

Computer-Related Visual Symptoms among Undergraduate Computer Users of Asian University for Women

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Abstract:

Objective: The objective of this study was to determine the prevalence of computer vision syndrome symptoms in a population of students and examined the association between these symptoms and both dry eye disease and other associated risk factors.

Method: A cross-sectional survey was conducted between January and February 2017 to quantify the prevalence and risk factors for computer vision syndrome and ocular surface disease in 110 undergraduate computer users of Asian University for Women (AUW), Bangladesh. The severity of the disease was measured via the Ocular Surface Disease Index (OSDI) questionnaire.

Results: Of 110 respondents, a total of 104 (94.5%) respondents reported the presence of CVS symptoms ‘at least some of the time’ during computer operation over a week. The most prevalent symptom was tired eyes, reported by 32.7% of subjects as occurring ‘at least half of the time’. A significant positive correlation was observed between the computer-related visual symptoms and the OSDI, a measure of dry eye. A significant positive correlation was observed between OSDI level and monitor distance (allowing reading the screen without leaning head, neck, or trunk forward / back), the type of refractive correction worn during computer use, and looking at far objects between work. Not adjusting the brightness/contrast setting of the computer/laptop monitor (OR=3, 95% CI=1.18-7.55), using a computer for a long time without taking any break (OR=3.13, 95% CI=1.39-7.04), and use of glasses as refractive correction (OR=2.97, 95% CI=1.23-7.28) were significantly associated with having a higher OSDI level. No significant association was found between the number of hours spent working on a computer and having a higher OSDI level.

Conclusion: A large number of undergraduate computer users reported having visual symptoms frequently. These symptoms are strongly associated with ocular surface disease. Preventive measures should be taken to reduce the high prevalence of CVS symptoms and ocular surface disease.

Keywords: Computer vision syndrome, dry eye, ocular surface disease.

1. Introduction

In the era of 21st-century usage of electronic devices by students in different institutions, universities, colleges, and at home has become a global phenomenon (File & Ryan, 2014). E-technologies used by students include cell phones, Android phones, 3G phones, iPads, PDAs, memory sticks/USBs, PCs, and laptops. The compelling reasons for university students using these devices are their involvement in research and academic assignments in or out of the classroom, communication, social networking, and entertainment, including games, music, and movies. The availability of these devices has increased in terms of cost and the variety of brands and quality. In addition, one of the reasons students use these devices is to keep up with peers in terms of fashion (Khan, 2012). However, using electronic devices also has disadvantages. It is believed that experiences of eye or vision-related symptoms are common among computer users (Aakre, 2007). Previous studies demonstrated that prolonged use of the computer is likely to lead to computer vision syndrome (CVS), lower backache, headache, and psychosocial stress (Bali et al., 2007; Chakrabarti, 2007; Sen & Richardson, 2007; Rathore et al., 2010). CVS refers to a collection of ocular complaints among computer users (Bali et al., 2007). Chakrabarti defined CVS as a by-product of viewing a visual display terminal excessively being indifferent to practical visual hygiene (Chakrabarti, 2007). The American Optometric Association (AOA) has defined CVS as “a complex of eye and vision problems related to activities, which stress the near vision and which are experienced in relation to or during the use of a computer” (AOA, 2013). The computer screen is made of tiny dots called pixels that are bright at center but the brightness decrease toward the outer edges. When human eyes face difficulty while focusing on pixels, eyes relax on to focus behind the screen. This focus point is called Resting Point of Accommodation (RPA) or the dark focus. The constant relaxation of eyes on RPA and straining to refocus on the screen

lead to eye strain and fatigue (Abelson & Ousler, 1999; Wimalasundera, 2009; Chakrabarti, 2007; Alexandre & Milano, 2006).

Similarly, Anshel reported when individuals' visual abilities cannot cope with the visual demand of the computer display, CVS is observed among those individuals (Anshel, 2006). One recent study showed that demanding computer work stimulates significant changes in both blood flow and muscle load in the orbicularis oculi muscle (Thorud et al., 2012). Symptoms of CVS have been categorized as (i) asthenopic —eye strain, tired eyes, sore eyes, dry eyes, (ii) ocular surface-related—watering, irritation, contact lens problems, (iii) visual —blurred vision, slowness of focus change, double vision, presbyopia, and (iv) extraocular—neck pain, back pain, shoulder pain (Wimalasundera, 2009). Previous studies indicated some contributing factors to CVS: prolong use of computer (Akinbinu & Mashalla, 2013; Smita et al., 2013), use of spectacles or contact lenses (Smita et al., 2013; Tauste et al., 2014; Kojima et al., 2011), decreased blinking rate (Freudenthaler, 2003), distance of the eyes from the computer screen (Bhandeni et al., 2008; Chiemeké et al., 2007; Taptagaporn et al., 1995), and lighting of the computer working place (Werker et al., 1990).

Previous studies have reported varying CVS prevalence rates across different study populations. Hayes et al. reported that the prevalence of CVS ranges from 75% to 90% among computer users (Hayes et al., 2007). Sen and Richardson reported that nearly 60 million people suffer from CVS globally, with one million new cases of CVS each year (Sen & Richardson, 2007). Zainuddin & Isa reported a 63% (92/146) prevalence of CVS among administrative staff in a public university in Malaysia (Zainuddin & Isa, 2014). In a study of computer use and vision-related problems among university students, Shantakumari et al. mentioned 72% (339/471) of the students reported frequent interruption (headache, tired eyes) of computer work (Shantakumari et al., 2014). Similarly, Logaraj et al. found 81.9% (176/215) prevalence of CVS among the engineering students, whereas it was 78.4%

(158/201) among the medical students (Logaraj et al., 2014). Some studies found a higher prevalence of CVS among females (Shantakumari et al., 2014; Ranasinghe et al., 2016), whereas others reported higher prevalence among males (Logaraj et al., 2014).

Although studies conducted in Malaysia (Zainuddin et al., 2014), Sri Lanka (Ranasinghe et al., 2016), and India (Logaraj et al., 2014) found a significant association between female gender and a higher prevalence of CVS, research focusing exclusively on women remains limited, particularly in Bangladesh (Parveen, 2015). In addition, with the provision of Digital Bangladesh, computer use has increased in administrative and service matters as well as in academia. As a result, it is essential to assess the prevalence of CVS, raise awareness among computer users in Bangladesh, and help prevent adverse effects among the young generation. This will contribute to the Sustainable Development Goal (SDG) 3: “Ensure healthy lives and promote well-being for all at all ages”. In view of the limited published documents pertaining to CVS in Bangladesh, a study was conducted among the students of Asian University for Women (AUW) with the following specific objectives:

- i. to determine the prevalence of CVS symptoms among AUW students
- ii. to evaluate the prevalence of and the risk factors for dry eye disease among the AUW students based on the Ocular Surface Disease Index (OSDI) questionnaire
- iii. to assess knowledge and practice of computer use among the AUW students
- iv. to understand the predictors for CVS to support future prevention and education programs

2. Method

2.1 Study Design and Population

A cross-sectional study was conducted from January to February 2017 among students at AUW, a private university in Chittagong, which is the second-largest city and financial center in southeastern Bangladesh with a major coastal seaport.

2.2 Sample Size and Sampling Methods

The sample size was calculated using a prevalence of computer vision syndrome of 10% (Shantakumari et al., 2014), 5% precision, a 95% confidence interval, and $\alpha = .05$; the estimated sample size was 138. In order to reach the calculated sample size, 175 students were invited to participate in the study, expecting an 80% response rate. However, only 110 students responded (response rate= 62.8%). Students who had been using a computer (laptop or desktop) for a minimum of 2 years and who had used a computer for at least 2 hours per day preceding the date of the study were included in the study. The IT department of the respective institution provided a list of students who met the inclusion criteria. Systematic random sampling was used to randomize this final list of students, and the selected students were invited to the study via email.

2.3 Study Tool

A questionnaire was developed by the investigator following an iterative process of questionnaire development based on previous studies (Portello et al., 2012; Reddy et al., 2013; Ranasinghe et al., 2016). The questionnaire was pretested with 10 students, and the suggested modifications were incorporated to improve clarity. The final version of the pretested, self-administered questionnaire was used to collect socio-demographic data, symptoms of CVS, details of computer usage, potential risk factors, knowledge of CVS, and knowledge and implementation of recommended postures when using computer. The questionnaire was in English. A questionnaire comprising 10 questions concerning the degree of ocular discomfort experienced was adapted from a previous study done by Hayes et al. (2007). Presence of any one of the symptoms, either intermittently or continuously for ‘at

least some of the time' during the previous week, was considered as 'presence of CVS.' In the absence of uniform diagnostic criteria, the above criteria were adopted after reviewing previous research (Portello et al., 2012). The sum of the symptom score was calculated from responses to this questionnaire. The OSDI survey, consisting of 4 parts (A, B, C, and D), was also used in the questionnaire to assess the prevalence of dry eye symptoms experienced by participants during the previous week. Part A consisted of 5 questions that evaluated ocular discomfort (ocular pain, photosensitivity, sensation of sand in the eye); part B consisted of 3 questions that evaluated the limitation of regular activities (reading, computer use, watching TV); and part C consisted of 3 questions that evaluated the influence of environmental factors (exposure to the wind or air conditioner) on ocular comfort (Gajta et al., 2015). The OSDI score was also recorded. Both the questionnaire and the OSDI were found to be repeatable based on their usage in previous studies.

2.4 Data Entry and Analysis

Data entry and analysis were done using SPSS version 22 (IBM Corp., 2013). Computer vision symptoms were graded as 4 (occurring all of the time), 3 (most of the time), 2 (half of the time), 1 (some of the time), or 0 (none of the time). A total score (ranging from 0 to 40) for CVS symptoms of each subject was obtained from the sum of the individual symptom scores. The prevalence of CVS-related symptoms was estimated as a percentage. Based on the OSDI score, subjects were categorized as having normal ocular surface (0-12 points), or mild ocular surface disease (13-22 points), moderate ocular surface disease (23-32 points), or severe ocular surface disease (33-100 points). A chi-square test was used to determine the association of monitor distance allowing reading the screen without leaning head, neck, or trunk forward/backward, type of spectacle correction worn during computer use, and looking at far objects in between work with severity of OSDI. A principal-component factor analysis was performed to evaluate the construct validity of the items included in the questionnaire.

Ordinal regression analysis was completed using the reported 'level of OSDI' calculated on an ordinal scale (1= no disease; 2= mild OSDI; 3= moderate OSDI; 4= Severe OSDI) as the dependent variable to determine the odds of having higher OSDI against selected independent variables.

2.5 Ethics

The study was approved by the Institutional Review Board (IRB) of AUW. The study followed the ethical standards laid down in the Declaration of Helsinki. Informed written consent was obtained from all the participants, followed by a briefing on the nature of the study, data confidentiality, and possible consequences.

3. Results

3.1 Socio-demographic Characteristics

The mean age of the participants was 21.91 ± 1.5 years (range 19-25 years). Most (92.7%) of the study population had been using a computer for more than two years. The majority (63.6%) of the study population worked more than 4 hours per day on a computer. Among the study population, 49.1% used spectacles for refractive correction during computer use (Table 1).

3.2 Prevalence of CVS

A major proportion (94.5%, n=104) of the respondents reported the presence of CVS symptoms 'at least some of the time' during computer use over the week. The median total symptom score was 6 [interquartile range (IQR) =10; overall range 0-40]. It was observed that 32.7% of the subjects reported having tired eyes 'at least half of the time' during the past week, while the percentage of subjects experiencing sensitivity to light, blurred vision while looking into the distance after computer work, difficulty or slowness in refocusing eyes from one distance to another, headache, and discomfort in eyes 'at least half of the time' was

24.5%, 23.6%, 21%, 20.9%, 20.9%, respectively (Table 2). The majority (52.7%) of the study population stated that they continuously stared at the computer screen for more than 1 hour.

Table 1: Socio-demographic characteristics of the population tested

Mean Age of the participants (SD)	21.91($\pm$ 1.5) years
Types of refractive correction worn during computer operation	n*(%)
None	43 (39.1)
Spectacles	52 (47.3)
Contact lenses	3 (2.7)
Contact lenses & glasses	7 (6.4)
Ocular surface disease index (OSDI)	
Normal	59 (53.6)
Mild	19 (17.3)
Moderate	11 (10.0)
Severe	21 (19.0)
CVS symptoms reported	
Yes	104 (94.5)
No	6 (5.5)
Number of hours using a computer every day	
1-2 hours	11 (10)
2-4 hours	29 (26.4)
More than 4 hours	70 (63.6)
Number of years using a computer	
1-2 years	8 (7.3)
More than 2 years	102 (92.7)
Duration of continuously staring at the computer	
1-30 minutes	52 (47.3)
31-60 minutes	27 (24.5)
61-120 minutes	23 (20.9)
121-180 minutes	4 (3.6)
181-360 minutes	4 (3.6)

*Number of subjects

3.3 Awareness of CVS

Majority of the participants were not aware of the term CVS (72.7%, n=80). Among those who were aware of the term CVS (27.3%, n=30), 83% (n=25) defined CVS correctly. In those who were aware of the term CVS (27.3%, n=30), 53.1% (n=16) had heard of it via the internet, 23.4% (n=7) from friends, 9.9% (n=3) via media (television/radio/newspaper), 9.9% (n=3) via books, and 3.3% (n=1) from a doctor.

Table 2: Study subjects (N=110) reporting symptoms during computer use ‘over the past week’

Symptom	None of the time n (%)	Some of the time n (%)	Half of the time n (%)	Most of the time n (%)	All the time n (%)
BVvC ^a	50 (45.5)	44 (40.0)	11 (10.0)	3 (2.7)	2 (1.8)
BVD ^b	51 (46.4)	33 (30.0)	6 (5.5)	16 (14.5)	4 (3.6)
Difficulty in refocusing	50 (45.5)	37 (33.6)	9 (8.2)	8 (7.3)	6 (5.5)
Irritated or burning eyes	55 (50.0)	40 (36.4)	6 (5.5)	7 (6.4)	2 (1.8)
Dry eyes	72 (65.4)	27 (24.5)	3 (2.7)	7 (6.4)	1 (0.9)
Eye strain	65 (59.1)	29 (26.4)	9 (8.2)	4 (3.6)	3 (2.7)
Headache	41(37.3)	46 (41.8)	12 (10.9)	8 (7.3)	3 (2.7)
Tired eyes	22 (20.0)	52 (47.3)	18 (16.4)	15 (13.6)	3 (2.7)
Sensitivity to light	43 (39.1)	40 (36.4)	9 (8.2)	16 (14.5)	2 (1.8)
Discomfort in eyes	48 (43.6)	39 (35.5)	9 (8.2)	10 (9.1)	4 (3.6)

a. Blurred vision while viewing the computer;

b. Blurred vision when looking into the distance

3.4 Knowledge and Implementation of Recommended Postures When Using a Computer

Majority of the participants were aware of the correct postures (67.3%, n=74), whereas 54% (n=40) of them did not implement those postures while using computer/ laptop. Common reasons for non-implementation were: lack of appropriate facilities (55%, n=22), not being convinced of the impact (12.4%, n=5), and other reasons (32.4%, n=13).

3.5 Prevalence of OSDI

Examination of both the total symptom score and OSDI data using the Shapiro-Wilk test indicated that neither was normally distributed (total symptom score: $W=0.877$, $p < 0.0001$; OSDI: $W=0.882$, $p < 0.0001$). The median OSDI score was 11.36 (IQR=18.75; range 0-59.09). Majority (53.6%) of the subjects were classified as having normal ocular surface, while 17.3%, 10%, and 19% had mild, moderate and severe ocular disease, respectively. A

significant positive correlation was observed between the total symptom score and the OSDI findings (Spearman $r_s = 0.786$; $p < 0.0001$) (Figure 1).

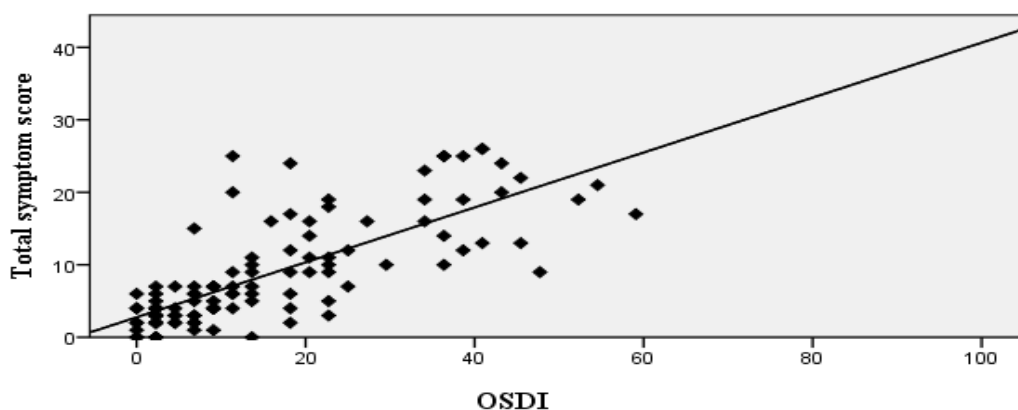


Figure 1: Correlation between the total symptom score and the OSDI index

Prevalence of severe OSDI was significantly higher (66.7%) among students whose monitor distance does not allow reading the screen without leaning head, neck or trunk forward/backward than in students (33.3%) whose monitor distance allows reading the screen without leaning head, neck or trunk forward/backward (Table 3).

Table 3: Association between pattern of computer usage and OSDI level

Variable	OSDI Level				P Value
	No disease n (%)	Mild n (%)	Moderate n (%)	Severe n (%)	
Monitor distance that requires leaning ^a					
Yes	20 (33.9)	6 (31.6)	2 (18.2)	14 (66.7)	0.020
No	39 (66.1)	13 (68.4)	9 (81.8)	7 (33.3)	
Refractive correction ^b					
None	28 (47.5)	7 (36.8)	5 (45.5)	3 (14.3)	0.047
Glasses	27 (45.8)	7 (36.8)	6 (54.5)	12 (57.1)	
Contact lenses	0 (0.0)	1 (5.3)	0 (0.0)	2 (9.5)	
Glasses and contact lenses	3 (5.1)	1 (5.3)	0 (0.0)	3 (14.3)	
Looking at far objects in between work					
Yes	6 (10.2)	3 (15.8)	0 (0.0)	10 (47.6)	<0.001
No	53 (89.8)	16 (84.2)	11 (100)	11 (52.4)	

a. Monitor distance requires reading the screen with/ without leaning head, neck or trunk forward / backward

b. Refractive correction worn during computer operation

Prevalence of severe OSDI was significantly higher (52.4%) among students who do not look at far objects in between working in a computer than in students (47.6%) who look at far objects in between working in a computer. Prevalence of severe OSDI was significantly higher (57.1%) among students who use glasses as a refractive correction during computer operation than in students who wear no refractive correction (14.3%), contact lenses (9.5%), and both contact lenses and glasses (14.3%).

3.6 Factor Analysis

An examination of the Kaiser-Meier-Olkin measure of sampling adequacy suggested that the sample was factorable (KMO=.849). Bartlett sphericity test showed a certain redundancy among the variables that could be summarized with few factors ($p < 0.0001$). These results indicate the validity of the procedure and allow identification of the key factors included in the questionnaire.

The significant correlation suggests an underlying latent variable that could reduce the dimensionality of the symptoms. Principal factor analysis (PFA) with orthogonal varimax rotation was undertaken to take advantage of these intercorrelations (Figure 2). The number of underlying latent variables was determined by selecting factors with eigenvalues higher than 1. Factor analysis supports 2 factors based on the factor loadings (correlation item-factor) (Table 4). The first factor was the association with dry eyes that included 3 items (dry eyes, burning eyes, eye strain), which had a higher correlation ($r > .70$) and explains 34.1% of the total variance. The second factor was the association with ocular accommodation that included 3 items (blurred vision looking into distance, blurred vision while viewing the computer, and slowness in refocusing) which had a higher correlation ($r > .70$) and explains 31.3% of the total variance.

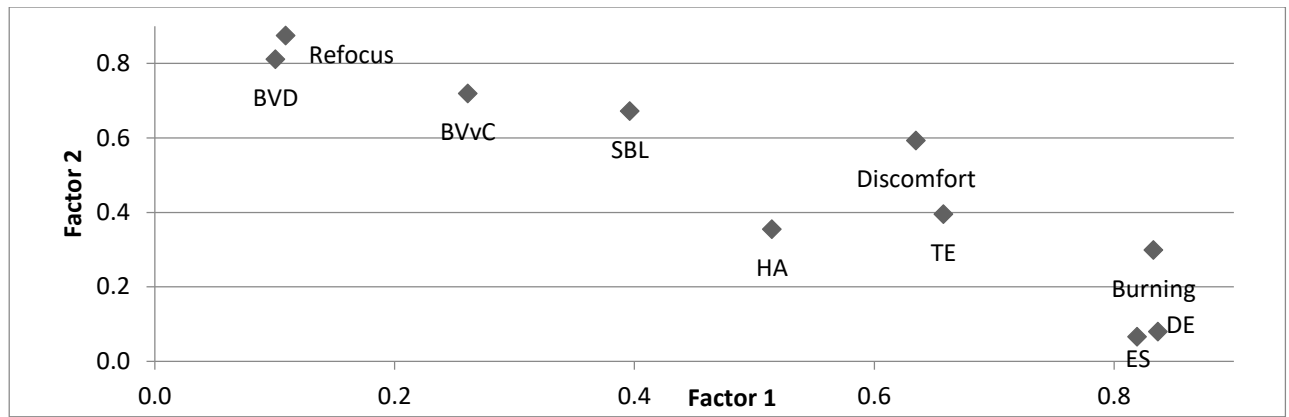


Figure 2. Factor loadings for the factor analysis.

SBL: sensitivity to bright light; HA: headache; ES: eyestrain; Discomfort: eye discomfort; TE: tired eyes; Burning: burning eyes; DE: dry eyes; BVD: blurred vision looking into the distance; BVvC: blurred vision while viewing the computer; Refocus: slowness in refocusing.

Table 4: Correlation matrix from factorial analysis with orthogonal varimax rotation

Item	Factors	
	1 r^*	2 r^*
Blurred vision while viewing computer	0.26	0.72
Blurred vision while looking into the distance after computer work	0.10	0.81
Difficulty or slowness in refocusing my eyes from one distance to another	0.11	0.88
Irritated or burning eyes	0.83	0.30
Dry eyes	0.84	0.08
Eye strain	0.82	0.07
Headache	0.52	0.36
Tired eyes	0.66	0.40
Sensitivity to light	0.37	0.67
Discomfort in eyes	0.64	0.60

* Pearson correlation coefficient

3.7 Ordinal Regression Analysis

Ordinal regression analyses were completed using the ‘severity of OSDI’ as the dependent variable and time of using the computer/laptop every day on average (in hours) as independent variables to determine whether the odds of having higher OSDI differ significantly for the amount of time spent on using computer/laptop every day (Table 5).

Table 5: Odds ratios for amount time spent on using the computer/laptop everyday on average (in hours) in two ordinal regression models for severity of OSDI

Time of using the computer/laptop every day on average (in hours)	Base model			Adjusted model		
	OR	P-value	Nagelkerke R ² %	OR	P-value	Nagelkerke R ² %
1-2 hours	0.62	0.47	0.60	0.60	0.46	28.70
2-4 hours	0.89	0.79		0.59	0.27	

Notes: OR= Odds Ratio; Base model: controls for amount of time spent on the computer/laptop every day on average (in hours); Adjusted model: controls for all the measured variables with a significant association with OSDI level.

The base model was not statistically significant, and the Cox and Snell R-Square and Nagelkerke R-Square values were 0.005 and 0.006. The base model results confirmed that there was no significant difference in OSDI based on the amount of time spent using the computer/laptop every day on average (in hours). The adjusted model was significant, and the Cox and Snell R-Square and Nagelkerke R-Square values were 0.26 and 0.29 (Table 6).

Table 6: Ordinal Odds model for OSDI level

Variable	Parameter	B	SE	OR	(95% CI)
Threshold	No disease to mild	-0.28	0.65	-	-
	Mild to moderate	0.65	0.65	-	-
	Moderate to severe	1.35	0.66	-	-
Adjusting the brightness of the screen	No	1.10	0.47	3.00*	1.18-7.55
Taking a break by closing eyes	No	1.14	0.41	3.13**	1.39-7.04
Level of computer screen	Below eye level	0.48	0.74	1.62	0.38-6.86
	At eye level	-1.40	0.47	0.25**	0.10-0.62
Type of refractive correction	Contact lenses	1.73	1.47	5.63	0.32-99.42
	Glasses	1.09	0.47	2.97*	1.23-7.28
	Reading glasses	1.65	0.92	5.15	0.85-31.78
	Glasses & lenses	1.51	0.82	0.22	0.90-22.64
Time of computer usage	1-2 hours	-0.51	0.70	0.60	0.15-2.35
	2-4 hours	-0.53	0.48	0.59	0.23-1.50

Notes: OR= Odds Ratio, CI= Confidence Interval, Nagelkerke pseudo R²=28.70%. *p<.05; **p<.01

The results indicated that individuals who did not adjust brightness of the screen to suit the surrounding were 3 times more likely to have higher OSDI compared to individuals who adjust brightness of the screen to suit the surrounding (3:1). Individuals who did not close eyes to prevent/ relieve the reported CVS symptoms were more likely to have a higher OSDI than individuals who closed eyes to prevent/relieve the reported CVS symptoms by around 3.13:1. Individuals putting computer screen at the eye level were less likely to have a higher OSDI compared to individuals putting the computer screen above the eye level by around 0.25:1. Individuals wearing glasses as a refractive correction were more likely to have a higher OSDI than those who used no refractive correction by around 2.97:1. However, time of using the computer/laptop everyday on average (in hours) was not significantly associated with having higher OSDI.

4. Discussion:

The results indicated that a large number of students experienced symptoms that were associated with computer use. One third of the individuals surveyed in this study reported the symptom of 'tired eyes' occurring 'at least half of the time' during the past week. Similarly, Portello et al. reported a prevalence of tired eyes of 39.8% 'at least half of the time' in the Computer-related Vision Symptoms study (Portello et al., 2012). Sensitivity to light was experienced 'at least half of the time' by a quarter of the individuals, while Portello et al. noted sensitivity to light 'at least half of the time' in 26.3% of New York City office workers (Portello et al., 2012). Blurred vision while looking into the distance after computer work was experienced by around 24% of individuals 'at least half of the time' during the past week. Difficulty or slowness in refocusing eyes from one distance to another, headache, and discomfort in eyes were experienced by around 21% of individuals 'at least half of the time' during the past week. It was difficult to compare these findings with previous reports. The

reason behind is that even though many studies reported the prevalence of one or more symptoms, these studies provided no indication of their frequency.

In the present study, almost a third of the subjects suffered from moderate to severe dry eye symptoms based on their OSDI score. Garza-León et al. found that 54.4% of the female university students in Monterrey, Mexico had a moderate or severe OSDI score (Garza-León et al., 2016). Another study among university students in Ajman found a higher prevalence of dry eye (48%) (Shantakumari et al., 2014), whereas a study among medical and engineering students in Chennai found an 18.6% prevalence of dry eye among female students (Logaraj et al., 2014). Differences in dry eye prevalence must be interpreted with caution, since socio-demographic characteristics differ among study populations and different methodologies have been used to identify individuals with this condition. For example, Shantakumari et al. defined dry eyes as a positive response to a question about having dry eyes. No attempt was made to quantify the severity of dry eyes (Shantakumari et al., 2014). In contrast, Logaraj et al. graded the severity of dry eyes as none, mild (transient symptoms persist for a few minutes to hours), moderate (persist for a few hours and subside after rest or sleep) or severe (needs medical consultation) during or after computer use.

Monitor distance that requires reading the screen with leaning head, neck or trunk forward / backward was significantly associated with having severe OSDI level. Supporting this finding, students viewing a computer at a distance of less than 20 inches were reported to have a significantly higher risk of developing visual symptoms (Logaraj et al., 2013). Similarly, more pronounced visual symptoms were noted among individuals who viewed a computer at a distance of less than 10 inches (Chiemeke et al., 2007). In this study, use of refractive correction was associated with higher level of OSDI. Supporting this finding, in a study in Malaysia, Rahman & Sanip reported that use of correction spectacle/lenses were significantly associated with CVS (Rahman & Sanip, 2011). In addition, Reddy et al. noted

that university students who were wearing spectacles experienced symptoms of CVS significantly more often than those who were not wearing spectacles (Reddy et al., 2013). In this study, looking at far objects in-between the work was significantly associated with less frequency in different OSDI level. Another study supported this finding by reporting less frequency of CVS symptoms among university students who looked at far objects in-between the work (Reddy et al., 2013).

The factor analysis indicated the broad categorization of the visual symptoms in two groups: association with dry eyes or accommodation. This categorization resembled the differentiation of asthenopia by Sheedy et al. (Sheedy et al., 2003). These authors noted that eyestrain, eye fatigue, discomfort, burning, irritation, pain, ache, sore eyes, diplopia, photophobia, blur, itching, tearing, dryness and foreign-body sensation were symptoms associated with asthenopia. The authors differentiated the symptoms into two broad categories: external symptoms and internal symptoms. External symptoms, including burning, irritation, ocular dryness, and tearing, were related to dry eye. In contrast, internal symptoms, including eyestrain, headache, eye ache, diplopia, and blur, were related to refractive, accommodative, or vergence anomalies (Sheedy et al., 2003). Therefore, the authors suggested that the presence of these internal and/or external symptoms indicates the presence of asthenopia among the individuals.

According to the results of the ordinal regression analysis, not adjusting the brightness/contrast setting of computer/laptop monitor was significantly associated with having higher OSDI. Another study supported this finding by reporting that students using computer in a very bright or dark room were more prone to visual fatigue symptoms. In addition, the complaints of dry eyes were more among students who used darker screen (Shantakumari et al., 2014). According to Sheedy et al. the screen lighting, contrast, and brightness should be adjusted to the optimum before staring the work on computer/laptop.

The luminance of the room should not exceed three times than the mean luminance on the screen (Sheedy et al., 2005). Using computer for a long time without taking any break was found to be significant risk factor for having higher OSDI level (3.13:1). Supporting this finding, several studies reported a significant risk of getting visual symptoms when not taking frequent breaks (Logaraj et al., 2014; Rahman & Sanip, 2011; Logaraj et al., 2013).

Having the computer screen at eye level was a significant protective factor for having a lower OSDI. This could be due to the large number of students (64.5%, n=71) having computer screen at eye level in our sample. However, Reddy et al. reported that significant reduction in symptoms of CVs between students who viewed the computer screen below eye level than those who viewed the screen at or above eye level (Reddy et al., 2013). Use of glasses was a significant risk factor for having a higher OSDI than individuals who use no refractive correction (2.97:1). A possible explanation for the increased risk of higher OSDI among those using glasses as a refractive correction is that it causes the eyes, which already have some corrective problems, to work a bit harder to keep the images in computer screen in focus (Ranasinghe et al., 2016). Other types of spectacle correction were not significantly associated with higher OSDI. This could be due to the small number of students using other types of spectacle correction, such as contact lenses (n=3), reading glasses (n=5), and contact lenses and glasses (n=7) in our sample. However, Garza-León et al. and Yun et al. reported that use of contact lenses was significantly associated with higher OSDI scores (Garza-León et al., 2016; Yun et al., 2012).

No significant difference was found in OSDI scores with the duration of working hours spent on a computer. Similarly, Unlu et al. did not find a statistically significant correlation between number of hours using computers each day and the mean OSDI (Unlu et al., 2012). Possible reasons could be the inaccuracy of these reports as subject might have over- or under-estimated the number of hours. The variability in the number of hours spent

working on a computer from one day to another was also unknown. Another possible reason might be the presence of moisture in the area where the computer is used that allows better dynamics in eye blinking and less evaporation of the tear film. Further, this question failed to consider other associated factors, such as the number of breaks taken, whether the task involved electronic screen exclusively, or a combination of computer and hard-copy assignments. However, several studies reported a significant association between the number of hours working on a computer daily and the presence of severe CVS (Portello et al., 2012; Reddy et al., 2013; Akinbinu et al., 2013). Rahman and Sanip reported that spending more than 7 hours per day on a computer was a significant risk factor for CVS (OR: 2.01) (Rahman & Sanip, 2011).

The strength of the study was that it measured the prevalence of CVS among the participants. In addition, it was an inexpensive and less time-consuming study. However, the present study had some limitations. The cross-sectional study design limited the inference of causality. The sample size was small, and the response rate was low. An important limitation of the study was the use of self-reported information using questionnaire on ocular surface disease because many studies reported poor correlation between symptoms measured and clinical findings (Mizuno et al., 2010; Hua, 2014). No information was collected on frequency of replacement of the glass/contact lens or type of cleaning solutions used for glass/contact lenses. Thus, the study was unable to comment on care patterns for dry eye symptoms. No information was collected on stress levels (Ahn et al., 2014), autoimmune diseases (Ahn et al., 2014; Lee et al., 2012; Her et al., 2013), extra-ocular symptoms such neck and shoulder pain (Logaraj et al., 2014; Reddy et al., 2013; Shrestha et al., 2011; Yan et al., 2008; Loh & Redd, 2008). Self-reported measurements of viewing distance and length of time while they were actually working on their computers/ laptops may be less accurate as no examination of participants' practices was involved.

5. Conclusion:

In conclusion, the findings of the present study underscored the high prevalence of both visual symptoms and ocular surface disease in university students who use computers for at least 2 hours. Prospective follow-up studies among the university students who use computers but have not developed CVS/ mild OSDI are required to identify risk factors for CVS during subsequent follow-up. Ophthalmic examination should also be included to avoid possible inaccuracy in reporting symptoms by the individuals. Participants can be asked to keep hourly diaries and/or direct record during computer operation to have greater accuracy in assessing actual usage.

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