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Duration of Gadget Use and Severity of Dry Eye Syndrome based on the Ocular Surface Disease Index (OSDI) Questionnaire in Final-Year Students of the Faculty of Medicine, Universitas Airlangga

Arya Agung Hari Subagiono[1], Evelyn Komaratih[2,3*], Pirlina Umiastuti[4,5], Rozalina Loebis[2]

[1]Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia.
[2]Department of Ophthalmology, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia.
[3]Indonesian Ophthalmologist Association (PERDAMI) East Java Branch, Surabaya, Indonesia.
[4]Department of Public Health and Preventive Medicine, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia.
[5]The Indonesian Physician of Community Medicine and Public Health Association (PDK3MI) Regional V Branch, Surabaya, Indonesia.

* Correspondence: evelyn.komaratih@fk.unair.ac.id

ABSTRACT

Introduction: People's screen time surged during and after the COVID-19 pandemic. Screen time was a risk factor for dry eye disease (DED). This study examined the correlation between screen time and DED severity based on an ocular surface disease index (OSDI) questionnaire in final-year undergraduate students of the Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia.

Methods: This was a cross-sectional study. Respondents were recruited via a total sampling method. One hundred eight students participated in this study. Independent variables were sex, average duration of device use per day, and degree of daily gadget usage time. Dependent variables were OSDI score, degree of dry eye based on OSDI score, and dry eye incidence. Chi-Square, Spearman, Kruskal-Wallis, and Mann-Whitney tests were used in data analysis.

Results: There was no significant relationship between daily gadget use duration and OSDI score (p=0.497; r=-0.066) and between the degree of daily gadget usage time and dry eye severity (p=0.609; r=0.050). Sex was unrelated to dry eye incidence (p=0.072) nor severity (p=0.125). There were no significant differences in daily gadget use duration between dry eye vs non-dry eye respondents (p=0.926) and across dry eye severity (p=0.934). There were no significant differences in OSDI scores between degrees of screen time (p=0.978). There was no significant correlation between the incidence of dry eye and the degree of daily gadget usage time (p=0.640). Female respondents had higher mean OSDI scores than males (p=0.009).

Conclusion: Screen time was not related to the incidence and severity of dry eye based on OSDI. However, many respondents had dry eyes based on OSDI.

Highlights:
1. Screen time is one of the risk factors for dry eye disease (DED). Therefore, students are at high risk for DED.
2. The ocular surface disease index (OSDI) is one method used to assess dry eye disease based on subjective symptoms. However, the correlation between screen time and the incidence of dry eye and/or its severity based on OSDI produces varying results.
3. The majority of respondents had dry eyes based on OSDI. There was no correlation between screen time and dry eye incidence or severity based on OSDI parameters. Females had higher mean OSDI scores than males.

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Introduction

Dry eye is a multifactorial disease on the ocular surface characterized by loss of tear film homeostasis. It is accompanied by symptoms of tear instability and hyperosmolarity, inflammation, and damage to the ocular surface, and neurosensory abnormalities accompany it.[1] Dry eye disease (DED) is common worldwide. A recent Tear Film & Ocular Surface Society Dry Eye Workshop II (TFOS DEWS II) stated that its prevalence may reach 75% in certain populations, with Southeast Asia having the highest prevalence globally.[2]

Gadgets are an inseparable part of human life. Nowadays, kids are introduced to gadgets since early childhood.[3] Changes in lifestyle during and after Corona Virus Disease-2019 (COVID-19) pandemic caused people to spend even more time using gadgets.[4–7] This is a global health concern, as screen time is a risk factor for DED.[2] Dry eye studies on students and office workers showed a prevalence between 25%-90%.[8–12] Screen time was related to dry eye due to decreased blink frequency in activities requiring visual concentration. A decrease in blink frequency promotes excess tear film evaporation, eventually leads to tear film hyperosmolarity, and eventually, may cause or worsen dry eye as tear film homeostasis is disrupted.[13]

Although dry eye is not a life-threatening condition, the morbidity and economic burden caused by it cannot be ignored. Dry eye disease is the most common reason patients seek eye-related medical care. It is an economic burden directly through maintenance costs and indirectly from lost productivity and a decreased quality of life.[2] Based on recent studies, DED patients' average treatment cost could reach $400 to $1,000 annually.[14–16] Common dry eye complaints in students and office workers were dry eye, watery eye, red eye, and blurred vision.[17–20]

Based on the previous information, knowledge about screen time as a risk factor for DED is very important. Recent studies regarding the correlation between screen time and dry eye yielded varying results. However, those studies regarding screen time and dry eye had different designs, places, samples, and results. Therefore, this study aimed to determine the correlation between screen time activities and the severity of dry eye syndrome in final-year undergraduate students of the Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia, with an ocular surface disease index (OSDI) score as a dry eye parameter. The types of gadgets studied in this study were smartphones, e-tablets, and computers in the form of desktops or portable (laptops), as these three types of gadgets are visual gadgets widely used today.[21]

Methods

Ethical clearance of this study was received from the Health Research Ethics Committee, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia (no. 181/EC/KEPK/FKUA/2022) on 3 October 2022. This cross-sectional study was performed from November to December 2022 in the Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia. Independent variables in this study were daily gadget use duration, degree of daily gadget usage time, and sex. Dependent variables in this study were the OSDI score and the degree of dry eye based on the OSDI score. The population in this study was final-year undergraduate students of the Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia. The total sampling method was used to recruit respondents in this study. Data were obtained primarily from questionnaires distributed to the respondents. The degree of daily gadget usage time parameter in this study was stated in the following:

Low daily usage gadget time: ≤4 hours/day
Moderate daily usage gadget time: 5-8 hours/day
High daily usage gadget time: 9-12 hours/day
Very high daily usage gadget time: >12 hours/day

Assessment of dry eye severity was performed using the OSDI questionnaire. The OSDI questionnaire was listed as one of the validated dry eye-specific questionnaires in the recent TFOS DEWS II. Cronbach alpha value for the overall questionnaire and each subscale exceed 0.7. Intraclass correlation between test and retest scores was also good for total scores and subscales, with results exceeding 0.7. It had good specificity (0.83) and moderate sensitivity (0.60) in distinguishing dry-eye respondents from normal subjects. Respondents answered 12 questions regarding the frequency of dry eye symptoms, limitations, and inconvenience on daily activities during the last 7 days before the questionnaire assessment. Respondents could answer each question with “always,” “often,” “sometimes,” “seldom,” or “never.” Some questions were allowed to be left vacant by the respondent. The range of OSDI score was 0-100, with a higher score meaning more frequent dry eye symptoms and disruption in daily life activities due to dry eye condition. The parameters of OSDI questionnaire answers in this study were stated below:

Always: Everyday
Often: 5-6 days a week
Sometimes: 3-4 days a week
Seldom: Less than 3 days a week
Never: Respondent never experienced the condition stated by the question

The degree of dry eye in this study was determined by OSDI score, with parameters used in this study stated in the following:

Normal: OSDI score <13
Mild dry eye: OSDI score 13 ≤ x < 23
Moderate dry eye: OSDI score 23 ≤ x < 32
Severe dry eye: OSDI score ≥ 32

In this study, respondents with OSDI scores <13 were classified as the normal group, and respondents with OSDI scores ≥13 were classified as the dry eye group. In total, 133 respondents participated in the study. Respondents who were currently on medications such as antihypertensives, antidepressants, antipsychotics, and antithyroid, currently using contact lenses, had a history of ocular surgery, had a medical history of epilepsy, were currently diagnosed with thyroid abnormalities, and were currently diagnosed with hypertension were excluded. Finally, there were 108 respondents after filtering all with the exclusion criteria. The Spearman correlation test was used to analyze the correlation between daily gadget use duration and OSDI score and the correlation between the degree of daily gadget usage time and degree of dry eye based on OSDI score. The Chi-square test was used to analyze the correlation between sex and the incidence of dry eye based on OSDI score, to analyze the correlation between sex and degree of dry eye based on OSDI score, and to analyze the correlation between the incidence of dry eye and degree of daily gadget usage time. Mann-Whitney test was used to analyze the difference in OSDI scores between sex groups and in daily gadget use duration between dry eye and normal group. The Kruskal-Wallis's test was used to analyze the difference in daily gadget use duration within a degree of dry eye based on OSDI score and to analyze the difference in OSDI score within a degree of daily gadget usage time. The International Business Machines Corporation (IBM) Statistical Package for the Social Sciences (SPSS) version 15.0 was used to perform statistical analysis on data collected in this study.[22]

Results

In total, 133 respondents participated in this study. Data from 25 respondents were excluded due to the exclusion criteria in this study. Characteristics of data from the remaining 108 respondents were listed below:

Table 1. Respondents' characteristics

Variable	
Sex[a]	
Male	35 (32.41)
Female	73 (67.59)
Age[b]	21.16±1.32
Daily gadget use duration (hours/day)[c]	8.67±3.30
Degree of daily gadget usage time[a]	
Low	7 (6.48)
Moderate	57 (52.78)
High	34 (31.48)
Very High	10 (9.26)
OSDI Score[d]	27.67±19.90
Degree of dry eye based on OSDI Score[a]	
Normal	31 (28.70)
Mild dry eye	21 (19.44)
Moderate dry eye	15 (13.89)
Severe dry eye	41 (37.96)

Source: Research data, processed
[a]Data presented as number of respondents (percentage)
[b]Data presented as age in years old±standard deviation
[c]Data presented as duration in hours/day±standard deviation
[d]Data presented as OSDI score±standard deviation
OSDI: ocular surface disease index

Based on Table 1, most 108 respondents were female (67.59 %). In this study, all respondents were relatively in the same age group, with a mean age of 21.16±1.32 years old, as almost all respondents originated from the same batch. The respondents' mean daily gadget use duration was 8.67±3.30 hours, with the majority of respondents (52.78%) spending between 5-8 hours/day using visual gadgets. The mean OSDI score in this study was 27.67±19.90, with most respondents classified as severe dry eye (37.96%), followed by normal (28.70%), mild dry eye (19.44%), and moderate dry eye (13.89%). Therefore, in this study, the percentage of respondents with dry eye was 71.30%. Normality test using Kolmogorov-Smirnov showed that the assumption of the normal distribution was not fulfilled in the OSDI score variable, age variable, and daily gadget use duration variable, with 2-tailed asymp sig 0.021, 0.000, and 0.000, respectively.

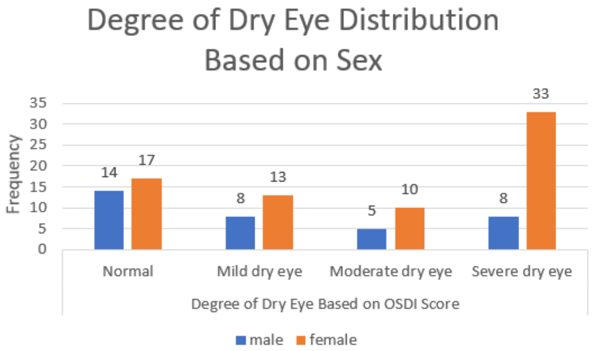

Figure 1. Degree of dry eye distribution based on sex
Source: Research data, processed

Based on Figure 1, out of 108 respondents, most were classified as severe dry eye group with female to male ratio close to 4:1. Thirty-one respondents (28.70%) were classified as normal, consisting of 14 male and 17 female respondents. Twenty-one respondents (19.44%) classified as mild dry eye group consisting of 8 male and 13 female respondents. Fifteen respondents (13.89%) classified to the moderate dry eye group consisted of 5 male and 10 female respondents. Forty-one respondents (37.96%) belonged to the severe dry eye group, consisting of 8 male and 33 female respondents.

Table 2. Test analysis between sex and dry eye variables

Variable	p
Sex vs incidence of dry eye	0.072*
Sex vs degree of the dry eye based on OSDI score	0.125*
Sex vs OSDI score	0.009**

Source: Research data, processed
*: Chi-square test
**: Mann-Whitney test

Based on Table 2, it could be known whether there was a correlation between sex and the incidence of dry eye and/or its severity or not from the p-value. In this study, results were considered significant at p-value <0.05. There was no significant correlation between sex and incidence of dry eye (p=0.072) and between sex and degree of dry eye based on OSDI score (p=0.125). However, this study found female respondents had significantly higher mean OSDI scores than male respondents using the Mann-Whitney test (p=0.09).

Table 3. Test analysis between gadget time variables and dry eye variables

Variable	r	p
Daily gadget use duration vs OSDI score	-0.660	0.497***
Degree of daily gadget usage time vs degree of dry eye based on OSDI score	0.050	0.609***
Incidence of dry eye vs daily gadget use duration	n/a	0.926**
Daily gadget use duration vs degree of dry eye based on OSDI score	n/a	0.934****
Degree of daily gadget usage time vs OSDI score	n/a	0.978****
Incidence of dry eye vs degree of daily gadget usage time	n/a	0.640*

Source: Research data, processed
*: Chi-square test
**: Mann-Whitney test
***: Spearman correlation test
****: Kruskal-Wallis's test

Based on Table 3, it could be known that there was no significant correlation between daily gadget use duration and OSDI score (p=0.497); p >0.05). In this statistical analysis, the Spearman correlation test was used instead of the Pearson correlation test because the normality assumption was not fulfilled on both variables. There was also no significant correlation between the degree of daily gadget usage time and the degree of dry eye based on the OSDI score. This study found no significant differences in daily gadget use duration between dry eye respondents and non-dry eye respondents (p=0.926) and between groups of dry eye severity (p=0.934). This study found no significant differences in OSDI scores between degrees of daily gadget usage time (p=0.978). This study also found no significant correlation between the incidence of dry eye and the degree of daily gadget usage time (p=0.640).

Discussion

This study demonstrated that based on the OSDI parameter, 71.29 % of respondents had a dry eye. This result is similar to a previous study on medical students in Maluku, where 70% of respondents had dry eyes based on OSDI parameters.[10] Another study on junior high school pupils in Makassar showed that 49.7% of respondents enrolled in the study had dry eye based on OSDI parameters.[23] The difference between the current results and the previous studies may be attributed to the difference in the sample age group within the studies. Age is a dry eye risk factor, according to TFOS DEWS II.[2] The prevalence of dry eye may increase by 2%-10.5% per decade of age.[2] This phenomenon is attributed to a decrease in the function of the lacrimal glands, the sensitivity of the cornea to mechanical and chemical stimuli, and goblet cells within the conjunctiva, which play a crucial role in maintaining the homeostasis of the tear film as a person ages.[13]

However, a previous study about dry eyes in medical students in Korea showed that only 27.1% of samples had dry eyes.[9] Another dry eye study on high school students in Makassar showed 87.2% of the samples had dry eye.[24] The difference in results between previous and current studies may be attributed to the different methods of assessing dry eye. In the former, a questionnaire of dry eye symptoms was used to assess dry eye. Samples were classified as having dry eye when they answered “often” or “always” in at least one question in the questionnaire. In the latter, the tear film break time (TBUT) test was used to assess dry eye. Samples with TBUT ≤ 10 seconds were classified as having dry eye. This shows that, in addition to the difference in the samples’ age groups, the difference in results in the dry prevalence study may be attributed to the different methods used between studies to assess dry eye.[2,25]

In this study, the percentage of dry eye respondents was more significant among females than males. This result aligns with a previous study in which dry eye was more prevalent in female samples than in males.[9] However, Table 2 shows that this study found no correlation between sex and the incidence of dry eye (p=0.072) and between sex and the degree of dry eye based on the OSDI score (p=0.125). This result is similar to some previous dry eye studies.[11,26] This result differs from the previous dry eye study on medical students, which showed a significant correlation between sex and dry eye incidence and severity.[9,10]

Tear Film & Ocular Surface Society Dry Eye Workshop II Epidemiology Report classified females as a dry eye risk factor.[2] A decrease in goblet conjunctival cells around the ovulational period, higher superior limbus keratoconjunctivitis prevalence in females, and various genetic and hormonal factors are claimed to be crucial in this phenomenon.[27] The Nasolacrimal duct in females is also claimed to be shorter and narrower than in males, thus causing dacryolith and obstruction in the nasolacrimal duct to be more prominent in females.[27] This caused tear outflow disturbances, further disrupting tear film homeostasis, which caused dry eye. A previous dry eye study from Berkeley University also showed that female respondents’ pain sensitivity questionnaire (PSQ) scores were significantly more significant compared to male respondents, and this phenomenon is associated with higher results of OSDI scores and more severe complaints in other dry eye questionnaires in female respondent than in male respondent.[28]

The disparity of results in dry eye studies regarding the correlation between sex and dry eye may be caused by some factors. First, the difference in the number of respondents and the ratio of female to male respondents between studies may cause differences in results. On the other hand, the different methods used in studies to assess dry eye may also contribute to the disparity in results. However, despite the current understanding of pathophysiology regarding females as dry eye risk factor, the TFOS DEWS II Epidemiology Report stated that the difference in dry eye prevalence in females and males is minimal and inconsistent under the age of 50.[2] This may also explain the inconsistencies and differences in results in recent studies regarding sex comparison on dry eye prevalence.[2]

Based on Table 3, this study showed no significant correlation between daily gadget use duration and OSDI score (p=0.497) and between degree of daily gadget usage time and degree of dry eye based on OSDI score (p=0.609). This result is in line with previous dry eye studies on medical students in Indonesia, where there was no significant correlation between screen time and the severity of dry eye.[10,11] On the contrary, other previous studies showed a positive correlation between screen time and dry eye incidence and severity.[23] Another study showed smartphone usage duration was not a significant risk factor for dry eye incidence, but computer usage duration was a significant risk factor for dry eye.[9]

Screen time is a risk factor that may cause and worsen dry eye.[2] Activities requiring visual concentration may reduce blink frequency. Normal blink frequency in healthy adults is 22°C, and 40% humidity is 15-20 times per minute.[13] During the interblink interval, the tear film is exposed to the external environment, which eventually impairs tear film stability and causes hyperosmolarity.[13] This condition may manifest as common dry eye complaints such as watery eyes, itchy eyes, and blurred vision.[20] Blinking removes debris from the eye surface and renews the tear film.[13] Therefore, decreasing blink frequency may cause dry eye and worsen its condition. A previous study showed a significant negative correlation between daily smartphone screen time and blink frequency.[23] Sleep quality may also play a role in this mechanism. A dry eye study in Saudi Arabia showed a significant positive correlation between the OSDI score and the Pittsburgh sleep quality index (PSQI) as a sleep quality indicator.[29] Another study showed screen time had a significant positive correlation with decreased sleep quality based on PSQI.[30] Another study showed sleep quality was worse in patients with dry eye than in non-dry eye counterparts.[31] Social media usage, an activity strongly associated with screen time, is significantly associated with insomnia. This showed that screen time may cause or worsen dry eye via impaired blinking mechanisms and decreased sleep quality. However, this study did not assess blink frequency and sleep quality.[32]

This study showed no significant correlation between daily gadget usage duration and OSDI score. Several factors may cause this result and differences with and within previous dry eye studies. First, previor studies used different methods to assess dry eye. Some used a symptoms or signs approach, OSDI score or tear meniscus examination to assess dry eye.[11] Some used a symptom-based approach, using OSDI scores to assess dry eye.[10,23] Some used other symptom approach methods, classifying samples as having dry eye when there was an “always” or “often” answer in at least one question regarding dry eye symptoms.[9] Also, studies with a symptoms-based approach are subject to subjectivity as pain-symptoms perception differs between individuals, for example, in the OSDI questionnaire.[28] Recall bias is also an important factor as each respondent in this study and previous study used the recalling method to collect data regarding screen time and OSDI score. Other external factors that may affect the result could not be completely excluded from this study, such as environmental temperature, humidity level, actual duration where the respondent stared at gadget screens, and sleep quality.[10,23]

It was found that this study and previous studies with similar methods to assess screen time (recall method) and dry eye severity (OSDI questionnaire) produced different results. The subjective interpretation of the OSDI questionnaire may cause this. Until today, there has been no international agreement regarding the interpretation of possible answers in OSDI questionnaires, such as “always,” “often,” “sometimes,” “seldom,” and “never.” This study used specific criteria to help each sample have a similar picture of each possible answer, as explained in the methods. However, these criteria regarding the OSDI questionnaire's possible answers may vary between studies or may not be explained in previous studies. It is suggested that future dry eye studies include topics regarding OSDI questionnaire interpretation and its correlation with other dry eye diagnosis methods to answer this phenomenon.[10,23]

This study showed no significant correlation between screen time, dry eye incidence, and severity. However, a high percentage of respondents in this study had dry eye based on the OSDI parameter. Untreated dry eye may cause a severe decrease in quality of life and disruption in daily activities. This condition may cause anxiety, elevated stress levels, and a decrease in learning motivation.[33,34] It is strongly recommended that visual hygiene is practiced when using gadgets. For those with dry eye, seeking medical care and using dry eye medications to relieve dry eye complaints is suggested.[35]

Strength and Limitations

This is the first study that assesses screen time and dry eye data on the final-year undergraduate students of the Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia. This study identified a high percentage of students with dry eye based on OSDI parameters. Therefore, everyone should be more aware of dry eye, practice visual hygiene, limit screen time, and seek medical care for those already experiencing dry eye symptoms to relieve and prevent disease progression. This study also highlighted the need for future dry eye studies with multiple dry eye diagnostic methods to be compared, as the results of this study and previous studies with similar or different methods to assess dry eye produced varying results. However, this study still had limitations, such as recall bias in screen time data and other confounding variables that could not be excluded or standardized, such as temperature, humidity, and sleep quality. It is suggested that the experimental method be used to investigate the effect of screen time on tear film homeostasis and dry eye in future studies to exclude recall bias in screen time assessment.

Conclusion

In this study, an analysis of screen time and dry eye incidence and severity based on OSDI score yielded no significant results. This means that when the OSDI score was used to assess dry eye, there was no significant correlation between screen time and dry eye incidence and between screen time and dry eye severity in final-year students of the Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia. However, many respondents were classified as having dry eye based on OSDI parameters. Hence, readers and the general population are recommended to limit screen time, practice visual hygiene, and seek medical care for those with dry eye symptoms. Implementing multiple dry eye diagnosis methods to be compared in future studies is recommended.

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Conflict of Interest

The authors declared there is no conflict of interest.

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Ethical Clearance

This study had received ethical clearance from the Health Research Ethics Committee, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia (No. 181/EC/KEPK/FKUA/2022) on 03-10-2022.

Authors' Contributions

Designed the study: AAHS, EK, PU, RL. Conducted background literature review, collected data, conducted statistical analysis, and wrote the manuscript: AAHS. Supervised data collection, results, analysis, and discussion: EK, PU, RL. All authors reviewed and approved the final version of the manuscript.

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