Relationship between Digital/Led Device use and Ocular Symptoms: A Cross-Sectional Study in Secondary School Girl Students

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ABSTRACT

Introduction: Use of LED based devices is increasing substantially in recent years, however, these devices could have an adverse effect on ocular health. Study aimed to evaluate the relationship between direct exposure to LED and ocular symptoms.

Material and Methods: The data was collected from secondary school students studying in a girls' college at Bareilly during an eye camp organized by Muskaan Foundation. Only girls having known intact vision (BCVA 6-6/6-9) were enrolled in the study. A total of 536 girls were enrolled in the study. Average daily direct exposure <3-4 hours was categorized as unexposed while those having >3-4 hours daytime or 1-2 hrs or more night time exposure were categorized as exposed. The exposed girls were divided into day exposed and night exposed respectively. Ocular symptoms were noted. Chi-square test and ANOVA were calculated using SPSS 21.0 software.

Results: Mean age of girls was 17.02±1.42 (Range 15-19) years. A total of 298 (55.5%) had direct exposure to LED. Prevalence of ocular symptoms like headache, pain in eyes, blurring, floaters, burning sensation and eye fatigue was 34.3%, 34.1%, 26.3%, 24.3%, 41.6% and 39% respectively. Total No. of symptomatic girls was 387 (72.2%) A significant increase in ocular symptoms was observed from unexposed to daytime and to night exposed girls ($p<0.001$). Mean number of total symptoms also showed a significant increasing trend from unexposed to nighttime exposure ($p<0.001$).

Conclusion: Direct LED light exposure for a substantial period, particularly during night time is detrimental to ocular health.

Keywords: Direct LED Exposure, Digital Devices, LED Illuminating Sources, Ocular Symptoms, Teenage Girls.

INTRODUCTION

Light emitting diodes are fast replacing the traditional home- and office illumination as they provide light using lesser amount of energy.[1] Owing to their energy-efficient nature and brighter displays, they are favourite choice as illumination source for digital devices like smart television, computer monitors, laptops, mobile phone, tablets, etc.[2,3] The technology behind LED sources works on the principle of transfer of a specific amount of energy to a complex semiconductor resulting in emittance of narrow-spectrum light. The narrow-spectrum of light in LED is dominated by short wave-length of blue light.[4,5] In the spectrum of visible light, blue light falls into short wave length category with wavelength ranging from 400-500 nm, which is considered to affect the human eye and is thus considered to be the most harmful component of visible light.[6] The short wavelength of high energy blue light component of LED has the ability to penetrate the retina and bring about irreversible changes as observed in experimental studies.[7,8,9] Interestingly, it has been shown that removal of blue light from the visible spectrum of light could help in decreasing retinal damage after high intensity exposure.[10]

Unfortunately, the younger generation has a direct exposure to LED devices either owing to compulsions of gathering more information, illuminating their study table as well as for communication and entertainment purposes or just for pastime. Smart phone, one of the most commonly used device with risk of direct exposure to LED is widely popular in teenagers. A meta-analysis has recently shown that smart phone addiction in India affects nearly 39% to 44% of teenager population.[11] As far as use of other sources of direct LED exposure are concerned, there is no authentic records available as yet, however, keeping in view the growing use of LED in different digital devices, home and office illumination, smart televisions, *etc.* It can be assumed that the problem is quite underrated and needs an exploration, particularly in view of the possible adverse effects of their direct exposure on vision.

Hence, the present study was carried out with an aim to evaluate the relationship between direct exposure to LED devices with ocular symptoms among secondary school girls aged 15 to 19 years.

MATERIAL AND METHODS

The data for the study was gathered during the eye-camps organized by Muskaan Foundation at a secondary school for girls in Bareilly district of Uttar Pradesh (India). During the camps, a presentation was made where information about dietary and lifestyle practices for protecting good vision was imparted to the participant girls. The girls were also described about the preliminary signs and symptoms suggestive of diminishing vision. Possible risks of use of electronic devices and gadgets having LED as light source

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were also told.

From amongst the 712 girls, aged 15 to 19 years studying in classes 11th and 12th, a total of 176 were excluded from further assessment owing to their unwillingness and/or having a known refractive error for which they were using spectacles. Remaining 536 girls comprising the study population, not using spectacles and not having any known refractive error were included in the study.

Details regarding possible direct exposure to LED light through use of mobile phone, laptop, computer monitor, tablet, video games and/or LED based table lamps during study were obtained. Direct exposure was defined as use of any of these devices from less than 2 feet distance.

They were further enquiring regarding ocular symptoms like headache, pain in eyes, burning sensation, blurring, floaters and eye fatigue. On the basis of pattern of LED exposure the girls were divided into three groups, *viz.*

Group I (Unexposed): Girls having an average daily direct exposure to LED devices for less than 3-4 hours in total and <2 hours in night.

Group II (Daytime exposure): Girls having an average daily direct exposure to LED devices for more than 3-4 hours in total but less than 2 hours in night.

Group III (Nighttime exposure): Girls having an average daily direct exposure to LED devices for more than 2 hours in night irrespective of daytime exposure status.

\The following definitions were used to describe the ocular symptoms:

Night Time users: Girls using any of the above LED devices in the night, generally with other lights switched off/dimmed, for an average duration of 1 hour or more with or without daytime exposure.

SN	Characteristic	Statistic
1.	Mean Age±SD (Range) in years	17.02±1.42 (15-19)
2.	Pattern of LED Exposure	
	Unexposed	238 (44.4%)
	Exposed	298 (55.5%)
	Daytime exposure	186 (34.7%)
	Nighttime exposure	112 (20.9%)
3.	Ocular symptom profile	
	Headache	184 (34.3%)
	Pain	183 (34.1%)
	Blurring	141 (26.3%)
	Floaters	133 (24.3%)
	Burning sensation	233 (41.6%)
	Eye fatigue	209 (39.0%)
4.	Total number of symptomatic girls	387 (72.2%)

Table-1: Age profile, Pattern of LED exposure and Ocular Complaints in study population (n=536)

Headache: Headache was defined as history of any medication (analgesic tablet/pain balm application) for three times of more during the last three months.

Pain in eyes: Recurrent pain in and around eyes.

Blurring: Difficulty in routine vision / while watching television or using digital device, during classroom.

Floaters: Presence of spots/fiber like floating structures. For this the girls were asked to close their eyes and open it while watching towards a white wall or against the sky.

Burning Sensation/Itchiness/Watery eyes

Eye fatigue: Feeling of heaviness of eyes/eyelids. Feeling of comfort in closing eyes even when not using them constantly.

Girls with presence of any of these symptoms were termed as symptomatic whereas absence of all these symptoms were termed as asymptomatic.

Data so obtained was subjected to analyzed seeking correlation between pattern of direct exposure to LED device and ocular complaints noted.

STATISTICAL ANALYSIS

The data was analyzed using Statistical Package for social sciences version 21.0. ANOVA and Chi-square tests were used to compare the data. A "p" value less than 0.05 indicated a statistically significant intergroup difference.

RESULTS

Age of girls ranged from 15 to 19 years. Mean age of girls was 17.02±1.42 years. A total of 298 (55.5%) had direct exposure to LED. Prevalence of ocular symptoms like headache, pain in eyes, blurring, floaters, burning sensation and eye fatigue was 34.3%, 34.1%, 26.3%, 24.3%, 41.6% and 39% respectively. Total No. of symptomatic girls was 387 (72.2%). With respect to exposure, daytime and nighttime exposure, the number of girls in Groups I (unexposed), II (Daytime exposed) and III (nightime exposed) was 238 (44.4%), 186 (34.7%) and 112 (20.9%) respectively (Table 1).

In Groups I, II and III the proportion of symptomatic girls was 43.4%, 94.1% and 99.1% respectively (p<0.001) (Table 2).

Proportion of girls with symptoms like headache, pain, blurring, floaters, burning sensation and eye fatigue was 21.8%, 18.9%, 8.0%, 2.5%, 23.1% and 18.1% respectively in Group I, 37.6%, 51.1%, 37.5%, 33.9%, 33.9%, 54.3% and 59.7% respectively in Group II and 55.4%, 38.4%, 46.4%, 41.1%, 59.9% and 49.1% respectively in Group III. Statistically, for all the ocular complaints, the proportion of those in Groups II and III was significantly higher as compared to that in Group I (p<0.001). Mean number of

SN	Symptoms	Group I (Unexposed) (n=238)	Group II (Daytime Exposure) (n=138)	Group III (Night time exposure) (n=112)
1.	Asymptomatic	137 (57.6%)	11 (5.9%)	1 (0.9%)
2.	Symptomatic	101 (43.4%)	127 (94.1%)	111 (99.1%)
$\div^2$=189.832; p<0.001				

Table-2: Comparison of presence of ocular symptoms among different study groups

SN	Symptoms	Group I (Unexposed) (n=238)	Group II (Daytime Exposure) (n=138)	Group III (Night time exposure) (n=112)	Statistical significance
1.	Headache	52 (21.8%)	70 (37.6%)	62 (55.4%)	$\div^2$=39.31; p<0.001
2.	Pain in eyes	45 (18.9%)	95 (51.1%)	43 (38.4%)	$\div^2$=49.185; p<0.001
3.	Blurring	19 (8.0%)	70 (37.5%)	52 (46.4%)	$\div^2$=76.923; p<0.001
4.	Floaters	6 (2.5%)	63 (33.9%)	46 (41.1%)	$\div^2$=93.22; p<0.001
5.	Burning sensation	55 (23.1%)	101 (54.3%)	67 (59.9%)	$\div^2$=61.15; p<0.001
6.	Eye fatigue	43 (18.1%)	111 (59.7%)	55 (49.1%)	$\div^2$=82.08; p<0.001
7.	Mean Total No. of symptoms±SD	0.92±1.35	2.74±1.49	2.90±1.31	F=120.44; p<0.001

Table-3: Comparison of ocular symptom profile among different study groups

symptoms was 0.92±1.35, 2.74±1.49 and 2.90±1.31 in Groups I, II and III respectively (p<0.001) (Table 3).

DISCUSSION

The present study showed a high prevalence of direct exposure to LED among teenaged girls with as many as 55.5% showing direct exposure to LED. Although, with increasing emphasis on use of energy-efficient LED lights for the purposes of home and office, in general the exposure to LED has shown a tremendous increase over the last few years, however, with its growing use in personal devices such as laptops, computer monitors, tablets, smartphones, desk illuminating systems, its exposure from close range has increased substantially. There have been reports regarding the widespread use of personal computers, laptops, and smartphone use in secondary school students as well as college students throughout India and abroad for leisure as well as academic enrichment.[11-17] In a recent study, the average mobile phone usage was reported to be >4 hours by 75% of youths.[17] Considering, the fact that almost none of the teenaged secondary school students are nowadays unexposed to these smart devices, the definition of usage needs to be extended beyond the point of "users" and "non-users" and hence we tried to objectively defined the level of exposure in terms of average hours of daily use in day and night. We kept average daily use >3-4 hours to be significant for the purpose of defining active direct exposure to LED device as it was found to be the time span generally spent by the teenagers on these devices.[11,17] Usage of mobile phone for >2 hours has been defined to be addictive,[18] and keeping in view this fact we assumed that usage >3-4 hours in a day or >2 hours at night is addictive in nature and could be perceived as a continuing phenomenon among the users.

The present study found majority of girls to be symptomatic (72.2%). The stress induced by use of computer or digital devices is often termed as digital / computer eye strain and is manifested in terms of headache, burning sensation, tired eyes and its prevalence has been reported to be nearly 50-70% among computer users.[19-22] A high prevalence of these symptoms in present study could be owing to the fact that we were evaluating this stress among those who had direct exposure to LED devices which are reported to have a dominance of blue spectrum of light which is considered to be harmful for ocular health.[4-10] As such use of personal devices, employing LED screen, such as mobile phone have been shown to result in higher symptomatic manifestations. Sadagopan et al., who studied this problem exclusively in cell phone using College students found this prevalence to be as high as 80% among those using cell phone for >2 hours per day.[23] In our study, a total of 55.5% girls were using LED based device for more than 3-4 hours per day and/or were having night usage for >2 hours while a large proportion of other girls also used these devices but for less than this period hence the symptomatic manifestation in our study is slightly higher than the average of previous studies.

In present study, we found that prevalence of symptoms was affected by usage pattern, i.e. it was minimum among those categorized as unexposed (43.4%) followed by those having daytime exposure (94.1%) and maximum among those who had night-time exposure (99.1%). The higher prevalence of these symptoms among those in night time exposure despite taking >2 hrs usage as the criteria (which is lesser than >3-4 hours for daytime exposure) could possibly be owing to the fact that most of the girls reporting night time exposure had a high daytime exposure too. Moreover, the possibility of high direct exposure of blue spectrum of LED light in night when all the other lights are dimmed can also not be ruled out. Moreover, blue spectrum of LED light, in general and at night, in particular has reportedly been have effect on circadian rhythm and sleep pattern too apart from affecting the eye physiology.[24,25] Blue light of LED devices could also induce photoreceptor damage,[25] could result in melatoninin suppression and affect sleepiness,[26] and could be responsible for insomnia too.[27] In present study, the high prevalence of symptoms like floaters which generally do not fall into the gamut of symptoms covered by computer/digital eye strain.

CONCLUSION

The findings made by our study thus show that direct exposure to digital/LED devices could be responsible for a high symptomatic manifestation, more so, when the usage is quite high. Moreover, night time usage of these devices was found to be more harmful. Some of the limitations of the study were our inability to assess the sleep pattern and general lifestyle of the girls which could play a confounding role. Further studies with inclusion of other variables are recommended.

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