DOI: 10.7860/JCDR/2026/81129.22566

Original Article

Ophthalmology Section

Computer Vision Syndrome in Digital Era: A Cross-sectional Study on its Prevalence, Risk Factors and Protective Behaviours among Young Adults

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ABSTRACT

Introduction: The increasing use of digital screens among young adults has led to a surge in cases of Computer Vision Syndrome (CVS), a condition characterised by eye and vision problems related to prolonged screen exposure.

Aim: To determine the prevalence of CVS and assess associated risk factors and protective measures for preventing CVS among young adults.

Materials and Methods: A cross-sectional clinical study was conducted among 166 individuals aged 21-30 years with significant daily screen time at Smt. B. K. Shah Medical College, Dhiraj Hospital, Vadodara, Gujarat, India, from October 2022 to December 2023. Participants underwent a comprehensive ophthalmic evaluation, including assessment of CVS-related symptomatology, Schirmer's I and II tests, Tear Break-Up Time (TBUT), and visual acuity testing. Data regarding screen use, symptoms, and break habits were collected and analysed using Fisher's exact test and the Chi-square test. A p-value of <0.05 was considered statistically significant.

Results: A total of 166 participants aged between 21 and 30 years were enrolled in the study. The mean age of the participants was 25±3 years, with a male-to-female ratio of approximately 1:0.64. Common symptoms of CVS included dryness, burning sensation, and blurred vision. The prevalence of CVS was observed in 121 participants (72.89%). Associated risk factors included prolonged screen time (>4-6 hours) and inadequate break intervals. Approximately 65.66% of participants took breaks of more than one minute per hour. Protective measures included taking sufficient breaks of ≥20 seconds every 20 minutes (i.e., ≥1 minute per hour).

Conclusion: CVS is highly prevalent among young adults with extensive screen exposure, with dry eye and blurred vision being the most common complaints. Preventive strategies such as frequent breaks, ergonomic adjustments, and regular ophthalmic evaluations are essential.

Keywords: Break-time, Dry eye, Ergonomics, Screen time, Vision problems

INTRODUCTION

With the widespread adoption of digital technology, screen-based devices such as computers, smartphones, and tablets have become integral to modern daily life. Young adults, in particular, rely heavily on these devices for academic, occupational, and recreational purposes. Although digitalisation has enhanced accessibility, productivity, and communication, it has simultaneously introduced new health challenges—most notably, CVS [1]. According to the American Optometric Association, CVS refers to a spectrum of eye and vision-related problems resulting from prolonged use of digital screens [1]. It is characterised by a combination of ocular and extraocular symptoms, including eye strain, dryness, blurred vision, burning or itching sensations, headaches, and musculoskeletal discomfort involving the neck and shoulders. These symptoms are primarily attributed to reduced blink rate during screen use, glare, poor ergonomics, uncorrected refractive errors, and excessive near work [2,3].

Recent literature has demonstrated that CVS has become a major occupational and lifestyle-related health issue among frequent digital device users. A 2023 systematic review and meta-analysis involving 66,577 participants reported a global pooled prevalence of CVS of approximately 69%, with university students and young professionals representing the most affected subgroups [4]. Similarly, studies among office workers and students in developing countries have documented prevalence rates ranging from 50% to over 90%, depending on screen time duration, ergonomic practices, and awareness levels [5,6].

Understanding the prevalence, risk factors, and preventive strategies for CVS is therefore crucial for timely intervention and the promotion of digital eye health. Previous studies have shown that the prevalence of CVS varies widely across populations and is influenced by factors such as screen time duration, posture, lighting conditions, and individual ocular health [3,7,8]. However, data focusing on young adults in clinical settings remain limited. As this age group is often overlooked despite high screen usage, identifying CVS prevalence and risk factors in this population is essential for early prevention and effective management [9].

This study aimed to determine the prevalence of CVS, identify associated risk factors and ocular manifestations, and evaluate preventive measures to minimise the impact of CVS among young adults.

MATERIALS AND METHODS

This cross-sectional clinical study was conducted in the Department of Ophthalmology at Smt. B. K. Shah Medical College, Dhiraj Hospital, Sumandeep Vidyapeeth, Vadodara, Gujarat, Western India. A total of 166 individuals aged 21-30 years with significant daily screen exposure (>4 hours/day) were recruited after obtaining written informed consent. The study was conducted between October 2022 and December 2023 following approval from the Institutional Ethics Committee (IEC) (Certificate No. SVIECON/Medi BNPG 21/Sep/22/43).

Inclusion criteria: Individuals aged between 21 and 30 years, having daily screen time of approximately 4 hours or more, and without any pre-existing ocular pathology or systemic illness affecting vision were included in the study.

Exclusion criteria: Individuals using ocular medications, with a history of refractive surgery, presence of ocular surface disease, or

systemic illness affecting tear production were excluded from the study.

Sample size: The sample size was calculated using the formula:

$n=(Z^2 \times P \times (1-P))/e^2$

Where:

Z= value from standard normal distribution corresponding to desired confidence level (Z=1.96 for 95% CI)

'P' is expected true proportion

'e' is the desired precision (half desired CI width).

Calculation: (P is taken 88% from similar study done by Noonari MH et al., [10])

P=0.88, So, 1-P=0.12

e=0.05, So, e^2=0.0025

Z=1.96, So, Z^2=3.8416

Putting all this in formula,

n={3.8416×0.88 (1-0.88)}/0.0025

So, n=(3.8416×0.1056)/0.0025

=0.4055/0.0025

=~162.3

So, a total of 166 patients were enrolled.

Ophthalmic evaluation: Each participant underwent a detailed symptomatology assessment using specific questions related to visual acuity, burning or itching sensation, watering, foreign body sensation, excessive blinking, pain, heaviness, blurring of vision, double vision, dryness, photophobia, headache, etc., along with the frequency of each symptom (always, occasionally, or never). All participants were evaluated for visual acuity using Snellen's chart. Tear production was assessed using Schirmer's I and II tests [11,12], while tear film stability was evaluated using the Tear Break-Up Time (TBUT) test [13,14]. A comprehensive slit-lamp examination and fundus examination were also performed.

Schirmer's I and II Test: Normal Reference Values [11,12]:

>15 mm wetting → Normal tear production

10-14 mm → Borderline

5-9 mm → Dry eye (abnormal)

<5 mm → Severe dry eye

Tear Break-Up Time (TBUT): Normal Reference Values [13,14]:

>15 seconds → Normal tear film stability

10-14 seconds → Borderline

5-9 seconds → Abnormal (tear film instability, suggestive of dry eye)

<5 seconds → Severe instability

There is no single objective test (such as a specific laboratory result or imaging finding) that definitively diagnoses CVS. The diagnosis is multifactorial and is based on demographic factors, ergonomic practices, screen time duration, break habits, and symptomatology.

Data collection: Participants completed a structured proforma that included demographic details, screen usage patterns, break habits, and symptom frequency.

STATISTICAL ANALYSIS

Data were entered and analysed using Microsoft Excel 365 software (Microsoft Office 2024). Descriptive statistics were used to calculate frequencies and percentages. Fisher's exact test and Chi-square test were applied to evaluate associations between screen habits and clinical findings. A p-value of <0.05 was considered statistically significant.

RESULTS

A total of 166 participants aged between 21 and 30 years were enrolled in the study. The mean age of the participants was 25±3 years, with a male-to-female ratio of approximately 1:0.64. The demographic characteristics of the study participants are shown in [Table/Fig-1]. Common symptoms of CVS included dryness, burning sensation, excessive blinking, watering and blurred vision [Table/Fig-2].

Characteristic	n (%)
Age group (years)	
21-25	95 (57.23)
26-30	71 (42.77)
Gender	
Male	102 (61.44)
Female	64 (38.56)
Educational status	
Undergraduate	64 (38.56)
Postgraduate	66 (39.75)
Others	36 (21.69)

[Table/Fig-1]: Demographic characteristics of study participants.

Symptoms	Always n (%) (n=166)	Occasionally n (%) (n=166)	Never n (%) (n=166)
Burning/Itching	27 (16.27)	117 (70.48)	22 (13.25)
Foreign body Sensation	8 (4.82)	91 (54.82)	67 (40.36)
Watering	39 (23.49)	71 (42.77)	56 (33.74)
Excessive blinking	37 (22.29)	92 (55.42)	37 (22.29)
Redness	27 (16.27)	73 (43.98)	66 (39.76)
Pain/Heaviness	11 (6.63)	57 (34.34)	98 (59.04)
Blurred vision	16 (9.64)	76 (45.78)	74 (44.58)
Double vision / Near focus issue	14 (8.43)	38 (22.89)	114 (68.68)
Photophobia/ halos	7 (4.22)	26 (15.66)	133 (80.12)
Headache	9 (5.42)	101 (60.84)	56 (33.74)
Dryness	29 (17.47)	112 (67.47)	25 (15.06)

[Table/Fig-2]: Symptoms of presentation of CVS.
Total prevalence of CVS was 72.89% of the total sample or 121 participants

Schirmer's Test Findings [6,7]

Schirmer's I test revealed normal tear production (>15 mm in 5 minutes) in only 7 participants (4.22%). Schirmer's II test showed that 147 participants (88.55%) had mildly reduced tear production (<14 mm), indicating impaired basal tear secretion, whereas the remaining 19 participants (11.45%) had normal tear production. A total of 119 participants (71.69%) demonstrated moderate tear film instability with TBUT values between 5-10 seconds. Severe tear film instability (TBUT <5 seconds) was observed in 31 participants (18.67%) [Table/Fig-3].

	Normal n (%) n=166	Mild n (%) n=166	Moderate n (%) n=166	Severe n (%) n=166
Schirmer I Test	7 (4.22)	71 (43.07)	88 (52.71)	0
Schirmer II Test	19 (11.45)	147 (88.55)	0	0
Tear Break-up Time (TBUT)	16 (9.64)	119 (71.69)	31 (18.67)	0

[Table/Fig-3]: Schirmer's Test and TBUT among participants.

Visual Acuity Assessment

Fifty-four participants (32.53%) had mildly reduced visual acuity (BCVA of 6/9) in at least one eye. The remaining 112 participants (67.47%) had BCVA of 6/6 but reported symptoms consistent with CVS.

Screen Habits and Breaks

As per the inclusion criteria, all participants reported screen exposure of more than 4 hours per day. A total of 109 participants (65.66%) reported taking breaks of more than one minute per hour, following the 20-20-20 rule (a 20-second break every 20 minutes by looking 20 feet away from the screen). These participants exhibited a lower prevalence of dry eye symptoms. In contrast,

57 participants (34.34%) who took irregular or no breaks had significantly higher rates of dry eye symptoms. Fisher's exact test revealed a statistically highly significant association (p-value <0.001) [Table/Fig-4].

Breaks (20-20-20 rule)	Dry eye symptoms present	Dry eye symptoms absent	Total
Regular breaks (>1 min/hr)	72 (43.37%)	37 (22.29%)	109 (65.66%)
Irregular/no breaks	49 (29.51%)	8 (4.81%)	57 (34.34%)
Total	121 (72.89%)	45 (27.11%)	166 (100%)

[Table/Fig-4]: Association between breaks (20-20-20 rule) and dry eye symptoms.
*Statistical test: Fisher's exact Test, p-value <0.001** (highly significant)

[Table/Fig-5] demonstrate the association between prolonged screen time and CVS. Of the 166 participants, 121 (72.89%) exhibited CVS symptoms. The likelihood of developing CVS increased with longer screen exposure. Chi-square analysis showed a statistically highly significant association between increased screen time and CVS (p-value <0.001).

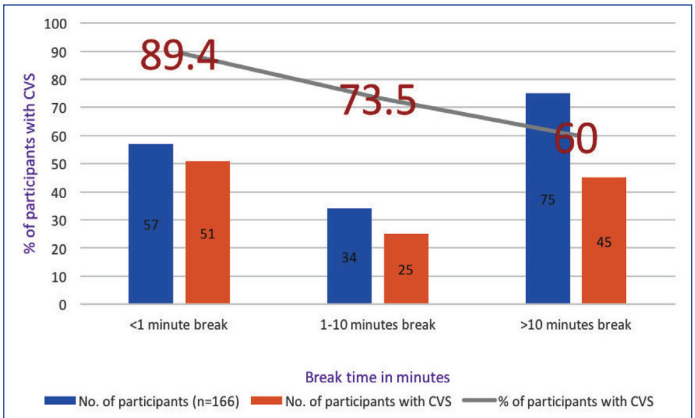
Screen time (hours)	With CVS	Without CVS	Total
≤4	15 (9.03%)	14 (8.43%)	15 out of 29 (51.72%)
4-6	52 (31.32%)	28 (16.86%)	52 out of 80 (65%)
>6	54 (32.53%)	3 (1.8%)	54 out of 57 (94.73%)
Total	121 (72.89%)	45 (27.11%)	166 (100%)

[Table/Fig-5]: Association between screen time and CVS.
Statistical test: Chi-square p-value <0.001**

[Table/Fig-6,7] depict the association between break duration and CVS. The findings indicate that CVS prevalence and severity decrease with increasing break duration. Participants who took longer breaks (>10 minutes) had significantly fewer CVS symptoms compared to those with shorter or no breaks. Chi-square analysis confirmed a statistically highly significant association between break duration and CVS symptoms (p-value <0.001).

Break time	No. of participants n (%)	No. of participants with CVS n (%)
<1 minute break	57 (34.34)	51 (30.72)
1-10 minutes break	34 (20.48)	25 (15.06)
>10 minutes break	75 (45.18)	45 (27.10)
Total	166 (100)	121 (72.9)

[Table/Fig-6]: Association between break time and CVS.
Statistical test: Chi-square p<0.001** highly significant)



[Table/Fig-7]: Bar diagram showing association between break time and CVS.

51 participants out of 57 participants (89.4%) taking <1 minute break per hour showed symptoms of CVS, 25 participants out of 34 participants (73.5%) taking 1-10 minutes break per hour showed symptoms of CVS, 45 participants out of 75 participants (60%) taking > 10 minutes break per hour showed symptoms of CVS.

DISCUSSION

The present study demonstrates a high prevalence of CVS among young adults aged 21-30 years, with 72.89% of participants exhibiting symptoms. This finding was consistent with global data reporting CVS prevalence of approximately 69% among digital screen users [3], highlighting the growing burden of digital eye strain in the modern era. Dry eye symptoms (67.47%) and blurred vision (45.78%) were the most frequently reported complaints, aligning with the diagnostic criteria defined by the American Optometric Association [1]. Objective clinical assessments supported these findings, with more than 55% of participants demonstrating Schirmer's I and II test values indicative of low to moderate tear production, and over 90% showing tear film instability on TBUT testing. These observations are consistent with findings from similar clinical studies [15,16].

Mild reduction in visual acuity (BCVA 6/9) was observed in 32.53% of participants, underscoring the transient yet clinically significant visual disturbances associated with prolonged digital screen exposure [17,18]. Furthermore, symptom prevalence and severity increased with longer screen time, with 94.73% of individuals using screens for more than 6 hours daily reporting CVS symptoms, compared to 51.72% among those with approximately 4 hours of screen exposure. This finding reinforces a clear dose-response relationship between screen time duration and CVS development [5,19]. Behavioural modifications, particularly adherence to the 20:20:20 rule, were strongly associated with reduced symptom severity and improved tear film parameters. This supports existing recommendations in the literature advocating scheduled breaks during prolonged screen use [2,20].

Present study findings are comparable to a clinical study conducted in Malaysia, which reported an 89.9% prevalence of CVS and identified tear film instability, prolonged screen exposure, and reduced blink rate as key contributing factors [15]. A review of cross-sectional studies among European populations similarly reported an average CVS prevalence exceeding 50% [3]. Additionally, a cross-sectional study in African populations demonstrated a CVS prevalence of 73%, with higher rates observed among females and contact lens users [21]. Several studies focusing on younger populations (<40 years) further corroborate present study results, indicating that screen time exceeding 4-5 hours per day and poor ergonomic practices significantly exacerbate CVS symptoms. Notably, these studies also reported that blue-light-blocking lenses do not provide measurable clinical benefit [22-24].

Overall, the data suggest that both tear quantity and tear quality are compromised in CVS, emphasising the clinical utility of Schirmer's and TBUT tests as screening tools in individuals with significant digital screen exposure. Public health initiatives and occupational guidelines should prioritise education on scheduled breaks, ergonomic optimisation, appropriate lighting conditions, and regular ophthalmic evaluations. Importantly, some commonly used protective measures, such as blue-light filters and over-the-counter eye drops, lack strong scientific evidence and may detract from more effective preventive strategies [25,26].

Limitation(s)

As a cross-sectional, single-centre study, this research cannot establish a causal relationship between screen exposure and CVS. Additionally, reliance on self-reported data for screen usage and break habits may introduce recall bias. The limited sample size and single-institution setting may also restrict the generalisability of the findings. Future longitudinal, multicentre studies incorporating objective screen-usage monitoring and controlled interventions—such as ergonomic optimisation and blink-reminder systems—are recommended to better elucidate causal mechanisms and evaluate intervention efficacy.

CONCLUSION(S)

The CVS is a prevalent and under-recognised ocular condition among young adults with high digital screen exposure. Dry eye symptoms and visual disturbances are the most common clinical manifestations, and both screen usage patterns and protective behaviours significantly influence symptom severity. Regular ophthalmic evaluations, increased public awareness, and promotion of effective preventive strategies—particularly adherence to the 20:20:20 rule—are essential to mitigate the growing burden of CVS in the digital age.

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PLAGIARISM CHECKING METHODS: [Jain H et al.]

- Plagiarism X-checker: Jun 20, 2025
- Manual Googling: Nov 15, 2025
- iThenticate Software: Nov 18, 2025 (6%)

ETYMOLOGY: Author Origin

EMENDATIONS: 9

AUTHOR DECLARATION:

- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. NA

Date of Submission: **Jun 15, 2025**
Date of Peer Review: **Aug 27, 2025**
Date of Acceptance: **Nov 20, 2025**
Date of Publishing: **Mar 01, 2026**