Original Article

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The Impact of Visual Digital Unit Exposure on Ocular Symptoms of Computer Vision Syndrome Among Selangor Office Workers

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Abstract:

Objective: Computer Visual Syndrome (CVS) is a common condition characterized by a range of ocular symptoms resulting from excessive screen time. As visual digital unit (VDU) usage has skyrocketed across all age groups, CVS has become a prevalent issue in both personal and professional life. Therefore, this study aimed to investigate the association between the impact of VDU and ocular symptoms of CVS among office workers in Selangor.

Material and Methods: In this cross-sectional study, 46 office workers completed a self-reported Computer Vision Syndrome (CVS) assessment using a questionnaire adapted from a previous study. The questionnaire includes 9 questions

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about ocular symptoms, rated on a 5-point scale: none, slight, moderate, severe, and very severe. Computer screen illumination was measured using a lux meter. To account for potential confounding factors, environmental conditions were also assessed. These included the number and type of light sources, window presence and size, window treatments, lighting fixture placement, and overall workspace cleanliness, following the guidelines on occupational safety and health for working with video display units by the Malaysia Department of Occupational Safety and Health.

Results: Among all participants, the majority (93.5%) did not use anti-glare screen monitors and 20% had inadequate lighting with less than 450 lux. Of the respondents, 63% of the respondents reported experiencing eye strain and eye fatigue (60.9%) during work hours. Eye fatigue was the most commonly reported ocular symptom, with 24% of respondents experiencing it more than six times per week. Lighting reflector was found to be 3.5 times more prevalent to cause eye redness (odds ratio (OR)=3.50; 95% confidence interval (CI)=0.50–24.33). The likelihood of experiencing eye strain due to the absence of an anti-glare was 1.8 times higher and the absence of a lighting reflector increased the likelihood by 1.7 times.

Conclusion: The alarmingly high prevalence of Computer Vision Syndrome (CVS) among office workers underscores the critical need for immediate and effective ergonomic interventions. This research is imperative to identify specific risk factors and develop targeted strategies to mitigate the detrimental effects of prolonged VDU use on ocular health.

Keywords: computer vision syndrome (CVS), ocular symptoms, office workers, Video display units (VDUs)

Introduction

Extended use of digital devices such as computers and mobile phones can lead to health risks such as increased ocular pressure and cause other negative impacts on human health, including posture issues, and neck, shoulder, and back pain. In the modern world, technology and devices are essential tools that people use for a wide variety of purposes. This has forced many people to spend long hours using electronic devices, thereby changing people's lifestyles[1]. Computer Vision Syndrome (CVS) is a significant health concern caused by prolonged computer use. CVS refers to the experience of one or more ocular or visual symptoms, such as eyestrain, eye fatigue, blurred vision, or dry eyes, after using VDUs. Studies estimated that up to 90% of computer users are affected by CVS. CVS is a common eye pressure condition that can lead to sleep disturbance, further exacerbating eye strain and discomfort[1,2]. CVS includes symptoms such as eye strain, fatigue, irritation, a sensation of burning redness, sunken eyes, and blurred and double vision[3]. The previous data shows that CVS affects almost 60 million people annually, and the number is growing[4]. Approximately 50 to 90% of individuals who use computers for long periods, more than 3 hours per day, experience some degree of eye strain or other symptoms associated with CVS[5,6]. The majority of daily workers in China spend between 6 to 11 hours working with VDUs, with an average of 8.7 hours which is prone to cause physical symptoms like eye discomfort[7]. Few studies have reported on office workers who use VDUs for less than 6 hours a day[8].

While prolonged exposure to electronic devices is a well-known risk factor for CVS, many other factors can contribute to the development of this condition. Glare from computer screens is one of the factors that can cause visual symptoms, including eye strain[9,10]. Glare occurs when there is improper lighting in the environment and when light reflects off a shiny surface such as a computer screen. This can cause discomfort and visual fatigue. Different age groups may require varying light intensities to see clearly and comfortably[11]. A previous study found that office workers over the age of 40 had a 72.7% higher risk of developing CVS and required brighter light than younger individuals to perform the same task[1]. Additionally, prolonged use of digital devices can exacerbate dry eye symptoms in contact lens wearers[1]. Computer vision syndrome is known to be contributed by the visual effects of computers, including brightness, resolution, glare, and quality.

A previous study found that 26.7% of office workers who spend extended periods in front of computers or other electronic devices are more likely to experience CVS symptoms, which can lead to myopia[12]. Prolonged exposure to blue light emitted by electronic devices and other sources may increase the risk of developing cataracts. Numerous studies have documented the prevalence of CVS and associated risk factors, including extended computer use and incorrect workstation alignment. Prolonged computer use, bad posture at workstations, and a variety of musculoskeletal discomforts have been linked in numerous studies. Several factors can contribute to the development of CVS, including the type of computer used. This is because the magnetic field of the Liquid Crystal Display (LCD) is lower in desktops than in laptops[13,14]. Laptop screens are generally smaller than desktop screens, and users may tend to get closer to the screen. This can result in eye strain and fatigue, especially if the user spends long hours working on the laptop[9-12].

Thus, it is important to investigate the influence of VDU exposure on office workers, as the increasing usage of electronic devices in society, especially in urban areas, can have negative effects on ocular health. This study aims to determine the effect of Visual Display Unit exposure on the ocular symptoms associated with Computer Vision Syndrome in Selangor office workers. By exploring the practices during VDU usage and considering environmental factors, this study can provide valuable insights for organizations to manage the ocular health of their workers, ultimately contributing to disease prevention and the overall well-being of society. Understanding the potential risks associated with VDU exposure and taking appropriate measures to minimize those risks can help to ensure the long-term health of office workers.

Material and Methods

Study design and sample population

This study was conducted in a Malaysian private university. This studied population was chosen among the staff that use the visual digital unit (mobile phones, laptops, computers, tablets, or e-readers) during their working hours. A cross-sectional study was done to get all the required data from June until July 2020. All respondents recruited through purposive sampling were aged 20 to 45 years old, employed for a minimum of 6 months and using any kind of VDU devices for a minimum of eight hours per day in at least one year, and were able to understand either English or Malay to answer the questionnaires. The respondents who are following the criteria were invited to join in this study through email and direct communication. The prevalence of CVS in a study was 11.6[15]. Based on this study and considering an 80% response rate and 90% ineligibility the minimum sample size was 70. However, due to COVID-19, the limitation of this study is it may not fully capture the impact of office environments on CVS symptoms due to the increasing prevalence of remote work, some respondents were working at home.

Materials and research procedures

Data were collected using a questionnaire consisting of four sections: Section A for socio-demographic data, Section B for reported health background, Section C for environmental factors that cause CVS, and Section D for ocular symptoms CVS-questions adopted from previous studies[5,14]. In this study, ocular symptom is defined as the presence of the symptoms during the previous year, with the symptoms lasting for at least one week during that period, either intermittently or continuously[1]. Symptoms frequency was assessed using a Likert scale (0=never, 1=occasionally, 2=often, 3=very often/always). The intensity was rated as moderate (1) or intense (2) for symptoms occurring at least occasionally. A symptom score was calculated by multiplying the frequency and intensity. Formal written instructions for the study were presented via verbal briefing to the respondents before the distribution of the questionnaires. The study adhered to Good Clinical Practice guidelines and ethical standards. Ethical approval was obtained from the Ethics Committee of Mahsa University (Ref no: FOHS/EH/20/UG65).

VDU assessment

Work-related factors assessed included daily and total computer usage, and break frequency. VDU-related factors evaluated were anti-glare measures, screen brightness, and monitor height, as outlined in the Guideline on Occupational Safety and Health for Working with VDUs[16]. To complement the survey data, workplace lighting conditions were assessed using a Lutron LX-101A Digital Lux Meter and a checklist based on the Guideline on Occupational Safety and Health for Lighting at Work[17]. This evaluation included measuring illumination levels and assessing factors such as natural light availability, artificial lighting sources, fixture placement, and overall workplace cleanliness.

A lux meter was employed to measure both general and task-specific lighting levels within the workstation area. General lighting, defined as uniform illumination across the workspace, was assessed for typical office activities. Measurements (Formula 1) were taken at various points within the room, considering factors such as room dimensions and lighting fixture height where L is the length of the room in meters, W is wide or room in meters and Hm is the height of the lighting above the working plane in meter.

$$\text{Room Index} = \frac{L \times W}{Hm\,(L+W)}$$

(Formula 1)

For tasks requiring specific work areas, such as a standard writing desk, illuminance measurements were taken at four equidistant points within the primary task zone. Measurements were conducted at the typical working height. In the absence of a defined task area, as in many computer workstations, measurements were taken at a height of 0.8 meters above the floor. The lux meter sensor was positioned horizontally on the work surface for general illuminance measurements. For tasks involving reading materials, the sensor orientation was adjusted to match the plane of the material (Figure 1).

Illuminance measurements were taken at four points: two at the keyboard position (20 cm apart) and two at the top of the screen (10 cm apart). The lux meter sensor was positioned horizontally for all measurements, as illustrated in Figure 2. The average illuminance at each workstation was calculated based on measurements taken at four points. These values were then compared to the recommended illuminance levels outlined in the Guidelines on Occupational Safety and Health for Lighting at the Workplace[17].

Statistical analysis

All statistical analyses were conducted using IBM SPSS statistics software version 23 (SPSS Inc., Chicago IL). Data analysis employed non-parametric tests due

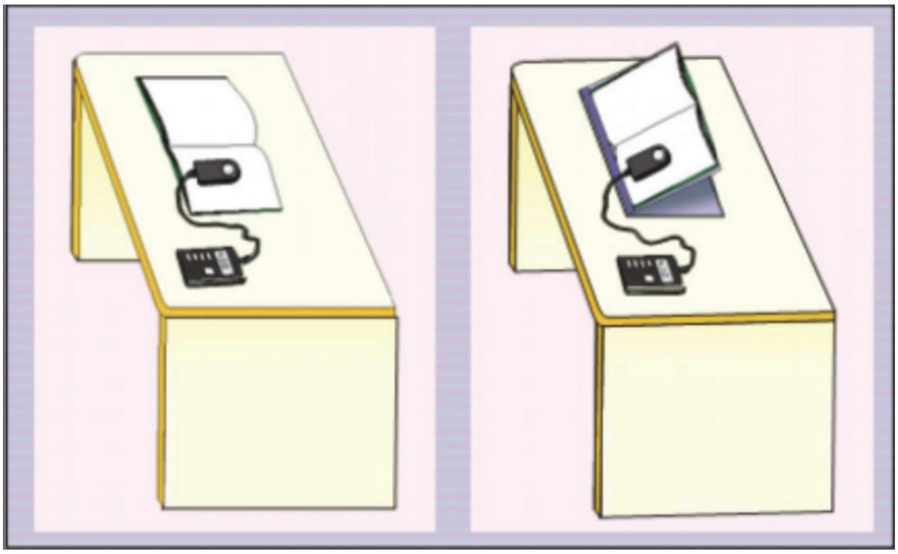

Figure 1 Lux meter sensor positioned on the work plane

Figure 2 Measurement points for a computer workstation

to the non-normal distribution of the data, as confirmed by the Kolmogorov-Smirnov test. Data are presented as frequencies and percentages. Pearson's chi-squared test was used to find the association between ocular symptoms and socio-demographic factors. In addition, the Pearson correlation test was used to find the association between ocular symptoms and anthropometric factors. Finally, the association between the ocular symptoms and VDU exposure was tested using Pearson's chi-squared test. All tests conducted were two-tailed with an alpha value of 0.05.

Results and Discussion

Demographic characteristics

A total of 46 respondents participated in the study with the majority being female (65.2%), 73.9% were married, and 78.3% had a Master's degree. The present study showed no significant associations were found between sociodemographic factors such as gender, marital status, race, education, and hobbies with the eye strain (p-value>0.05). Eye strain was primarily linked to prolonged exposure to electronic devices. Consistent with previous research, gender was not associated with eye strain[18]. However, respondents working more than six hours daily reported higher prevalence. Managing screen distance and eye level and incorporating regular breaks, along with anti-glare measures and adjustable brightness, can alleviate symptoms. Marital status and ethnicity were not associated with eye strain, but improper posture and excessive screen brightness were identified as risk factors[19]. Similar to findings by Assefa et al. (2017), education level was not associated with eye strain, but frequent breaks and eye health education were emphasized as preventive measures[20].

No significant associations were found between sociodemographic factors and eye fatigue (χ^2=0.05, p-value>0.005). Eye fatigue was influenced more by environmental factors, such as fluorescent lighting and visual disturbances. Consistent with previous research, gender, marital status, ethnicity, and education level were not associated with eye fatigue[19,21]. However, prolonged screen time, improper lighting, and inadequate breaks contributed to optical symptom development. Optimizing workplace conditions, including lighting and display quality, along with limiting screen time and incorporating regular breaks, may help mitigate eye fatigue.

Double vision was not significantly associated with sociodemographic factors (χ^2=0.05, p-value>0.05). This symptom was primarily linked to improper screen distance and inadequate eye-level positioning. Prior research also found no association between double vision and gender, marital status, or education level[1]. However, maintaining proper viewing distance, using screen filters, and optimizing room lighting were identified as potential preventive measures.

Excess blinking was not associated with sociodemographic factors (χ^2=0.05, p-value>0.05). This symptom was primarily linked to environmental factors such as high air conditioning and prolonged computer use. Consistent with previous research, gender and education level were not associated with excess blinking[22]. However, dry eye conditions and exposure to forced-air heating contributed to increased blinking. Implementing regular breaks and adjusting workplace ventilation may help alleviate this symptom.

Hobbies significantly influenced eye blurriness (χ^2=7.52, p-value=0.006). Activities such as watching movies, reading, online activities, and gaming were associated with increased eye blurriness (42.9%), aligning with previous research[23]. Conversely, outdoor activities like cycling and hiking (94.4%) did not impact eye blurriness, supporting a finding by Rose et al. (2008). Factors contributing to eye blurriness included prolonged screen time, reduced blinking rates, and inadequate lighting conditions.

Excess watery eyes were not associated with sociodemographic factors (χ^2=0.05, p-value>0.05). This symptom was primarily linked to excessive screen brightness. Consistent with previous research, gender and marital status were not associated with excess watery eyes[18,20]. Adjusting screen brightness to match ambient lighting and incorporating regular breaks were identified as potential management strategies.

Eye irritation and redness of eyes were not significantly associated with sociodemographic factors (χ^2=0.05, p-value>0.05). This symptom was primarily linked to excessive monitor screen angles, prolonged computer use without breaks, improper viewing distances, and dry conditions. Previous research also found no association between eye irritation and gender or education level[1,20]. Meanwhile, previous research also found no association between redness of the eyes and sociodemographic factors or hobbies[24]. Maintaining optimal viewing distances (16 to 24 inches), adjusting monitor angles minimizing exposure to unwanted light sources, and incorporating regular breaks were recommended to reduce redness.

Anthropometric factors on ocular symptoms

In the correlation analysis (Table 2), the weight of the respondents was correlated with both eye fatigue (r=0.386, p-value=0.008) and excess blinking (r=0.368, p-value=0.012), suggesting that higher weight is associated with increased symptoms. Previous studies support these

Table 1 Association between ocular symptoms and socio-demographic characteristics

Variable	χ^2 (p-value)							
	Eye strain	Eye fatigue	Double vision	Excess blinking eyes	Eye blurry	Excess watery eyes	Eye irritation	Redness of eye
Gender								
Male Female	1.791 (0.181)	0.220 (0.754)	0.540 (0.645)	<0.001 (0.919)	3.006 (0.083)	3.124 (0.114)	0.486 (0.486)	3.092 (0.079)
Marital Status								
Single Married	2.869 (0.163)	3.44 (0.090)	0.108 (0.999)	<0.001 (0.254)	0.206 (0.650)	<0.001 (0.999)	0.996 (0.318)	0.318 (0.999)
Race								
Malay Chinese Indian Other	4.845 (0.252)	4.845 (0.529)	2.432 (0.394)	2.732 (0.479)	1.294 (0.711)	2.732 (0.455)	5.074 (0.169)	1.942 (0.877)
Education								
Diploma Bachelor Master PhD	4.188 (0.277)	0.371 (0.999)	6.584 (0.112)	1.605 (0.197)	0.89 (0.999)	1.605 (0.596)	0.426 (0.999)	1.045 (0.999)
Hobbies								
Visual hobbies Non-visual hobbies	0.047 (0.828)	3.549 (0.060)	<0.001 (0.999)	0.217 (0.691)	7.519 *(0.006)	0.217 (0.639)	2.159 (0.142)	2.197 (0.138)

Chi-square (χ^2) test, fisher's exact test *Significant p-value<0.05

Table 2 Association between anthropometric measurement and ocular symptoms

Correlation	Mean±S.D.	R (p-value)							
		Eye strain	Eye fatigue	Double vision	Excess blinking eyes	Eye blurry	Excess watery eyes	Eye irritation	Redness of eye
Weight (kg)	70.54±16.165	0.231 0.122	0.386 *0.008	0.100 0.508	0.368 *0.012	0.009 0.952	−0.186 0.215	−0.267 0.072	−0.153 0.309
Height (cm)	160.5±8.123	0.139 0.356	0.333 *0.024	0.061 0.689	0.169 0.260	0.189 0.207	−0.96 0.526	0.40 0.791	−0.90 0.552
Tenure	4.43±3.851	0.005 0.973	0.132 0.383	−0.217 0.147	−0.029 0.846	−0.111 0.462	0.101 0.505	0.113 0.453	−0.117 0.441

Pearson correlation (R) test *Significant p-value≤0.05

findings, linking obesity to prolonged sedentary behavior, increased caloric intake, and reduced physical activity[25]. Height was also positively correlated with eye fatigue (r=0.333, p-value=0.024), potentially due to ergonomic challenges associated with taller stature[26]. To isolate the effects of VDU use, weight, height, and job tenure were controlled for in subsequent analyses. The relationship between height and ocular symptoms has been less extensively researched compared to weight and current findings remain inconclusive.

Environmental factors on ocular symptoms

It was observed in Figure 3 that anti-glare (93.5%), ambient lighting (56.5%), eye level (54.3%), light direction (21.7%), and computer brightness (89.1%) were the most significant factors contributing to the occurrence of CVS which are ocular symptoms among respondents. Similar results were reported by a previous study, which also showed that the lack of anti-glare features was directly related to eye symptoms[27]. Our study also revealed that lighting problems (workstation located far from the window and not adequately lit) showed respondent counteracting behavior on ocular symptoms. Although lighting problems have been reported to increase ocular symptoms, Kolawole et al. (2017) indicated that the presence of large windows and overhead fluorescent lighting may reflect light and create more glare on computer screens[22].

The present study found that workers with ocular symptoms reported a high prevalence of the monitor screen position not being in line with eye level. One possible reason for this association between ocular symptoms is discussed by Ahuja et al. (2021)[28]. Taken together, the majority of the respondents (89.1%) have to increase the brightness on their devices due to inadequate lighting. Abudawood et al. (2020) indicated that workers are more likely to have high computer brightness, which could lead to the risk of ocular symptoms[29]. Our findings are consistent with those of Darsanj et al. (2018), showing that a longer duration of work was associated with an increased risk of ocular symptoms[21]. A previous study found that working for more than six hours in front of the computer increased eye fatigue[19]. During work, changing posture, shielding the eyes from the light sources, and adjusting the brightness levels could reduce the glare[22].

Association between the visual digital unit exposure factors with ocular symptoms

The results of analyses for factors associated with ocular symptoms are shown in Table 3. Needing to move closer was associated with eyestrain, and Table 3 showed

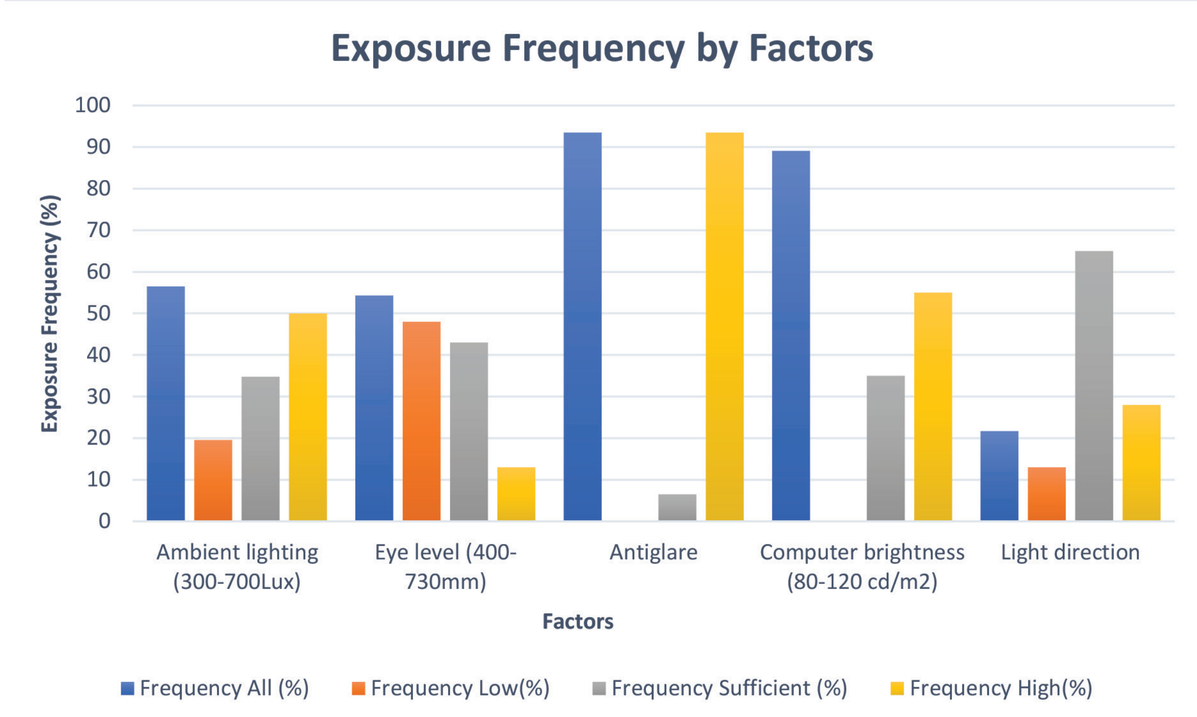

Figure 3 Ocular symptoms level exposure by different factors

that not using an anti-glare screen can increase the risk of experiencing eyestrain symptoms by 2 times (odds ratio (OR)=1.80, 95% confidence interval (CI)=0.23-14.11). Nopriadi et al. (2019) found that eyestrain symptoms result in a significant usage of anti-glare screens, which may reflect light more strongly[30]. Taken together, eyestrain among these respondent workers may be associated with the habit of viewing distant screens up close. The office workers are required to focus on their screens while working, and without anti-glare screens will cause the high intensity of VDU lighting. Adjustment of the font size and working at a distance from the screen could be seen as human adaptations to cope with glare. Reflective lighting was reported by 63.9% of respondents and was associated with a 1.68-fold increased likelihood of eyestrain (OR=1.68, 95% CI=1.31-2.16). This finding suggests that lighting sources positioned behind or above users, causing screen glare, contribute to eye strain. Consistent with these results, Katabaro and Yan (2019) found that 50.3% of respondents experienced discomfort due to reflective lighting, with 2.53 times higher odds of eyestrain (OR=2.53, 95% CI=2.41-2.66)[31].

Exposure to room lighting was reported by 63.6% of respondents and was associated with a 1.250-fold increased likelihood of eye fatigue (OR=1.250, 95% CI=0.381-4.104). However, this association was not statistically significant due to the wide confidence interval. Excessive room illumination compared to recommended levels of 300 to 500 lux for office environments may contribute to eye fatigue. Our findings are consistent with those of Katabaro and Yan (2019), who found that respondents exposed to room illumination had a 3.08% chance of developing eye fatigue[31]. Regarding the lack of an anti-glare screen, 52.4% of respondents experienced eye fatigue, indicating that glare is produced from poorly constructed luminaries surrounding the workstation. Additionally, 63.9% of respondents experienced a 1.7 times increased risk of eye fatigue due to the reflective lighting factor, as most of the respondents' workplaces relied on fluorescence instead of direct natural lighting. We could not find any studies to either support or contradict our findings. However, interestingly, in our study, respondents who use fluorescence lighting experienced poor visual performance and eye fatigue. Adnan et al. (2021), indicated that most respondents were dissatisfied with the quality of their office lighting and felt uneasy due to lack of natural sunlight, with a focus solely on artificial lighting installations[32].

95.3% of the respondents experienced double vision, with a 1.2% likelihood attributed to exposure to high levels of room lighting exceeding 500 lux. Our finding is consistent with that of Sari et al. (2018), who showed that exposure to high illumination was associated with an increased risk of double vision[33]. Similar to the above studies, we also found that 58.3% of respondents who had an imbalance between eye level and computer screen experienced a negative effect on double vision, with the risk increasing by 1.74 times among respondents. The top of the computer screen should be slightly below eye level. Maintain a viewing distance of at least 400 millimeters[16]. Montagni et al. (2018) indicated that most respondents reported using low eye levels of less than 50 cm, which can cause ergonomics problems as well as the risk of double vision[34]. The present study found that 63.9% of respondents who experienced double vision had an imbalance between computer monitors and lighting reflection. Lemma et al. (2020) highlight the importance of considering double vision symptoms through office lighting and monitor placement by installing Venetian shades and tilting computer monitors horizontally by 15 degrees[35].

Excessive blinking among VDU respondents (Table 3) showed that imbalanced lighting in the environment is one of the factors where respondents increased the likelihood by 2 times (95% CI=0.34-6.37). Other factors, such as humidity and poor lighting, were found to increase the likelihood by 31.0% among respondents (OR=1.00, 95% CI=0.982-1.018). Additionally, the lack of anti-glare screens increased the likelihood of excessive eye blinking by 52.4% (OR=1.548, 95% CI=0.16-14.77) among respondents, where respondents have to adapt to the evolutionary perspective of applying pressure to the computer to enhance the image. Taken together, it is recommended to install anti-glare screens and adjust the lighting setup in the workplace to cope with work and reduce ocular symptoms[36].

The association between exposure factors such as room lighting and reflector lighting with eye blurriness is presented in Table 3, showing that 63.6% of the respondents experienced a 1.2 times likelihood (OR=1.19, 95% CI=0.66-2.14) and 14.2% of respondents experienced a 1.25 times likelihood (95% CI=8.5-21.7), respectively. Some studies that examine the association between work-related factors and eye blurriness report that insufficient room lighting and reflector lighting were considered risk factors for eye blurriness in workers[37]. Light significantly influences our physical and emotional well-being. Increased light levels typically boost energy and alertness, while decreased light can induce feelings of fatigue and lethargy. This may be due to poorly designed workplace layouts, where some areas reflect windows or whiteboards and produce glare spots that can be uncomfortable for the eyes.

In the analysis, the imbalance between eye level and computer position and lighting reflector was analyzed with excessive watery eyes among respondents. The present study found that 58.3% of the respondents increased the likelihood of excessively watery eyes due to a lower eye level and distance from the monitor screen. Nadhiva and Mulyono (2020) indicated that an imbalance between eye level and computer position resulted in an increased likelihood of excessively watery eyes (95% CI=1.00-3.13), where most of the respondents viewed their screens above eye level[37]. We found that the use of specific lighting configurations is expected to increase the likelihood of excessively watery eyes by 2 times in 63.9% of participants (95% CI=0.18-22.55).

The present study found that 52.4% of respondents with eye irritation symptoms reported a high prevalence (1.6 times) of not using anti-glare compared to those without eye irritation symptoms. One possible reason for the association between anti-glare and eye irritation is that respondents spent more than 4 hours working continuously on their monitor while using another device without taking any breaks, which caused the eyes to constantly refocus. Although the lack of use of anti-glare has been reported to increase eye irritation, reflector illumination displays a higher prevalence of eye irritation among 63.9% of respondents, with 1.3 times likelihood.

Table 3 Association between VDU exposure and ocular symptoms

VDU exposure	Eye strain			Eye fatigue			Double vision		
	N (%)	χ^2	OR (95% CI)	N (%)	χ^2	OR (95% CI)	N (%)	χ^2	OR (95% CI)
Room lighting	12 (54.5)	1.307	0.494 (0.146-1.667)	14 (63.6)	0.348	1.250 (0.381-4.104)	41 (95.3)	0.348	1.192 (0.662-2.144)
Eye's level	13 (59.1)	0.283	0.722 (0.217-2.400)	14 (58.3)	1.394	0.600 (0.182- 1.979)	14 (58.3)	1.394	1.737 (0.262-11.515)
Display brightness	25 (61)	0.692	0.762 (0.461-1.259)	25 (58.1)	0.692	0.271 (0.29-2.533)	2 (9.1)	0.692	0.13 (0.001-0.175)
No anti-glare	26 (61.9)	0.269	1.800 (0.230-14.110)	22 (52.4)	3,288	1.625 (0.208-12.705)	22 (52.4)	3,288	0.881 (0.788-0.985)
No reflector lighting	23 (63.9)	0.051	1.680 (1.309-2.156)	23 (63.9)	0.051	1.739 (0.299-10.104)	23 (63.9)	0.051	1.147 (1.017-1.294)
VDU exposure	**Eye blurry**			**Excess watery**			**Excess blinking**		
	N (%)	**χ^2**	**OR (95% CI)**	**N (%)**	**χ^2**	**OR (95% CI)**	**N (%)**	**χ^2**	**OR (95% CI)**
Room lighting	14 (63.6)	0.348	1.192 (0.662-2.144)	4 (9.3)	0.348	0.140 (0.141-8.556)	17 (77.3)	0.348	1.471 (0.340-6.365)
Eye's level	14 (58.3)	1.394	0.588 (0.159-2.179)	14 (58.3)	1.394	1.100 (0.141-8.556)	14 (58.3)	1.394	0.844 (0.195-3.652)
Display brightness	11 (25.6)	0.692	0.759 (0.121-4.747)	2 (9.1)	0.692	0.405 (0.35-4.690)	9 (20.9)	0.692	0.250 (0.128-12.252)
No anti-glare	22 (52.4)	3,288	0.667 (0.534-0.832)	22 (52.4)	3,288	0.500 (0.44-5.637)	22 (52.4)	3.288	1.548 (0.162-14.767)
No reflector lighting	23 (63.9)	0.051	1.238 (0.857-1.788)	23 (63.9)	0.051	2.00 (0.177-22.550)	23 (63.9)	0.051	0.646 (0.068-6.159)

VDU exposure	Eyes irritation			Eyes redness		
	N (%)	χ^2	OR (95% CI)	N (%)	χ^2	OR (95% CI)
Room lighting	4 (18.2)	0.348	0.188 (0.49-0.724)	20 (90.9)	0.348	1.091 (0.873-1.363)
Eye's level	14 (58.3)	1.394	0.443 (0.129-1.524)	14 (58.3)	1.394	0.500 (0.082-3.046)
Display brightness	17 (39.5)	0.692	0.200 (0.196-7.362)	6 (14.0)	0.692	0.714 (0.069-7.435)
No anti-glare	22 (52.4)	3,288	1.563 (0.268-9.101)	22 (52.4)	3,288	0.846 (0.740-0.967)
No reflector lighting	23 (63.9)	0.051	1.339 (0.261-6.861)	23 (63.9)	0.051	3.500 (0.504-24.328)

Chi-square (χ^2) test *Significant at p-value<0.05; Significant OR>1, 95% CI=95% confidence interval, OR=odds ratio, VDU=video display units
a=Fisher's exact test data

The association between VDU exposure and eye redness among workers is rarely addressed, and the present study further found that poor room lighting had a 1.1 times increased likelihood associated with eye redness. Most likely, 45% of the respondents who spend a minimum of 6 hours per day, five days per week, and do not have anti-glare are at a 1.23 times higher risk of developing eye redness, which can cause discomfort and dryness[20]. Poor posture could be seen as one of the challenging factors and caused individuals to concentrate more on the computer screen, further causing muscle spasms in their eyes. The majority of the respondents (63.9%) who experienced reflective illumination had a 3.5 times higher chance of developing eye redness symptoms (95% CI=0.50-24.33). Similarly, in another study, 23.3% of participants reported reflective illumination, which increased the likelihood of eye redness by 1.9 times[38]. The need to stand close to the monitor can result in inadequate illumination, which exacerbates the symptoms. In Malaysia, there are standard guidelines to prevent visual discomfort and associated conditions. It is recommended that the user maintains a minimum distance of 50 cm or 200 inches from the computer screen to avoid discomfort caused by ocular symptoms[39].

Conclusion

The present study revealed that a significant proportion of office workers experienced visual discomfort, exacerbated by the absence of anti-glare screens. These findings highlight a growing occupational health concern with potential long-term implications. Prolonged computer use can induce eye strain and fatigue among office workers. To mitigate these issues, reducing VDU exposure and optimizing work environments are essential. Implementing measures such as providing anti-glare screens and appropriate lighting can help alleviate ocular symptoms. The study found that the absence of anti-glare screens and appropriate lighting increases the prevalence of ocular symptoms. Therefore, addressing these factors may help reduce the risk of Computer Vision Syndrome. While this study focused on office workers, the widespread use of computers across various occupations necessitates a broader approach to address VDU-related health problems. It is crucial to acknowledge the study limitations, including the relatively small sample size, which may restrict the generalizability of findings. Additionally, the cross-sectional design precludes establishing the causal relationship between VDU use and ocular symptoms. Future research with larger sample sizes and longitudinal designs is warranted to strengthen the evidence base.

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Conflict of interest

There were no potential conflicts of interest disclosed by the authors in connection with the research, authorship, and/or publication of this work. The findings of this research have never been published before.

References

1. Ranasinghe P, Wathurapatha WS, Perera YS, Lamabadusuriya DA, Kulatunga S, Jayawardana N, et al. Computer vision syndrome among computer office workers in a developing country: an evaluation of prevalence and risk factors. BMC Research Notes 2016;9:1–9.
2. Parihar JKS, Jain VK, Chaturvedi P, Kaushik J, Jain G, Parihar AKS. Computer and visual display terminals (VDT) vision syndrome (CVDTS). Med J Armed Forces India 2016;72:270–6.
3. Gupta N, Moudgil T, Sharma B. Computer vision syndrome: prevalence and predictors among college staff and students. IOSR J Dental Med Sci 2016;15:28–31.

4. Boadi-Kusi SB, Adueming PO, Hammond FA, Antiri EO. Computer vision syndrome and its associated ergonomic factors among bank workers. Int J Occup Saf Ergon 2022;28:1219-26.
5. Lee JW, Cho HG, Moon BY, Kim SY, Yu DS. Effects of prolonged continuous computer gaming on physical and ocular symptoms and binocular vision functions in young healthy individuals. Peer J 2019;1–14.
6. Venkatesh SH, Girish AT, Shashikala PK, Mannava S, Rajarathnam R. A study of computer vision syndrome at the workplace - prevalence and causative factors. Int J Contemp Med Res 2016;157:53-9.
7. Felix N, Chizurumoke M, Emmanuel E. Measurement of magnetic fields from liquid crystal display (LCD) computer monitors. Int J Curr Res 2013;5:1771–3.
8. Mowatt L, Gordon C, Santosh AB, Jones T. Computer vision syndrome and ergonomic practices among undergraduate university students. Int J Clinical Practice 2018;72.
9. Akinbinu TR, Mashalla YJ. Medical practice and review impact of computer technology on health: computer vision syndrome (CVS). Academic J 2014;5:20–30.
10. Anggrainy P, Ashar T, Lubis RR. Difference in computer-attributed vision problem between laptop and desktop users. The International Conference on Public Health Proceeding Surakarta: Master's Program in Public Health Graduate School, Universitas Sebelas Maret; 2018.
11. Pandey R, Gaur S, Kumar R, Kotwal N, Kumar S. Curse of the technology-computer related musculoskeletal disorders and vision syndrome: a study. Int J Res Med Sci 2020;8:661.
12. Zalat MM, Amer SM, Wassif GA, El Tarhouny SA, Mansour TM. Computer vision syndrome, visual ergonomics and amelioration among staff members in a Saudi medical college. Int J Occup Saf Ergon 2021;28:1033-41.
13. Bogdănici CM, Săndulache DE, Nechita CA. Eyesight quality and computer vision syndrome. Romanian J Opht 2017;61:112–6.
14. Jamrozik A, Clements N, Hasan SS, Zhao J, Zhang R, Campanella C, et al. Access to daylight and view in an office improves cognitive performance and satisfaction and reduces eyestrain: a controlled crossover study. Building Env 2019;165:106379.
15. Reddy SC, Low CK, Lim YP, Low LL, Mardina F, Nursaleha MP. Computer vision syndrome: a study of knowledge and practices in university students. Nepal J Ophthalmol 2013;5:161-8.
16. Department of Occupational Safety and Health (DOSH). Guidelines on occupational safety and health for working with video display units (VDU's) [homepage on the Internet] Putrajaya: Ministry of Human Resources, Malaysia [JKKP: GP (I) 6/2003]. 2003 [cited 2024 March 7]. Available from: https://www.dosh.gov.my/index.php/legislation/guidelines/ergonomic/605-03-guidelines-on-occupational-safety-and-health-for-working-with-video-display-unit-vdu-s-2003/file
17. Department of Occupational Safety and Health. Guidelines on Occupational Safety and Health for Lighting at Workplace [homepage on the Internet] Putrajaya: Ministry of Human Resources, Malaysia. 2018 [cited 2024 March 20]. Available from: https://www.dosh.gov.my/index.php/competent-person-form/occupational-health/regulation-2-1/guidelines/industrial-hygiene-1/2912-guidelines-on-osh-for-lighting-at-workplace/file
18. Agarwal S, Goel D, Sharma A. Evaluation of the factors which contribute to the ocular complaints in computer users. J Clin Diagn Res 2013;7:331–5.
19. Lin JB, Gerratt BW, Bassi CJ, Apte RS. Short-wavelength light-blocking eyeglasses attenuate symptoms of eye fatigue. Invest Ophthalmol Vis Sci 2017;58:442–7.
20. Assefa NL, Weldemichael DZ, Alemu HW, Anbesse DH. Prevalence and associated factors of computer vision syndrome among bank workers in Gondar city, Northwest Ethiopia. Clin Optom (Auckl) 2017;9:67–76.
21. Darsanj A, Yarmohammadi H, Poursadeghiyan M, Dalvand S, Javadzad H, Salehi R, et al. Investigating the visual fatigue in VDT operators in the banks of Qasr-e Shirin (Kermanshah-Iran). Arch Hyg Sci 2018;7:225–31.
22. Kolawole OU, Iyanda RA, Isawumi MA. Computer-related vision problems in Osogbo, South-Western Nigeria. African J Biomedical Res 2017;20:267–72.
23. Lee JW, Cho HG, Moon BY, Kim SY, Yu DS. Effects of prolonged continuous computer gaming on physical and ocular symptoms and binocular vision functions in young healthy individuals. Peer J 2019;7:e7050.
24. Arif KM, Alam MJ. Review article: computer vision syndrome. Faridpur Med Coll J 2015;10:33–5.
25. Wiegand DM, Hanowski RJ, McDonald SE. Commercial drivers' health: a naturalistic study of body mass index, fatigue, and involvement in safety-critical events. Traffic Inj Prev 2009;10:573–9.

26. Saw SM, Chua WH, Hong CY, Wu HM, Chia KS, Stone RA, et al. Height and its relationship to refraction and biometry parameters in Singapore Chinese children. Invest Ophthalmol Vis Sci 2002;43:1408–13.
27. Hassan A, Kashif M, Masud Z, Raza MA. Prevalence of computer vision syndrome (CVS) amongst the Students of Khyber Medical University, Peshawar. Islamabad Congr Ophthalmol 2017;15:59-64.
28. Ahuja S, Stephen M, Ranjith N. Assessing the factors and prevalence of digital eye strain among digital screen users using a validated questionnaire-an observational study. Int J Med Public Health 2021;11:19-23.
29. Abudawood GA, Ashi HM, Almarzouki NK. Computer vision syndrome among undergraduate medical students in King Abdulaziz University, Jeddah, Saudi Arabia. J Ophthal 2020;2789376:1-7.
30. Nopriadi N, Pratiwi Y, Leonita E, Trsnanengsih E. Factors associated with the incidence of computer vision syndrome in bank officers. The Ind J Pub Health 2019;15:111–9.
31. Katabaro JM, Yan Y. Effects of lighting quality on working efficiency of workers in office building in Tanzania. J Environ Pub Health 2019;3476490.
32. Adnan NA, Sujali NS, Md Amin ND. Case study on the impact of artificial light on lightning performance quality for architecture studios. Int J Integrated Eng 2021;13:184-91.
33. Sari FTA, Himayani R, Faktor Risiko Terjadinya Computer Vision Syndrome. Majority 2018;7:278–82.
34. Montagni I, Cariou T, Feuillet T, Langlois E, Tzourio C. Exploring digital health use and opinions of university students: field survey study. JMIR MHealth UHealth 2018;6:1–13.
35. Lemma MG, Michael Beyene KG, Tiruneh MA. Computer vision syndrome and associated factors among secretaries working in ministry offices in Addis Ababa, Ethiopia. Clinical Optometry 2020;12:213–22.
36. Chlasta-Twardzik E, Górecka-Nitoń A, Nowińska A, Wylęgała E. The influence of work environment factors on the ocular surface in a one-year follow-up prospective clinical study. Diagnostics 2021;11:392.
37. Nadhiva RF, Mulyono M. The relation between symptoms of computer vision syndrome and visual display terminal utilization. The Ind J Occup Safety Health 2020;9:328.
38. Bodunde OT, Sholeye OO, Onabolu OO, Otulana TO, Ajibode HA. Perception of red eye among senior secondary students in Sagamu, Southwest Nigeria. J Family Med Prim Care 2016;5:89-93.
39. Coles Brennan C, Sulley A, Young G. Management of digital eye strain. Clin Exp Optom 2018;102:18-29.