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Research Article **Open Access**

Awareness and Predominance of Blue Light Related Visual Problems Among Undergraduate Medical Students

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Abstract

Objectives:As students spend more time for online class sessions by using computer, they get more prone toblue light exposure.Visual problems among the university students can have an adverse impact on their educational and employment opportunities.The aim of this study is to investigate the blue light exposure and visual problems among the undergraduate university students.
Methods:A cross-sectional study was carried out in a private medical school in the Kedah state, Malaysia. Total of 200 students from pre-clinical years were taken as sample by convenient sampling method.A self-administered structured questionnaire was used, and the data were computerized and analysed by using IBM SPSS Statistics Version 22.
Results: The prevalence of refractive error was 66.6% and the highest problem was short sightedness with astigmatism. Sufficient awareness towards eye problems was noticed among the respondents. More than 90% of the students showed satisfactory knowledge related to the harmful effects of blue light.Dry eyes and recent headache were associated to fluorescent light. Recent visual complaints were depending on computer exposure whilerecent headache was related to mobile use. Worsening of eye problems and computer or projector exposure were found to be associated.
Conclusion: Our study highlights the constrained awareness among novice medical students regarding ocular health. We carefully discerned the pattern of blue light exposure and the prevalence of ocular symptoms and refractive errors in the studied population. Recommendations for further research that can help improve eye health were suggested.

Key words: Blue light, Visual, Problems, Awareness, Knowledge

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INTRODUCTION

Due to the rapid development of Information Technology, electronic gadgets have become vital not only for those who are working but also students. Most schools in Malaysia have adopted teaching and learning via technology as many teachers are well-equipped and readily progressing towards 21st century skills for students.

As students spend more time for online class sessions by using computer, they get more chance to expose to blue light. Blue light can be produced naturally and artificially. High energy blue wavelengths from the sun collide with the air molecules causing blue light to scatter in the atmosphere. In its natural form, blue light helps to increase the feeling of wellbeing. Electronic devices such as cell phones, laptop computer, fluorescent bulbs and LED lights can also emit blue light as artificial sources.1Digital eye strain, disruptions to the circadian rhythm, permanent eye damage and increase risk of diabetes or heart disease can be caused by prolong exposure to electronic devices.2

The effect of blue light on eye was an important concern in recent years and evidence showed that short-wave blue light with wavelength between 415 nm and 455 nm was closely related to ocular damage. The negative consequences of the high energy blue light as it passes through the cornea and lens to the retina were dry eye, cataract, age-related macular degeneration. Hormonal imbalance, and sleep disturbance occur commonly as well. Symptoms such as diplopia and inability to concentrate could affect people's learning and working efficiency.3

According to the recent study, college students spent 8 to 10 hours a day using cell phone almost every day. It was reported that students spent their time texting, sending emails, checking Facebook, and using internet. Moreover, study showed that 86 percent of college students regularly slept with their cell phone, tablet, or laptop. If students failed to protect their eyes, it might lead to serious eye damage and eye disorders later in their life. 4

Refractive errors were the most common eye problem affecting all age groups. According to WHO and recent studies, refractive error was shown to be the first cause of visual impairment and the second cause of visual loss worldwide.5 KS et al., 2016. reported that visual impairment in 101.2 million people and blindness in 6.8 million people in 2010 were because of uncorrected refractive errors. 6

The prevalence of visual impairment was estimated to be 2.7% based on the National Eye Survey Malaysia in 1996.7Fiona Chew et al., 2018,demonstrated that 86.3% of causes of blindness were avoidable based on the study among the elderly Malaysians.8

Exposure to screen technology is unavoidable for digital generation like university students. Spending a great number of hours in front of devices each day for academic, leisure, and social purposes could lead to visual discomfort accompanied by dizziness, headache, red or itchy eyes and inability to concentrate. The length of usage, the posture and the type of device used were also important factors for Computer Vision Syndrome.9 Students should pay attention to eye health to prevent vision issues. Most of the symptoms among the students were temporary while some students continued with reduced vision and that could worsen if not treated properly.10

Young adults are at a vulnerable stage of eye development. Visual problems among the university students can contribute severe impact on their educational and employment opportunities. More economic loss for the country if economically active population is affected with visual impairment. The aim of this study is to investigate the blue light exposure and visual problems among the undergraduate university students.

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METHOD

A cross-sectional study was carried out as a research project from January to August 2019 in a private medical school in the Kedah State of Malaysia. Total of 200 students from pre-clinical years were taken as sample by convenient sampling method. Almost equal proportion of medical students from Year 1 and Year 2 of both gender from different ethnic backgrounds were taken as participants. As for the exclusion criteria, medical students from Year 3 to 5 and students from other courses were not considered as participants. A self-administered structuredquestionnaire was used in this study and the overall Cronbach alpha value for questionnaire was 0.737 based on the test-run. Following data collection, the data were computerized and analysed mainly by Chi-square test by using IBM SPSS Statistics Version 22. The data collection was preceded only after the approval from the institutional ethical committee to conduct this study and the approval number was (FOM/SSM/2019/026). The participants were briefly explained about the objectives of this study, and they were informed the importance of completing the questions precisely and honestly. They were also explained about ethical consideration including the right to withdraw from the study anytime. For any clarification, the mobile contact of two researchers were provided in the questionnaire. This study was conducted in accordance with the Declaration of Helsinki.

RESULTS

Total 200 students took part in this study and 86% participants were from the age group 18-21 and 24% participants from the age group 22-25. The ratio of year 1 and year 2 students in this study was 1:1, comprising 118 Chinese (59%), 81 Indians (40.5%) and 1 Malay (0.5%). There were 112 (56%) of the participants wearing glasses, 71 (35.5%) of them not wearing and 17 (8.5%) of them wearing contact lens.

Based on the findings, 33.5% of the respondents do not have any refractive error and those with refractive errors were 66.5%. Out of 200, 133 students have refractive errors, showing prevalence of 66.5%. Thecommonest problem was short-sightedness withastigmatism (28.5%) and short-sightedness alone was the second highest (27.5%). Far-sightedness and far-sightedness with astigmatism showed equal percentage of 0.5%.

As for the reported vision associate symptoms, 47% of the participants suffering from headache, 31.2% of them suffering from tired eyes, 21.6% of the participants suffering from blurred vision and 0.2% of them suffer from dry eyes.

Knowledge related to the prime source of the blue light were asked to the participants.There were 106 (53%) of them thinking that source of blue light was from computer screen, 83 (41.5%) thought that it was from mobile screen, 8 (4%) believed that blue light was from sunlight, 2 (1%) thought that it came from fluorescent light and 1 (0.5%) of them thinking that the source was from projector screen.

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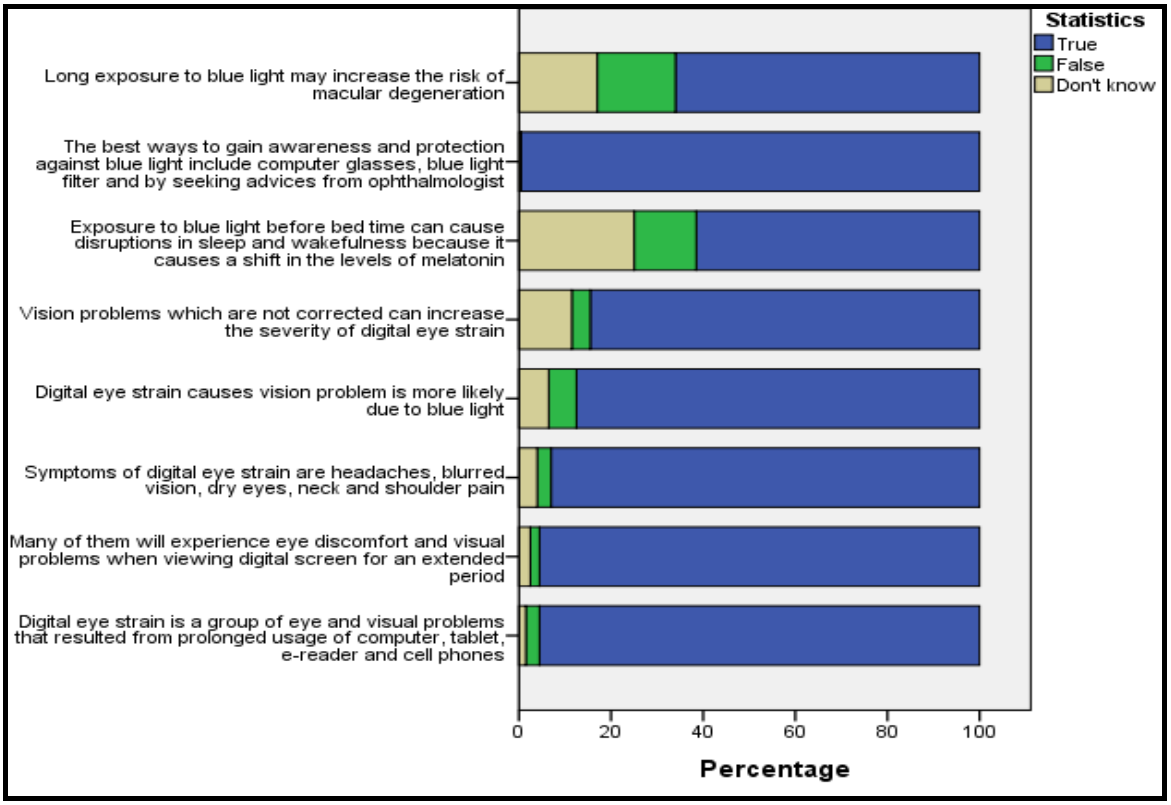

Figure 1. Respondents' awareness toward eye problems

When we tried to ask about awareness towards the eye problems, majority of them were quite aware to protect against the blue light by seeking advice from the ophthalmologist and experiencing eye discomfort and visual problems when viewing digital screen for prolong period. They were aware that digital eye strain is a group of eye and visual problems that result from prolonged usage of electronic gadgets. However, insufficient awareness was seen among the respondents towards certain areas such as pre-bed exposure to blue light and sleep disruption because of a shift in the melatonin levels and exposure of blue light and associated macular degeneration (Figure1).

While assessing knowledge towards the blue light, more than three fourth of the respondents had satisfactory knowledge by choosing strongly agree and agree to the correct statements and for the negative statement, they choose more strongly disagree and disagree (Figure 2).

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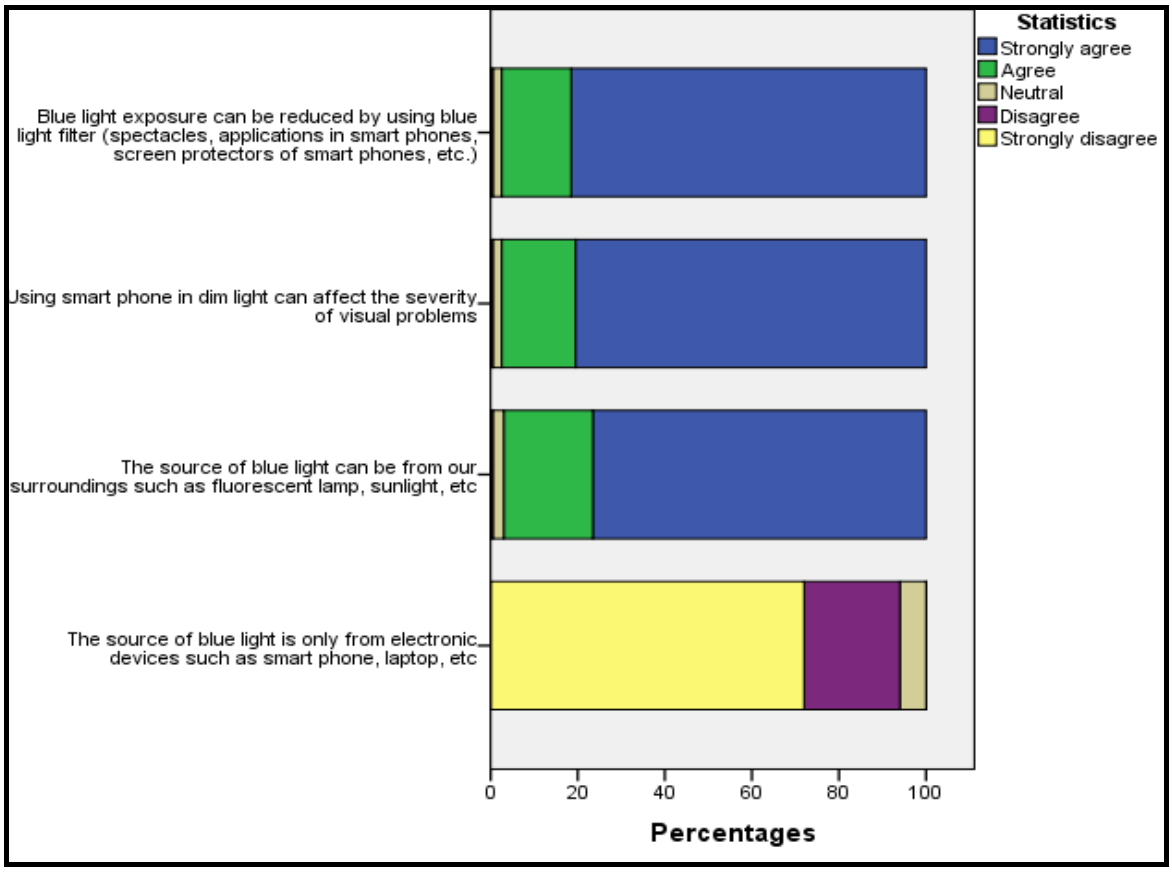

Figure 2. Participants' knowledge towards blue light

Questions were asked to assess the different practice measures to reduce the blue light exposure among the students. Majority of them felt exposed to compact florescent light or LED environment. Approximately half of the respondents tried to adjust the controls on devices to reduce the brightness and wear lenses that help to reduce blue light exposure. Compared to these practices, respondents practiced less on taking breaks while using devices continuous for more than 2 hours. Nearly 40% of the students had never used lenses that help to reduce blue light exposure. (Figure 3)

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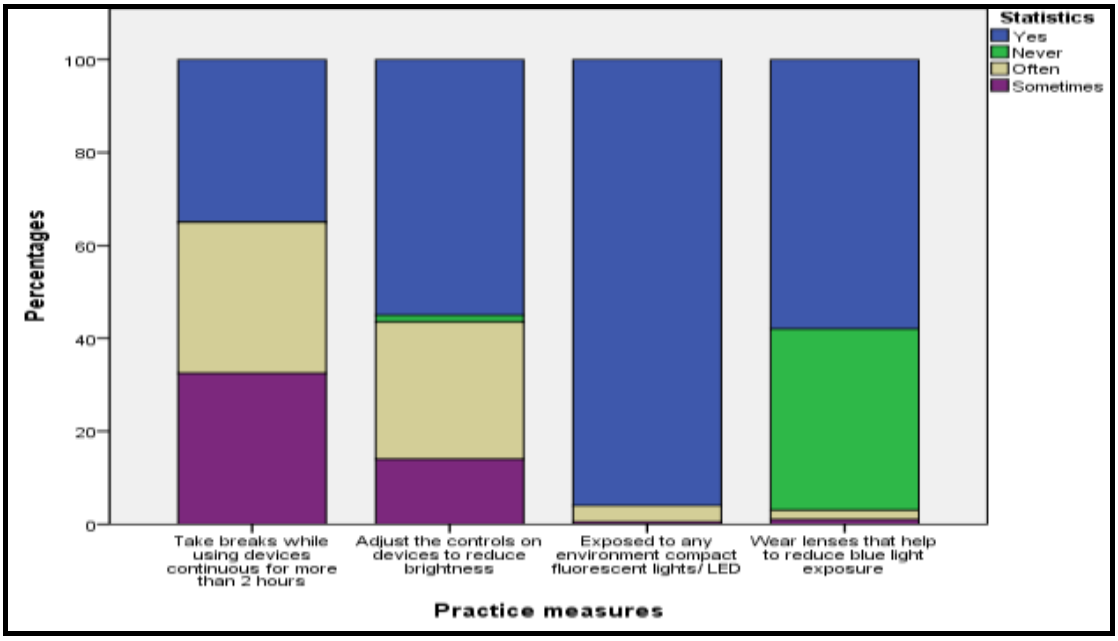

Figure 3. Different practice measures to reduce blue light exposure among the respondents

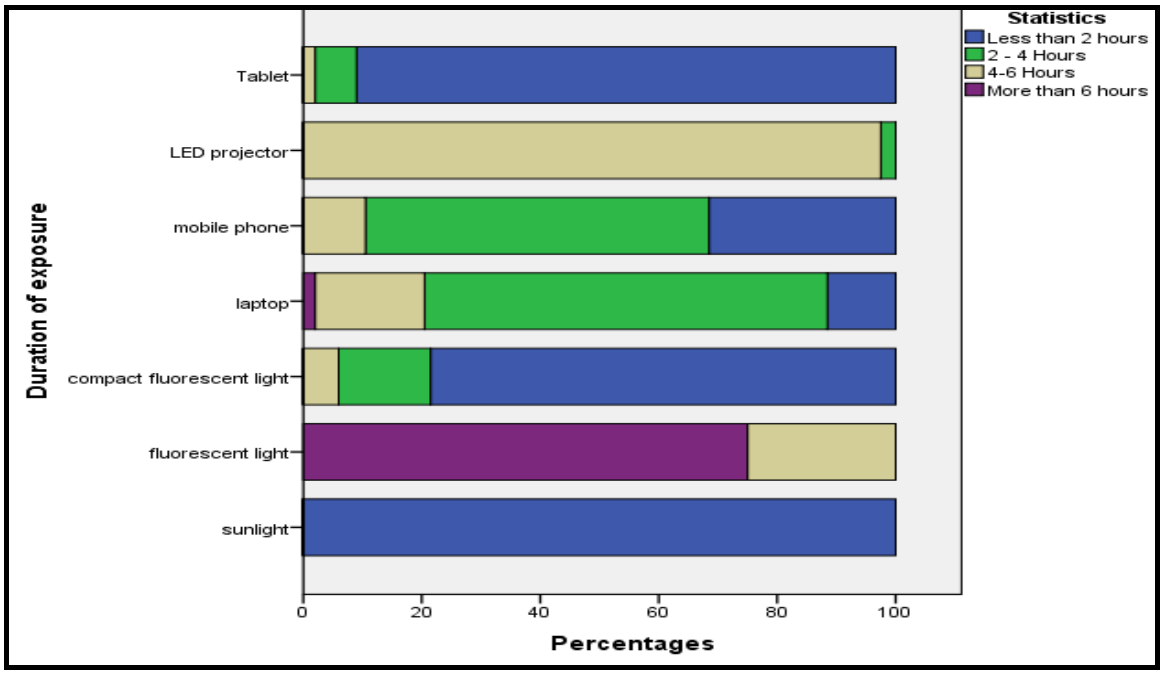

Figure 4. Duration of blue light exposure from each device per day

In this study, all the students exposed to sunlight for less than 2 hours and they got less exposed (<2 hours) to tablets and compact florescent light. Almost equal proportion (60%) of 2-4 hours was seen among the mobile users and laptop users. Four to six hours exposure was highest among LED projector users, showing 97.5%. Three fourth (75%) of the students exposed to fluorescent light for more than 6 hours. (Figure 4)

Out of 200, 62% of the respondents expressed that their eye problems had worsened whereas 38% said no worsening

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eye problem. Chi-square test of association was performed to identify any association between duration of device use and associate eye problems. In this study, no association between duration of device use and watering from the eyes or tiredness of the eyes. Some extents of associations were noticed in the duration of blue light exposure based on recent dry eyes, blurred vision, and headaches.

Table 1. Duration of blue light exposure to different devices by recent dry eyes

	Respondents without dry eyes	Respondents with dry eyes	Total	*P*-value for Pearson's chi-square test
Fluorescent light				
4-6 hours	23	27	50	0.007*
More than 6 hours	101	49	150	
Compact Fluorescent Light				
Less than 2 hours	99	58	157	0.665
2-4 hours	19	12	31	
4-6 hours	6	6	12	
Computer/Laptop				
Less than 2 hours	12	11	23	0.705
2-4 hours	86	50	136	
4-6 hours	24	13	37	
More than 6 hours	2	2	4	
Mobile phone				
Less than 2 hours	41	22	63	0.159
2-4 hours	74	42	116	
4-6 hours	9	12	21	
LED light/ Projector				
2-4 hours	1	4	5	0.05*
4-6 hours	123	72	195	
Tablet				
Less than 2 hours	110	72	182	0.349
2-4 hours	11	3	14	
4-6 hours	3	1	4	

*$p < 0.05$, statistically significant

Based on the findings, significant association was seen in recent dry eyes and exposure to fluorescent light (Pvalue=0.007) and LED light or projector (P value=0.05). Recent dry eyes were not significantly related to exposure to compact florescent light, computer or laptop, mobile phone, and tablet in this study. (Table 1).

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Table 2. Duration of blue light exposure to different devices by recent blurred vision

	Respondents without blurred vision	Respondents with blurred vision	Total	*p*-value for Pearson's Chi-square test
Fluorescent light				
4-6 hours	20	30	50	0.412
More than 6 hours	70	80	150	
Compact Fluorescent Light				
Less than 2 hours	69	88	157	0.292
2-4 hours	13	18	31	
4-6 hours	8	4	12	
Computer/Laptop				
Less than 2 hours	16	7	23	0.020*
2-4 hours	56	80	136	
4-6 hours	18	19	37	
More than 6 hours	0	4	4	
Mobile phone				
Less than 2 hours	27	36	63	0.874
2-4 hours	54	62	116	
4-6 hours	9	12	21	
LED light/ Projector				
2-4 hours	2	3	5	0.820
4-6 hours	88	107	195	
Tablet				
Less than 2 hours	82	100	182	0.967
2-4 hours	6	8	14	
4-6 hours	2	2	4	

*$p < 0.05$, statistically significant

Table 2 showed that recent blurred vision was depending on the exposure of computer or laptop with P-value 0.020. Blurred vision was not significantly related to other gadgets exposure.

Table 3. Duration of blue light exposure to different devices by recent headache

	Respondents without headache	Respondents with headache	Total	*P*-value for Pearson's Chi-square test
Fluorescent light				
4-6 hours	47	3	50	0.02*
More than 6 hours	149	1	150	
Compact Fluorescent Light				

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	Respondents without headache	Respondents with headache	Total	*P*-value for Pearson's Chi-square test
Less than 2 hours	154	3	157	0.783
2-4 hours	30	1	31	
4-6 hours	12	0	12	
Computer/Laptop				
Less than 2 hours	22	1	23	0.797
2-4 hours	134	2	136	
4-6 hours	36	1	37	
More than 6 hours	4	0	4	
Mobile phone				
Less than 2 hours	62	1	63	0.032*
2-4 hours	115	1	116	
4-6 hours	19	2	21	
LED light/ Projector				
2-4 hours	5	0	5	0.746
4-6 hours	191	4	195	
Tablet				
Tablet				
Less than 2 hours	174	4	182	0.817
2-4 hours	14	0	14	
4-6 hours	4	0	4	

*$p < 0.05$, statistically significant

Significant associations were revealed in between exposure to fluorescent light and recent headache (P-value=0.02) and exposure to mobile phone and recent headache with P-value 0.032. In this study, no significant relation between recent headache and exposure to different devices other than fluorescent light and mobile phone. (Table 3).

Table 4. Association between duration of exposure to blue light and worsening of eye problems

	Respondents with worsen eye problem	Respondents without worsen eye problem	Total	*P*-value for Pearson's Chi-square test
Fluorescent light				
4-6 hours	27	23	50	0.178
More than 6 hours	97	53	150	
Compact Fluorescent Light				
Less than 2 hours	100	57	157	0.316
2-4 hours	19	12	31	
4-6 hours	5	7	12	
Computer/Laptop				
Less than 2 hours	8	15	23	0.017*

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	Respondents with worsen eye problem	Respondents without worsen eye problem	Total	*P*-value for Pearson's Chi-square test
2-4 hours	88	48	136	
4-6 hours	24	13	37	
More than 6 hours	4	0	4	
Mobile phone				
Less than 2 hours	39	24	63	0.629
2-4 hours	70	46	116	
4-6 hours	15	6	21	
LED light/ Projector				
2-4 hours	1	4	5	0.05*
4-6 hours	123	72	195	
Tablet				
Less than 2 hours	113	69	182	0.871
2-4 hours	9	5	14	
4-6 hours	2	2	4	

*$p < 0.05$, statistically significant

Findings revealed that worsening of eye problems among the students were associated to exposure of computer and laptop showing P-value 0.017 and worsened eye problems were also associated with LED light or projector exposure, comprising P-value of 0.05. Therewas no association between exposure to other devices and eye problem worsening. (Table 4)

DISCUSSION

Ametropia was of common occurrence in the studied population. Out of 200, 133 students have refractive errors, and the commonest reported error was Myopia with Astigmatism (42.86%), and Myopia alone is the second highest (41.35%) – total of 82.41%. An earlier study at the same institute reported similar prevalence and distribution of refractive errors; the prevalence of refractive errors was 32.24 % (C.I.:27.79% to 36.69%). Myopia (87.6%) was the most common refractive error with prevalence of 28.23 % (C.I.:23.96% to 32.5%). The prevalence of refractive errors and myopia were found more common in Chinese (47.1% and 43.8%) than Indian (25.8% and 21.3%) students.11 157 second year medical students (aged 19-23 years) in Singapore were examined and refractive error measurements determined the prevalence rate of myopia was 89.8 percent. Hyperopia was present in 1.3 percent of the participants and the overall astigmatism prevalence rate was 82.2 percent.12 A cross sectional study involving fifth year medical students in Nigeria was done to determine the prevalence of refractive errors and spectacle use behaviour among medical students and reported Sixty-six (79.5%) of subjects had a form of refractive error; 63.6%%, 16.7% and 19.7% were myope, hyperope or simple astigmatism, respectively.13 Myopia was found to be the commonest error of refraction 53.7% with hyperopia next to it in a cross-sectional descriptive study conducted at Qassim University, Saudi Arabia over a study population comprising 162 male and female medical students from different academic years. 13 off the 133 respondent who reported having a refractive error, 112 reported wearing corrective glasses where as17 use contact lenses and 4 of them do not wear any refractive correction. It is not uncommon to find young adults with a mild to moderate refractive error not wearing any

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correction; this perhaps is due to non-acceptance, cosmetic disadvantage, and the fact that they can manage their daily activities without any optical aid.

In this study, 47% of the participants reported suffering from headache, 31.2% of them suffering from tired eyes, 21.6% of the participants suffering from the blurred vision and 0.2% of them suffer from dry eyes. All these are recognised features of asthenopia or ocular tiredness. Asthenopia symptom appears to be common among college students; and it is strongly associated with computer use, psychosocial state, environment conditions. Aakre and Doughty assessed the association between self-reported symptoms of asthenopia and video display terminal (VDT) use. Their results indicated that the people reporting experiencing some visual symptoms or specific ocular symptoms sometimes were 70.0% and 82.5%, respectively.14 Fifty-seven percent of the college students complained of asthenopia in a study from Xi'an, China as reported by Han CC et al.15 Most frequent asthenopic symptoms were headache 28(93%), blurred vision 27(90%), Discomfort 27(90%) tiredness of eye 21(70%), Slowness of focus 23(78%) in a recent study from Pakistan that was done to find out the frequency of presenting clinical features of asthenopia.16

When enquired about the knowledge related to the source of the blue light 53% of them thought that the primary source of blue lights is from computer screens whereas 41% intuited that the blue light that they get exposed to, is from their mobile screens. There are multiple sources of blue light in the environment, and this is exceedingly important in this digital age where the use of handheld devices or computers is a routine practice.

Most of the students were aware of “digital eyestrain” as a symptom complex and the features related thereof. They were also cognizant of the fact that such features may become prominent with the extended use of digital screens and 87% of them understood that digital eyestrain is more likely due to the blue light exposure. However relatively a smaller number of them were conscious that exposure to blue light before bedtime can cause disruptions in sleep and wakefulness because it causes a shift in the levels of melatonin and that long exposure to blue light may increase the risk of macular degeneration as reported by many studies.16,17

In our study, 96.0% claimed getting exposed to some form of environmental factor or fluorescent lights/ LED. The results of a recent study among citizens of Hangzhou, China showed that most people were not aware of the dangers of blue light, and many people had more or less certain eye problems.18 As regards the practice measures taken by the students to reduce blue light exposure, only 35.0% claim to take breaks while using devices continuous for more than 2 hours. 55.0% reported adjusting the controls on devices to reduce brightness while 58.0% wore lenses that help to reduce blue light exposure. The blue light hazards of electronics display screen have been concerned by people, and the corresponding protection of the blue light hazards has become the need of consumers. The protective effect of blue light filters has been documented by many studies viz. Margrain, T. H., Boulton, M., Marshall, J., & Sliney, D. H. (2004), Glazer-Hockstein, C., &Dunaief, J. L. (2006). 19,20

The majority (75%) in the group were exposed to fluorescent light for an average of more than 6 hours each day. 97.5% were exposed to 4-6 hours/day to LED projectors. The time spent on mobile phones, laptops and tablets was astonishingly less as compared to the national average. Significant classroom-based activities with more face-to-face teaching learning activities were perhaps a key contributing factor.

CONCLUSION

In this era of digitalization and with the current pandemic, which has

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tremendously increased the use of electronic devices, the deleterious effects of blue light on eye health have become a significant public health problem.The young college going population – the Generation Z, being extremely "tech-savvy" are particularly at risk. We carefully discerned the pattern of exposure and the prevalence of ocular symptoms and refractive errors in the studied population. Our study highlights the limited awareness among novice medical students regarding such issues.Further studies are required that perhaps should include young adults from various varsities and the general population. Newer approaches to educate and ameliorate eye health amongst young adults also need to be established.

Conflict of interest

No conflict of interest.

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