Original Article

A Study to Estimate the Magnitude of Dry Eye Disease among Adolescent Population using Visual Display Terminals in Lockdown Period — A Cross-sectional Observational Hospital Based Study

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Background : Dry Eye a grave problem in recent days has become a matter of concern for its diversity of symptoms including blurred vision and foreign body sensation and difficulty in diagnosis. There has been a sharp rise of Dry Eye symptoms during lockdown period in individuals who are using Visual Display Terminals (VDT). This study was conducted to find out the magnitude of Dry Eye among adolescents using VDTs during COVID Lockdown.

Material and method : A cross-sectional study was conducted in a medical college for a duration of one year. Individuals in the adolescent age group with digital eye strain and history of VDT use were included; those with any ocular abnormality and ocular surgery were excluded. After taking a detailed history and proper examination they were evaluated for Dry Eye using OSDI score, TBUT test and Schirmer's test. Subjects with an OSDI score of greater than 13, Tear Film Break Up Time (TBUT) less than 10 seconds and Schirmer's test ≤5mm were considered Dry Eye patient in our study.

Result : In 303 patients between age group 10-19 years with complaints of Digital Eye Strain such as eye discomfort, burning & foreign body sensation etc were selected for this study. The mean age of study population was 15.22±1.91 years with a range between 10 years to 19 years median being 15 years. Among them 162 patients (53.46%) were female and 141 (46.54%) were male (male: female ratio - 1.15:1). The overall proportion of Dry Eye in our study population was found to be 67.98%. In 85.44% of Dry Eye patients belonged to severe Dry Eye group while 11.16% belonged to moderate group and only 3.4% had a mild variety. Burning (32.95%) and foreign body sensation (47.72%) were most common significant symptoms found in severe Dry Eye. Mean total screen time in Non-Dry Eye patients (159.17±56.71) mins was significantly lower that of dry eye patients (417.57±76.83) mins.

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Dry Eye disease is one of the most commonly encountered problem in Ophthalmology[1]. It manifest as a Plethora of Symptoms such as Burning, photophobia, tearing, grittiness etc. Patients with Dry Eye disease may suffer from difficulties in daily routine activities, blurred vision etc, and thus quality of life gets compromised. Rising trend in different visual display terminal (eg, smart phone, computer, tablets, laptop etc) use with advent of technology has resulted in an increased incidence of Dry Eye in general population. Use of Visual Display Terminals (VDT) for long hours causes a decrease in maximum blink interval and ocular fatigue which lead to development of Dry Eye[2,3].

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Editor's Comment :
- Screen time should be reduced in Children and adolescents so as to decrease the incidence of different eye diseases including Dry Eye syndrome.
- Parents must bring their children to an Ophthalmologist as soon as symptoms of Eye strain appear for early diagnosis and treatment.

Even in the Pre-COVID time it was seen that high proportion of adolescents used screen based media much more than the recommended screen time[4]. Increased screen time among them resulted in Dry Eye in many situations. This existing problem of Dry Eye among VDT users had a sharp upshot with implementation of Lockdown for COVID epidemic. People lost all their outdoor activities and got confined in their rooms. So television, laptop, smartphones etc became the only source of news as well as entertainment for them resulting in a sharp increase of screen time. This was again added up by compulsory online classes of students. As a whole a large section of people was getting affected with Dry Eye related symptoms.

There are several studies which estimated the

Worldwide prevalence of Dry Eye varying between 5% to 30% in various age group and also revealed that 25 to 30 million people was affected by Dry Eye Worldwide[5]. There are very few published report on the prevalence of dry eye in lock down period among different age groups and no study was available on its prevalence in adolescent (10-19 years) age group in West Bengal.

This study was conducted in West Bengal to find out the magnitude of Dry Eye among adolescent population in lock down period and its relationship with increased screen time, so that the gravity of the problem can be understood and necessary recommendation could be made for its prevention.

MATERIALS AND METHODS

This observational, cross-sectional study was conducted in a Medical College of West Bengal for one year from April, 2020 to March, 2021. In 303 patients in adolescent age group (10 to 19 years), attending the Outdoor patient Department of Ophthalmology, Department were included in the study based on the criteria mentioned below:

Inclusion criteria :

(1) Age between 10 to 19 years

(2) With complaint of digital Eye strain (eg, foreign body sensation, burning sensation, dryness, watering, stickiness, blurred vision, discomfort etc.)

(3) History of using some sort of visual display terminals eg, smart phone, computer, electronic tablet, television etc.,

Exclusion criteria:

(1) Patients with history of any life threatening disease, lid abnormalities of allergic Conjunctivitis.

(2) Contact lens users

(3) Taking any medication known to cause Dry Eye

(4) Patients who had any ocular surgery in last 6 months

Sample size was calculated taking prevalence of dry eye as 23.33%[6]. At 95% confidence level and absolute precision of 5%, the minimum required sample size for this study was calculated as follows

$n = \{Z^2 \times p(1-p)\} / d^2$.

(Z = 1.96, p = 23.33%, d= 5%) ~ 275

Further adding for an anticipated non-response rate of 10%, the final minimum sample size come out to be 303.

Due consent was taken from all study participant and their parents (in case of a minor). A detailed history regarding their complaints and usage of VDT was taken. We enquired for a specific symptom which was present always or most of the time of a day and was termed as significant symptom. They were than subjected to a thorough Ophthalmological Examination and evaluated for Dry Eye using OSDI questionnaires, Tear Film Break up Time (TBUT) and Schirmer's test. Subjects with an OSDI score of greater than 13, TBUT less than 10 seconds and Schirmer's test ≤5mm were considered Dry Eye patient in this study.

Ocular Surface Disease Index Questionnaire (OSDI) :

This was created by Outcomes Research Group at Allergan Inc. It is a self-administered 12 item questionnaire. It has 3 subscales: Ocular symptoms, vision related functions and environmental triggers. Patients have to rate their response on a 0 to 4 scale where '0' indicates 'none of the time' and '4' indicates 'all of the time'. The final score is calculated by the formula: OSDI = (sum of scores for all questions answered X 100) / (total no of questions answered) X 4 and it ranges from 0 to 100. Score 0 to 12 is considered as normal, 13 to 22 as mild Dry Eye, 23 to 32 representing moderate Dry Eye and 33 to 100 as severe[7].

Tear Film Break-up Time (TBUT) :

This test is done by Slit Lamp Examination. Patient is asked not to blink after instillation of fluorescein dye in his eye, the time interval from last complete blink to the first appearance of dry spot is considered as the tear break-up time. A TBUT less than 10 seconds is considered consistent with Dry Eye[8].

Schirmer's Test :

This test was conducted after giving a gap of 30 mins from TBUT test. Patient was asked to close his eyes after placing a fiter paper (Whatman filter paper no 41) in each lower fornix at the junction of outer and middle third without touching the fornices and left for 5 mins. After 5 mins the amount of wetting was noted in each strip. The result was considered positive if the amount of wetting was ≤5 mm[8].

Statistical Analysis :

In this study all data were depicted as actual number and percentages. Data was entered in Microsoft excel and mean, standard deviation and median was calculated. For comparison of mean we used WINPEPI software. 95% confidence level was considered acceptable, p-value less than 0.05 was considered significant. Pearson's correlation coefficient test was used to find out relationship between variables.

RESULT

In 303 patients between age group 10-19 years with complaint of digital Eye strain such as Eye discomfort,

burning & foreign body sensation etc were selected for this study. The mean age of study population was 15.22±1.91years with a range between 10yrs to 19yrs median being 15yrs. Among them 162 patients (53.46%) were female and 141 (46.54%) were male (male:female ratio - 1.15:1).

The overall proportion of Dry Eye in study population was found to be 67.98% while among females it was 76.54% and 58.15% was among males. Dry eye patients were graded according to their OSDI score into mild (13-22), moderate (23-32) and severe (33-100). 85.44% of Dry Eye patients belonged to severe Dry Eye group while 11.16% belonged to moderate group and only 3.4% had a mild variety. Burning (32.95%) and foreign body sensation (47.72%) were most common significant symptoms found in severe dry eye (Table 1).

The mean total screen time in Non Dry Eye patients (159.17±56.71)min was compared with that of Dry Eye patients (417.57±76.83)mins and it was seen that total screen time was significantly higher inDry Eye patients (Table 2).

Total screen time of severe Dry Eye group (442.33±36.12)mins was compared with that of mild to moderate group (272.33±91.18)mins and a higher screen time was noticed in severe variety which was statistically significant.

In this study we tried to find out whether there was any relationship between total screen time of study population with their OSDI score, Schirmer test and TBUT by a pearson correlation coefficient test (Fig 1).

Pearson correlation coefficient test revealed that a significant large positive relationship exist between screen time and OSDI score [r(301) =0.671, p <0.001] (Fig 2).

Result of pearson's correlation between screen time and Schirmer's Test indicated that there is a significant

negative relationship between them [r(301) = -0.71, p <0.001.] (Fig 3).

Result of the Pearson's correlation indicated that there is a significant negative relationship between Total Screen time and Tear Break up Time [r(301) = -0.712, p <0.001].

DISCUSSION

This study was done when our country as well as the world was facing 'Total Lock Down' due to COVID attack. Addiction to their smartphone for news, social media and online classes, all played a major role in increasing the Total Screen Time which resulted in
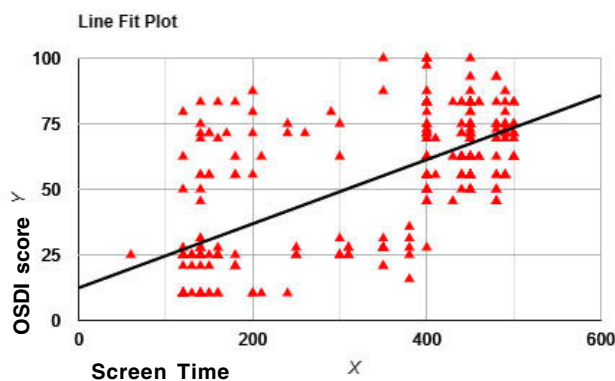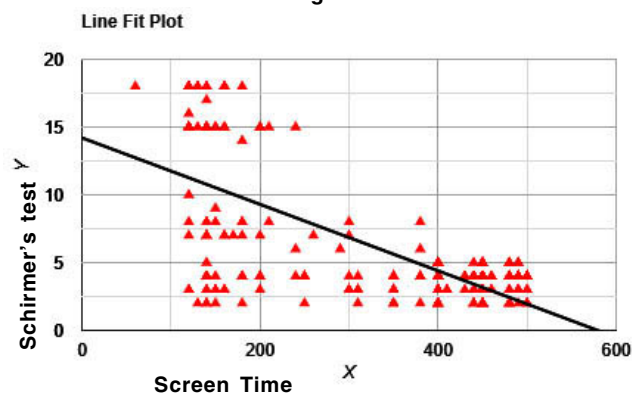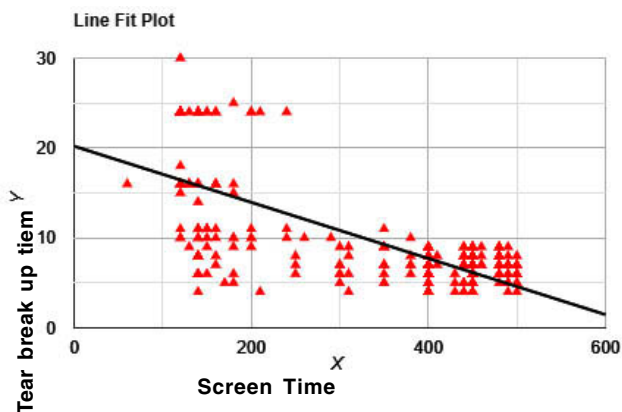

Fig 1

Fig 2

Fig 3

Table 1 — *Distribution of study population according to their screen time*			
Study population (n=303)	Mean±SD (mins)	Range (mins)	median (mins)
Non-dry eye patients (n= 97)	159.17±56.71	60- 380	140
Dry eye patients (n= 206)	417.57±76.83	130-500	445
95% CI = 241.1865 to 275.6135, t-statistics = 29.541 DF = 301, p<0.0001 (Highly significant)			

Table 2 — *Distribution of* Dry Eye *patients according to their screen time*			
Group	Mean ± SD (mins)	Range (mins)	median (mins)
Mild - moderate (n=30)	272.33±91.18	130-400	305
Severe (n=176)	442.33±36.12	300-500	450
95% CI = 151.3185 to 188.6815, t-statistics = 17.942 DF = 204, p< 0.0001 (Highly significant			

reduced blinking, evaporation of tears and subsequently to Dry Eye.

Study population had a mean age of 15.22±1.91 years with a female: male ratio of 1.15:1. This is similar to a study by Donthineni PR *et al* where the mean age was 15.2 ± 5.6yrs, while in another study by Ayaki M *et al* it was found to be 16.0±2.5 years.[9,10] In their studies female: male ratio was found to be 1.41:1 which is very close to this study.

Proportion of dry eye in present study was found to be 67.98%, among female it was 76.54% and among male 58.15%. A higher proportion of Dry Eye was found in female than male which is in accordance with several studies[11,12,13]. There are other studies where a much lower prevalence of Dry Eye was noted eg in study by Ayaki M *et al* it was 21.7% and study by Bhatt R *et al* revealed a prevalence of 23.33% in 13-18yrs age group[6,10]. These studies were conducted in pre-COVID time when there was no lock down and no online classes. A much higher proportion was encountered in this study probably because it was done during lock down period when people were using visual display terminals for much longer time.

A study by Mohan A *et al* (done during COVID-19 pandemic) found a higher prevalence (50.23%) of Dry Eye disease[14]. Napoli *et al* in his study proposed a term "Quarantine Dry Eye" and highlighted that there is a potential connection between Dry Eye disease and lock down related lifestyle and also expected that Lockdown will result in an increase in Dry Eye all over the World[15]. In a separate study by Prescott CR *et al* it was concluded that a complication of COVID-19 is Dry Eye caused due to increased screen time during lock down which may even contribute to depression and suicide[16]. Reddy SC *et al* noticed a prevalence of 89.9% of symptoms of Computer Vision Syndrome in their study[17].

So from the above discussion it is clear that there had been a sharp increase in use of digital devices during lock down period which resulted in a higher proportion of Dry Eye during that period.

Dry eye patients were graded into mild, moderate and severe group according to their OSDI score in this study. 176 patients (85.44%) of Dry Eye belonged to severe Dry Eye group while 11.16% and 3.4% were grouped in moderate and mild variety respectively. In study by Mohan A *et al* it was revealed that 26.3% were of mild grade while 11.1% were of severe grade Dry Eye disease[14]. Farrand KF *et al* reported only 8% severe Dry Eye in his study[18]. In contrast to the present study their studies had a low prevalence of severe degree Dry Eye, probably this was due to the fact for this study, patients were selected from a Tertiary Hospital OPD in lock down period. In COVID situation only those patients who were facing grave problem with their Eyes should have attended the OPD, most of the mild to moderate patients probably avoided hospital due to the fear of getting COVID infected till their problem got exacerbated and reached a severe grade.

In OPD during examination all patients were enquired for a symptom that the subject was experiencing always or most of the time in a day, which was termed as significant symptom. It was found that among Dry Eye patients foreign body sensation was the most common significant symptom (47.72%) followed very closely by burning sensation (32.95%) in severe variety. Foreign body sensation was also most commonly present in mild and moderate variety. It was also the most common symptom found in a study by Basak SK *et al* in their study[19].

This study revealed a mean total screen time of 417.57±76.83 mins in dry eye patients which was much higher than that of Non-dry Eye patients (159.17±56.71mins)and was found to be statistically highly significant (p<0.0001). A comparison was done between the mean screen time of mild to moderate with that of severe Dry Eye and it was found that a significantly higher screen time exists in severe variety. So we can infer from the present study that screen time is a significant risk factor of Dry Eye. This finding is in accordance with a study by Shirley Z *et al* where it was concluded that a significant risk factor of Dry Eye is screen time.[20]In another study by Akkaya S *et al* it was observed that screen time in computer using individuals was 7.70±0.86 hours which was much higher than their control group[21].

Pearson's Correlation Coefficient Test was done to find out the relationship between total screen time of study population with their OSDI score, Schirmer test and TBUT and it was seen that there is a significant positive relationship with OSDI score. [r(301) =0.671, p <0.001] while a significant negative relationship existed with Schirmer test [r(301) = -0.71, p < 0.001.] and TBUT [r(301) = -0.712, p < 0.001]. Almost similar findings was seen in a study by Pang Yi where it was revealed that OSDI scores were statistically significantly correlated with social media usage (r_s = 0.13, p = 0.014) and screen time (r_s = 0.12, p = 0.006). They also concluded that longer screen time is associated with worse Dry Eye symptoms[22]. Akib MN *et al* concluded in their study that a significant relationship was present between prolonged use of smart phone and Dry Eyee and found a positive

correlation with OSDI score and a negative correlation with TBUT and Schirmer values[23].

Limitations :

As this study was conducted in a Tertiary Hospital during COVID Lockdown, there may be selection bias. Probably in that period we mostly received the severe cases. Moreover, we had to rely on patients and their parents regarding the time of VDT usage and any mis-information from their side may result in information bias.

CONCLUSION

A higher proportion of Dry Eye disease was noted among adolescents who were subjected to over use of video display terminals during COVID Lockdown period. In addition to their general addiction to Smart phones they were forced to have prolonged online classes both from institutions and private tutors. As the proportion of Dry Eye in the present study was much higher along with a high daily screen time than most of the studies done before Lock down we suggest that the guidelines made by Human Resource Development for Health Research (HRD) ministry by the name 'Pragyata'(which introduced a cap on screen time for students) should be strictly followed by the respective institutions. We also like to suggest that Clinicians and Public Health Experts should make parents aware of the gravity of this problem so that they restrict their children from playing online games and getting addicted to their smartphones. Parents also should be made aware to bring their children to an Ophthalmologist as soon as Symptoms of Digital Eye Strain appear so that an early intervention could be done.

REFERENCES

1 Brewitt H, Sistani F — Dry eye disease: the scale of the problem. *Surv Ophthalmol* 2001; **45 Suppl:** 199-202.

2 Moon JH, Kim KW, Moon NJ — Smartphone use is a risk factor for pediatric dry eye disease according to region and age: a case control study. *BMC Ophthalmol* 2016**; 16(1):** 188.

3 González-Pérez M, Susi R, Antona B, Barrio A, González E — The Computer-Vision Symptom Scale (CVSS17): development and initial validation. *Invest Ophthalmol Vis Sci* 2014; **55:** 4504-11.

4 Dubey M, Nongkynrih B, Gupta SK, Kalaivani M, Goswami AK, Salve HR — Screen-based media use and screen time assessment among adolescents residing in an Urban Resettlement Colony in New Delhi, India. *J Family Med Prim Care* 2018; **7(6):** 1236-42.

5 Phadatare SP, Momin M, Nighojkar P, Askarkar S, Singh KK — A Comprehensive Review on Dry Eye Disease: Diagnosis, Medical Management, Recent Developments, and Future Challenges. *Adv Pharm* 2015; **2015:** 1-12.

6 Bhatt R, Prajapati V, Viramgami U — Evaluation of the Prevalence and Risk Factors of Dry Eye in Young Population. *DJO* 2020; **30:** 44-7.

7 Schiffman R, Christianson M, Jacobsen G, Hirsch J, Reis B — Reliability and validity of the Ocular Surface Disease Index. *Arch Ophthalmol* 2000; **118(5):** 615-21.

8 Bron A, Abelson M, Ousler G, Tomlinson A, Yokoi NN, Smith JA, *et al* — Methodologies to diagnose and monitor dry eye disease: report of the Diagnostic Methodology Subcommittee of the International Dry Eye Workshop. *Ocular Surface* 2007; **5(2):** 108-52.

9 Donthineni PR, Das AV, Basu S — Dry eye disease in children and adolescents in India. *Ocul Surf* 2020; **18(4):** 777-82.

10 Ayaki M, Kawashima M, Uchino M, Tsubota K, Negishi K — Gender differences in adolescent dry eye disease: a health problem in girls. *Int J Ophthalmol* 2018; **11(2):** 301-7.

11 Schein OD, Munoz B, Tielsch JM, Bandeen-Roche K, West S — Prevalence of dry eye among the elderly. *Am J Ophthalmol* 1997; **124:** 723-8.

12 Schaumberg DA, Sullivan DA, Buring JE, Dana MR — Prevalence of dry eye syndrome among US women. *Am J Ophthalmol* 2003; **136:** 318-26.

13 Sahai A, Malik P — Dry eye: prevalence and attributable risk factors in a hospital-based population. *Indian J Ophthalmol* 2005; **53:** 87-91.

14 Mohan A, Sen P, Shah C, Jain E, Jain S — Prevalence and risk factor assessment of digital eye strain among children using online e-learning during the COVID-19 pandemic. *IJO* 2021; **69(1):** 140-4.

15 Napoli PE, Nioi M, Fossarello M — The "Quarantine Dry Eye": The Lockdown for Coronavirus Disease 2019 and Its Implications for Ocular Surface Health. *Risk Manag Healthc Policy* 2021; **14:** 1629-36.

16 Prescott CR — Increased Screen Time and Dry Eye: Another Complication of COVID-19. *Eye Contact Lens* 2021; **47(8):** 433.

17 Reddy SC, Low CK, Lim YP, Low LL, Mardina F, Nursaleha MP — Computer vision syndrome: a study of knowledge and practices in university students. *Nepal J Ophthalmol* 2013; **5(2):** 161-8.

18 Kimberly FF, Moshe F, Ipekzer S, Debra AS — Prevalence of diagnosed dry eye disease in the united states among adults aged 18 years and older. *Am J Ophthalmol* 2017; **182:** 90-8.

19 Basak SK, Pal PP, Basak S, Bandyopadhyay A, Choudhury S, Sar S — Prevalence of dry eye diseases in hospital-based population in West Bengal, Eastern India. *J Indian Med Assoc* 2012; **110(11):** 789-94.

20 Shirley ZZWu,, Chong JK, Tracer N — Prevalence of dry eye symptoms and relationship to screen time in a New York City pediatric population. *IOVS* 2020; **61(7):** 340

21 Akkaya S, Atakan T, Acikalin B, Aksoy S, Ozkurt Y — Effects of long-term computer use on eye dryness. *North ClinIstanb* 2018; **5(4):** 319-22.

22 Pang Yi, Madro S, Hobi D — Effect of screen time on dry eye symptoms in young adults. *IOVS* 2020; **61(7):** 341

23 Marlyanti NA, Suryana RP, Siti RS, Muhammad MF, Hasnah E, Arifin S — Association between prolonged use of smartphone and the incidence of dry eye among junior high school students. *Clinical Epidemiology and Global Health* 2021; **11:** 100761.