority had normal findings based on the OSDI questionnaire, medical students showed more DES signs rather than experiencing the symptoms. Hence the importance of ocular examination of DES as a screening tool especially for those who did not experience symptoms of DES. This can be due to decreased corneal sensation during the long course of DES. In a study by Onwubiko et al, OSDI was inversely correlated with Schirmer and TBUT which was explained as patients in the study had a long course of dry eye disease and might undergo decreased corneal sensation (22). Therefore, symptoms evaluated by the OSDI questionnaire may not be consistent with the ocular surface signs (22).

There was a high percentage of abnormality in TBUT (77.9%) compared to Schirmer's test (14.3%) where most of them had normal tear production. In comparison, Basnet et al reported occurrence of DES among students using VDT was 58 % according to TBUT and 57% of students have DES based on Schirmer's test (21). VDT users are largely affected by tear film instability. Tear evaporation increases when there is reduced blinking. Tsubota et al reported that blinking frequency was significantly decreased during VDT work (23). This was also comparable to another study by Wu H et al, which revealed that the long-time VDT workers had more severe ocular discomfort and dry eye conditions than the short-time workers despite normal aqueous productions (24). Schirmer's test has poor reproducibility and low sensitivity for detecting dry eyes (25). It may show false-negative results due to several factors such as the placement of the Schirmer's strip in the eye and the effects of reflex tearing due to the ocular irritation caused by the Schirmer's strip (26).

Factors such as age, gender, race, and duration of VDT usage were not statistically significant with both objective and subjective DES assessments. This current study had a narrow range of age is 22 to 29 years of

age. Medical students in an institution may not represent the population of a particular area. Apart from that, the duration of VDT might have been under-estimated by the medical students as their online classes alone contributed about five to six hours per day. This may have affected the results of this study. Titiyal et al studied the prevalence and risk factors of dry eye disease in North India and found similar findings of no significant difference in the severity of DES between males and females (27). Although we found more students who used a longer duration of VDT usage had abnormal DES assessment, the results were not statistically significant. This was comparable to a study by Tangmonkongvoragul et al at Chiang Mai, 2022 (3). They reported the history of refractive surgery, duration of VDT use, and hours of reading paperwork were not significantly different between those with and without DES (3).

Factors such as age, gender, race and DES were not statistically significant with a duration of exposure to VDT except for Schirmer's test. In a study by Sano et al, they found that basal tear secretion decreases in response to stress in mice (28). Evaporative dry eye occurs due to a deficiency in the lipid layer tear film which leads to an increase in tear evaporation (6). Usually, the lacrimal gland function is normal, and the volume of lacrimal fluid is adequate (7). Conditions that may lead to decreased blinking are among visual display terminal users, Parkinson's disease or medication-related such as antipsychotics (4).

People using a VDT tend to be more physically sedentary and restrained to a desk. Prolonged VDT use is associated with poor health and severe psychological distress (29). Therefore, prolonged VDT use should be prevented. VDT users should make the "20-20-20" rule a habit, which recommends that every 20 minutes, an individual should take a 20-second break and focus their eyes on something at least 20 feet away. To practice limited screen time every day. Evaluation of tear film status should be regularly performed on all VDT users. Management with ocular lubricants can improve ocular discomfort and improve both qualities of life and productivity.

There were several limitations to this study. Firstly, we did not study other factors that may contribute to DES such as blink rate abnormalities, meibomian gland and goblet cell dysfunction, or corneal effects of the peak emission wavelength in modern LEDs and psychological stress.<sup>15</sup> Secondly, the data was collected during the COVID-19 pandemic, in which medical students had an increase in both digital screen time for online lectures and stress. The prevalence of DED in a normal situation may be different. Thirdly, we did not include data on on-screen protective eyewear during VDT usage and year of study about DES in our study. In future, more tools should be implemented in assessing DES such as blink rate measurements, cornea staining and tear

meniscus measurement. To include data on the use of screen protective eyewear during VDT usage. Stress elements should also be evaluated to eliminate other causes of DES. To study several categories of duration of VDT usage.

## CONCLUSION

DES is common among VDT users. This study showed a high prevalence of DES among medical students in the health campus, HUSM. We found no statistical significance between age, gender, race and the duration of VDT usage and DES. Detected DES needs to be treated accordingly to avoid severe ocular surface disease. The findings of this study may raise the awareness of the daily practice of VDT usage and implement preventive measures to avoid VDT-related DES.

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