

Article • Prevalence of Computer Vision Syndrome Among Engineering and Nursing College Students in Bangalore

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ABSTRACT

Background: Computer vision syndrome (CVS) is a group of visual symptoms experienced during the use of computers. Globally, about 60 million people suffer from CVS, resulting in reduced productivity at work and decreased quality of life. The present study aims to determine the prevalence of CVS and create awareness about CVS among engineering and nursing college students in Bangalore, India.

Methods: A prospective study was conducted among students of engineering and nursing colleges in Bangalore, India. Students in the age group of 17-35 years were included in the study. A brief history, along with details on hours of computer usage, was documented. Each subject underwent an optometric examination to investigate non-strabismic binocular vision dysfunctions and dry eye. Each subject completed a symptom survey.

Results: A total of 247 students between the ages of 17 and 35 years from four different colleges in Bangalore were assessed. Of the 247 students, 108 students were from engineering college and 139 students were from nursing college. In addition, 25.12% were male and 74.89% were female. The overall prevalence of CVS was found to be 85.02%.

The prevalence of CVS among engineering students and nursing students was 86.11% and 84.17%, respectively.

Conclusion: The present study revealed a high prevalence of CVS among students; more than three-fourths of the students were symptomatic. These preliminary results indicate a need for improved awareness, diagnosis, and management of binocular dysfunctions to increase the academic potential of these students and to increase productivity.

Keywords: binocular vision, computer vision syndrome, dry eye, symptoms, students

Introduction

Computer vision syndrome (CVS) is a condition in which a person experiences various ocular symptoms as a result of prolonged working on a computer, tablet, e-reader, and/or cell phone.¹ CVS is also defined as the combination of eye and vision problems associated with the use of a computer.² It has also been referred to as digital eye strain. The computer has become an integral part of our lives and is one of the most common office tools. The characters on a computer screen are made of tiny dots called pixels.³ Pixels are the result of an electronic beam striking the phosphor-coated rear surface of the screen. Each pixel is bright at its center, with decreasing brightness towards the outer edges. Therefore, electronic characters have blurred edges as compared to letters on a printed page with sharply defined edges.³ This makes it challenging for the human eye to maintain focus on pixelated characters. In an attempt to focus on the plane of the computer, the eye fails to sustain focus, and therefore relaxes to focus behind the screen. This point is referred to as the resting point of accommodation (RPA) or the dark focus.³ Therefore, the eye is constantly relaxing to the

RPA and straining to refocus on the screen, leading to eye strain and fatigue.³ The most common symptoms of CVS include eyestrain, headache, blurred vision, and neck or shoulder pain, as well as dry eye that generally increases with the amount of video display terminal (VDT) use.⁴

CVS can occur in any age group, but children are found to report fewer symptoms.⁵ The prevalence of CVS among computer users is 64% to 90%.⁶ Each year, a million new cases of CVS occur.⁷ Logaraj et al.⁴ in 2014 studied the prevalence of computer vision syndrome and associated factors among medical and engineering students in Chennai. The prevalence of CVS among engineering students was 81.9% and among medical students was 78.6%.

Dry eye disease (DED) is defined as "a disorder of the tear film due to tear deficiency or excessive evaporation, which causes damage to the interpalpebral ocular surface and is associated with symptoms of ocular discomfort."⁸ DED includes a variety of conditions that affect the ocular surface, impacting up to 20% of the population in Asia, Europe, and North America. Rosenfield et al.⁹ reported that 32% of subjects reported symptoms of dry eye; this may be a primary cause of CVS since both a significantly reduced blink rate and increased corneal exposure have been observed during computer operation.

Minimal research has been performed to assess the effects of computer use on the physical health of Indian users, especially among college students. Most studies were questionnaire-based, and none were clinically correlated. In addition, the current generation of students are more likely to study online from a computer, smart phone, or tablet. This study was designed to determine the prevalence of CVS among nursing and engineering students and to create awareness of CVS at the student level.

Methods

Permission from the respective college authorities was obtained, and every student was informed about the purpose and procedure of the study. A written consent form was signed by each student before enrollment into the study. Students who used a VDT for a minimum of 1 hour per day were included in the study, which was determined through the Computer Vision Syndrome questionnaire.

Clinical setup was divided into three stations. The first station included vision, refraction (objective & subjective without dilation), sensory (stereopsis,

Table 1. Expected Findings of Various Tests¹¹

Test	Expected Findings
Distance lateral phoria	Ortho – 0.5 exophoria
Near lateral phoria	6 exophoria
Gradient AC/A ratio	4:1
Base-out break/blur/recovery Distance Near	7 / 19 / 10 15 / 21 / 15
Base-in break/blur/recovery Distance Near	x / 9 / 5 14 / 22 / 18
Negative relative accommodation	+2.00 D
Positive relative accommodation	-2.25 D
Amplitude of accommodation Push-up test	18-1/3 Age
Gradient AC/A ratio	4:1
Monocular accommodative facility 13-30 yr old	11 cpm
Binocular accommodative facility 13-30 yr old	10 cpm
Monocular estimation method retinoscopy	+0.50 D
Vergence facility testing (12 base- out/ 3 base- in)	15 cpm

Worth 4-dot & color), and motor evaluation (EOM, cover test, Maddox rod, AC/A ratio). The second station included accommodation (NPA, AA, AF, NRA, PRA) and vergence tests (NPC, NFV, PFV, VF), and the third station included dry eye assessment (Schirmer I, II, & TBUT). At the end of the examination, each participant was surveyed using a questionnaire, which included the basic demographic profile, hours of computer use per day, and common CVS related symptoms like eyestrain, headache, dry eyes, neck or shoulder ache, etc.

They were also asked to indicate the level of visual problems during or after computer use. Categories for different visual problems were as follows: none, mild (transient symptoms persisting for a few minutes to hours), moderate (persisting for a few hours and subsiding after rest or sleep), or severe (needing medical consultation). Students with existing eye disease, strabismus, and/or amblyopia were excluded from the study. Participants were asked to answer 10 validated questions taken from *Diagnosing and Treating Computer-Related Vision Problems* by James E. Sheedy (Appendix A).¹⁰ A score between 1 and 40 was considered to be mild, between 41 and 70 was considered to be moderate, and from 71 to 100 was considered to be severe.

Table 2. Schirmer Test and Tear Break-up Time Normative Values¹²

Schirmer score	Normal ≤ 10 mm Abnormal < 10 mm in 5 min
TBUT	Mild: ≤ 10 sec Moderate: ≤ 5 sec Severe: immediate

Table 3. Prevalence of Non-Strabismic Binocular Vision Anomalies

	Frequency	Percent
Accommodative excess	55	22.3%
Accommodative insufficiency	24	9.7%
Accommodative infacility	1	0.4%
Basic esophoria	2	0.8%
Convergence excess	4	1.6%
Convergence insufficiency	23	9.3%
Divergence insufficiency	5	2%
Fusional vergence dysfunction	6	2.4%
Ill-sustained accommodation	3	1.2%

To assess the prevalence of non-strabismic binocular vision anomalies (NSBVA), data was compared to norms reported by Scheimann and Wick (Table 1).¹¹ Dry eye data was compared to normative values for the Schirmer test and tear break-up time (Table 2).¹²

Statistical Analysis

All data were analyzed using Statistical Package for Social Sciences (SPSS) software, version 23.00. Descriptive data were presented as percentages or as mean and standard deviation. Chi-square was performed to assess the association between symptoms and CVS, and the Z-test was performed to compare dry eye in engineering and nursing students. Pearson’s correlation was performed to find the correlation between hours of computer use per day and CVS.

Results

In the study, 247 students ages 17-35 years (mean: 26) were evaluated. Of these participants, 62 (25.10%) were male and 185 (74.9%) were female. Of the 4 colleges, 3 were nursing and 1 was engineering.

- The prevalence of CVS among engineering and nursing students was 86.11% and 84.17%, respectively.
- Of 62 male students, 49 (79.03%) had CVS, and of 185 female students, 161(87.03%) had CVS.



Figure 1. Association between hours of computer usage per day and computer vision syndrome

Table 4. Comparison of NSBVA Between Engineering and Nursing Students

	Engineering	Nursing
Accommodation Excess	23.14%	21.58%
Accommodative insufficiency	11.11%	8.63%
Accommodation Infacility	0.93%	0%
Basic Esophoria	0.93%	0.72%
Convergence Excess	0%	2.88%
Convergence Insufficiency	10.19%	8.63%
Divergence Insufficiency	3.70%	0.72%
Fusional Vergence Dysfunction	2.78%	2.16%
Ill sustain accommodation	2.78%	0%

- There was no statistically significant association between an increase in the number of hours of computer usage per day and CVS (Figure 1). The prevalence of specific NSBVAs was: accommodative excess (22.03%), accommodative insufficiency (9.7%), convergence insufficiency (9.3%), fusional vergence dysfunction (2.4%), divergence insufficiency (2.00%), convergence excess (1.6%), ill-sustained accommodation (1.2%), accommodative infacility (0.4 %), and basic esophoria (0.8%) (Table 3).
- Comparison of NSBVA between engineering and nursing students (Table 4).
- Of 108 engineering students, 80 (74.07%) had mild dry eye, and 12 (11.11%) had moderate dry eye. Of 139 nursing students, 83 (59.71%) had mild dry eye, 20 (14.38%) had moderate, and 1 (0.71%)

Table 5. Dry Eye Severity in Engineering & Nursing Students

TBUT	Overall	Engineering	Nursing
Mild	65.58%	74.07%	59.71%
Moderate	12.95%	11.11%	14.38%
Severe	0.40%	0%	0.71%

Table 6. Grades of Symptoms Associated with Computer Vision Syndrome

	Overall	Engineering	Nursing
Mild	82.59%	84.26%	81.29%
Moderate	11.33%	6.48%	15.10%
Severe	0.80%	0.92%	0.71%

had severe dry eye (Table 5). The difference in average TBUT between engineering and nursing was found to be statistically significant ($P < 0.01$), showing that engineering students have lesser tear film stability as compared to nursing students.

- Overall, 82.59% of the students had mild CVS symptoms, 11.33% had moderate symptoms, 0.80% had severe symptoms, and 5.28% were asymptomatic. In engineering students, 84.26% had mild symptoms of CVS, 6.48% had moderate symptoms, 0.92% had severe symptoms, and 8.34% were asymptomatic. In nursing students, 81.29% had mild symptoms of CVS, 15.10% had moderate symptoms, 0.71% had severe symptoms, and 2.90% were asymptomatic. The p value (< 0.05) of grades of symptoms associated with computer vision syndrome between engineering and nursing students showed statistical significance (Table 6).

Discussion

As CVS is a growing problem, it is very important to know about the populations at highest risk in order to ensure diagnosis and management as early as possible. Timely diagnosis of the condition can improve the prognosis of CVS.

Previous studies were carried out based on a questionnaire without clinical evaluation,^{1,4,13} but the current study included a questionnaire, clinical binocular vision assessment, and dry eye assessment. In the current study, the prevalence of CVS was found to be 85.03%. The differences in the prevalence rates of computer-related problems in various studies depend on factors like workstation environment, the degree of immobilization and levels of constrained postures, awareness levels, and practices of workers regarding computer ergonomics. On the other hand, musculoskeletal symptoms have a cumulative effect on patients, with the initial symptoms being mild and temporary, becoming more intense and permanent in nature.¹³ It is evident that computer-related morbidity has become an important occupational health problem and is a matter of great concern.⁷

This study has also brought into focus factors contributing to these problems. The high prevalence makes it imperative to take serious note and for all concerned parties to collaborate and enforce suitable preventive measures. Relevant and necessary knowledge about ergonomics is crucial. The current study showed that there was no statistically significant association between the number of hours of computer use per day (average 4.67) and CVS. Previous studies have shown that students with good visual hygiene were at lower risk of developing symptoms of CVS as compared to those students who did not take breaks during working hours.¹⁴ An Australian study of 1000 computer workers showed a reduction in the symptoms of asthenopia by optimizing desk ergonomics and taking frequent work breaks.¹⁴ Taking short breaks of 5 min for every hour has been shown to decrease discomfort (eye and musculoskeletal) while not impeding productivity.¹⁵ Many studies recommend frequent breaks to avoid CVS,^{16,17} although Brewer et al.¹⁸ in their systemic review concluded that the evidence was insufficient to conclude that rest breaks have an effect on visual outcomes. CVS symptoms have been found not to vary significantly with age or cigarette smoking.⁹

Dry eye assessment

In our study, the prevalence of dry eye was 78.9%, which was higher compared to the study done by Shah in India.¹⁹ The overall prevalence of dry eye in that study was 54%. The prevalence of CVS can vary due to outdoor work, indoor work in air conditioning, the presence of meibomian gland dysfunction, previous ocular surgery, smoking, extreme cold or hot weather conditions, low relative humidity, contact lens wear, and certain medications.^{20,21}

Binocular vision assessment

In the current study, the overall prevalence of NSBVA was 49.8%. The major problem was accommodative excess, followed by convergence insufficiency. Repetitive visual demands result in eye strain, which in turn results in less-accurate vision, reduction in speed and comprehension in reading and other visual tasks, headache, disorientation, and reading difficulties.²¹ In a study done by Richman et al.,²² the overall prevalence of NSBVA was 42%, which is consistent with our study finding.

Questionnaires

The most common symptoms presented by the students were headache, followed by blurred vision, dry eye, and neck and shoulder pain.

Headache

In our study, 79.6% of nursing and 63% of engineering students reported headaches. Several previous studies have shown that headache is one of the symptoms presented by many computer users. Bali et al.²³ reported that 82.1% of their study population complained of headache, whereas Logaraj et al.⁴ reported that 43.3% of medical and 45% of engineering students sustained headaches, respectively. A similar study to the present one by Sen and Richardson et al.²⁴ reported a headache prevalence of 61%. Lower prevalence of headache was reported by Talwar et al.²⁵ and Kesavachandra et al.²⁶ (29.9% and 17%, respectively). Most of the nursing students were female, and estrogen has been linked to headaches in females.²⁷ Both the introduction and withdrawal of these hormones, either naturally (during a woman's monthly cycle) or artificially (by starting or stopping estrogen-containing medications), can trigger headaches.²⁷ Females are more likely to experience migraine and other kinds of headaches around the time of menstruation.

Blurred vision

In the current study, 51.8% of nursing and 44.4% of engineering students reported blurred vision. Studies by Logaraj⁴ and Talwar et al.²⁵ reported the prevalence of blurred vision to be 31.6% and 13.2%, respectively. Reddy et al. showed the prevalence of blurred vision to be 10.2%.¹ Blurred vision may result from nearsightedness or farsightedness that requires corrective lenses, or it may be due to binocular vision or accommodative issues.

Dry eyes

Overall, 87.09% of male participants and 78.37% of female participants reported dry eyes while using a computer. A study by Logaraj showed that around 18.6% of females and 30% of males reported dry eyes following computer use.⁴ The current study showed that there was a statistically significant difference in the prevalence of dry eyes between engineering and nursing students, indicating that the engineering students were at greater risk of developing dry eyes compared to the nursing students. This could be due to the use of computers, smart phones, and/or tablets for a greater number of hours by engineering students, causing a reduction in blink rate resulting in dry eye.

Neck and shoulder pain

Approximately 62% of the students reported neck and shoulder pain after prolonged computer use. This is supported by Diepenmaat et al.,²⁸ who also found

the level of symptoms to be 62%. The current study revealed that males had fewer symptoms of neck and shoulder pain compared to females.

Eyestrain

In the present study, 40% of the participants were mildly affected, 15% were moderately affected, 3% were severely affected, and the rest were asymptomatic. Blink rate is significantly decreased during prolonged computer use. As a result, the blinking mechanism is severely affected; fewer tears are produced, resulting in asthenopia.

Tired eyes

The current study found that 38% were mildly affected, 21% were moderately affected, 2% were severely affected, and the remaining were asymptomatic.

Asthenopia

In this study, 33% of the students were mildly affected, 9% were moderately affected, only 2% were severely affected, and the rest were asymptomatic. Asthenopia usually results from improper rest of the eyes and decreased blink rate due to overuse of computers and smart phones/tablets, usually at night.

Lighting or glare discomfort

Lighting or glare discomfort is often the result of the scattering of light. In CVS, the tear film is disturbed due to a decreased blink rate, making the ocular surface dry and causing the scattering of light. Thus, more dryness means more scattering. As a result, the cornea becomes more sensitive to light, and the patient will have lighting and glare discomfort. As per the current study, 35% were mildly affected, 13% were moderately affected, 3% were severely affected, and the rest were asymptomatic.

Backache

In this study, 39% were mildly affected, 18% were moderately affected, 5% were severely affected, and the rest were asymptomatic. This may be due to improper positioning of a computer screen or desk and also the use of inappropriate chairs. Reading in bed from devices also causes significant problems.

Conclusion

The present study revealed a high prevalence of CVS among students; more than three-fourths of the students were symptomatic. The current study showed that engineering students were at higher risk of developing CVS compared to nursing students. There was no association between greater numbers of hours of computer use with CVS. Extended computer

use causes temporary ocular discomfort, which reduces the efficiency and productivity of work and thereby quality of life. Therapeutic regimens need to be developed for this widespread condition.

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Computer Vision Syndrome (CVS) Questionnaire Assessment Form

Name:

Serial Number:

Age:

Class:

Part 1 symptom assessment

Please circle whether or not (Y or N) you experience each of the following symptoms. For each Y answer, circle the appropriate number for the severity of the symptom.

Visual:

Y N Eyestrain Mild Moderate Severe
If YES, rate: Severity 1 2 3 4 5 6 7 8 9 10

Y N Tired eyes Mild Moderate Severe
If YES, rate: Severity 1 2 3 4 5 6 7 8 9 10

Y N Headache Mild Moderate Severe
If YES, rate: Severity 1 2 3 4 5 6 7 8 9 10

Y N Irritated/sore eyes Mild Moderate Severe
If YES, rate: Severity 1 2 3 4 5 6 7 8 9 10

Y N Dry eyes Mild Moderate Severe
If YES, rate: Severity 1 2 3 4 5 6 7 8 9 10

Y N Lighting or glare discomfort Mild Moderate Severe
If YES, rate: Severity 1 2 3 4 5 6 7 8 9 10

Y N Blurred vision Mild Moderate Severe
If YES, rate: Severity 1 2 3 4 5 6 7 8 9 10

Physical:

Y N Neck or shoulder ache Mild Moderate Severe
If YES, rate: Severity 1 2 3 4 5 6 7 8 9 10

Y N Backache Mild Moderate Severe
If YES, rate: Severity 1 2 3 4 5 6 7 8 9 10

Y N Hand or wrist ache Mild Moderate Severe
If YES, rate: Severity 1 2 3 4 5 6 7 8 9 10

Hours per day of VDT viewing:

Y = Yes

N = No