ORIGINAL ARTICLE

Digital Learning's Toll: A High Prevalence of Computer Vision Syndrome in University Students During Lockdown

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ABSTRACT

Background: Computer Vision Syndrome (CVS) encompasses a range of ocular and musculoskeletal symptoms, such as dry eyes, eye strain, blurred vision, neck pain, and light sensitivity, resulting from prolonged digital device use. During the COVID-19 lockdown, the shift to online learning increased screen exposure, potentially exacerbating CVS among university students. This study aimed to assess the CVS prevalence, and its associated Internal Symptoms Factors (ISF) and External Symptoms Factors (ESF) among students at UCSI University, Kuala Lumpur, during the pandemic-induced lockdown.
Method: A cross-sectional online survey was conducted using the Computer Vision Symptoms Scale 17 (CVSS17) questionnaire. **Results**: Among 150 participants (mean age 21.36 ± 1.87 years; 99 females, 51 males), the mean CVSS17 score was 34 ± 10.61, with ESF and ISF scores of 24 ± 7.07 and 15 ± 4.95, respectively. A high prevalence of CVS was observed, with 80.67% reporting moderate to severe symptoms. Specifically, 56.67% experienced moderate to severe ESF, while 83.33% reported moderate to high ISF. Female students exhibited significantly higher CVSS17, ESF, and ISF scores compared to males ($p<0.01$). **Conclusion**: The findings indicate a substantial prevalence of CVS among students during the lockdown, driven predominantly by internal symptom factors. These results highlight the need for preventive measures to mitigate CVS in digital learning environments.

INTRODUCTION

Computer Vision Syndrome (CVS), clinically termed digital eye strain, has emerged as a significant occupational and environmental health challenge in our technology driven society. This multifactorial condition arises from prolonged interaction with digital displays-including computers, tablets, and smartphones and is characterized by a constellation of visual, ocular and musculoskeletal symptoms (Chawala et al., 2019).

The pathophysiology of CVS involves three primary mechanisms; ocular surface disruption (dry eye, irritation, redness), accommodative dysfunction (eye strain, blurred vision) and ergonomics related strain (neck/shoulder pain, migrain (Wimalsundera, 2006; Parihar et al. 2021). The clinical presentation of CVS ranges from transient visual disturbances to chronic discomfort, with studies reporting 50-90% prevalence among regular device users (Bali et al., 2007), increased 2.8x risk of severe symptoms with more than 4 hours daily use (Kim et al. 2016) and significant comorbidity with cervicobrachial disorders (Berolo et al., 2011).

Unlike traditional print media, digital screens present distinct visual stressors. Letter on screens, made up of pixels usually have clear sharp central and decrease toward the edges, reading with a digital screen could be attributed to screen brightness, glare, font size, contrast, and eye to screen distance (Lema and Anbesu, 2022). Compared to the static contrast of print media, digital displays are pixel dependent. Turgut (2018) reported 40% greater accommodative demand when viewing a digital screen. Glares are more apparent with digital screen reflectance, Lee et al. (2016) reported of 2.5x increased of photophobia risk. Fixed ergonomics with digital displays cause as high as 68% musculoskeletal complaints (Parihar et al. 2021).

The COVID-19 pandemic triggered a profound global transformation, marked by widespread lockdowns and unprecedented societal disruptions. In Malaysia, multiple iterations of the Movement Control Order (MCO) were implemented over two and a half years to mitigate the crisis. These measures impacted all sectors, with education facing particularly acute challenges. Educational

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institutions worldwide were forced to rapidly transition to online learning as their primary instructional mode. While this shift enabled continuity in teaching, it also introduced new pedagogical complexities and raised concerns about health risks linked to prolonged computer use notably, computer vision syndrome (CVS).

MATERIALS AND METHODS

This cross-sectional study investigated the prevalence and symptom profile of Computer Vision Syndrome (CVS) among university students during mandatory online learning under COVID-19 lockdown conditions. The research had two primary objectives: to quantify CVS prevalence in this unique educational context, and to identify the most significant contributing symptoms and risk factors. The study employed a convenience sampling approach, with all research activities - including participant recruitment, screening, and data collection - being conducted virtually due to movement restrictions. Prior to participation, all respondents received complete study information through digital patient information sheets. Written informed consent was obtained electronically from each participant before they accessed the study questionnaire.

The required sample size was calculated a priori using G*Power version 3.1.9.3 (Heinrich Heine University Dusseldorf, Germany). Based on a two-tailed independent t-test design comparing means between two groups, we established the following parameters, statistical power (1-β) was set at 0.8, significant level (α) at a 0.05, 0.50 effect size (d) and 0.5 ratio of two groups. Analysis yielded a critical t value of 1.66, degree of freedom (df) 112, minimum total sample required 114 participants with larger group of 76 participants and 38 participants for smaller groups. This calculation followed established methodological recommendations for research (Faul et al., 2017). The effect size was selected based on comparable studies of visual symptoms in digital device users, while the allocation ratio reflected the expected gender distribution in our target population.

The study enrolled participants aged 17 years or older who reported a minimum computer usage of either four hours daily or twenty hours weekly and who provided informed consent. Individuals were excluded if they presented with active ocular inflammation or trauma, severe refractive errors exceeding ±6.00 dioptres, systemic diseases affecting ocular health, or current use of medications known to influence ocular surface integrity or visual function—including but not limited to antihistamines, beta-blockers, diuretics, psychotropic agents, and oral contraceptives. Participants with corrected refractive errors were instructed to respond to survey questions while wearing their habitual optical correction. The study protocol received ethical approval from the Institutional Review Board (ICE-2021-FMH-074) and was conducted in full compliance with the ethical principles of the Declaration of Helsinki, ensuring protection of participant rights and welfare throughout the research process.

The study employed the validated Computer Vision Syndrome Severity 17 (CVSS17) questionnaire (Gonzalez-Perez et al. 2018), a psychometrically robust instrument developed using the Rasch measurement model to objectively quantify CVS symptom severity. This 17-item tool transforms ordinal response data into interval level measurement by accounting for both item difficulty and respondent ability, thereby enabling precise evaluation of symptom severity. The questionnaire incorporates three response formats: a seven-point frequency scale (never-always) for one item, a six-point intensity scale (not at all-very much) for six items, and four-point scales (never-always or false-true) for the remaining ten items. Total scores (range: 17-53) were calculated by multiplying the sum of responses by 17 and dividing by the number of valid answers, with higher scores indicating greater severity. These scores were categorized into five severity levels (Level 1 (17-22), Level 2 (23-28), Level 3 (29-35), Level 4 (36-42), and Level 5 (43-53).

CVSS17 evaluates two subscales: the External Symptom Factor (ESF) and the Internal Symptom Factor (ISF). Each factor comprises eleven and six items, respectively. ESF assesses external factors influencing ocular symptoms, specifically dry eye symptoms associated with computer use. On the other hand, ISF examines factors related to the vision function, such as refraction and accommodation. ESF total scores are calculated based on the sum of score x 11 questions over the number of valid responses. There are five performance levels: Level 1 (score between 11 and less than 18), Level 2 (score between 18 and less than 24), Level 3 (score between 24 and less than 30), Level 4 (score between 30 and less than 35) and Level 5 (score greater than or equal to 35). ISF total scores are calculated based on the sum of score x 7 questions over the number of valid responses. Three performance levels are defined: Level 1 (score between 7 and less than 12), Level 2 (score between 12 and less than 16) and Level 3 (score greater than or equal to 16).

All statistical analyses were conducted using IBM SPSS Statistics 29.0, employing descriptive statistics to determine prevalence rates and chi-square tests (with and without Yates' correction) to examine gender-based associations, with statistical significance set at $p < 0.05$.

RESULTS

Descriptive statistics are summarised in Table 1.0. A total of 150 students participated, comprising 99 females and 51 males with mean age of 21.36 ± 1.87 years. A significant proportion of students were in their fourth year, followed by second-year, fifth year, and third year. The average CVSS17 score was 34.43 ± 6.29, indicating that 80.67% of participant experienced a moderate to severe CVS. The average ESF score was 23.68 ± 4.59 (56.67%) and the average ISF score was 14.56 ± 2.84 (83.33%).

Table 1.0: Socio-demographic Characteristics of Study Participants

Characteristic	Number, n /Score (%)
Mean age	21.36 ± 1.87 years
Gender	
i. Male	51 (34%)
ii. Female	99 (66%)
Year of study	
i. First	24 (16.00%)
ii. Second	28 (18.67%)
iii. Third	19 (12.67%)
iv. Fourth	53 (35.33%)
v. Fifth	26 (17.33%)
CVSS17 Score	34.43 ± 6.29 (80.67%)
ESF Score	23.68 ± 4.59 (56.67%)
ISF Score	14.56± 2.84 (83.33%)

Figure 1.0 shows the distribution of responses from all participants to the CVSS17 questionnaires, ranging from the most negative to the most positive items according to question number. Table 1.1 shows the distribution of CVSS17 levels among study participants.

Table 1.1: Distribution of CVSS17 Levels for Participants

CVSS17	1	2	3	4	5
Male	3	11	23	14	0
Female	2	13	22	50	12

Figure 1.1 provides a detailed breakdown of the study responses for the ESF component while Table 1.2 shows the distribution breakdown of ESF level among all participants. Figure 1.2 presents detailed responses for ISF related questions and Table 1.3 summarises the distribution breakdown of ISF levels of all participants.

Overall, 80.67% (121 of 150) participants experience CVSS17 level 3 and above. In terms of gender, 72.54% (37 of 51) male participants experience moderate to severe CVS compared to 84.84% (84 of 99) female participants. The most frequently reported symptom was under External Symptom Factor, ESF was tired eyes (ESF question A4), with 78% of participants reporting experiencing it from occasional to constant. 74.67% of participants concurred that they needed to shut their eyes to alleviate dry eye symptoms (ESF question C23), while 72.67% agreed they experienced a sensation of heaviness in their eyes at the end of working day (ESF question C16), 58.67% of participants reported heavy eye after working on the computer for a while (ESF question A17). Other symptoms reported by less than 50% of study participants included excessive blinking (ESF, question A20) at 46%, eye pain (ESF question A9) at 35.55%, a stinging sensation in the eyes (ESF question A32) at 29.33%, watery eyes (ESF question B7) at 27.33%, red eye after prolonged computer work at 22.67% and burning eye sensation (ESF question A21) at 21.33%.

Based on Table 1.2., 56.67% (85 of 150) participants experienced ESF level 3 and above. In terms of gender, 39.22% (20 of 51) male participants experience moderate to severe CVS compared to 65.65% (65 of 99) female participants.

Table 1.2: Distribution of ESF Score Level for All Participants

ESF	1	2	3	4	5
Male	9	22	20	0	0
Female	9	25	57	8	0

Under ISF questions, 68.67% agreed with the statement that they were bothered by light after extended periods of work (ISF question C24), and 68% concurred they had to exert extra effort to see clearly (ISF question C21). This is followed by eye strain (ISF, question A22) at 41.33%, followed by discomfort due to lighting (ISF question A33) at 40%, blurred text on the screen (ISF question A2) at 30%, a feeling of crossing the eyes (ISF question A28) at 25.33% and double vision (ISF question A30) at 23.33%.

Table 1.3: Distribution of ISF Score Level for All Participants

ISF	1	2	3
Male	13	24	14
Female	12	39	48

Based on Table 1.3., 83.33% (125 of 150) participants experience ISF level 2 and above. In terms of gender, 74.50% (38 of 51) male participants experience moderate to severe ISF compared to 87.87% (87 of 99) female participants.

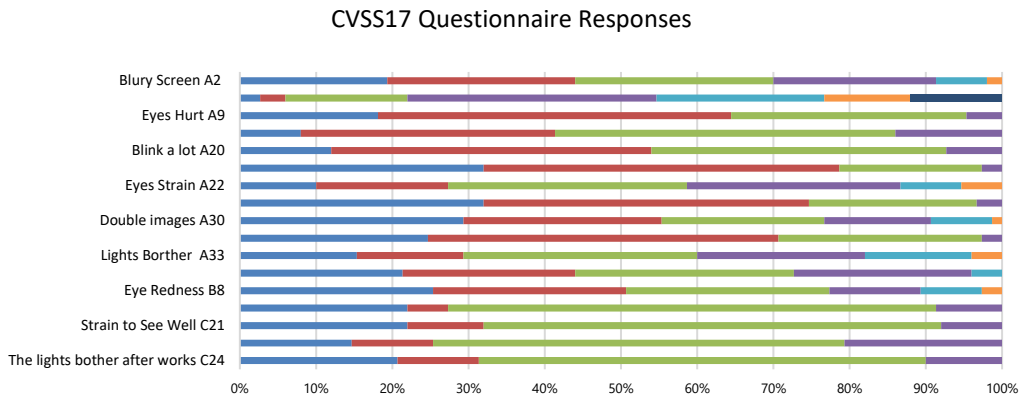

Figure 1.0: Stacked Cluster Bar Chat of CVSS17 Questionnaire Responses for All Participants

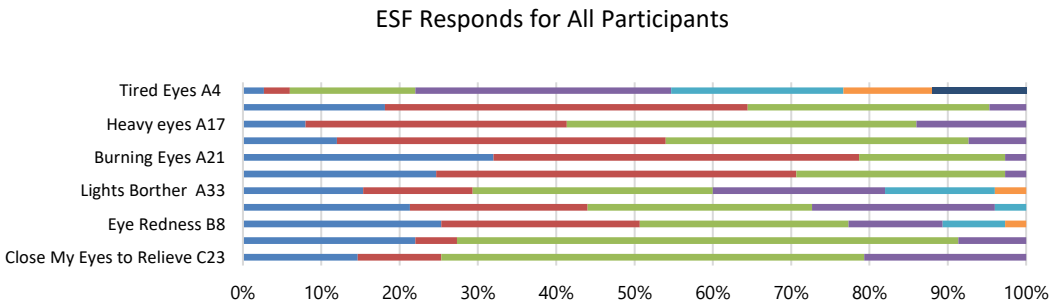

Figure 1.1: Stacked Cluster Bar Chat of CVSS17 ESF Responses for All Participants

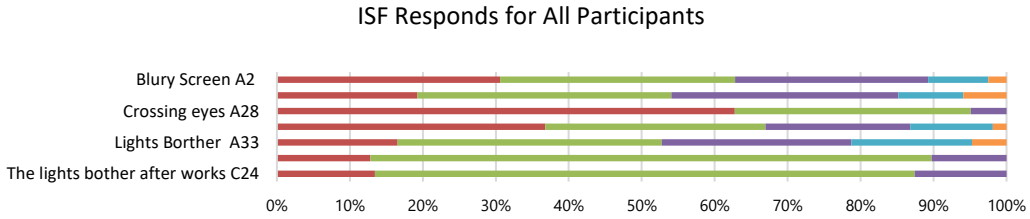

Figure 1.2: Stacked Cluster Bar Chart of ISF Responses for All Participants

Table 1.4 Comparison of CVS score for all participants and result Mann-Whitney U Test Between Genders

	CVSS17	ESF Score	ISF Score
Overall (n=150)	34.43 ± 6.29	23.68 ± 4.59	14.56 ± 2.84
Prevalence	80.67%	56.67%	83.33%
Male (n=51)	32.02 ± 5.82 Mean rank 58.87	22.04 ± 4.26 Mean rank 59.73	13.45 ± 2.68 Mean rank 58.98
Female (n=99)	35.68 ± 6.19 Mean rank 84.07	24.53 ± 4.55 Mean rank 83.63	15.13 ± 2.76 Mean rank 84.01
Z score	U=1676.50, z=3.37 $p<0.01^{\dagger\dagger}$	U=1720, z=3.20 $p<0.01^{\dagger\dagger}$	U=1682, 3.36 $p<0.01^{\dagger\dagger}$
Effect size	r=0.27	r=0.26	r=0.27

p-value, significance value; $p<0.01^{\dagger\dagger}$

Table 1.5 Significant Association Between Gender and the Symptoms Experienced by the Participants During Their Last Four Working Weeks

Symptoms	Pearson Chi-square	df	p-value
Strains to See Well C21	10.29	1	$<0.01^{\dagger\dagger}$
Blurry Letters A2	7.18	1	$<0.01^{\dagger\dagger}$
Watery Eyes B7	6.63	1	$<0.05^{\dagger}$
Tired Eyes A4	5.44^{γ}	1	$<0.05^{\dagger}$
Light bother After Works C24	5.00	1	$<0.05^{\dagger}$

$^{\gamma}$ Chi-square with Yates's correction, df, degree of freedom; p-value, significance value; $p<0.05^{\dagger}$, $p<0.01^{\dagger\dagger}$

The results presented in Table 1.4 show significant differences between genders for CVSS17 ($p<0.01$), ESF score ($p<0.01$), and ISF score ($p<0.01$). The Mann-Whitney test revealed that female participants had significantly higher CVSS17 scores (mean rank=84.07, n=99) compared to male participants (mean rank=58.87, n=51), with U=1676.50, z = 3.37, and $p < 0.01$ (two-tailed), indicating a small effect size (r = 0.27). Similarly, the ESF score for female participants (mean rank=83.63, n=99) was significantly higher than for male participants (mean rank=59.73, n=51), with U=1720, z=3.20, $p<0.01$ (two-tailed) and a small effect size (r=0.26). The ISF score showed a similar pattern, with female participants (mean rank=84.01, n=99) having significantly higher scores than male participants (mean rank=58.98, n=51), U=1682, z=3.36, $p<0.01$ (two-tailed), a small effect size (r=0.27).

The chi square test results presented in table 1.5 show that several questions revealed significant differences between male and female participants. For the ESF related questions, significant differences were observed for blurry vision on screen (question A4) with χ^2 (1, N=150) =7.18, $p<0.01$ and watery eyes, (question B7) with χ^2 (1, N=150) =6.63, $p< 0.05$). For ISF, significant differences were found for blurry letters (question A2) with χ^2 (1, N=150) =7.18, $p<0.01$, the need to strains to see well (question C21) with χ^2 (1, N=150) =10.29, $p<0.01$, and light bothering after wok (question C24) with χ^2 (1, N=150) =5.00, $p< 0.05$).

DISCUSSION

The transition to exclusive online learning during the COVID-19 lockdown provide a unique context to examine CVS prevalence among university students. Our study reveals 80.7% of respondents (n=150) experienced moderate to severe symptoms, underscoring the substantial ocular strain associated with prolong digital device use in academic settings. This finding carries important implications for both public health and educational policy as digital learning becomes increasingly prevalent.

When contextualized within the existing literature, our prevalence rate demonstrates both consistencies and divergences that merit discussion. Among Malaysian populations, our results align closely with Yuan et al. (2022) (76.7% prevalence) while being slightly lower than Reddy et al. (2013) (89.9%), likely reflecting differences in assessment methodologies (CVS-Q vs custom survey instrument) and sampling frame.

However, global literature on CVS prevalence presents intriguing variations. South Asian studies report an extreme range from 71.6% in Nepal (Sitaula and Khatri (2018) to 94.8% in Pakistan Hassan et al. (2017). Middle Eastern data shows moderately high prevalence at 72% in UAE (Shantakumari et al. 2014). Indian studies demonstrate significant methodological variation, with Logaraj et al. (2014) reporting 78.7-81.9% among professional students versus Ganne et al. (2021) documenting just 50.6% during COVID-19. These disparities likely stem from three key factors, population characteristics (medical versus general students), diagnostic criteria (validated tools vs symptom checklists) and environmental contexts (pre-pandemic vs lockdown condition).

Notably, our lockdown-era findings remain consistent with historical pre-pandemic estimates of 75-90% prevalence among computer user (Anshel 2005, Sheedy et al. 2007, Yan et al. 2008, Rahman and Sanip, 2011, Ranasinghe et al., 2016), suggesting that the shift to exclusive online learning may have simply extended occupational CVS patterns to academic populations.

The observed symptom profile offers important insights into the pathophysiology of CVS during prolonged

academic screen use. The higher prevalence of internal symptoms (ISF = 83.3%) compared to external symptoms (ESF = 56.75%) suggests that CVS in academic settings is primarily driven by visual processing demands rather than ocular surface factors alone. Key indicators include 68% of participants reporting extra focusing effort and 68.7% experiencing photophobia, reflecting accommodation and pupillary stress responses. These findings align with existing research, such as a transient myopia shift observed in 20% of VDT workers after prolonged screen exposure due to reduced accommodative power (Luberto et al., 1989). Additionally, studies show a larger lag of accommodation and a 25-30% slower reading speed on digital screens compared to print (Chu et al., 2011), with screen brightness and contrast further affecting performance (Hue et al., 2013). Smaller smartphone screens may also increase accommodative strain due to prolonged reading demands (Bababekova et al., 2011; Kim et al., 2017).

Despite being secondary to accommodative issues (ESF=56.75), dry eye symptoms remain clinically significant, with 78% reporting ocular fatigue, 76.7% requiring lid closure for relief, and 72.7% experiencing eye heaviness. These correlate with reduced blink rates (Patel et al., 1991), increased tear evaporation (Rosenfield, 2011), and a high prevalence of incomplete blinks in VDT users (Portello et al., 2013). Beyond accommodative strain, vergence demands, extraocular muscle fatigue, and tear film abnormalities may also contribute to blurred vision during screen use (Alemayehu & Alemayehu, 2019).

The robust gender difference in CVS severity ($p<0.01$ across all subscales) persists even CVSS17's unidimensionality was validated via Rasch analysis (Gonzalez-Perez et al. 2018), suggesting genuine biological and behavioural mediators. Endocrine related factors may contribute, as estrogen receptors are present in corneal epithelium (Auw-Haedrich & Feltgen, 2003) and progesterone-mediated meibomian gland dysfunction (Versura et al. 2014). Additionally, academic behavioural patterns are more apparent, where female students demonstrate 23% longer continuous study periods (Lenskiy & Paprocki, 2016) and 40% higher likelihood of multi device use (Kim et al. 2017). The 65:35 female: male ratio in our sample mirror national tertiary enrolment trends (Ahmad, 2009), reinforcing the need for gender sensitive interventions. These findings align with prior research demonstrating higher visual symptom scores among female VDT operators in Japan (Shima et al., 1993) and greater visual fatigue in female systems analysts in Brazil (Rocha & Debert-Ribeiro, 2004).

CONCLUSION

This study reveals a striking prevalence of Computer Vision Syndrome (CVS), affecting over 80% of university students engaged in online education during the COVID-19 pandemic. As digital screen use remains integral to modern academia, these findings underscore an urgent need for institutional action. Proactive measures such as structured screen-time breaks, ergonomic training, and awareness programs should be embedded into academic frameworks to alleviate the burden of CVS. Addressing this issue holistically will not only enhance student well-being but also safeguard long-term visual health in an increasingly digital learning landscape.

DECLARATION

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