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Research Article

Investigating the Association of Computer Vision Syndrome with Forward-Headed and Kyphotic Posture among Undergraduate Information Technology Student

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ABSTRACT

Introduction: Computers and visual display devices have become indispensable in our daily lives. The frequent use of these devices has led to the emergence of computer vision syndrome (CVS). Coupled with poor ergonomics, musculoskeletal diseases are on the rise due to excessive computer use. Accordingly, this study investigates the association between CVS and forward-headed and kyphotic posture in undergraduate IT students.

Materials and Methods: We conducted an observational cross-sectional study involving 300 undergraduate IT students. We used a modified CVS questionnaire to assess CVS and the Kinovea software to diagnose forward head posture. We also used the occiput wall distance test to assess kyphosis.

Results: In this study, a majority of undergraduate students (88%, 264 out of 300) exhibited CVS, resulting in forward head posture and kyphosis. There was a significant association between CVS, forward head posture, and kyphosis.

Conclusion: Computer vision syndrome is strongly associated with forward head posture and kyphosis. Prolonged computer device usage leads to changes in body posture, affecting the neck, shoulders, elbows, wrists/hands, upper back, and lower back.

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Introduction

Computer vision syndrome (CVS) refers to a collection of vision-related symptoms caused by prolonged digital device usage. Work-related musculoskeletal disorders are common among computer users, primarily due to incorrect posture and poor ergonomic work setups [1]. Forward-head posture (FHP), the forward displacement of the head on the cervical spine, is frequently associated with neck pain among computer users [2]. Proper computer screen placement is essential for preventing neck and lower back pain. Prolonged computer use without proper posture and ergonomics can lead to tight pectoralis minor muscles, protracted scapula, and reduced cervical range of motion [3, 4]. Work-related musculoskeletal disorders develop in tendons, muscles, nerves, and other soft tissues due to repetitive actions, prolonged improper posture, stressful work, long working hours without breaks, and ergonomic deficiencies [5]. Forward neck posture weakens the deep flexor muscles of the cervical spine, reducing neck stability and causing neck pain [6]. Mechanical neck discomfort has been linked to reduced activity in the longus colli and longus capitis muscles [7]. CVS affects up to 70% of computer users and is a significant occupational hazard in the 21st century, with approximately 60 million cases worldwide and a million new cases diagnosed annually [8]. Individuals who use computers for more than 3 h a day experience CVS symptoms approximately 90% of the time [9]. CVS is also referred to as visual fatigue and digital eye strain, highlighting its connection to various health issues related to digital devices. CVS symptoms encompass visual, ocular, and extraocular symptoms. Vision symptoms include diplopia, visual fatigue, discomfort, and blurred vision [10]. Dry eye symptoms include redness, eye strain, and discomfort. Extraocular symptoms encompass headaches, shoulder, neck, and back pain, along with wrist and finger pain, all categorized as musculoskeletal symptoms of CVS [11]. Neck pain is a common condition with 43% to 66.7% of people experiencing it at some point in their lives. Impaired cervical proprioception and FHP in computer users may contribute to neck pain [12]. The craniovertebral (CV) angle is a practical clinical measure for evaluating cervical position [13]. Research indicates that a CV angle of less than 50° in the sagittal plane is pathogenic for FHP [14]. Changes in the vertebrae lead to an increase in the thoracic kyphosis angle. The normal range for thoracic kyphosis is 20° to 40° with values below 20° indicating hypo kyphosis (flat back) and values exceeding 40° indicating hyper-kyphosis [15]. Kyphosis refers to a sagittal spinal alignment distortion, often encountered today due to sustained flexion postures and age-related degeneration [16]. The occiput-wall distance (OWD) test is a useful tool for detecting thoracic kyphosis [17]. Maintaining proper sitting posture and an ergonomic workstation design are essential for preventing musculoskeletal discomfort [18]. A cross-sectional study in Bangalore revealed a high prevalence of arm, neck, and shoulder complaints among computer professionals [19]. A similar study in Pakistan found that computer workers, particularly women, commonly experience symptoms in the arm, neck, and shoulders due to sitting posture [18]. Another study identified upper back pain as a common issue related to kyphosis [18]. While various studies have explored CVS and its effects, none have investigated the correlation between CVS and FHP with kyphosis [20]. Postural imbalances, such as forward head and kyphosis, can lead to complications, including respiratory problems in old age. Accordingly, this study examines the association between CVS and forward-headed and kyphotic posture in IT undergraduate students in Hyderabad, India.

Materials and Methods

We conducted a cross-sectional observational study in January 2023, involving 300 undergraduate IT students, to investigate the association of CVS with FHP and kyphosis. We calculated the sample size using the Rao soft calculator with a 95% confidence interval and employed a systemic random sampling technique for data collection. The participants aged 18-25 years who were undergraduate IT students and regular users of smart devices. We utilized a modified CVS questionnaire with the following three sections: Visual symptoms, neck pain, and upper back pain, rated on a 6-point ordinal scale (scores ranging from 0-5). A score of 0 indicated no symptoms, while a score of 5 indicated very intense symptoms. To assess FHP, we measured the CV angle, and for kyphosis evaluation, we used the occiput wall distance test. The participants received detailed information about the study and provided written consent to participate. The occiput wall distance test demonstrated excellent rater reliability (intraclass correlation coefficient [ICC] >0.9, P<0.001), with sensitivity and specificity values of 71.4% and 76.6%, respectively [20]. We employed frequency tables to determine the association between CVS, forward-headed posture, and kyphotic posture in IT undergraduate students in Hyderabad. All statistical analyses were conducted using the SPSS software, version 26.0.

Figure 1. Participant's measurement of the craniovertebral angle

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Study procedures

Craniovertebral angle measurement

To measure the CV angle, we asked the participants to sit on a stool with their feet flat on the ground. We then captured a lateral view photograph using an iPhone 13 camera. The photograph was imported into Kinovea software, version 0.8.15, where we drew a horizontal line passing through the ear tragus and C7 spinous process, forming a right angle with the vertical line to calculate the CVA (Figure 1). The participants were categorized into three groups as follows: Minimal or non-FHP (≥55º), moderate FHP (50º-54º), and severe FHP (<50º) [21]. We measured the CVA using the Kinovea software, version 0.8.15 [22].

Occiput to wall distance test

To conduct the occiput-to-wall distance test, the participants were instructed to stand as upright as possible, ensuring that their heels, sacrum, and back were pressed firmly against the wall. Additionally, they were instructed to align their upper and lower orbital and auditory meatus margins on a horizontal plane. Using rulers, we measured the perpendicular distance between the bony prominence of C7 and the wall (Figure 2). Three separate trials of this measurement were performed, with sufficient downtime between trials. The average distance from the three trials was then calculated. An occiput-to-wall distance value exceeding 2 cm was considered abnormal [23].

Statistical analysis

The data were analyzed using the SPSS software, version 26.0. Descriptive statistics of frequency and percentage were used to interpret the results.

Table 1 presents key findings from the study. The mean age of the participants was 23.2 years, with a standard deviation of 1.2 years. On average, the participants had been engaged in their current work for 3 years and three months and spent approximately 7 h a day using digital devices. The mean occiput wall distance test result was 3.6, indicating an abnormality, while the mean CV angle was 47.8 degrees. The majority of students were right-handed (95.3%), and some used an antiglare screen (17.3%) or artificial tear drops (5.3%).

Table 1 also provides information on the frequencies and percentages of visual symptoms reported by participants. The most common visual symptoms included watery eyes (58%), dry eyes (52.3%), pain behind the eyes (55.3%), itchy eyes (56%), tired eyes (61%), eye redness (57%), and headaches (58%). Additionally, a significant portion of participants reported blurred vision (54.6%) and burning eyes (56.3%).

Regarding kyphotic posture, Table 1 shows that the majority of participants (87.4%) had kyphotic posture, with varying degrees of severity: Mild (47.3%), moderate (31.6%), and severe (8.3%). There was a statistically significant correlation between kyphosis and CVS

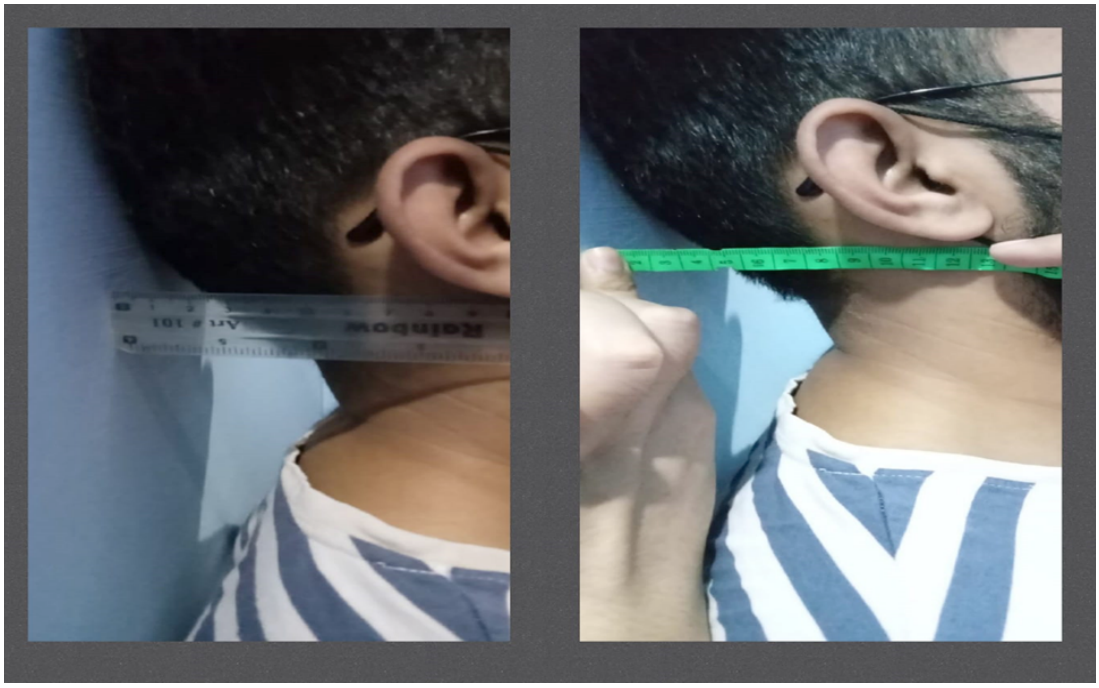

Figure 2. Participants' measurement of the occiput wall distance test

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(odds ratio [OR]=2.2, P=0.03) as well as FHP (OR=3.1, P=0.001).

Table 2 displays the frequencies and percentages of reported pain in the locomotive organs among participants. Neck trouble was the most commonly reported issue (60.6%), followed by shoulder trouble (62.3%), elbow trouble (27.3%), wrist/hand trouble (46.3%), upper back trouble (35.3%), lower back trouble (53.3%), hip/thigh trouble (37.6%), knee trouble (35.6%), and ankle trouble (46%). More than half of the undergraduate students experienced low back pain, neck pain, and shoulder trouble, which impacted their work and leisure activities. The majority of those affected reported experiencing pain for 8 to 30 days over the past 12 months, with some experiencing pain for 7 days.

In this study, a significant majority of participants (87.7%) exhibited FHP. There was a notable correlation between FHP and kyphosis (OR=4.3, P=0.02) as well as CVS (OR=2.5, P=0.01).

Table 3 presents significant correlations between FHP and kyphosis with various factors. The odds ratios suggest that male students, those working more than 7 h a day, right-handed individuals, and users of artificial tear drops were correlated with FHP and kyphosis. Additionally, Table 4 indicates a significant association between CVS and various types of pain in the neck, shoulders, elbows, wrists/hands, upper back, and lower back (P=0.05).

Discussion

Modern life's heavy reliance on digital technology, particularly digital screens, has led to a heightened prevalence of CVS. This observational cross-sectional study explored the relationship between CVS and forward-headed and kyphotic posture among undergraduate IT students. The study's findings reveal a strong association between FHP and kyphosis with CVS, which negatively impacts the students' body posture.

The results also indicated that a significant portion of undergraduate students reported various visual symptoms, with CVS being more common in those who used computers for extended periods, typically more than 2 h continuously per day. In normal conditions, the head's center of gravity is positioned anterior to the atlanto-occipital joint, requiring minimal muscle activity to maintain a neutral head posture. However, in the case of FHP, muscle activity in the posterior neck region increases substantially as the head leans forward or shifts forward concerning the trunk in the sagittal plane [24]. FHP leads to alterations in the muscle-tendon unit length of the cervical extensors and flexors, affecting the atlanto-occipital joint and impeding the activity of the neck's superficial and deep stabilizing muscles. This often re-

Table 1. Participants' frequency and percentage of computer vision syndrome, visual symptoms, and kyphotic posture

Parameters	Mean±SD/No. (%)
Age (y)	23.2±1.2
Present work (year)	3.3±0.2
Per day work (h)	7.2±1.5
Occiput-to-wall distance test	3.6±1.8
Craniovertebral angle (degree)	47.8±6.1
Left-handed	14(4.6)
Right-handed	286(95.3)
Use of an antiglare screen	52(17.3)
Use of artificial tear drops	16(5.3)

Visual Symptoms	No. (%)
Watery eye	174(58)
Dry eye	157(52.3)
Pain behind eye	166(55.3)
Itchy eye	168(56)
Tired eye	183(61)
Eye redness	171(57)
Blurred vision	164(54.6)
Burning eye	169(56.3)
Headache	216(58)

Kyphotic Posture Severity	No. (%)
Normal	38(12.6)
Mild	142(47.3)
Moderate	95(31.6)
Severe	25(8.3)

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Table 2. Pain in locomotive organ

Pain		No. (%)
Trouble with neck	No	118(39.3)
	Yes	182(60.6)
Trouble with shoulder	No	113(37.6)
	Yes	187(62.3)
Trouble with elbows	No	218(72.6)
	Yes	82(27.3)
Trouble with wrists/hands	No	161(53.6)
	Yes	139(46.3)
Trouble with upper back	No	194(64.6)
	Yes	106(35.3)
Trouble with lower back	No	140(46.6)
	Yes	160(53.3)
One or both hips/thighs	No	187(62.3)
	Yes	113(37.6)
One or both knee	No	193(64.3)
	Yes	107(35.6)
One or both ankle	No	162(54)
	Yes	138(46)

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Table 3. Correlation of forward-head posture and kyphosis with various factors

Factors	Category	Odds Ratio		P
		Forward-Head Posture	Kyphosis	
Gender	Female	1 (Reference)	1 (Reference)	0.02
	Male	5.4	4.8	
Hours of work	<7 h	1	1	0.05
	>7 h	2.1	2	
Use of hand	Left hand	1	1	0.001
	Right hand	4.3	4.2	
Use of anti-glare screen	No	1	1	0.31
	Yes	1.3	1.1	
Use of artificial tear drops	No	1	1	0.001
	Yes	4.4	4.2	

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Table 4. Correlation of forward-head posture and kyphosis with various types of pain

Nordic Pain		Odds Ratio		P
		Forward-Head Posture	Kyphosis	
Trouble with neck	No	1 (Reference)	1 (Reference)	
	Yes	4.2	3.8	0.001
Trouble with shoulder	No	1	1	
	Yes	6.1	5	0.001
Trouble with elbows	No	1	1	
	Yes	3.1	3	0.04
Trouble with wrists/ hands	No	1	1	
	Yes	2.3	2.1	0.02
Trouble with upper back	No	1	1	
	Yes	4.4	4.2	0.001
Trouble with lower back	No	1	1	
	Yes	2.3	2.2	0.001
One or both hips/thighs	No	1	1	
	Yes	1.3	1.1	0.06
One or both knee	No	1	1	
	Yes	1.3	1.2	0.31
One or both ankle	No	1	1	
	Yes	1.2	1.1	0.22

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sults in hyperactivity of the sternocleidomastoid muscle compared to the longus colli muscle. People with FHP exhibit higher electrical activity in their neck muscles compared to those without FHP [25].

Tasks requiring close attention to detail have been found to cause increased contraction of the trapezius muscle in the neck and shoulder region [26]. Various methods exist for evaluating FHP, including observational assessments based on visually observing the head's position about reference anatomical landmarks [27].

The study's results also reveal a significant association between CVS and musculoskeletal discomfort in the neck, shoulder, elbows, wrists/hands, upper back, and lower back. More than half of the undergraduate students reported experiencing pain in these areas, which hindered their ability to perform both work and leisure activities. These students typically experienced pain for 8 to 30 days in the previous academic year, with some reporting pain every seven days.

These findings align with prior research conducted by Mohan et al. (2019), which focused on the prevalence of arm, neck, and shoulder complaints among computer professionals in Bangalore. That study found a 58.6% prevalence of complaints among professionals who use computers for work [19]. Similar studies conducted in Europe and Asia have reported incidence rates of com-

plaints of the arm, neck, and shoulders among computer users ranging from 54% to 64% [19].

Another study by Karacan et al. (2021) observed a significant relationship between thoracic kyphosis angle, Internet addiction, and the duration of Internet use [15]. Additionally, a study by Kashif et al. (2020) concluded that complaints of the arm, neck, and shoulders are common among office workers, particularly women, with age, work environment, and sitting positions being closely associated risk factors [18].

Conclusion

CVS is on the rise among undergraduate students, as computers have become an integral part of educational life for tasks such as finding relevant materials, preparing assignments, studying for exams, and watching videos. This study underscores the strong association between CVS, FHP, and kyphosis among IT students. Prolonged use of computer devices has led to changes in body posture and an increased incidence of discomfort in the neck, shoulders, elbows, wrists/hands, upper back, and lower back. These findings emphasize the importance of addressing ergonomics and promoting awareness of proper posture and eye care practices among IT students to mitigate the negative effects of prolonged computer use on their health and well-being.

Ethical Considerations

Compliance with ethical guidelines

The study was conducted after the approval of the Ethics Review Committee of Moomal Institute of Physiotherapy and Allied Health Sciences (MIPAHS). Written informed consent was taken from each participant before engagement in the study.

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Authors' contributions

Conceptualization and Design: Muhammad Haris Noonari; Data collection: Muhammad Haris Noonari, Sajida Bibi Noonari, Bakhtawar Samejo; Data analysis and Interpretation: Muhammad Haris Noonari, Sajida Bibi Noonari, Bakhtawar Samejo; Writing: Muhammad Haris Noonari, Sajida Bibi Noonari, Bakhtawar Samejo; Critical revision: Muhammad Haris Noonari, Sajida Bibi Noonari, Bakhtawar Samejo; Final approval: Muhammad Haris Noonari, Sajida Bibi Noonari, Bakhtawar Samejo.

Conflict of interest

The authors declared no conflict of interest.

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