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"ASSESSMENT OF VISUAL DISPLAY TERMINAL USE AS A RISK FACTOR FOR PAEDIATRIC DRY EYE DISEASE" : A CROSS SECTIONAL STUDY

Ophthalmology

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ABSTRACT

Purpose: To assess Visual Display Terminal(VDT) exposure as a risk factor for paediatric Dry Eye Disease(DED). **Methodology:** In this cross sectional study, children(5-15 years) from both urban and rural regions with VDT(computer,smartphone,television) exposure(1-2,3-4,>=5hours) were enrolled. Dry eye evaluation was done using Ocular Surface Disease Index (OSDI) Questionnaire, Schirmer's without anesthesia, Fluorescein-Tear film Break-up Time(F-TBUT) and corneal , conjunctival fluorescein staining as per Tear Film and Ocular Surface Society(TFOS) Dry Eye Workshop II Guidelines 2017(DEWS II). DED diagnosis was based on OSDI grading(>=13) and objective tests(>=1 positive test). **Results:** 315 children exposed to VDT were selected for the study. Burning sensation and redness were the most common symptoms. Prevalence of DED was observed to be 6.03%(19 children-38 eyes). Mean age and hours of VDT exposure was significantly higher and hours of outdoor activity and sleep significantly lower in DED children compared to NON DED children(p<.05). Urban elder children had highest DED prevalence rate of 13.19% .Prevalence of DED in children using VDT for 1-2 hours was .74%,3-4 hours was 28.57%, and >=5 hours was 47.83% (p=<.001). Children with short hours of outdoor activity(<3hours) had DED prevalence of 24.62 % whereas children with longer outdoor activity(>=3 hours) showed 1.20% prevalence(p<.001). Children with less hours of sleep(<8hours) showed DED prevalence of 22.58% and those with longer hours(>=8 hours) of sleep had only 1.98% DED prevalence (p<.001). **Conclusion:** DED was found to be associated with elder age, longer hours of VDT exposure , short hours of outdoor activity and sleep in VDT exposed children.

KEYWORDS

INTRODUCTION :-

Visual Display Terminal (VDT) are now extensively used by children in schools as well as at home . With increased popularity of notebooks, tablets, smart phones and e-book readers, use of digital devices are not confined only to the desktops.[1] Various authors have cited incidences of Dry Eye Disease (DED) associated with VDT use among adult population. The prevalence of DED in Indian adult population ranges from 18.4% to 32% with VDT use as a major association for developing DED.[2,3] Data regarding DED among paediatric VDT (smartphone, computers and television) users is very limited. A study among South Indian Medical and Engineering college students detected prevalence of DED to be 81.9% among engineering students and 78.6% among medical students with significant association with hours of computer use. Students who used computer for >=4.6 hours were observed to have significantly higher risk of developing redness,burning sensation and dry eyes compared to those who used computer for < 4 hours.[4] The prevalence of DED in children may be overlooked or underestimated as they are attributed to other causes of ocular irritation, including allergies.[5] To the best of our knowledge , our study is the first study conducted in eastern part of India to find out the prevalence of DED in paediatric VDT users as well as associated risk factors.

MATERIALS AND METHODS :-

Our study was a teaching hospital -based cross sectional type of observational study. We took history and performed ophthalmologic examinations on 315 VDT exposed children (5-15 years) from both and rural regions who attended ophthalmology outpatient department (OPD) of Calcutta National Medical College and Hospital from June 2019 through May 2020. Data collection was done in first 9 months and data analysis in next 3 months. This study was performed according to the Declaration of Helsinki on Biomedical Research Involving Human Subjects. The Institutional Ethics Board of Calcutta National Medical College and Hospital and West Bengal University of Health sciences Ethics committee approved the clinical study. Both parents and children themselves provided written informed consent after being given a detailed explanation of the study.We confirmed that parents had seen the manuscript and patient data and agreed to it's publication in a journal.

Exclusion criteria were: (1) Any type of eye surgery in the past 6 months, 2) Lagophthalmos, (3) Eyelid problems (trichiasis, distichiasis, or epiblepharon), (4) Allergic conjunctivitis with the use of antihistamine drugs, (5) Contact lense use (6) Congenital, endocrinal, or autoimmune disease, (7) Vitamin A and essential fatty acid deficiency, (8) Any chemical or thermal or mechanical corneal abrasion (corneal foreign body),(9) Corneal ulcers (fungal,viral, bacterial), (10) Inflammatory , infiltrative systemic diseases like sarcoidosis , lymphoma ,graft versus host disease.

Diagnostic criteria for Dry Eye Disease: DED was diagnosed using a combination of questionnaire data and clinical ophthalmologic examination that elicited information on symptoms and signs based on the 2017 Tear Film and Ocular Surface Society (TFOS) Dry Eye Workshop (DEWS) II guidelines.Children scoring >= 13 points on the modified Ocular Surface Disease Index (OSDI) questionnaire and >=1 positive objective tests (one or both eyes) were diagnosed to have DED.[6]

Questionnaire: A self-administered set of questionnaire was given to the children (with parents) and they completed their set with help of their parents. Questionnaires were designed to obtain information regarding risk factors for DED, including the daily duration of VDT (smart phone, computer, television) use,outdoor activities, sleep and past history of allergic disease and antihistamine drug use and to rule out all the exclusion factors. Triage questionnaires were used to rule out dry eye mimics. Subjective ocular symptoms were measured with the modified OSDI score. Modified OSDI score ranges from 0 to 100 points, and higher scores indicate greater discomfort due to DED.

Subjective symptoms

A modified OSDI score of >=13 points was considered as a positive measure of subjective symptoms.

Ocular examination: A single examiner performed all ocular examinations. These included visual acuity tests (snellen's chart), slit-lamp examination of the cornea and conjunctiva, and evaluation of eyelid problems, allergic conjunctivitis, and exposure keratitis. Tear film break-up time (TBUT) was measured with a 2% fluorescein strip coated with one drop of balanced salt solution. After applying the strip to the inferior conjunctival fornix, the participant resumed normal blinking for several seconds. After the fluorescent solution spread

across the corneal surface, the participant was asked to keep his or her eye open until the first defect of the tear film occurred. TBUT was defined as the interval between the last complete blink and the first appearance of a dry spot on the precorneal surface of the tear film.[7]The procedure was repeated three times for each eye tested, with results reported as the mean value of the three measurements. A single examiner evaluated punctate epithelial erosions (PEE) in the cornea and conjunctiva using a slit lamp according to the Oxford Scheme Panel from 0 to 5 grades.[8]

OBJECTIVE SIGNS

included were (1) TBUT <10 seconds OR (2) positive corneal(>5) , conjunctival (>9) fluorescein staining.

STATISTICALANALYSIS

We made the following analysis and comparisons in VDT exposed children : Prevalence of DED in VDT exposed children, DED children vs. NON DED children , urban elder vs rural elder vs urban younger vs rural younger children , Prevalence of DED cases based on hours of VDT exposure , hours of outdoor activity and sleep. Categorical variables have been expressed as number of patients and percentage of patients and compared across the groups using Pearson's Chi Square test for Independence of Attributes / Fisher's Exact Test as appropriate.

The statistical software Statistical Package For Social Sciences (SPSS) version 20 has been used for the analysis. An alpha level of 5% has been taken, i.e. if any p value is less than 0.05 it has been considered as significant, with appropriate standard deviation (SD).

RESULTS

Comparative analysis of DED children and NON DED children

The mean age of DED children was 12.11 years (SD= 1.91) and that of NON DED children was 10.33 years(SD=2.66) and the difference was observed to be statistically significant (p=.008). Mean hours of VDT exposure in DED children was 4.58 hours(SD=1.39) compared to 1.87 hours(SD=1.01) in NON DED children(p<.001). Mean hours of outdoor activity in DED children was 2.38 hours(standard deviation 0.52) compared to 3.01 hours(standard deviation 0.45) in NON DED children (p=.001). Mean hours of sleep in DED children was observed to be 7.25 hours(standard deviation 0.53) compared to 7.91 hours(standard deviation 0.44) in NON DED children(p=.001). **(TABLE 1)**

Prevalence of DED in VDT exposed children

The prevalence of DED in VDT exposed children was observed as 6.03%.**(TABLE 2)**

DED cases and Hours of VDT exposure

The prevalence of DED among 1-2 hour VDT users was .74% , among 3-4 hour users was 28.57% and >=5 hour users was 47.83% (p<.001).**(TABLE 2)**

Prevalence of DED in Urban and Rural children

Urban children constituted 54.9 % and rural children constituted 45.1 % of the study population . Prevalence of DED in Urban children was 8.09% and in rural children was 3.52% (p=.09) .

Prevalence of DED in Elder (11-15 years) and Younger(5-10 years) children

Younger children (5 - 10 years) constituted 44.8 % and Elder children (11 - 15 years) constituted 55.2 % of the study population. Prevalence of DED in elder children was observed to be 9.77% and that among younger children was 1.42% (p=.002).

Prevalence of DED in Age and Demographic Location wise population groups

Rural young children constituted 18.7%, Rural elder children 26.3% , urban young children 26% and urban elder 29% of study population. The corresponding prevalence of DED was 13.19% in urban elder children , 2.44% in urban young children and 6.02 % in rural elder children and no DED case was found among rural young children(p=.003)).

Prevalence of DED in Age and Demographic Location wise population groups based on hours of VDT exposure

58.33% of DED cases in urban elder children was observed among >=5 hour VDT users and 25% ,16.67% among 3-4 hour , 1-2 hour users(p<.001). 50% of DED cases in urban young children were observed among >=5 hour VDT users and rest 50% among 3-4 hour VDT users(p<.001). In rural elder children 60% of DED cases were observed among >=5 hour VDT users and rest 40% among 3-4 hour users(p<.001). No DED case was observed in rural young children.**(TABLE 3)**

Prevalence of DED in Male and Female children

Female children constituted 42.2 % and male children constituted 57.8 % of the study population . Prevalence of DED in male children was observed to be 6.59% and that of female children was 5.26% (p=.624).

DED cases and Hours of Sleep

The prevalence of DED among children sleeping for <8 hours was observed to be 22.58% and among those sleeping for >=8 hours was 1.98% (p<.001).**(TABLE 4)**

DED cases and Hours of outdoor activity

The prevalence of DED among children with outdoor activity for <3hours was observed to be 24.62 % and among those having outdoor activity for >=3hours was 1.20% (p<.001).**(TABLE 5)**

DISCUSSION

Previous studies showed that increased use of VDT causes an increase in reports of symptoms such as irritation, burning sensation, conjunctival injection, strain, headache, fatigue.[9,10] VDT use leads to relative decrease in lacrimation and blink rate.[11] The post task ocular and visual symptoms are associated with either a decreased blink rate or a higher prevalence of incomplete and infrequent blinks.[12,13] Inducing blinks with wink glasses was found to improve symptoms [14] . Decreased lacrimation , blink rate leads to an increase in the Inter Blink Interval (IBI). Ocular Protection Index (OPI) which is a ratio of Tear Film Break Up time / Inter Blink Interval is an index for risk of ocular surface disease. OPI of < 1 is considered as a risk for Dry Eye Disease and exposure related complications.[15] A reduced blink rate during continuous VDT use causes faster evaporation of the tear film, which may then lead to DED. In a previous study, it was noted that VDT use reduced the blink rate to 5–6/min (1/3 of the resting state rate) and promoted tear film evaporation.[16-19] Here, we pose the possibility that paediatric VDT use induces a lower blink rate, which may contribute to or cause pediatric DED. The prevalence of DED in our study was observed to be 6.03% **(TABLE 2)**. A similar study in korea showed prevalence of 6.6 % in VDT exposed children.[20] The mean hours of of VDT use was significantly higher in the DED children than NON DED children **(TABLE 1)** and statistically significant difference in prevalence of DED was noted among between 1-2 hour, 3 -4hour and >=5hour VDT users **(TABLE 2)**. There was a statistically significant difference with lower mean hours of outdoor activity and sleep in DED children compared to NON DED children**(TABLE 1)** with higher prevalence of DED cases among children having outdoor activity for <3 hours **(TABLE 4)** and sleep <8 hours**(TABLE 5).** Sleep deprivation compromises lacrimal system function and induces dry eye.[21]Prevalence of DED was found to be higher in Urban children than rural children ;however, the difference was not statistically significant (p=.09) .

The mean age of DED children was significantly higher compared to NON DED children**(TABLE 1)** and statistically significant higher prevalence of DED was observed in elder children than younger children (p=.002). Prevalence of DED was found to be higher in male children than female children ;however the difference was not statistically significant (p=.624). Highest proportion of children who were exposed to VDT for longer hours(3-4 , >=5 hours) were observed to be urban elder children(21.98%)followed by rural elder(15.66%) and urban younger children(9.76%) **(TABLE 3)**. A statistically significant higher prevalence of DED cases was observed in Urban Elder children followed by Rural elder and Urban younger children(p=.003) . A statistically significant higher prevalence of DED cases was also observed in those children using VDT for longer hours (3-4 ,>=5hours) across Urban Elder ,Rural elder and Urban younger population groups(p=<.001) **(TABLE 3)**. It is suggested that the difference in hours of VDT exposure between age and demographic location wise population groups led to the statistically significant difference in their DED prevalence.DED cases were neither observed in rural young children nor in 1-2 hour VDT users among urban young and rural elder children. However 16.67 % DED cases in Urban elder children was observed among 1-2 hour VDT users which can be attributed to environmental pollution in urban regions.[22]

The focusing systems of human eyes are not meant for electronically generated characters on the VDT. It responds perfectly to images that have well defined edges with good background contrast (eg. Solid black letters on white background). VDT letters are made of small dots or pixels. Each pixel is bright at it's center and with decreasing brightness towards it's outer edge.The human eye finds it very difficult to focus on the pixel characters. The eyes focus on the plane of computer screen but cannot sustain focus. Then it will relax on to a focus behind the screen. This point is called the resting point of accommodation (RPA) or dark focus. RPA is different from person to person but is somewhat away than the normal working distance to computer. Therefore eyes are constantly relaxing to RPA and straining to refocus on the screen constantly. The constant changing of focusing by the ciliary body creates fatigue to the eyes and causes accommodative symptoms pertaining to Computer Vision Syndrome (CVS).[23] Limitation of our study is the cross sectional design of the study , limited sample size . Our study was conducted among children, so there may have been difference in self-reporting and expression of ocular discomfort and comprehension of the questionnaire between younger children and elder children along with help from parents , which could have affected our estimates of DED prevalence. More objective tests like tear osmolarity and conjunctival impression cytology were not taken into consideration in our study. In our study we used subjective symptom criteria (modified OSDI score) and objective signs (low TBUT or PEE) to diagnose DED. These criteria were based on adults and subjective signs of DED were not obvious. Thus, the true prevalence of DED in children may be increased or decreased due to the use of adult-targeted diagnostic criteria. In previous study it is confirmed that DED coexists with allergic conjunctivitis [24]; however, because DED and ocular allergies have similar symptoms , it was difficult to separate children with DED from those with ocular allergies.[25,26] Thus, the prevalence of DED may have been affected by the prevalence of allergies in our study population.

CONCLUSION

The results of our present study showed 6.03% prevalence of DED among VDT exposed children between 5-15 years of age. DED in VDT exposed study population was observed to be significantly associated with increase in hours of VDT use , increase in age of children and decreased hours of outdoor activity (OA) and sleep. No significant association of DED was observed with gender and demographic location of children. However significant association of DED was observed with age and demographic location wise population groups in our study population. Statistically significant difference with highest percentage of DED cases in urban elder children followed by rural elder and urban younger children was observed . No DED case was detected among rural younger children. The prevalence of DED in children may be underestimated because the condition is often overlooked or attributed to other causes of ocular irritation, including allergies.

The first step in preventing DED from emerging as a lifestyle driven disease among children is better awareness of the condition among health care professionals and parents. Children and their parents should be educated about importance of optimum screen time ,outdoor activity and sleep. VDT screen should not have too bright illumination causing glare , screen to eye distance should be optimum , screen set below eye level , optimum break in between screen time , and use of progressive computer glasses.

Table 1

DED		AGE	VDT (Hours)	OA	SLEEP
No	Mean	10.33	1.87	3.01	7.91
	Median	11.00	2.00	3.00	8.00
	Std. Deviation	2.66	1.01	0.45	0.44
Yes	Mean	12.11	4.58	2.38	7.25
	Median	12.00	5.00	2.50	7.00
	Std. Deviation	1.91	1.39	0.52	0.53
	p Value	0.008	<0.001	0.001	0.001
	Significance	Significant	Significant	Significant	Significant

Table 2

		DED		Total	p Value	Significance
		No	Yes			
VDT use (Hours)	1-2hrs	269(99.26)	2(0.74)	271(100)	<0.001	Significant
	3-4hrs	15(71.43)	6(28.57)	21(100)		
	>=5hrs	12(52.17)	11(47.83)	23(100)		
Total		296(93.97)	19(6.03)	315 (100)		

Table 3

Age wise Demographic groups			VDT (Hours)			Total	p Value	Significance
			1-2	3-4	>=5			
Rural Young	DED	No	56(94.92)	3(5.08)	0(0)	59(100)	NA	NA
	Total		56(94.92)	3(5.08)	0(0)	59(100)		
Rural Elder	DED	No	70(89.74)	5(6.41)	3(3.85)	78(100)	<0.001	Significant
		Yes	0(0)	2(40)	3(60)	5(100)		
	Total		70(84.34)	7(8.43)	6(7.23)	83(100)		
Urban Young	DED	No	74(92.5)	3(3.75)	3(3.75)	80(100)	<0.001	Significant
		Yes	0(0)	1(50)	1(50)	2(100)		
	Total		74(90.24)	4(4.88)	4(4.88)	82(100)		
Urban Elder	DED	No	69(87.34)	4(5.06)	6(7.59)	79(100)	<0.001	Significant
		Yes	2(16.67)	3(25)	7(58.33)	12(100)		
	Total		71(78.02)	7(7.69)	13(14.29)	91(100)		

Table 4

		DED		Total	p Value	Significance
		No	Yes			
Outdoor Activity (hrs)	<3	49 (75.38%)	16 (24.62%)	65 (100)	<0.001	Significant
	>=3	247 (98.8%)	3 (1.2%)	250 (100)		
Total		296 (93.97%)	19(6.03%)	315 (100)		

Table 5

		DED		Total	p Value	Significance
		No	Yes			
SLEEP (hrs)	<8hrs	48 (77.42&)	14 (22.58%)	62 (100%)	<0.001	Significant
	>=8hrs	248 (98.02%)	5(1.98%)	253 (100%)		
Total		296 (93.97%)	19(6.03%)	315 (100%)		

ABBREVIATIONS

DED :- Dry Eye Disease ,**VDT** :- Visual Display Terminal, **TFOS** :- Tear Film and Ocular Surface Society ,**DEWS** :- Dry Eye Workshop ,**OSDI** :- Ocular Surface Disease Index ,**OA** :- Outdoor Activity ,**OSS** :- Ocular Surface Staining ,**SPSS** :- Statistical Package For Social Sciences ,**OPD** :- Out Patient Department ,**FTBUT** :-Fluorescent Tear Film Break Up Time ,**CVS** :- Computer vision syndrome, **PEE** :- Punctate epithelial erosions , **SD** :-Standard deviation.

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