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Original Article

Identifying the Burden of Digital Eye Strain: Prevalence, Clinical Manifestations, and Risk Factors in Indonesian Medical Students

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ABSTRACT

Introduction: The increasing use of digital devices among university students, particularly in medical education, has raised concerns regarding Digital Eye Strain (DES). This study aimed to assess the prevalence, symptom profile, and risk factors of DES among Indonesian medical students. Methods: A cross-sectional study was conducted among 356 medical students using the validated Computer Vision Syndrome Questionnaire (CVS-Q). Data on demographic characteristics, ocular history, digital device usage habits, and DES symptoms were collected. Bivariate and multivariate logistic regression analyses were performed to identify factors associated with DES, with a significance level set at $p < 0.05$. Results: The prevalence of DES was 62.9%. Common symptoms included itchy eyes (76.8%), blurred vision (70.1%), and headaches (76.33%). Bivariate analysis revealed associations between DES and refractive errors (OR 1.889, $p = 0.004$), poor posture (OR 0.467, $p = 0.001$), and the use of more than two digital devices daily (OR 1.610, $p = 0.030$). Multivariate analysis identified refractive errors (OR 2.049, 95% CI: 1.300–3.227, $p = 0.002$), poor posture (OR 0.413, 95% CI: 0.258–0.663, $p < 0.001$), and the use of more than two devices (OR 1.879, 95% CI: 1.171–3.015, $p = 0.009$) as independent risk factors for DES. Conclusion: DES is highly prevalent among Indonesian medical students. Refractive errors, poor posture, and the concurrent use of multiple digital devices were significant risk factors. Vision screening, ergonomic education, and digital health awareness are recommended to reduce DES and support ocular health.

Introduction

In recent years, technological advancements have significantly transformed education, particularly through digital platforms like Google Forms, Drive, Classroom, Meet, and WhatsApp Groups. Digitization has enhanced learning flexibility and accessibility for students, while also improving motivation and cognitive engagement.[1,2] However, increased digital device usage has led to user complaints, such as watery eyes, itchiness, and blurred vision. A study in Jabodetabek reported these symptoms among smartphone users, and a similar study in India found that 92.8% of students experienced eye symptoms during online learning.[3,4] These symptoms are associated with Digital Eye Strain (DES), which arises from prolonged screen exposure. Digital images lack the sharpness and contrast of printed text, increasing eye strain.[5] The prevalence of DES varies by region, with studies reporting rates of 76.7% in Spain, 64.24% in South Africa, and 67.2% in Pakistan.[6-8] Common symptoms include dry, itchy eyes and musculoskeletal complaints like neck and back pain.[9]

Studies show that most university students use digital devices for over 6 hours daily, with those exceeding 4 hours a day being 2.29 times more likely to develop DES.[10-12] Poor posture further contributes to complaints like neck and back pain.[13] Despite awareness of DES and its impact on eye health, few students adopt preventive measures.[11,14] The high incidence of DES may also negatively affect academic performance.[7]

Digitalization is also revolutionizing medical education globally, with e-learning platforms using audiovisual clips and virtual models, significantly enhancing learning experiences and accessibility.[15] Given this phenomenon, understanding the effects of digital device usage, especially among medical students, is crucial. However, data on DES in Indonesia is limited to certain groups, such as office workers.[16,17] Available studies on Digital Eye Strain (DES) among students have predominantly been conducted in other countries, with no comprehensive data reported in Indonesia.[6-8] To date, there is a lack of comprehensive evidence describing the burden of DES among Indonesian students, particularly with respect to its prevalence, symptom profile, and associated risk factors. Therefore, this study aimed to determine the prevalence of Digital Eye Strain among Indonesian medical students, to characterize the symptoms experienced, and to identify factors associated with DES in this population.

Method

This is an analytical study using a cross-sectional research design. Based on its design, this study was conducted at one time to determine the relationship between the variables in the study. Data collection was conducted between July and November 2022. The population of this study are medical students at the Universitas Sumatera Utara, Medan, Indonesia. The sample was selected using a random sampling method, involving 356 students who met the predetermined inclusion and exclusion criteria. This research has been reviewed and approved by The Health Research Ethics Committee, Universitas Sumatera Utara, and received ethical clearance under number 718/KEPK/USU/2022.

Self-administered questionnaires were used to collect sociodemographic data, symptoms of DES, computer usage patterns,

and potential risk factors among students. The prevalence and symptoms of DES was obtained using CVS-Q that has specificity and sensitivity over 70% which incorporates standardized descriptors to differentiate between ocular complaints.[18] The symptoms include burning sensation, worsening eyesight, itching, colored halos around objects, foreign body sensation, focus difficulty, excess tearing, double vision, eye redness, blurred vision, eye pain, dryness, heavy eyelids, neck pain, shoulder pain, and back pain. Participants were instructed to rate the frequency and intensity of each symptom based on these descriptors, thereby minimizing misclassification between similar symptoms. Other data that was recorded in this study included demography, refractive errors, use of glasses, use of contact lenses, ocular surface disorders, eye distance to digital devices, the position of the screen monitors to eyes, body posture, duration of digital devices usage, breaks during digital devices usage, number of digital activities, and the total number of digital devices used concurrently, irrespective of device type or combination. Data were collected online using Google Forms. Descriptive statistics were used to assess the prevalence and distribution of DES symptoms, chi-square tests were used to analyze the relationship between risk factors and DES events, and multiple logistic regression statistics were used to analyze DES risk factors with a statistic SPSS Version 25.0. For statistical significance and precision, P<0.05 and 95%CI were used in this study.

Results and Discussion

A total of 356 medical students participated in this study. According to **Table 1** the majority of respondents were female (67.4%), while 116 students (32.6%) were male. Most participants reported using digital devices for extended periods, with 331 students (93%) using devices for 4 hours or more per day, and 25 students (7%) for less than 4 hours. Regarding ocular history, 215 participants (60.4%) had refractive errors, and 177 participants (49.7%) used glasses. The majority of respondents had no history of ocular surface disorders (98.6%).

Table 1. Risk Factors of DES among Medical Students

Variabel	N	%
Gender		
Male	116	32.6
Female	240	67.4
Refractive Error		
Yes	215	60.4
No	141	39.6
Use of Glasses		
Yes	177	49.7
No	179	50.3
Use of Contact Lenses		
Yes	14	3.9
No	342	96.1
Ocular Surface Disorder		
Yes	5	1.4
No	351	98.6
Eye distance to devices (cm)		
<50	290	81.5
>50	66	18.5
Position of monitor to eyes		
Higher	8	2.2

Equal/Lower	346	97.8
Body Posture		
Poor	238	66.9
Good	118	33.1
Total use of devices (hours/day)		
≥4	331	93.0
<4	25	7.0
Take eye breaks		
No	20	7.3
Yes	330	92.7
Number of Digital-related activities		
>2	240	67.4
≤2	116	32.6
Number of devices		
>2	215	60.4
≤ 2	141	39.6

Regarding digital usage habits, 215 students (60.4%) used more than two digital devices, while 141 students (39.6%) reported using less than two devices daily. Most respondents engaged in more than two digital-related activities daily (67.4%), while 116 students (32.6%) performed two or fewer activities. When considering body posture, 238 students (66.9%) did not maintained a proper sitting position during device use.

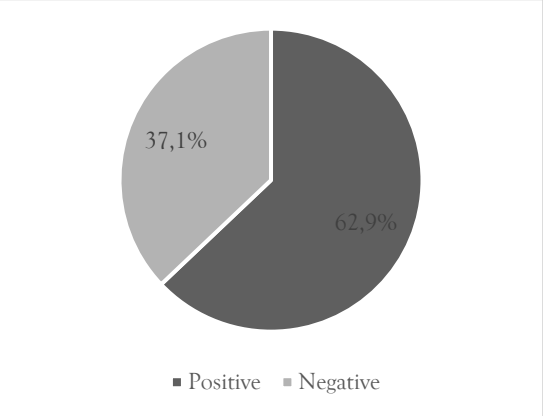

Figure 1. Prevalence of DES among Medical Students

The prevalence of Digital Eye Strain (DES) among respondents as shown in **Figure 1** was 224 students (62.9%), while 132 students (37.1%) did not meet the criteria for DES. Regarding specific ocular symptoms (**Table 2**), the most commonly reported complaints included itching (76.78%), blurred vision (70.08%), eye pain (68.3%), and dry eyes (62.05%). For extraocular symptoms, headache (76.3%) and neck pain (75.0%) were the most frequently reported.

Table 2. Symptoms of DES among Medical Students

Symptoms	N	%
Ocular Symptoms		
Burning	130	58.03
Itching	172	76.78
A feeling of a foreign body	104	46.42
Tearing	104	46.42
Excessive blinking	119	53.12
Eye redness	125	55.80
Eye pain	153	68.30
Heavy eyelids	138	61.60

Symptoms	N	%
Ocular Symptoms		
Burning	130	58.03
Itching	172	76.78
A feeling of a foreign body	104	46.42
Tearing	104	46.42
Excessive blinking	119	53.12
Dryness	139	62.05
Blurred vision	157	70.08
Double vision	67	29.91
Difficulty focusing for near vision	84	37.50
Increased sensitivity to light	147	51.10
Colored halos around objects	74	33.03
Feeling that sight is worsening	132	58.92
Extraocular symptoms		
Headache	171	76.33
Neck pain	168	75.00
Back pain	114	50.89
Shoulder pain	133	59.37

Bivariate Analysis

The bivariate analysis was conducted to identify factors associated with the occurrence of Digital Eye Strain (DES) among medical students (**Table 3**). The results showed that students with refractive errors were significantly more likely to experience DES compared to those without refractive errors. The odds ratio (OR) was 1.889 with a 95% confidence interval (CI) ranging from 1.218 to 2.931 (p = 0.004), indicating that students with refractive errors had nearly twice the risk of DES.

Table 3. Association between Risk Factors and DES among Medical Students

Variable	N	%	P Value	OR (95%CI)
Gender				
Female	159	66.3	0.061	1.54 (0.978-2.425)
Male	65	56.0		
Refractive Error				
Yes	148	68.8	0.004*	1.889 (1.218-2.931)
No	76	53.9		

Use of Glasses				
Yes	120	67.8	0.058	1.518 (0.985-2.34)
No	104	58.1		
Use of Contact Lenses				
Yes	9	64.3	0.914	1.063 (0.349-3.242)
No	215	62.9		
Ocular Surface Disorder				
Yes	4	80.0	0.426	2.382 (0.263-21.583)
No	220	62.7		
Eye distance to devices (cm)				
<50	183	63.1	0.881	1.043 (0.601-1.810)
>50	41	62.1		
Position of monitor to eyes				
Higher	150	64.4	0.602	1.197 (0.763-1.876)
Equal/Lower	74	60.2		
Body Posture				
Poor	60	50.8	0.005*	0.467 (0.297-0.753)
Good	164	68.9		
Total use of devices (hours/day)				
≥4	14	56.0	0.457	0.733 (0.323-1.666)
<4	210	63.4		
Take eye breaks				
No	17	65.4	0.787	1.122 (0.485-2.595)
Yes	207	62.7		
Number of devices				
>2	173	65.0	0.030	1.610 (1.027-2.524)
≤ 2	51	56.7		

*P statistically significant

Posture while using digital devices was also found to be significantly associated with DES. Students who maintained a good sitting posture had a lower risk of experiencing DES compared to those with poor posture. The OR for this association was

0.467 (95% CI: 0.297–0.753, p = 0.005), suggesting that good posture served as a protective factor against DES in this population. In addition, the number of digital devices used daily was significantly associated with DES. Students using more than two devices had a 1.61-fold increased risk of DES (OR 1.610, 95% CI: 1.027–2.540, p = 0.030)

On the other hand, several other variables did not demonstrate statistically significant associations with DES. Gender was not associated with the risk of DES, with an OR of 1.54 (95% CI: 0.983–2.248, p = 0.061), although it approached the threshold for significance. Similarly, the use of glasses showed no significant association with DES occurrence (OR 1.518, 95% CI: 0.985–2.340, p = 0.058). Meanwhile, the duration of digital device use, whether less than or more than four hours per day, was not significantly related to DES occurrence, with an OR of 0.733 (95% CI: 0.323–1,666, p = 0.457). These findings indicate that, among the variables examined, refractive errors, posture, number of devices used were significantly associated with the risk of DES in medical students.

Multivariate Analysis

A multivariate logistic regression analysis was performed to identify independent factors associated with Digital Eye Strain (DES) among medical students (**Table 4**). Variables that showed a p-value of less than 0.25 in the bivariate analysis were included in this model. The results indicated that several factors remained significantly associated with DES after controlling for potential confounders.

Table 4. Multivariate Analysis: Risk Factors for DES among Medical Students

Variable	OR	95% CI	P Value
Refractive Error	2.049	(1.300-3.227)	0.002
Poor Posture	0.413	(0.258-0.663)	<0.001
Number of devices used	1.879	(1.171-3.015)	0.009

Refractive errors were found to be an independent risk factor for DES. Students with refractive errors were twice as likely to develop DES compared to those without, with an odds ratio (OR) of 2.049 and a 95% confidence interval (CI) of 1.300 to 3.227 (p = 0.002). This finding reinforces the result observed in the bivariate analysis. Body posture while using digital devices also maintained a significant association with DES. Good sitting posture was associated with a lower risk of DES, with an OR of 0.413 (95% CI: 0.258–0.663, p < 0.001). This indicates that maintaining a proper posture during digital device use may serve as a protective factor against the development of DES.

In addition, the number of digital devices used daily emerged as another independent factor associated with DES. Students who used more than two digital devices per day had a significantly higher risk of experiencing DES, with an OR of 1.879 (95% CI: 1.171–3.015, p = 0.009). This suggests that increased exposure to multiple devices may contribute to a higher likelihood of developing DES symptoms. Meanwhile,

other variables such as gender, use of glasses, number of digital-related activities performed per day, and duration of digital device use did not show significant associations with DES in the multivariate model. Their respective p-values were all above 0.05, indicating that these factors were not independent predictors of DES in this study population.

Discussion

In response to the limited evidence on Digital Eye Strain (DES) among Indonesian students, this study examined the prevalence, symptom profile, and associated factors of DES among medical students. The results demonstrate a high prevalence of DES and highlight refractive errors, poor posture, and the use of multiple digital devices as key factors associated with DES.

Prevalence and Symptom Distribution of Digital Eye Strain

This study involved 356 medical students and utilized the CVS-Q to assess complaints of Digital Eye Strain (DES), revealed a prevalence rate of 62.9%. This high prevalence reflects the significant health impact of prolonged digital device use among university students, which has been consistently documented across multiple countries.[9,10] These findings are consistent with studies conducted in Karachi, which reported a DES prevalence of 67.2% among 196 students, and in South Africa, where 64.24% of 290 students experienced DES as assessed using the CVS-Q.[7,8] This finding indicates that DES remains a prevalent issue among university students worldwide. However, no prior study has comprehensively reported DES prevalence, symptoms, and associated risk factors among Indonesian medical students using a validated instrument, making this study the first of its kind locally.

Excessive digital device use among medical students is closely associated with both ocular and systemic symptoms.[19] In the terms of symptomatology, this study identified the most prevalent ocular symptoms as itchy eyes (76.78%), blurred vision (70.08%), and eye pain (68.3%), while the most common extraocular complaints were headaches (76.33%) and neck pain (75%), reflecting the multisystem impact of DES and the need for comprehensive preventive measures. These findings align with Iqbal et al.'s study, which reported blurred vision (40.9%) and headaches (46.8%) as primary complaints among medical students.[23] In summary, the symptom profile and prevalence identified in this study align with global patterns, confirming DES as a relevant health concern in Indonesian medical students.

Factors Associated with Digital Eye Strain: Bivariate Analysis

In the bivariate analysis, several factors showed significant associations with DES. Students with refractive errors were nearly twice as likely to develop DES compared to those without (OR 1.889, 95% CI: 1.218–2.931, p = 0.004). This finding aligns with research by Mohammed et al. conducted on 227 students in Kerala, which also found a significant association between refractive errors and DES (p = 0.03, OR = 2.6, 95% CI).[21] Additionally, posture during digital device use was significantly associated with DES. Students who maintained good sitting posture had a lower risk of DES than those

with poor posture (OR 0.467, 95% CI: 0.297–0.753, p = 0.005), supporting the conclusions from Adane et al.'s meta-analysis linking ergonomic factors to ocular and musculoskeletal symptoms.[24] Furthermore, the number of digital devices used concurrently, irrespective of device type was also significantly associated with DES. Students using more than two devices had a 1.61-fold higher risk of developing DES (OR 1.610, 95% CI: 1.027–2.540, p = 0.030). This aligns with findings from Usgaonkar et al., who identified a significant link between higher digital device usage and symptoms like itchy eyes (p = 0.036) and sore eyes (p = 0.005).[19] These findings suggest that both visual factors and digital usage behaviors play substantial roles in contributing to DES risk within this population.

Other variables, including gender, glasses use, screen time duration, and viewing distance, did not demonstrate significant associations with DES in this study. Although the prevalence of DES was higher among female students (66.3%) than males (56%), the difference was not statistically significant. Previous studies have shown inconsistent results regarding gender differences in DES, with some attributing increased prevalence in females to hormonal and tear film factors, while others found no substantial differences.[19,20]

Independent Risk Factors for DES: Multivariate Analysis

In the subsequent multivariate analysis, three variables remained independently associated with DES after controlling for potential confounders, namely refractive errors, poor posture, and number of digital devices used. Refractive errors remained the strongest risk factor (OR 2.049, 95% CI: 1.300–3.227, p = 0.002), confirming its significance as a primary predictor of DES. Refractive errors, such as myopia, hyperopia, and astigmatism, significantly contribute to the severity of symptoms. These conditions require the eyes to exert additional effort to maintain focus on digital screens, exacerbating symptoms such as eye strain, fatigue, and discomfort. The combination of blurred vision, poor contrast on screens, and prolonged focus demands intensifies the visual challenges for individuals with untreated refractive errors.[22] Myopia and astigmatism were the most common refractive errors among medical students in this study. Iqbal et al. reported a significant association between refractive errors, particularly myopia and astigmatism, and Digital Eye Strain (DES) (p = 0.0003), aligning with findings from King Abdulaziz University, which noted the prevalence of myopia (22.6%), hyperopia (14.7%), and astigmatism (11.7%), with astigmatism significantly linked to headaches (p = 0.001) and photophobia (p = 0.01) [9,23]

Good posture during device use continued to act as a protective factor (OR 0.413, 95% CI: 0.258–0.663, p < 0.001), reinforcing the importance of ergonomics in minimizing DES symptoms. Adane, Alamneh, and Desta's meta-analysis supports these findings, reporting that improper seating (OR = 3.22, 95% CI) significantly elevates DES risk.[24] Preventing Digital Eye Strain (DES) requires attention to factors like lighting, posture, and device positioning.[5] Poor posture, such as sitting hunched or using devices at improper distances, significantly contributes to DES. This study found a strong association between poor body positions

(66.9%), including slouching or lying down, and DES (p = 0.005, OR = 0.467). While using devices closer than 50 cm (OR = 1.043) or above eye level (OR = 1.197) increased DES risk, these were not statistically significant (p > 0.05). Additionally, poor posture has been linked to headaches (p = 0.006) and neck/shoulder pain (p = 0.003).[8] Das et al. confirmed that improper viewing distance (OR = 3.2) increases DES risk, while Abudawood, Ashi, and Almarzouki reported that screens positioned above eye level were associated with double vision, eye sensitivity, and color vision changes (p < 0.05).[9,25]

The number of digital devices used concurrently, regardless of device type, remained a significant independent risk factor for the presence of Digital Eye Strain. (OR 1.879, 95% CI: 1.171–3.015, p = 0.009), reflecting how increased exposure amplifies ocular strain. The use of multiple digital devices significantly increased the risk of Digital Eye Strain (DES). Although not statistically significant, engaging in more than two digital activities daily showed a tendency towards increased DES risk (p = 0.155, OR = 1.423), suggesting that multitasking across devices may contribute to visual discomfort.[19] However, contrary to common assumptions, the total screen time per day was not significantly correlated with DES, as reported both in this study and by Cantó-Sancho et al. and Mohammed et al., who found no substantial link between screen duration and DES symptoms (p > 0.05).[6,21] These findings suggest that multitasking demands may play a more critical role in DES development than sheer screen exposure time, emphasizing the importance of addressing device usage behaviors rather than just limiting screen time.

Clinical Implications

The findings of this study carry important implications for student health management and medical education settings. The identification of refractive errors, poor posture, and the use of multiple digital devices as independent risk factors further underscores the need for targeted interventions addressing modifiable behaviors and environmental conditions. Routine vision screening programs should be integrated into university health services to detect and manage refractive errors early, reducing the risk of visual fatigue and associated complications during intensive academic activities. Additionally, implementing ergonomics awareness initiatives focused on promoting correct posture and workstation setup may serve as a practical strategy to lower DES prevalence.[10,25,26]

Considering the independent risk posed by the concurrent use of multiple digital devices, educational campaigns advocating for regulated device usage, scheduled screen breaks, and structured digital habits are essential. These preventive strategies could be incorporated into student orientation programs, academic skill workshops, or digital health campaigns at the faculty level.[21] Ultimately, the study highlights the importance of establishing institutional guidelines and recommendations on digital device use within medical schools, to protect students' ocular health and support their long-term academic performance and well-being.

Strengths and Limitations

This study possesses several notable strengths. It is one of the first to

comprehensively assess the prevalence, symptom distribution, and risk factors of Digital Eye Strain (DES) among Indonesian medical students using a validated instrument, the Computer Vision Syndrome Questionnaire (CVS-Q). The relatively large sample size enhances the representativeness of the findings for medical student populations, and the use of multivariate analysis allowed for the identification of independent risk factors after controlling for potential confounders. However, several limitations must be acknowledged. The cross-sectional design of the study precludes the establishment of causal relationships between identified risk factors and the occurrence of DES. The reliance on self-reported data introduces the possibility of recall and reporting bias, particularly in estimating screen time, symptoms, and ergonomic habits. Additionally, the study was conducted within a single academic institution, which may limit the generalizability of the findings to other medical student populations or different educational settings. Future research should consider employing longitudinal or multicenter designs and incorporating objective clinical assessments, such as visual acuity tests, tear film evaluations, and screen time monitoring, to validate self-reported data and better understand the long-term impact of digital device use on ocular health.

Conclusion

This study identified a high prevalence of Digital Eye Strain (DES) among Indonesian medical students, affecting 62.9% of respondents. The most commonly reported symptoms were itching, blurred vision, and eye pain, alongside extraocular complaints such as headaches and neck pain. Refractive errors, poor posture during digital device use, and the use of more than two digital devices daily were found to be independent risk factors for DES in this population. These findings highlight the urgent need for preventive strategies targeting modifiable factors such as regular vision screening, ergonomics education, and the promotion of healthy digital habits among medical students. Institutional policies and awareness programs addressing digital device use should be considered to minimize the impact of DES and support student ocular health and academic performance.

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