Int J Med. Public Health. 2021; 11(1):19-23.
A Multifaceted Peer Reviewed Journal in the field of Medicine and Public Health
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Original Article

Assessing the Factors and Prevalence of Digital Eye Strain among Digital Screen Users using a Validated Questionnaire – An Observational Study

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ABSTRACT

Introduction: Digital screen usage has grown up rampantly and various ocular complaints arise as a result of the same. Digital eye strain causes constant trouble to people with prolonged digital screen usage and this study was done to find the factors in digital screen that could be modified to reduce the eye strain. **Methods:** In this study a validated questionnaire was used among computer users and various symptoms people experienced were analysed. Dry eye test i.e. Schirmer's tests I and II were performed in all the study subjects and dry eye was confirmed among the users. **Results:** In our study grittiness was the most common complaint and questionnaire employed in this study was 85 % sensitive and 72 % specific for identifying Digital eye strain. It also has a high positive predictive value of 85.6% in identifying dry eye among the users. In this study it has been found that almost all people with computer screen usage of >5 hr had symptoms of dry eye and also test positive for the same. **Conclusion:** Digital eye strain present most commonly as minor complaints like grittiness of eyes and more symptoms are seen in people who used contact lens and used digital screen for prolonged duration. A self administered questionnaire will be a potential tool in diagnosing digital eye strain at the earliest among digital screen users.
Key words: Digital eye strain, Digital screen, Dry eye, Questionnaire, Schirmer's.

INTRODUCTION

In today's world there is an increasing use of digital screen usage our lives. Not just the use bit prolonged, use comes with huge health issues. The term Computer Vision Syndrome is now being recoined as Digital Eye Strain (DES).[1] Related factors and treatment modalities for CVS.\nMETHODS: Relevant literature on CVS published during the past 65 years was analyzed.\nRESULTS: Symptoms reported by computer users are classified into internal ocular symptoms (strain and ache It is now emerging as a global health issue. The condition presents as a discomfort in long use of these equipments. The awareness amongst users is low.[2] The phenomenon is seen across all age groups. It is estimated to be present in more than 50 percent of users. By one estimate 82 % of people use smartphones.[3] Bedtime mobile phone usage among adults has became a common habit and associated with sleep deprivation.[4] Two thirds of the world is connected by mobile phones and digital screen usage has drastically increased among teenage population resulting in increased prevalence of digital eye strain.[5] It can manifest from minor ocular ailments to severe complaints which as affect daily activities of the person.[6]

DES comprises of various ocular and/or visual disturbances while using a digital device.[7] Initially the symptoms are transient and are ignored, but once they become frequent and persistent, the professional help is sought. Most of the people with digital eye strain require minor life style modification for recovery.[8] Proper identification of digital eye strain by a screening tool is the need of the hour.

The present study was undertaken to design such a tool. The advantage is that it can be administered by a non-medical individual, is user friendly and fairly accurate and a good workplace screening tool especially in developing countries. Positive subjects can then be referred to an ophthalmologist for further management.

METHODOLOGY

The present study was done among digital screen users, adult patients using digital devices regularly were included. A validated questionnaire was provided to all the study participants after getting informed consent for the study and information relevant for this study and ocular complaints associated are noted.

The questionnaire was validated with a pilot study using 25 other study participants; principal component analysis was carried out for the pilot

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History
• Submission Date: 12-07-2020;
• Revised Date: 04-01-2021;
• Accepted Date: 03-02-2021;

DOI : 10.5530/ijmedph.2021.1.3

Article Available online
http://www.ijmedph.org/v11/i1

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Cite this article : Ahuja S, Stephen M, Ranjith N, Parthiban. Assessing the Factors and Prevalence of Digital Eye Strain among Digital Screen users using a Validated Questionnaire – An Observational Study. Int J Med Public Health. 2021;11(1):19-23.

test. The questionnaire was designed with series of questions beginning with patients demographic data. It was aimed to collect the details including type of digital screen; duration; workplace setting and the various ocular complaints study participants had while using digital screen. The questionnaire also designed to get the relieving measures for the participants. The details were obtained and entered in datasheet which was analysed meticulously using SPSS software version 20.0. All participants were next subjected to dry eye tests, namely, Schirmer's test as per standard protocol.

- Schirmer's test include
- Schirmer's I for both basal and reflex secretion.
- Schirmer's II for reflex secretion.

Schirmer's test

The study was done in a room with ambient conditions. Once the procedure has been properly explained, Schirmer's I test done, with the help of commercially available test strip (Tear touch; Madhu instruments Pvt. Ltd, New Delhi) (Figure 1 and 2). Study subject is made to sit comfortably and test strip in placed in lower fornix at junction of medial 2/3rd and lateral 1/3rd with initial 5mm of strip folded at the notch. Test results are noted by measuring the wetting on test strip after 5 min. Test was done simultaneously for both eyes. Schirmer's I test reflects both reflex and basal secretion.

Study subjects were then explained about Schirmer's II test. One drop of proparacaine (Aurocaine eye drops 0.5%; Auro Laboratories Ltd.) will be instilled in both eyes. After 5 min, test was repeated as in Schirmer's I. Wet area of tear strip was noted and reflected basal secretion of lacrimal gland.

Schirmer's test values of <10 mm was taken as dry eye.

The values of Schirmer's test were compared with the responses in questionnaire.

Inclusion Criteria

The study participants were people working with digital screen in administrative department whose age was more than 18 and who gave consent for the study.

Exclusion Criteria

Patients using eye drops for the last six months. Smokers; Subjects who underwent any surgeries in the eye, Subjects who were a known case of diabetes mellitus were excluded.

Participants were considered positive for Digital eye strain if 6 of the answers were positive.

Subjects were said to have dry eye when Schirmer's test I and/or II is less than 10 millimetres

The data collected was statistically analysed using SPSS software version 20.0.

RESULTS

A total of 141 participants were enrolled in the study.

Analysis

Data was analysed using SPSS version 20.0 (SPSSInc. Chicago,IL) Associations between various variables were analysed by odds ratio.

The data was represented in tables. Table 1: Representing the demographic details of the study participants; Table 2: Describes the various parameters in workplace and symptoms in respective group; Table 3: Represent various ocular complaints and dry eye in that group.

Sensitivity of the questionnaire for identifying DES subjects was 84.5%. Specificity was found to be 71.9%.

Diagnosing false positive cases with the questionnaire was 28.1% and false negative was 15.5%.

Positive predictive value of the questionnaire was found to be 81.6% and the negative predictive value was 75.9%.

Figure 1: Test strip after Schiermer's test I, showing wet area of 20 mm.

Figure 2: Test strip after Schirmer's test II, showing wet area of 5 mm.

It was found that 37.6% of the participants were asymptomatic while 15.5% had persistent symptoms and did not seek any medical care.

DISCUSSION

There are various questionnaires used to diagnose dry eyes in patients.[9] These are primarily used by ophthalmologists for diagnosis of dry eye among mass population. We have therefore attempted to use the specific questionnaire to be used by employer especially in the software industries. School teachers can be screening children and advise them to see an ophthalmologist early. Therefore, a need for accurate, handy and reliable tool is met.

Table 1: Showing baseline demographic details of the study participants and features of computer vision syndrome among various baseline parameters. (*n*=141).

Study parameters		Percentage (*n*=141)	People with features of dry eye
Gender	Male	95 (67.4%)	80 (84.21%)
	Female	46 (32.6%)	33 (71.73%)
Age distribution	20 to 30 years	54 (38.2%)	41 (75.92%)
	30 to 40 years	49 (34.9%)	44 (89.7%)
	40 to 50 years	38 (26.9%)	28 (73.68%)
Occupation type	Full time digital screen users	86 (61.3%)	80 (93.02%)
	Part time users	55 (38.7%)	33 (60%)

*Full time digital screen users: Work involving usage of digital screen for more than 4 hr in a day. Part time users: Work involving usage of digital screen for less than 4 hr in a day

Table 2: Representing the study parameters related to the workplace and features of computer vision syndrome in that group.

Study parameters		Percentage (*n*=141)	People with features of computer vision syndrome in that group
Spectacle usage	Yes	87 (62.4%)	68 (78.1%)
	No	54 (37.6%)	35 (64.8%)
Contact lens usage	Yes	28 (19.85%)	27 (96.4%)
	No	113 (80.14%)	80 (70.79%)
Duration of digital screen usage in years	<5 years	39 (27.6%)	29 (74.3%)
	5 – 10 years	62 (43.9%)	54 (87.09%)
	>10 years	40 (28.3%)	33 (82.5%)
Duration of digital screen usage in a day	< 3 hr	24 (17.02%)	16 (66.67%)
	3to 6 hr	48 (34.04%)	37 (77.08%)
	>6 hr	69 (48.93%)	55 (79.71%)
Nature of digital screen usage	Continues	114 (80.85%)	101 (88.5%)
	Interrupted	27 (19.14%)	15 (55.56%)
Screen illumination (Brightness)	<50 %	98 (69.5%)	90 (91.83%)
	>50 %	43 (30.49%)	34 (79.06%)
Level of screen	Below eye level	138 (97.87%)	118 (85.5%)
	Above eye level	3 (2.1%)	2 (66.67%)

Table 3: Representing the various complaints experienced by the study participants and people who had low Schirmer's test values among them.

Parameters	Percentage (*n*=141%)	People who had low Schirmer's Test value (<10 mm)
Burning	28 (19.8%)	16 (57.14%)
Itching	11 (7.8%)	5 (45.4%)
Grittiness	82 (58.1%)	60 (73.1%)
Foreign body sensation	15 (10.6%)	4 (26.67%)
Excessive blinking	8 (5.6%)	5 (62.5%)
Eye redness	10 (70.9%)	7 (70%)
Eye pain	6 (4.2%)	2 (33.3%)
Watering	24 (17.02%)	7 (29.16%)
Dryness	35 (24.82%)	31 (88.5%)
Blurred vision	3 (2.1%)	1 (33.3%)
Double vision	0	0
Difficulty in near vision	19 (13.4%)	13 (68.4%)

*Many of the patients had multiple complaints.

Digital eye strain has seen in about 50% of people using computers and also has been increasing among children. Amy *et al.* found that dry eye and accommodative eye strain are the common cause of visual morbidity among prolonged digital screen users.[10] So that extensive daily use for both social and professional purposes is now normal. Digital eye strain (DES Ioanna *et al.* revealed video game is an important cause for digital eye strain and results in dry eye among teenage population.[11] In our study digital eye strain has been studied among professional computer / Laptop users.

Prevalence of 71.6% of digital eye strain has been found amongst medical students in a.[12] Only 22.2% of these had awareness of digital eye strain and only 25.5% of them were compliant to the preventive measures.

Sultan *et al.* found no gender association with incidence of digital eye strain.[13] In this study, males tend to have a greater tendency to develop eye problems probably because our study had more male participants.

In our study 62.4% (87) of participants were spectacle users and 78.1% (68) of them had symptoms suggestive of DES. Bali *et al.* done a study and found patient with pre-existing refractive error had more symptoms of dry eye among study patients with digital eye strain. Some studies have stated that use of computer specific progressive addition lenses (PC-PALS) show a reduction in CVS.[14] In our study 19.85% (28) study participants were using contact lens and almost all 96.4% (27) of them features of computer vision syndrome.

Previous contact lens users were found to be more prone to develop dry eyes. The finding can be due to the mechanism proposed by Kojima that ocular surface damage due to friction induces inflammation on the conjunctival and corneal surface with release of cytokines and matrix metalloproteinase(MMP).[15]

In our study the risk factors regarding digital device use were use for more than 5 years, daily continuous use for more than 6 hr. 43.9 % (62) of participants were using digital screen for 5 to 10 years and 87.09% (54) of them had features of DES. Similar finding has been observed in participants who used digital screen for more than 10 years. Tawil *et al.* report use for more than 5 hr as a significant risk factor which is similar to our study.[16]

Screen illumination of more than 50% was found to be a significant risk factor for dry eyes. Symptoms of eye strain were more common when the monitor of the device was placed below the eye level. This can perhaps be due to accommodation and especially convergence induced during near vision. Similar result is reported by Brennnan *et al*. and Rosenfeld who suggested that reduced blink rate and incomplete blinking may also contribute to this effect.[17] This is in contrast to the observation made by Agarwal *et al*. where the eyes were placed above the screen level to decrease the complaints of eye strain.[18]

Kharei and Khatri reported that the most common symptom was headache (50%) and dry eye (45%).[12] Tawil *et al*. found the neck or shoulder pain as the most common complaint in an all women study.[16] In our study grittiness was found to be the most common complaint among study participants; found in 82 (58.1%) of participants. Our study also had found various ocular symptoms associated with digital screen users; common symptoms seen in our study were burning sensation of eyes in 19.8% (28), dryness of eyes in 24.82% (35), watering, itching, difficulty in near vision. Agarwal *et al*. found eye strain as the most common complaint after prolonged computer use.[18]

Our study led to development of a questionnaire to be used as a screening tool in workplace. It can be administered by an employer as it is simple, easy and accurate. The sensitivity of this tool is 84.5% and the specificity is 71.9%. The positive predictive value was found to be 81.6%. In contrast, Amy *et al*. developed a questionnaire to be used for clinical trials and researchers with the sensitivity and specificity of 70%.[19]

CONCLUSION

There is a paucity of screening tool for this emerging global problem. The study identifies certain risk factors like males, spectacle users, previous contact lens users, daily use of more than 6 hr, placing the monitor below the eye level and with screen illumination of more than 50%. Recommended rehabilitation should ensure that these factors are corrected. Regular screening by the employers will improve the efficiency and performance in the workplace.

Limitations

The study did not include age as a variable and current status of refractive errors. Improvement of symptoms after the workplace correction has not been followed up.

ACKNOWLEDGEMENT

The authors express sincere thanks to the study participants and to the journal.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

Author comments

Digital eye strain is an evolving global problem and this study helped in assessing the factors associated and also the prevalence among digital screen usage, with the help of a simple validated questionnaire.

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APPENDIX

Validated questionnaire

Digital eye strain assessment questionnaire

Demographic details **Date**

Name:

Age:

Sex:

1. History of spectacle usage
   Yes/ No
2. History of contact lens usage
   Yes/ No
3. If Yes duration of usage
   <5 years/ 5-10 years / > 10 years
4. Type of monitor used
   Laptop / Ordinary computer screen
5. Duration of computer usage in a single day
   <3 hr/ 3-6 hr / >6 hr
6. Nature of computer usage in a day
   Continous / Interrupted
7. What will be your normal screen illumination while working in computer
   <25% / 25 – 50 % / >50 %
8. Level of your screen while working
   Below eye level / At eye level / Above eye level
9. How many years you have been working with computer on daily basis
   < 5 years / 5-10 years / > 10 years
10. Describe the details of the object you see after prolonged use of computer?
    Clear / Blurry / Hazy
11. What all the common ocular complaints you are experiencing presently

- Burning
- Itching
- Foreign body sensation
- Heaviness of eyelids
- Excessive blinking
- Eye redness
- Eye pain
- Watering
- Dryness
- Blurred vision
- Double vision
- Difficulty in near vision

12. Have you used any tear substitutes in past one year?
    Yes/ No.
13. How frequently you experience the complaints

- 0 – Never
- 1 - < 5times a week
- 2 - > 5 times a week

14. Severity of the ocular complaints

- 0 – Mild discomfort
- 1 – Disturbs work
- 2 – Severe enough to stop work and take rest

15. What measure you will take if you experience ocular complaints

- Take a break
- Use of eye drops
- Massaging of eyes
- Others, if so specify

.....

16. Have you been diagnosed with any other ocular condition or usage of any eyedrops for dry eye previously?
    If yes, specify.....
17. Have you ever been diagnosed by a clinician as having dry eye syndrome?
18. How often do your feel dry (not wet enough)?
    Often / Sometimes / Never

Schirmer's I

Right eye - Left eye –

Schirmer's II

Right eye - Left eye -

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