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Prevalence and Risk Factors for Digital Eye Strain and Musculoskeletal Disorders among Financial Workforce of Brunei Darussalam.

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Abstract

Background: The increased use of digital devices during the COVID-19 pandemic highlighted its impact on the visual and musculoskeletal systems. This study aims to determine the combined prevalence and symptoms of digital-eyestrain and related musculoskeletal disorders and its contributing risk factors. **Methods:** A one-year cross-sectional study was conducted during the COVID-19 pandemic among computer-users in financial institutions in Brunei. A self-administered questionnaire was distributed via email, and non-responders reminded. Descriptive statistics and simple proportions were used to determine the sociodemographic factors, usage, prevalence, and digital device related symptoms. Chi-square tests and multiple logistic regression were applied to determine the associated risk factors. **Results:** Total number of participants was 281 (mean age 36.2 ± 8.3 years, 67.3% females and 62.6% spending >5 hours daily on digital screens without breaks). The prevalence of combined digital-eyestrain and related musculoskeletal disorders was 63.8%. The most common symptoms were pain, stiffness, numbness, or tingling sensation in the shoulder (87.5%), neck (86.3%), and back (85.4%), followed by headache (83.1%), itchy eyes (74.8%), increased light sensitivity (72.5%), and watery eyes (70.7%). Daily computer use of >5 hours without breaks, independently and significantly increased the risk of developing digital-eyestrain and related musculoskeletal disorders over two-fold (OR = 2.38, 95%CI:1.01,5.66). Only 18.5% of the participants had regular eye examinations and 58.7% did not consult a doctor ($p<0.01$) despite experiencing problems. **Conclusion:** Digital-eyestrain and related musculoskeletal disorders are highly prevalent. Efforts made to manage these problems can prevent permanent damage. Mobility breaks at work, regular eye checkups and proper workplace ergonomics are recommended.

KEYWORDS: Digital eye strain, Musculoskeletal disorders, Prevalence, Risk factors.

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Introduction

The widespread use of digital devices has increased exponentially, making tasks easier, and faster. Excessive use of these devices is linked to a wide range of problems. Digital eyestrain (DES) and related musculoskeletal disorders (MSD) are among the most common. The term DES and computer vision syndrome (CVS) are interchangeable. The American Optometric Association defined CVS as a group of eyes and vision-related problems that result from prolonged use of computers, tablets, electronic devices, and cell phones.[1] The symptoms of DES include eyestrain, tired eyes, sore eyes, dry eyes, watery eyes, irritated eyes, blurred vision, double vision, and headache.

Worldwide, it is estimated that 60 million worldwide suffer from DES, with approximately 1 million new cases reported each year.[2] A systematic review of 104 studies between 1980-2014 reported a DES prevalence of 64-90%.[3] Research suggested that around 90% of individuals who use computers for more than 3 hours per day can develop DES symptoms.[4] DES has dire economic consequences including decreased occupational productivity, increased disability, and workplace absenteeism.[5]

Like DES, MSD due to computer use account for a large proportion of work-related injury. The World Health Organization (WHO) defined MSD in parts as "*conditions that are characterized by pain (often persistent) and limitations in mobility, dexterity and overall level of functioning, reducing people's ability to* work" and considers it the leading cause of disability worldwide as well as the leading cause of disability on the job, both short- and long-term.[9] Computer use has been associated with a range of MSD especially neck, shoulder, and back problems.[10] Low back pain is the most common MSD problem, affecting an estimated 577 million people in 2017.[11] Time spent working on digital screens and poor ergonomics are the most common risk factor associated with MSD.[12] In the United States, at least half of work-related injuries are computer-related MSD and in addition to productivity costs, the employers had to pay 20 billion dollars annually in workers' compensation.[13]

Only a few studies have looked at the prevalence and risk factors of DES and MSD together [14,15]. Given that ocular and ergonomic symptoms are both adversely associated with digital screen use, the current study combined both DES-MSD and assessed prevalence, symptoms, and risk factors in Brunei Darussalam. We expect with the increasing long hours spent on digital devices, our working population would have similar prevalence and associated risk factors. This study hopes to raise awareness about DES-MSD and identify modifiable risk factors. Workplace digital screen usage guidelines, action plans and policies may be developed to assist occupational health professionals in managing the condition to avoid long-term effects on individuals, institutions, and communities.

Materials and Methods

Study design

A cross-sectional study conducted from August 2021 to April 2022, sampling the financial working population of Brunei Darussalam.

Inclusion criteria: Older and equal to 18 years, have worked with digital screens for ≥1 year prior to the study, fluent in English. The inclusion criteria of having used digital screens for at least a year was to ensure that the study captured chronic effects of digital device usage, and that participants recognised the symptoms to report them. As both DES and MSD are often regarded as transient and symptoms are relieved with rest, participants may mistake the symptoms as being related to other factors and not report them.

Exclusion criteria: Self-reported history of existing ocular and musculoskeletal problems in the neck, shoulders, and back due to a medical condition, accident, or surgery.

Sampling and sample size: The total working population of Brunei, aged 18-59 years, in 2020, is estimated at 208,693.16 A sample size calculator for prevalence studies17 was used to calculate the sample size. A sample size of 323 is required to estimate the prevalence of DES-MSD with 95% CI for a precision of ± 5%. The expected prevalence was 70%.18 There was no known specific studies that we were aware of that looked at the prevalence of DES-MSD in the working population, like our study. An estimate of 70% was decided, considering, prevalence of DES reported at 69% 19 as well as a review paper that reported prevalence ranging up to

65% in pre-COVID studies to 80-94% 20 during the COVID-19 epidemic phase.

All financial institutions in Brunei were invited to participate. Nine out of thirteen institutions consented to participate. The four institutions that did not consent were small and had only a few eligible members. All eligible individuals from the nine institutions were invited to participate by email. A total of 364 workers consented and participated. Finally, 281 participants were included for further analysis, and the study precision remained at ± 5.3%.

Data Collection Methods

Qualtrics survey software was used for data collection.21 Each participating institution appointed a gatekeeper, and they forwarded an email invitation to all staff to participate in the study. The e-mail included the study's introduction and eligibility criteria. Those who met the eligibility criteria were directed to the participant information sheet (PIS) and consent form. Participants were asked to fill out the questionnaire after understanding the PIS and giving their consent. The participants submitted the questionnaire anonymously. Participants were allowed to withdraw from the study at any time prior to submitting the questionnaires online. The collected data was exported to Microsoft Excel for further analysis.

Research Instrument

The questionnaire DESRIL-27 (Digital Eye Strain and Risk Level), developed and validated in our previous study,22 was used to assess the prevalence and risk factors for DES-MSD. The questionnaire comprises two scales: symptom severity and risk level, totaling 38 items: 27 scoring items, and 11 non-scoring. There are 3 sections in the questionnaire comprising of i) 11 items related to the sociodemographic and work-related information ii) 16 items assessing eye, neck, shoulder, and back symptoms and iii) 11 items assessing workplace conditions, environment of the workstation and ergonomic factors. It takes approximately 15 minutes to complete the questionnaire. Part (ii) of the questionnaire queried 16 symptoms that are associated with DES-MSD. Each item score of the symptoms had a range of 0 to 12 and was calculated by multiplying the frequency and intensity scores. Therefore, the severity scale of the symptoms ranges from 0 to 192 for the 16-item scale. Higher scores indicate symptoms that are more severe. We consider participants to have DES-MSD if their total symptom score was 15 or higher. This score was decided after a thorough literature review and consultation with experts.23,24 At this score, a person can have several mild symptoms of DES-MSD or one or two symptoms of a moderate to severe form. The instructions below were given to the participants to help them report their responses.

A.**FREQUENCY:** (how often the symptom occurs)

0 Never	the symptoms DOES NOT occur at all
1 Sometimes	occasionally, once a week
2 Often	2 or 3 times a week
3 Almost always	almost every day

B.**INTENSITY**: (how strong the feeling of the symptom is and if it stops you from performing daily activities).

1 Mild	DOES NOT bother you and DOES not stop you from daily activities.
2 Moderate	DOES bother you but DOES not stop you from daily activities.
3 Intense	DOES bother you and DOES stop you from daily activities.
4 Very Intense	DOES bother you and DOES stop you from daily activities and makes you seek medical help

A symptom score was calculated for each participant by multiplying the frequency and intensity scores.

Data Analysis

All analyses were conducted using R (ver. 4.1.1) and RStudio for Mac (ver. 4.0.2). Descriptive analyses were reported as mean and standard deviation or median and interquartile range (IQR). Data were presented as frequency distributions and percentages. Chi-square test and multivariate logistic regression analysis were used to compare and determine the association of risk factors with DES-MSD. Multiple logistic regression analysis was used to determine the independent predictors of DES-MSD. In all hypothesis tests, a *P* value of <0.050

was regarded as statistically significant.

Ethics approval and consent to participate

The study protocol was in accordance with the Declaration of Helsinki. Approval from the PAPRSB Institute of Health Sciences Research Ethics Committee (IHSREC) and the University Research Ethics Committee (UREC), Universiti Brunei Darussalam (UBD/PAPRSBIHSREC/2021/58) was obtained. Administrative approval and consent were obtained from all financial institutions. Informed consent was given by all participants included in the study. All measures to ensure the confidentiality of the participants were adopted.

Results

Sociodemographic characteristics

A total of 281 participants were included in the study and the results were estimated with 95% CI. Two participants did not answer the questions related to age and type of employment and one did not disclose their educational level. The participants' mean age was 36.2 ± 8.3 years (95% CI:35.2,37.1) and 63.4% were under the age of 40. More than half (67.3%) were females, almost all (98.6%) were employed full-time, majority were of Malay ethnicity (69.4%), majority (87.5%) used computers for ≥3 hours daily without breaks, and (65.5%) wore glasses or contact lenses for vision problems. Among the participants, only 18.5% were getting regular eye checkups (at least once a year). Detailed descriptions are presented in Table I.

Table I: Sociodemographic and work-related characteristics of the study population (*n* = 281).

Variables	Mean (SD)	*n* (%)
Age in years	36.2 (8.3)	
Gender		
Male		92 (32.7)
Female		189 (67.3)
Ethnicity/Race		
Malay		195 (69.4)
Chinese		70 (24.9)
Others		16 (5.7)
Educational level		
Below Bachelor level		44 (15.7)
Bachelor level		193 (68.9)
Higher than bachelor level		43 (15.4)
Type of employment		
Full time		275 (98.6)
Part-time		4 (1.4)
Monthly income in BND		
Less than 2000		70 (24.9)
2000 – 4000		129 (45.9)
Above 4000		82 (29.2)
Duration of current employment		
1 to 3 years		66 (23.5)
More than 3 years		215 (76.5)
Use of glasses or contact lenses to improve eyesight (vision)		
Yes		184 (65.5)
No		97 (34.5)
Regular eye checkups		
Yes		52 (18.5)
No		229 (81.5)
Total time spent viewing the digital screen per day without break		
Less than 3 hours		35 (12.5)
3 to 5 hours		70 (24.9)
More than 5 hours		176 (62.6)

SD = Standard deviation; BND = Brunei Dollar

Prevalence of DES-MSD

The overall prevalence of DES-MSD was 63.8% (95% CI:57.65,69.63). Results of Chi-square tests showed that there were no significant differences in the prevalence of DES-MSD between different age groups, genders, ethnicity, and duration of current employment, and total time spent viewing digital screens. There was a statistically significantly higher prevalence of DES-MSD in individuals who used glasses or contact lenses for vision problems (68.2%, p=0.043), spent ≥3 hours working with digital screens (66.2%, p=0.033), considered their job hours to be uncomfortable (73.3%, p=0.032) and took inadequate breaks during computer work which made them stop their work occasionally (75%, p=0.044). **Table II** shows prevalence of DES-MSD with respect to multiple variables. It should be noted that the total number of participants in Table II differ and are less than those in Table I. Data collection was done at the height of COVID-19, and substantial amount of missing information were noted. In order to ensure valuable information pertaining to the research question is kept as much as possible, whilst maintaining statistical integrity, only those who answered > 50% of the questions related to the eye and MSD problems were included in the analysis.

Table II: Prevalence of DES-MSD in the past 12 months with respect to sociodemographic and work-related factors.

Variables	n(%)	Prevalence of DES-MSD (%)	X^2-Statistic[a] (df)	*P*-value
Age (in years)				
18-39	163 (63.2)	105 (64.4)	0.14 (1)	0.710
40-59	95 (36.8)	59 (62.1)		
Gender				
Male	86 (33.1)	52 (60.5)	0.64 (1)	0.425
Female	174 (66.9)	114 (65.5)		
Ethnicity/Race				
Malay	176 (67.7)	113 (64.2)	0.43 (2)	0.806
Chinese	68 (26.2)	44 (64.7)		
Others	16 (6.2)	9 (56.3)		
Duration of current employment				
1 to 3 years	61 (23.5)	38 (62.3)	0.08 (1)	0.773
More than 3 years	199 (76.5)	128 (64.3)		
Use of glasses or contact lenses to improve eyesight (vision)				
Yes	170 (65.4)	116 (68.2)	4.10 (1)	***0.043****
No	90 (34.6)	50 (55.6)		
Estimated total time spent viewing the digital screen per day				
Less than 3 hours	32 (12.3)	15 (46.9)	4.55 (1)	***0.033****
3 hours or more	228 (87.7)	151 (66.2)		
Job hours				
Comfortable	140 (58.1)	84 (60.0)	4.57 (1)	***0.032****
Uncomfortable	101 (41.9)	74 (73.3)		
Short breaks during work				
Adequate	162 (68.1)	100 (61.7)	4.06 (1)	***0.044****
Inadequate	76 (31.9)	57 (75.0)		

a = Chi-square test; * = Statistically significant values

Prevalence of symptoms

A score of zero is the absence of a symptom, and a score of 1-12 indicates the presence of the symptom. Higher scores denote higher severity. **Table III** shows a detailed description of the prevalence of individual symptoms of DES-MSD.

Figure 1 is a graphical representation of the prevalence of DES-MSD symptoms from the most frequent to the least. The most common symptoms were pain, stiffness, numbness, or tingling sensation in the shoulders (87.5%) followed by in the neck (86.3%) and back (85.4%). Headache (83.1%) was the next most common. The least common symptom was colored circles of light around objects (37%). Itching in the eyes (74.8%), increased sensitivity to light (72.5%) and eye watering (70.7%) were the most common ocular complaints.

Association of risk factors

Multivariate analysis using multiple logistic regression assessed independent factors associated with DES-MSD **(Table IV).** The only variable that was statistically significant and independently associated

with DES-MSD was the time spent viewing digital screens without breaks. Participants (62.2%) who worked continuously for >5 hours on digital displays are 2.38 times more likely to develop DES-MSD compared to those who did not (OR=2.38, 95% CI:1.01,5.66). Two variables that increased the risk of developing DES-MSD were not significant but possibly suggested a trend. Those were taking inadequate breaks (p=0.172; OR=2.72, 95%CI:0.67,12.55), and using glasses or contact lenses for vision problems (p=0.193, OR=1.51, 95%CI:0.81,2.82).

Table III: Prevalence of self-reported symptoms of DES-MSD in the past 12 months in the study population (n = 281).

Symptoms	(95% CI)	Prevalence of DES-MSD (%)
Burning in eyes	(40.33, 52.80)	(40.33, 52.80)
Itching in eyes	(68.97, 79.89)	(68.97, 79.89)
Feeling of something in the eyes	(54.02, 66.29)	(54.02, 66.29)
Watering of eyes	(64.64, 76.05)	(64.64, 76.05)
Excessive blinking	(42.99, 55.48)	(42.99, 55.48)
Eye pain	(46.24, 58.70)	(46.24, 58.70)
Blurred vision	(61.04, 73.10)	(61.04, 73.10)
Double vision	(37.81, 50.55)	(37.81, 50.55)
Difficulty focusing	(58.94, 71.18)	(58.94, 71.18)
Increased Sensitivity to Light	(66.41, 77.95)	(66.41, 77.95)
Coloured circles of light around objects	(31.02, 43.48)	(31.02, 43.48)
Feeling that eyesight is getting weak	(61.73, 73.76)	(61.73, 73.76)
Headache	(77.69, 87.49)	(77.69, 87.49)
Pain, stiffness, numbness, or tingling sensations in the neck	(81.16, 90.26)	(81.16, 90.26)
Pain, stiffness, numbness, or tingling sensations in the shoulders	(82.48, 91.28)	(82.48, 91.28)
Pain, stiffness, numbness, or tingling sensations in the back	(80.16, 89.50)	(80.16, 89.50)

a = Chi-square test; * = Statistically significant values

DISCUSSION

The current study is the first to evaluate the combined prevalence and risk factors for DES-MSD in the working population of Brunei. DES-MSD was prevalent in more than half of our sample (63.8%). Our study highlights the necessity to study DES-MSD together as prolonged usage of digital devices, especially without breaks, precipitates combined symptoms of DES-MSD. A study on DES in Pakistan included MSD and reported a high prevalence of back pain (66%), neck and shoulder pain (63.6%).[25] Similar studies in Saudi Arabia in 2020 and 2021 also reported a high prevalence of neck/shoulder pain in 85.2% and 82.2% participants respectively.[26,27]

Wide variation in reported prevalences may be due to different definitions used to diagnose DES and setting cut-off points. Studies in Saudi Arabia and India also reported a time period of >5 hours as a factor for DES.[26,28] Other studies found no association between time spent and DES.[29,30] More studies are needed to ascertain the number of hours that can be considered as "safe viewing". Inadequate breaks during computer work were significantly associated with DES-MSD

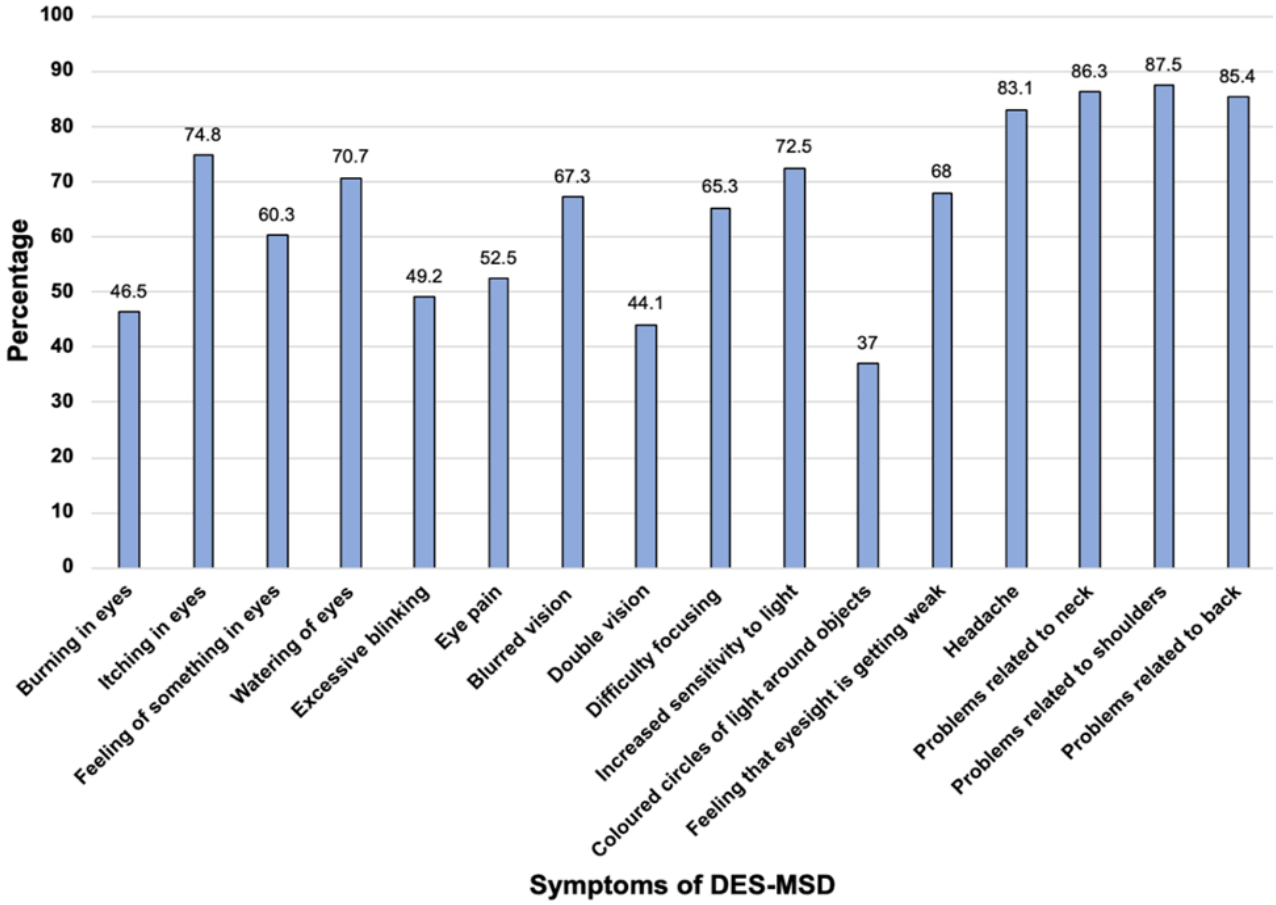

Figure 1: Prevalence of individual symptoms of DES-MSD.

Table IV: Factors associated with DES-MSD (using Multiple Logistic Regression).

Variables	Log (Odds)	*OR*	(95% CI *OR*)	*Z*-stat	*P*-value
Age	-0.01	0.99	(0.95, 1.04)	-0.30	0.766
Gender					
Female[a]		1.00			
Male	-0.03	0.97	(0.53, 1.79)	-0.11	0.912
Duration of employment					
1-3 years[a]		1.00			
More than 3 years	-0.06	0.95	(0.43, 2.06)	-0.14	0.890
Time spent viewing digital screens per day without break					
Less than 3 hours[a]		1.00			
3-5 hours	0.45	1.57	(0.62, 4.02)	0.95	0.344
More than 5 hours	0.87	2.38	(1.01, 5.66)	1.99	0.047*
Use of glasses or contact lenses					
No[a]		1.00			
Yes	0.41	1.51	(0.81, 2.82)	1.30	0.193
Short breaks during work					
Very Adequate[a]		1.00			
Adequate	0.27	1.31	(0.49, 3.46)	0.55	0.582
Slightly Inadequate	0.64	1.90	(0.63, 5.68)	1.15	0.250
Very Inadequate	1.00	2.72	(0.67, 12.55)	1.37	0.172

OR = Odds ratio; CI = Confidence interval; a = Reference or baseline; * = Statistically significant values

(*p=0.044*). Taking breaks during computer work relaxes the accommodation facilities and reduces the risk of DES. Hence frequent breaks must be taken when working with digital screens.[31]

In our study, DES-MSD was significantly more prevalent in participants who wore glasses or contact lenses for vision correction (68.2%; *p*=0.043) and more than half of our participants (65.5%) wore glasses for vision problems. Studies on bank workers in Ethiopia reported that glasses increased risk of DES by 3-fold (OR=3.19, 95%CI:1.07,9.51)[32] to a 5-fold increased risk OR=5.01) on info-tech personnel in Egypt.[33]

Digital work requires additional demands on the visual system causing extra burden on the eyes. This excess can aggravate DES development. This burden is worse if the refractive error is not/under-corrected. Only a small portion of our sample go for regular eye checkups (18.5%), which increases the risk of under-corrected refractive errors which contributes to DES.[34] Glasses and contact lens use are associated with dry eye syndrome which also contributes to DES.[35] Shockingly, more than half (58.7%) of our population did not seek medical attention even when DES-MSD symptoms interfered with their daily activities. This can be due to the lack of awareness of the existence and seriousness of the problem. DES-MSD symptoms are often regarded as transient but if ignored, can have permanent and detrimental complications such as retinal damage[36] and strabismus which may require expensive surgical intervention.[37] In our study, although the risk of developing DES-MSD was initially significantly more prevalent in those who wore glasses and contact lenses (*p*=0.043, Table II), in our multivariate analysis non-significant (*p*=0.193, Table IV). Perhaps increasing the power of the study with more participants, this variable would have been significant. Increased prevalence of MSD related to the neck, shoulders and back have also been reported in glasses wearers. People with vision problems tend to adopt abnormal head postures and ergonomics, leading to MSD.[38]

In our study no significant differences in the prevalence of DES-MSD were found between genders (*p*=0.425). This may be because majority of our participants were females (62%) ≤40 years of age. Our investigation of age did not reveal any significant association with DES-MSD. Previous research showed that females of advancing age are more prone to develop DES due to increased prevalence of dry eye.[39,40] This could explain

our finding of nonsignificant associations. Our study focuses on the working population and there were more younger people and females in our workforce, which reflects our population.

Results of this study aim to increase awareness of DES-MSD among individuals, occupational health workers and policymakers. Safety guidelines, action plans and policy are needed particularly on usage time and ergonomic environment whilst working on digital screen. Proper understanding of symptoms, diagnosis and management of DES-MSD can prevent further expensive and permanent complications such as strabismus and vision loss due to retinal damage. Regular eye checkups and seeking help when symptoms of DES-MSD appear are important. These efforts will improve the safety and comfort of workers whilst working on digital screens. Consequently, a decrease in sick leave and worker compensation will increase productivity and financial benefit. Prevention of DES-MSD can also reduce the financial burden on the health system.

Future research should aim to use objective methods to determine DES-MSD such as examination by eye-care and occupational professionals, for more accurate diagnosis of cases. Objective methods for assessing ergonomic conditions and environmental factors should also be adopted. COVID-19 pandemic and technological advancements have accelerated the adoption of online and digital technologies for remote work, online education, and virtual socialising. Prospective studies are needed to determine the causative factors of DES-MSD in users of digital screens. Individuals suffering from DES-MSD need to be aware of their symptoms to avoid long term consequences. Regular health monitoring including eye checkups, particularly those who already have existing refractive errors, should be included in health policies or work requirements. There is an urgent need for eye care and occupational health professionals to play a proactive part in recognising symptoms and predisposing risk factors of DES-MSD. Preventive healthy workplace measures must be implemented across all ages when using digital screens, particularly those at work and exposed to extended screen time. At the community level, awareness campaigns, collaboration with health organisations and businesses can be instrumental to mitigate long term effects of DES-MSD. Further studies are needed to explore the role and efficacy of anti–glare screens, anti-fatigue lenses, and blue-blocking filters, while focusing on understanding the risk factors among larger and different groups.

Limitations of the study are that the diagnosis of DES-MSD was based on self-reported symptoms that occurred during the last 12 months, giving rise to the possibility of reporting and recall bias. Another notable limitation of our study was the challenge in recruiting participants, who at the time were in lockdown measures and working remotely, resulting in a lower than anticipated respondent rate during the data collection phase. Although this study sets to investigate the extended digital device usage and may introduce bias, as it was conducted during the COVID-19, it was not intended to thoroughly analyse the various effects on work-life balance during the pandemic.

Conclusions

The prevalence of combined DES-MSD is high at 63.8% among the financial workforce in Brunei. Spending >5 hours on a digital screen without breaks increases the risk of developing DES-MSD by more than 2-fold. MSD in the shoulders, neck, and back and headaches are the most common symptoms. Individuals wearing glasses or contact lenses, and who took inadequate breaks during computer work are found to suffer more from DES-MSD.

Abbreviations

CVS	Computer vision syndrome
CI	Confidence interval
DES	Digital eye strain
IQR	Interquartile range
MSDs	Muscular skeletal disorders
OR	Odds ratio
PIS	Participant information sheet
WHO	World health organisation

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Additional information

The questionnaire DESRIL-27, used in this study was adopted from our previous study. It is available in word and PDF along with the user manual and coding guidelines for both individual and total item scoring Microsoft Store. https://sites.google.com/view/thedesril-27project/

Conflict of Interest & Funding

The authors declare no competing interests, and no funding was involved in this study project.

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