Computer Vision Syndrome in Lebanese Male Adolescents:
Correlates With Mental Health and Mediating Effect of Stress

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ABSTRACT

Objective: To determine the prevalence of computer vision syndrome (CVS) and the relationship between CVS and depression, anxiety, insomnia, stress, and aggression among a sample of Lebanese male adolescents.

Methods: This cross-sectional observational study enrolled 389 male Lebanese students (aged 13–17 years) between October and December 2019.

Results: After adjusting for the covariates (age, body mass index, and House Crowding Index), those with CVS had significantly higher mean depression ($P < .001$), anxiety ($P = .003$), and insomnia ($P = .007$) scores compared to those without CVS. The presence of CVS was associated with significantly higher depression (B = 3.25), anxiety (B = 4.11), and insomnia (B = 4.49), but not aggression. Stress mediated the association between CVS and depression, anxiety, insomnia, and aggression ($P < .001$ for all).

Conclusions: The findings of this study indicate the importance of recognizing CVS in adolescents and raising awareness of time spent daily using computers and other electronic devices.

Prim Care Companion CNS Disord 2023;25(1):21m03180

To cite: Merhy G, Akel M, Kheir N, et al. Computer vision syndrome in Lebanese male adolescents: correlates with mental health and mediating effect of stress. *Prim Care Companion CNS Disord.* 2023;25(1):21m03180.

To share: https://doi.org/10.4088/PCC.21m03180

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In today's world, use of computers, tablets, and cell phones has become an integral part of life. In offices, schools, and universities and during daily free time, screens have become our companions. The development of technology in education made a noticeable transformation in teaching methods, information presentation, and study resources.[1] Therefore, adolescents increasingly use more technologies to adapt to these new methods.[2] However, this use raises a health-related concern: computer vision syndrome (CVS). It is a rising health concern related to technology due to continuous use of computers, tablets, and cell phones and given that around 75% of people's daily activities include such usage.[3]

CVS, also referred to as digital eye strain, describes a group of eye and vision problems that result from prolonged computer, tablet, and cell phone use. Many individuals experience eye discomfort and vision problems when viewing digital screens for extended periods.[4] CVS may present the following symptoms and signs: neck pain, neck stiffness, headache, shoulder pain, backache, double vision, blurry vision, myopia, and presbyopia.[5]

Research has shown that 90% of computer users may experience symptoms related to CVS after prolonged computer usage.[6] There are a number of factors that determine the amount of strain the body feels while working on a computer or other digital device, including lighting in the room, distance from and glare on the screen, seating posture, and the angle of the head.[7] In addition, CVS can also be explained by decreased blinking reflex while staring at the screen, leading to dry eyes.[3] One study[3] found that redness, burning sensation, blurred vision, and dry eyes were comparatively higher in males than in females. Males had a significantly higher risk of developing dry eyes than females.[3]

Nearly 60 million people experience CVS globally, resulting in reduced productivity at work and quality of life.[8] Prevalence of CVS ranges from 64% to 90% among computer users.[6] Among youth aged 15–17 years, more than 90% use computers, and at least three-quarters use the Internet.[9] In Lebanon, adolescents are the most vulnerable to Internet addiction and excessive computer and technology usage in the population, with more than 40% of adolescents having problematic Internet use.[10]

The overuse of devices for gaming is considered a subtype of Internet addiction.[11] This addiction could lead to eye damage.[12] Also, many psychological/psychiatric problems are a consequence of excessive screen use.[13] Overuse of devices such as cell phones and tablets may lead to depression or anxiety, which can in turn result in sleep problems.[14] In addition, CVS is significantly associated with poor sleep quality in medical students.[14]

Stress can contribute to the development of computer or Internet addiction.[15] Stress has been shown to be a powerful mediator in many studies.[16,17] One study[18] demonstrated that perceived stress

Clinical Points

- Computer vision syndrome (CVS) was associated with depression, anxiety, and insomnia.
- Psychiatrists, psychologists, and educators should consider CVS when confronted with adolescents presenting with depression, anxiety, insomnia, or aggression.

Table 1. Bivariate Analysis of Factors Associated With Depression, Anxiety, Stress, Aggression, and Insomnia[a]

Variable	Depression	Anxiety	Aggression	Insomnia
Age	0.164[b]	0.082	0.065	0.098
Body mass index	−0.027	0.055	−0.113[c]	0.036
House Crowding Index	0.035	−0.04	0.046	0.035

[a]Values correspond to Pearson correlation coefficients.
[b]$P < .01$.
[c]$P < .05$.

fully mediated the effect of academic stress on depressive symptoms. Aggression has also been associated with excessive computer use. A study[19] found that adolescents with internet addiction were more likely to have aggressive behaviors. The association was more significant among adolescents in junior high than in senior high/vocational school.[19]

The aim of this study was to determine the prevalence of CVS and the relation between depression, anxiety, insomnia, stress, and aggression among a sample of Lebanese male adolescents. No previous studies, to the best of our knowledge, have been conducted in Lebanon on the relation between CVS and psychiatric disorders.

METHODS

Study Design and Procedure

This cross-sectional observational study enrolled 389 male students from 5 Lebanese schools between October and December 2019. A list of the schools available in each Lebanese district was provided by the Ministry of Education and Higher Education. One school was chosen from each district using a simple randomization technique; the districts included the capital Beirut, Mount Lebanon, North, Beqaa, and South. A list of students was obtained from the designated school; all male students in grades 9–12 (aged 13–17 years) were asked to participate. Students were allowed to fill out the questionnaires on a voluntary basis, and the survey was administered in classrooms to avoid parental influence. Data were stripped from any personal identifying information to protect the participants' privacy. A pilot test was conducted on a sample of 20 adolescents to make sure that questions were clear and understood. No changes were made to the original survey; thus, those 20 answers were entered in the database.[20] The study was approved by the ethical committee at the Lebanese International University (2020RC-039-LIUSOP). Written informed consent was obtained from the parents of all students.

Minimal Sample Size Calculation

According to the G-power software and based on an effect size of f2 = 2%, an α error of 5%, a power of 80% and taking into consideration 4 factors to be entered in the multivariable analysis, the results showed that a minimal number of 264 was needed.

Data Collection and Measures

The self-report survey questionnaire was in Arabic and was handed out in paper form. Before use, the questionnaire was translated into Arabic (process involving 2 independent translations, synthesis of the 2 translations, back translations, review of the pre-final version, and pretesting). The questionnaire included 2 sections. The first section collected demographic information, including the participant's age and socioeconomic characteristics. Body mass index (BMI) was computed by dividing the weight (in kg) by the squared height (in meters). The House Crowding Index was computed by dividing the number of persons living in the house by the number of rooms in the house, excluding the kitchen and bathrooms. A higher House Crowding Index reflects lower socioeconomic status. The second part of the survey was dedicated to the assessment of 5 main psychiatric issues (aggression, depression, anxiety, stress, and insomnia) and the CVS assessment.

The Computer Vision Syndrome Questionnaire[21] was developed to measure visual symptoms related to exposure to computers in the workplace. There are 16 items inquiring about symptoms such as blurred vision, tearing, and excessive blinking when using the computer. A 3-point Likert scale is used to rate symptom frequency (0 = never, 1 = occasionally, 2 = often or always) and intensity (0 = never, 1 = moderate, 2 = intense). The scores for intensity and frequency were multiplied and then recoded (0 = 0, 1 or 2= 1, 4 = 2). The scores were then summed to provide a total score out of 32. A score ≥6 points indicates the likely presence of CVS. In this study, the Cronbach α for this scale was 0.905.

The Patient Health Questionnaire-9,[22] validated in Lebanon,[23] was used to assess depression severity, with a score ranging from 0–27. The total score was computed by adding the items' individual scores, since each of the 9 items can be scored from 0 (not at all) to 3 (nearly every day). In this study, the Cronbach α value was 0.869.

The Hamilton Anxiety Rating Scale,[24] validated in Lebanon,[25] was used to assess anxiety symptom severity. It consists of 14 items scored on a scale of 0 (not present) to 4 (severe). The total score was computed by the sum of all item scores, with higher scores indicating higher levels of anxiety. In this study, the Cronbach α was 0.883.

The Lebanese Insomnia Scale[26] was used to assess insomnia. It consists of 17 items graded on a 5-point Likert scale, with higher scores indicating higher insomnia. In this study, the Cronbach α was 0.610.

Stress was assessed using the Perceived Stress Scale,[27] which consists of 10 items that measure the perception of stress during the last month based on a 4-point scale, with higher scores indicating higher perception of stress. In this study, the Cronbach α was 0.834.

Table 2. Multivariable Analysis

Model 1: depression taken as the dependent variable				
Variable	β	*P*	95% CI	Partial Eta Squared
Age	0.37	.05	0.000 to 0.74	0.015
House Crowding Index	0.02	.962	−0.86 to 0.90	0.001
Body mass index	0.004	.959	−0.13 to 0.14	0.001
Computer vision syndrome (yes vs no*)	3.25	**<.001**	1.57 to 4.93	0.055
Model 2: anxiety score taken as the dependent variable				
Variable	β	*P*	95% CI	Partial Eta Squared
Age	0.03	.925	−0.56 to 0.62	0.001
House Crowding index	−0.53	.460	−1.92 to 0.87	0.002
Body mass index	0.21	.062	−0.01 to 0.42	0.014
Computer vision syndrome (yes vs no*)	4.11	**.003**	1.43 to 6.79	0.035
Model 3: aggression score taken as the dependent variable				
Variable	β	*P*	95% CI	Partial Eta Squared
Age	1.64	.167	−0.69 to 3.98	0.008
House Crowding Index	−1.25	.657	−6.78 to 4.28	0.001
Body mass index	−0.96	**.027**	−1.82 to 0.11	0.02
Computer vision syndrome (yes vs no*)	3.65	.499	−6.97 to 14.27	0.002
Model 4: insomnia score taken as the dependent variable				
Variable	β	*P*	95% CI	Partial Eta Squared
Age	0.25	.502	−0.47 to 0.97	0.002
House Crowding Index	0.56	.516	−1.14 to 2.27	0.002
Body mass index	0.25	.068	−0.02 to 0.51	0.013
Computer vision syndrome (yes vs no*)	4.49	**.007**	1.22 to 7.76	0.029

*Reference group; numbers in bold indicate significant *P* values (*P* < .05).

The Buss-Perry Scale[28] was used to assess aggression and consists of 29 statements scored using a 5-point scale to indicate how uncharacteristic or characteristic each of the statements is in describing the student. The total score for aggression is the sum of the factor scores, with higher scores indicating higher aggressive behavior. The Cronbach α was 0.758.

Statistical Analysis

SPSS software version 25 was used to conduct the data analysis. A descriptive analysis was done using the counts and percentages for categorical variables and mean and standard deviation for continuous measures. Since the dependent variables followed a normal distribution (with its skewness and kurtosis varying between −2 and +2),[29] parametric tests were used. Pearson correlation test was used to compare 2 continuous variables, whereas the Student *t* test was used to compare 2 means. A multivariate analysis of covariance (MANCOVA) was conducted to compare multiple measures (depression, anxiety, insomnia, and aggression taken as dependent variables) and CVS as the independent variable, accounting for potential confounding variables: age and Household Crowding Index. $P < .05$ was considered significant.

The PROCESS SPSS Macro version 3.4, model 4[30] was used to calculate 3 pathways. Pathway A determined the regression coefficient for the effect of CVS on stress. Pathway B examined the association between CVS and each dependent variable (depression, anxiety, insomnia, and aggression), independent of stress. Pathway C estimated the total and direct effect of CVS on each dependent variable (depression, anxiety, insomnia, and aggression). Pathway AB calculated the indirect intervention effects. Significance was assumed when the bias-corrected bootstrapped 95% confidence intervals did not include zero.[30] Covariates included in the model were age, House Crowding Index, and BMI.

RESULTS

Sociodemographic and Other Characteristics of the Adolescents

A total of 389 students of 500 (77.8%) consented to participate in the study. The mean ± SD age of the participants was 15.83 ± 1.93 years, and the Household Crowding Index was 1.39 ± 1.59. The mean ± SD scale scores were as follows: depression (4.46 ± 5.03), anxiety (21.01 ± 7.61), insomnia (46.10 ± 10.58), stress (16.32 ± 5.53), and aggression (94.96 ± 33.33). In addition, 45 (13.4%) of the adolescents had CVS (95% CI, 0.097–0.171).

Bivariate Analysis

Higher age was significantly associated with higher depression, whereas higher BMI was significantly associated with lower aggression (Table 1). Furthermore, higher mean depression (7.46 vs 3.71, $P < .001$), anxiety (24.49 vs 20.47, $P < .001$), and insomnia (50.33 vs 45.49, $P = .006$), but not aggression (98.11 vs 95.47, $P = .381$), were found in adolescents with CVS compared to those without CVS (unadjusted results).

Multivariate Analysis

The MANCOVA analysis was performed taking the depression, anxiety, insomnia, stress, and aggression scores as the dependent variables and the presence/absence of CVS as the independent variable and adjusting for the covariates

Table 3. Mediation Analyses: Regression Coefficients Between the Independent Variable, Mediator, and Dependent Variables

	Effect of CVS on stress					Effect of CVS and stress on depression					Direct effect of CVS on depression				
Model 1: depression	β	95% BCa CI		T	*P*	β	95% BCa CI		*t*	*P*	β	95% BCa CI		*t*	*P*
CVS	0.02	0.01	0.03	3.55	**<.001**	0.03	0.02	0.04	8.66	**<.001**	0.03	0.02	0.04	9.58	**<.001**
Stress						0.25	0.16	0.34	5.56	**<.001**					
Model 2: insomnia	Effect of CVS on stress					Effect of CVS and stress on insomnia					Direct effect of CVS on insomnia				
	β	95% BCa CI		T	*P*	β	95% BCa CI		*t*	*P*	β	95% BCa CI		*t*	*P*
CVS	0.02	0.01	0.03	3.79	**<.001**	0.05	0.03	0.06	4.79	**<.001**	0.05	0.03	0.07	5.63	**<.001**
Stress						0.40	0.16	0.64	3.31	**.001**					
Model 3: anxiety	Effect of CVS on stress					Effect of CVS and stress on anxiety					Direct effect of CVS on anxiety				
	β	95% BCa CI		T	*P*	β	95% BCa CI		*t*	*P*	β	95% BCa CI		*t*	*P*
CVS	0.02	0.01	0.03	3.65	**<.001**	0.03	0.02	0.04	5.00	**<.001**	0.04	0.03	0.05	6.13	**<.001**
Stress						0.50	0.33	0.68	5.68	**<.001**					
Model 4: aggression	Effect of CVS on stress					Effect of CVS and stress on aggression					Direct effect of CVS on aggression				
	β	95% BCa CI		T	*P*	β	95% BCa CI		*t*	*P*	β	95% BCa CI		*t*	*P*
CVS	0.02	0.01	0.03	3.82	**<.001**	0.03	−0.02	0.08	1.36	.174	0.06	0.01	0.11	2.25	**.025**
Stress						1.25	0.60	1.90	3.80	**<.001**					

Abbreviations: BCa = bootstrap confidence interval, CVS = computer vision syndrome.

Table 4. Mediation Analyses: Direct and Indirect Effects of the Associations Between Computer Vision Syndrome, Stress, and the Dependent Variables (depression, insomnia, anxiety, and aggression)

	Direct Effect			Indirect Effect		
Mediator	Effect	SE	*P*	Effect	SE	95% BCa
Depression	0.03	0.003	<.001	0.004	.001	0.002–0.007*
Insomnia	0.05	0.01	<.001	0.007	.003	0.003–0.01*
Anxiety	0.03	0.01	<.001	0.008	.003	0.004–0.01*
Aggression	0.03	0.03	.174	0.02	.008	0.009–0.04*

*Indicates significant mediation. Abbreviation: BCa = bootstrap confidence interval.

(age, BMI, and Household Crowding Index). The presence of CVS was significantly associated with higher depression (B = 3.25), anxiety (B = 4.11), and insomnia (B = 4.49), but not aggression (Table 2).

Mediation Analysis

Stress mediated the association between CVS and all dependent variables (depression, insomnia, anxiety, and aggression) (Tables 3 and 4).

DISCUSSION

Among the 389 students who completed the survey, 13.4% had CVS, which was a lower prevalence than that found among medical students in Saudi Arabia.[31] A high prevalence of CVS was also observed in other studies among engineering[32] and medical students[33] (67.2% and 77.4%, respectively). The prevalence of CVS may be higher among medical and engineering students (age range, 18–34 years) given that they use technology much more, especially during their studies, than younger students.[34] We found no studies regarding the prevalence of CVS in adolescents specifically.

Regarding depression, the results of our study showed that the presence of CVS was significantly associated with higher depression. The depression score of 7.39 could reflect a mild level of depression in students who have CVS. This finding is similar to that of a study[14] that linked excessive use of technology with depression among 500 medical students. Eye conditions such as dry eye disease may be accompanied by symptoms of anxiety relating to work, or even depression.[35] Also, depression was shown to be related to subjective symptoms of dry eye disease but not to objective symptoms.[36]

Regarding anxiety, our results showed that the presence of CVS was associated with an elevation in anxiety scores. This result is in line with a previous study[14] that linked CVS and excessive technology use in medical students to anxiety. Previous research linked anxiety and some eye conditions such as dry eye disease.[36] Just like depression, anxiety was related to subjective symptoms of dry eye disease, as the sensation of having dry eyes came with a negative objective clinical examination.[36]

For insomnia, those with CVS in our study had higher insomnia scores compared to those without CVS. These results are in line with a previous study[14] associating CVS with poor sleep quality among medical students. Another study[37] found that the bright light of a computer screen may alter the body's biological clock and suppress the natural production of melatonin (a hormone in the body that helps regulate sleep-wake hours) that is critical to the normal sleep-wake cycle.

As for aggression, the results of our study revealed that CVS was not associated with more aggressive behavior. These results are not in line with those of a previous study[19] associating aggressive behaviors with Internet addiction and online activities in adolescents. It is noteworthy that

aggressive behavior may represent a normal developmental stage for adolescents.[38] Although research suggests that male adolescents are involved in more violence than female adolescents,[39] in recent years national data have indicated a shift in this pattern with females increasingly likely to be involved in violence.[40] However, males were more likely than females to report causing someone to need medical attention, whereas females were more likely than males to report dating violence (ie, physical aggression),[40] although males may underreport due to negative social stigmas.[41] Previous findings[42] suggested a correlation between excessive computer usage and aggressive behavior and impulsiveness in adolescents. However, the causal relationship between aggression and internet addiction has thus far not been clearly demonstrated.[43] To explain the negative association between CVS and aggression obtained in our study, we hypothesize that aggression is not externalized in Lebanese adolescents and might be internalized, which manifests through depression, anxiety, and insomnia. More studies are needed to evaluate this association in depth.

Mediating Effect of Stress

Stress mediated the association between CVS and depression, anxiety, insomnia, and aggression. Research has confirmed that continued strain on the body from stress may contribute to medical problems such as heart disease, high blood pressure, and diabetes, as well as psychiatric disorders such as depression, anxiety, and temporary insomnia.[44] On the other hand, irritability and anger can become common reactions in adolescents under stress[40] and in adults who tend to adopt more aggressive behaviors in response to negative experiences.[42] Further research is needed to understand the mediating effect of stress between CVS and mental illness.

Clinical Implications

Our results show that CVS is associated with psychiatric disorders such as depression, anxiety, and insomnia. The significant association between screen time and well-being may have important clinical implications for the mental and physical health of children and adolescents and for the development of guidelines for specific screen time limits for older children and adolescents. These results indicate the importance of recognizing CVS in adolescents and being aware of how much time they spend on computers and electronic devices. Health care professionals generally, and psychologists and psychiatrists specifically, should consider CVS and prolonged exposure to computers and electronic devices in male adolescents presenting with depression, anxiety, insomnia, or increased aggressive behavior. These adolescents may need surveillance when it comes to computer or cell phone usage, as they might be more prone to psychiatric disorders.

Eye damage from CVS may be avoided by taking frequent breaks every hour for 5 minutes to decrease the associated discomfort[45] and looking at far objects frequently during work.[46] In addition, the level of awareness and knowledge of CVS among adolescents can be increased by incorporation of the topic of CVS and related ergonomics in the school curriculum. Health and education professionals in Lebanon have suggested the need for parents, teachers, and students to be ergonomically conscious when using computers.[47] Sleep education programs should be implemented, as there is a need to improve sleep hygiene (behavior improving quality and quantity of sleep).

Limitations and Strengths

This study had a few limitations. CVS diagnosis in this study was based on self-reported symptoms without ophthalmic examination with an ophthalmologist, which may have resulted in underestimation of the number of students with CVS. No exclusion criteria were implemented in which those with preexisting medical or ocular conditions were included, which might have resulted in overestimation of the percentage of Lebanese students with CVS. Our study only included male participants, so we cannot generalize our results to the general population. An information bias is possible given that the answers of the students might not be totally accurate. The results could not be generalized to the general population, as there was one school withdrawn from each district (predisposing to a selection bias). A residual confounding bias might also be possible, since many factors associated with the dependent variables (depression, anxiety, stress, insomnia, and aggression) were not included in the questionnaire. The duration of computer, tablet, or cell phone use and the type of content consumed by the students on these devices were not assessed in this study, which might have influenced the results. Finally, the scales used have not all been validated in Lebanon. On the other hand, our study is the first in Lebanon concerning CVS and its psychiatric effect on male adolescents. The students filled out the questionnaire anonymously with no supervision, which decreases the Hawthorne effect. Previously tested, objective, and standardized methods were used to collect data.

CONCLUSION

This study showed a significant association between CVS and psychiatric disorders such as depression, anxiety, and insomnia among Lebanese male adolescents. The findings of this study will serve as a first step toward recognizing this problem and raising awareness regarding the daily use of computers and electronic devices. Psychiatrists, psychologists, and educators should consider CVS when confronted with adolescents presenting with depression, anxiety, insomnia, or aggression. Assessing not only the total time spent using any kind of digital screens but also the reason for doing so can be important when planning treatment for both eyesight and psychiatric problems.

Submitted: October 21, 2021; accepted January 28, 2022.
Published online: January 19, 2023.

Relevant financial relationships: None.

Funding/support: None.

Acknowledgments: The authors thank all students who participated in the study as well as the school directors.

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