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BLUE LIGHT AND PROTECTION AWARENESS AMONG UNIVERSITY STUDENTS: A SURVEY STUDY

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Abstract

Objectives: Our study aimed to evaluate the awareness levels of university students about the harmful effects of blue light and protection methods.

Materials and Methods: A cross-sectional survey study consisting of 20 questions was conducted online to university students in Ankara. After obtaining basic information about the participants, questions related to the hazardous effects of blue light, blue light sources, blue light filters and protectors were directed.

Results: A total of 387 participants were included in the study. 75.1% of the students thought of vision problems as the most harmful effect of blue light and phones, computers and televisions as blue light sources (93.8%). 58.8% of the students were using the blue light filter, 67.6% knew about blue light protective glasses, and only 26.9% were wearing them. The average daily computer, smartphone and television usage time was 3.18 hours, 5.2 hours and 0.5 hours, respectively. 71.5% of the students were taking breaks when using electronic devices, while 28.5% were not. 56.2% of the students were experiencing tired eyes, 49.7% headaches, 31.9% blurred vision, 30.8% dry eyes and 30.3% insomnia. 95.1% of the students were adjusting their settings to reduce the brightness. Students in medical fields were more aware of blue light-related sleep problems and blue light protective glasses than students in other fields.

Conclusion: Awareness of blue light was moderate among university students, however awareness of protective methods was lower. This study will contribute to increasing awareness on this issue in terms of protecting the health of young people, and subsequently general society.

Keywords: Blue light, digital devices, awareness, protection methods, university students

Introduction

Blue light is a type of high-energy visible electromagnetic wave that possesses a wavelength between 380 and 495 nm, and it is an important part of natural light. Despite its beneficial effects on the human body (keeping alertness and cognitive performance) during the day, blue light overexposure, especially before bedtime, has harmful side effects.[1,2] In the modern-day world, there are many blue light sources that are unnatural but have a great influence on human life and cause overexposure, and their number is increasing. These sources include smartphones, tablets, laptops, fluorescent lamps, light-emitting diodes (LEDs), liquid crystal displays (LCDs), mobile phone displays, modern flat panel displays and so on.[3]

In recent years, it has been noticed that blue light is especially harmful to the human eye and has caused concern.[4] It has begun to be argued that it causes many eye problems, from digital eye fatigue to macular degeneration, thus irreversible damage to the vision.[4] One of the situations of concern is that the percentage of transmission of blue light from the corneal surface to the retina is higher in children and teenagers than in adults.[3] In addition, its harmful effects on the brain and circadian rhythm, and therefore, sleep patterns have become seriously considered.[5] Disruption of the circadian rhythm, which is the body's internal clock that regulates the sleep-wake cycle, is thought to be caused by the harmful effects of blue light on the production of melatonin, a hormone involved in sleep regulation.[5] Difficulty in falling asleep, staying asleep and experiencing poor sleep quality have been associated with the blue light exposure in the evening or at night which is caused by melatonin production suppression process.[5] Prolonged exposure may cause chronic sleep disturbances, which may result to have increased risk of mood disorders and other health issues in people.[5]

A limited number of studies have highlighted the need for increased awareness and education on the potential health risks of blue light exposure.[6,7] By collecting information on knowledge and behavior related to blue light exposure, it is possible to gain a better understanding of the public's perception of the issue and identify potential areas for education and intervention. However, according to our knowledge, no study has been conducted to evaluate the level of blue light awareness among university students, who are the population that has the potential for longer exposure to electronic devices and has the capacity to direct the progress of society.

The purpose of this survey is to evaluate the awareness level of university students about blue light, its harmful effects and protection methods.

Materials and Methods

Participants and Design:

This cross-sectional survey study was conducted online after receiving ethical approval from the Ankara Bilkent City Hospital Ethics Committee (Approval number: E2-22-1502). The survey was designed by the Ankara Yildirim Beyazit University Ophthalmology and Neuroscience Departments. Google documents were used as a platform to create online questionnaires that were automatically hosted via a unique URL. The survey was shared via e-mail and social platforms, ensuring the participation of university students living in Ankara. The survey included 20 questions in total. Participants were first asked to confirm their willingness to participate, and then those who agreed were able to continue with the self-report survey. The questions were aimed at revealing the characteristics and basic information of the participants, their awareness of blue light and its harmful effects, and their knowledge of protection methods. Questions were asked in both English and Turkish language in order to reach as many respondents as possible.

Questionnaire:

1- I voluntarily agree to participate in this survey (Yes/No)

2- What is your age group? (18-25/ 25-30/ 30-35/ >35)

3- What is your gender? (Male/Female)

4- Do you smoke or use alcohol? (Yes/No)

5- Do you have any chronic disease (such as diabetes, hypertension, glaucoma, etc.), any medical condition that requires medication or use any medication (including supplements)? (Yes/No)

6- What is your level of education? (Undergraduate student/ Master student/ PhD student)

7- Which university do you study in?

8- What is your education field?

9- What are the most hazardous effects of blue light? (Brain damage/ Sight problem/ Sleep problem/ Aging/ Cancer/ Spinal pain)

10- Which of the following do you believe are the sources of blue light? (Phone, computer, TV/ Printer/ LED light/ Bathroom heater/ Gaming machine/ Do not know)

11- How often do you use the blue light filter option on your phone? (Always/ During the day/ During the night/ Never)

12- Have you ever heard about blue-light protective eyeglasses? (Yes/No)

13- The question is corrected as "Would you use these glasses? If you wouldn't, why? Choose one of the following". (I would use/I already use/Wouldn't use since feeling no difference between the two/Wouldn't use since feeling useless)

14- What is your daily computer usage time?

15- What is your daily smartphone usage time?

16- What is your daily television usage time?

17- Do you take breaks while using these devices for more than 2 hours? (Yes/No)

18- Do you suffer from one or more of the following conditions? (Dry eyes/Watery eyes/Tired eyes/Blurred vision/Headaches/Insomnia)

19- Do you adjust the settings on your device to reduce the brightness? (Yes/No)

20- Do you have compact fluorescent lights (CFL) or LED lights in your house? (Yes/No)

Statistical Analysis:

SPSS Statistics 22.0 was used for the statistical analysis. Responses were calculated as percentages. For the comparisons between the two groups, a chi-square test was performed. A p value lower than 0.05 was considered as statistically significant.

Results

A total of 535 responses were collected via an online questionnaire. One hundred forty-eight respondents were excluded for either smoking, using alcohol, having any chronic disease (such as diabetes, hypertension, glaucoma, etc.) or using any treatment (including supplements). We included participants only ≤35 years of age, and the largest proportion of respondents (74.6%) were in the 18-25 age range, while 9.8% were 25-30, and the rest were in the 30-35 age range. 70.9% of the survey participants were female and 29.1% were male. Among the 20 responding universities, students from Ankara Yildirim Beyazit University provided most of the participation (60%). Considering the education level of the study participants, 85.2% were undergraduate students, 9.1% were master students, and the remaining 5.7% were PhD students.

Figure 1: A: Awareness about the most hazardous effect of blue light **B:** Awareness about the sources of blue light

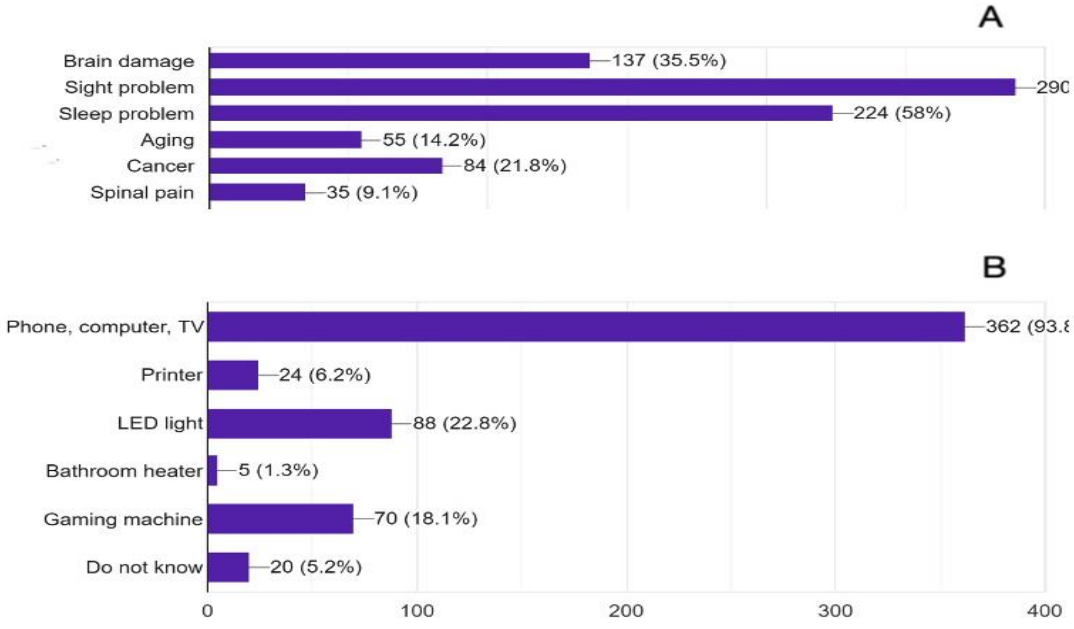

Figure 1A shows the responses about the most hazardous effects of blue light. For this question, the respondents were able to choose multiple answers. According to the data, respondents thought that the most harmful effects of blue light were vision problems (75.1%), sleep problems (58%), brain damage (35.5%), cancer (21.8%), aging (14.2%) and spine pain (9.1%).

Figure 1B shows the percentage of respondents who replied about the sources of blue light. For this question, the respondents were able to choose multiple answers. The data shows that 93.8% of the respondents thought that the sources of blue light were phones, computers and televisions. On the other hand, 22.8% thought that the LED light was a source of blue light, 18.1% thought that the gaming machine was a source, 6.2% thought that the printer emits blue light, and 1.3% thought that blue light could be generated from the bathroom heater. 5.2% of the respondents chose that they did not know the sources of blue light.

Figure 2: A: Usage of blue light filter by the participants **B:** Previous knowledge about blue light protective eyeglasses **C:** Participants thoughts about using blue light protective eyeglasses

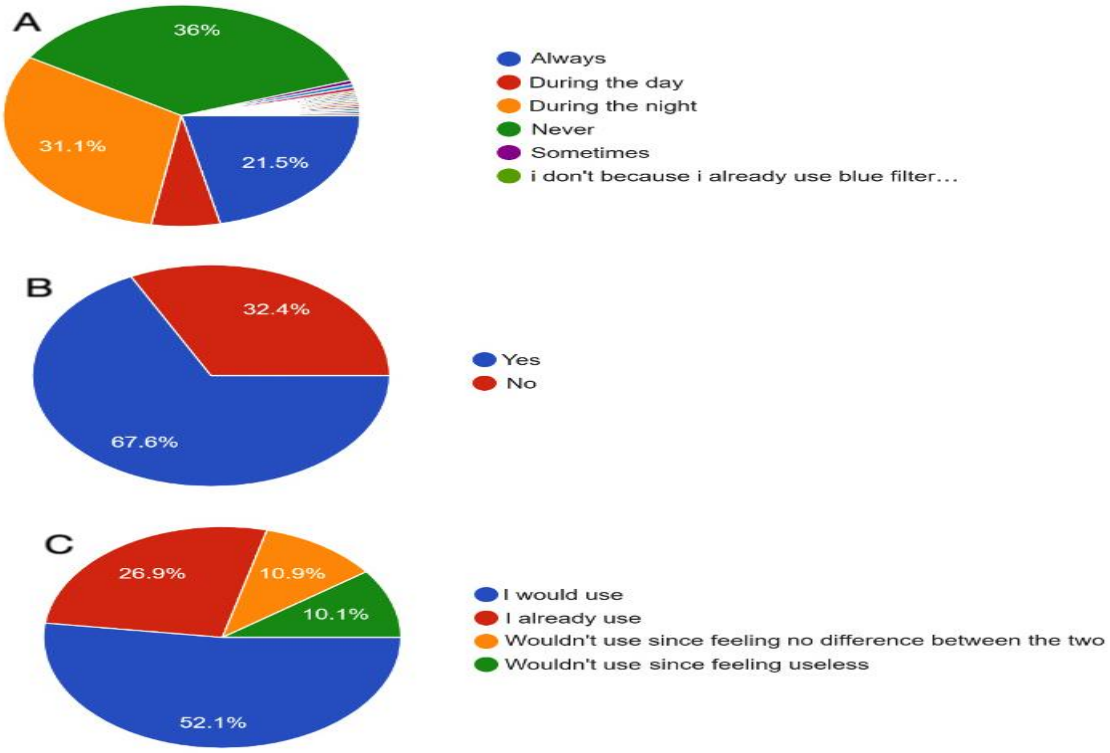

Figure 2A shows how often the respondents were using the blue light filter option on their phones. 36% said that they never use the blue light filter, while 31.1% were using it during the night, 21.5% of the respondents using the blue light filter all the time, and 6.2% said that they use the filter during the day hours. The rest, 5.2%, of respondents gave other insignificant answers. This indicates that more than half of the participants were using the blue light filter, and 52.6% of them used it during the night, which is the most recommended time to use the blue light filter.

Figure 2B shows the percentage of respondents who have heard about blue-light protective eyeglasses before. The data showed that 67.6% of the participants knew about blue light protective glasses, while 32.4% hadn't heard about it before.

Figure 2C shows the responses of the participants to question 13: "Would you use the blue light glasses, and do you think that it is protective?". More than half (52.1%) indicated that they would use it, and 26.9% said that they were already using the blue light filtering eyeglasses. However, 10.9% said that they won't use it because they can't find any difference from the normal eyeglasses, and 10.1% wouldn't use it because they think that it is useless.

Figure 3: Participants daily **A:** computer, **B:** smartphone, **C:** television usage time

Figure 3A shows the daily computer usage (in hours) of the participants. The average is 3.18 hours, with a minimum of 0 hours (82 responses) and a maximum of 14 hours (1 response). The most common number of hours of daily usage is 0 hours, with a total of 82 participants indicating that they don't use the computer daily. Figure 3B shows the daily usage of smartphones (in hours) by the participants. The average is 5.2 hours, with a minimum of 0.5 hours (2 responses) and a maximum of 15 hours (15 responses). The most common number of hours of daily smartphone usage is 5 hours, with a total of 74 participants. Figure 3C shows the daily usage of television (in hours) by the participants. The average time is 0.5 hours, with a minimum of 0 hours (267 responses) and a maximum of 6 hours (1 response). The most common time spent daily watching television is 0 hours, with a total of 267 participants.

Figure 4: A: Participants who take breaks or not while using blue light emitting devices for more than 2 hours **B:** Conditions experienced by participants after long screen time

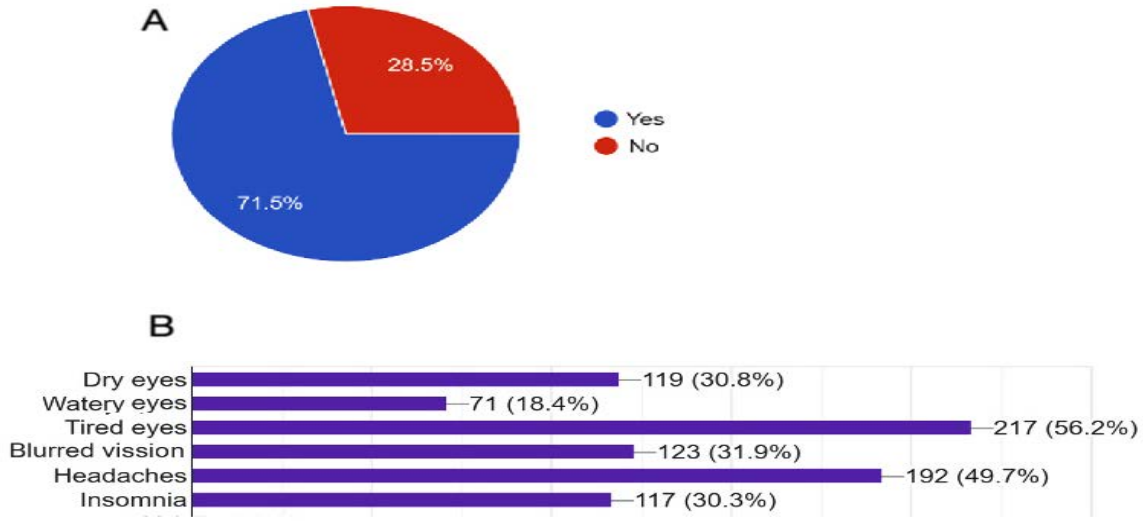

Figure 4A shows the responses of the participants to the question: "Do you take a break while using these devices for more than 2 hours?". More than half (71.5%) indicated that they take breaks when using electronic devices for more than 2 hours. However, 28.5% of the participants said that they don't take breaks while using blue light-emitting devices for long hours.

Figure 4B shows the most visual and neurological symptoms that the participants experienced after using blue light-emitting devices for long hours. For this question, the respondents were able to choose multiple answers. More than half of the respondents (56.2%) said that they experience tired eyes, 49.7% of the participants mentioned that they suffer from headaches, 31.9% said that they experience blurred vision, 30.8% said that they get dry eyes, 30.3% mentioned that they suffer from insomnia, and 18.4% were experiencing watery eyes. On the other hand, 8.03% of the participants indicated that they don't experience any of the symptoms mentioned above.

Figure 5: A: Percentage of participants that adjusted their settings or not to reduce the brightness of their devices. **B:** Participants who have compact fluorescent light (CFL) or LED light in their houses or not

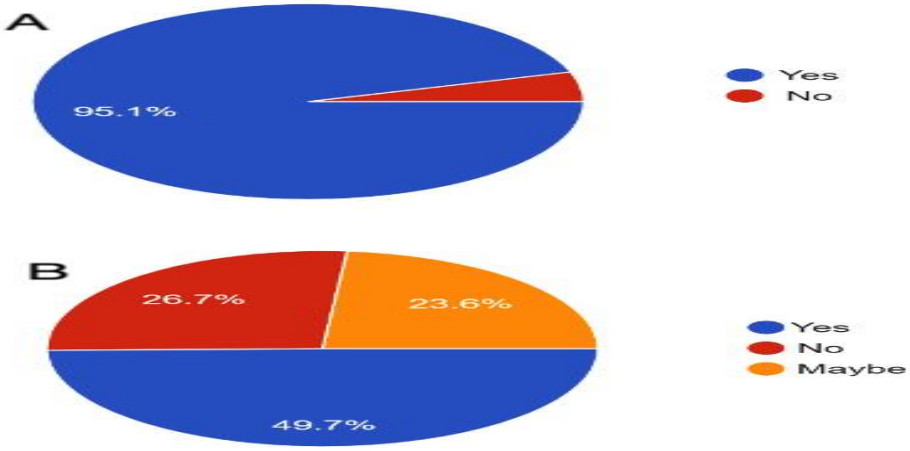

Figure 5A shows the percentage of respondents who adjust the settings on their devices to reduce the brightness. Most of the participants (95.1%) mentioned that they do adjust their settings in order to reduce the brightness, while the other 4.9% said that they don't often reduce their devices' brightness.

Figure 5B shows the percentage of participants who have compact fluorescent lights (CFL) or LED lights in their houses. 49.7% mentioned that they do have CFL or LED lights in their houses, while 26.7% said that they don't have CFL or LED lights, and 23.6% indicated that they are not sure whether they have these lights or not.

Lastly, we divided the participating students into two groups, studying medicine or other fields. A comparison of results between these two groups is given in Table 1. Participants in both medical and other fields thought that the most harmful effects of blue light were sight problems (72.19% vs. 79.26% and p:0.19), sleep problems (64.12% vs. 49.39% and p:0.01) and brain damage (32% vs 40.85% and p:0.54), respectively. Participants in both medical and other fields thought that sources of blue light were phone/computer/TV (93.27% vs. 94.51% and p:0.85), LED light (20.17% vs. 26.82% and p: 0.16) and gaming machines (15.24% vs. 21.95% and p: 0.07), respectively. The frequency of using the blue light filter option on their phones was higher among students in the medical field (61.42% vs. 55.5% and p>0.05), while the rate of never using them was higher among students in other fields (34.52% vs. 39.02% and p>0.05). Students in the medical field were significantly more aware of the existence of blue light protective glasses than students in other fields (75.33% vs. 56.70% and p<0.001), while students in other fields believed more that these glasses were protective and they could use (49.77% vs. 56.09% and p>0.05).

Table 1: Comparison of responses between students in the medical field and other fields

Questions and Responses	Students in the	Students in Other	p-
What are the most hazardous effects of blue			
Brain Damage	%32	%41.36	0.54
Sight Problems	%72.57	%78.39	0.19
Sleep Problems	%63.27	%50.61	**0.01**
Cancer	%22.57	%20.37	0.60
Aging	%17.69	%9.25	**0.02**
Spinal Pain	%7.08	%11.73	0.12
Don't Know	%0.88	%1.85	0.41
Which of the following do you believe is a			
Phone, computer, TV	%93.36	%93.83	0.85
Printer	%3.09	%9.25	**0.01**
LED light	%19.91	%25.93	0.16
Bathroom Heater	%0.88	%1.85	0.41
Gaming Machine	%15.04	%22.22	**0.07**
Don't Know	%5.31	%5.55	0.92
How often do you use the blue light filter			
Always	%20.79	%21.60	0.85
During the day	%5.31	%7.41	0.40
During the night	%33.63	%26.54	0.14
Never	%34.95	%36.42	0.77
Other	%4.42	%6.17	0.44
Have you ever heard about blue-light			
Yes	%75.66	%55.55	**<0.001**
No	%23.89	%44.44	**<0.001**
Would you use these glasses, and do you think			
I would use	%50.00	%56.17	0.23
I already use	%28.32	%24.07	0.33
Wouldn't use it since feeling no difference	%11.06	%11.11	0.99
Wouldn't use it since feeling useless	%11.94	%8.02	0.21

Discussion

Increased screen time due to the acceleration of digitalization after the COVID-19 epidemic and quarantine has further increased concerns about the harmful effects of blue light.[8] As such, it has become more essential that awareness must first be increased in order to be protected from the harmful effects of blue light. Afterward, the effect of blue light can be reduced by some methods, such as blue light-proof glasses and blue light-proof screen membranes. Although there are many types of blue light sources today, and we are highly exposed to them, our awareness and use of these protective methods are still very low. This awareness becomes even more important, especially among university students, where screen use is more common than in the general population. However, to date, no study has investigated the blue light awareness of this special group.

In this study, it was revealed that the majority of university students were aware of blue light-related vision (75%) and sleep problems (58%). Interestingly, 9.1% of the participants replied spinal pain was a consequence of blue light exposure, although it was not a relevant outcome. According to the review conducted by Wahl et al., chronic low-intensity blue light exposure right before bedtime may have substantial consequences on the circadian cycle and sleep quality.[5] Recently, a survey study conducted on children aged 1-3 years showed that the use of electronic devices that emit blue light in the dark just before bedtime affected sleep time by 16.5%.[9] Moreover, a recent review study emphasized that even just preventing blue light exposure at night, many metabolic and hormonal disorders, including circadian rhythm, can be controlled, mental health and cognitive performance can be improved, and even skin problems and the effects of premature aging can be reduced, and ultimately the quality of life can be increased.[10]

As for the sources of blue light, in our study, 93.8% of the students knew that blue light was sourced from screens such as phones, computers and televisions. This information was verified by previous research.[11] Despite their knowledge about the issue and its sources, their awareness about protection methods such as blue light-proof glasses was still low (67%), and the use of this protection method was even lower (27%). Although mobile phones are widely used devices and are known to emit serious blue light by students, only 21% of them use the blue light filter option on their phones routinely, and even 36% do not use it at all. Highlighting the importance of blue light filter use, a recent randomized clinical trial conducted on medical sciences workers showed that Pittsburgh Sleep Quality Index and Visual Function Questionnaire results were significantly improved after three months of use of blue light screen filters.[12] On the other hand, in our study, the collective average of screen time for university students was found to be around 8.88 h/day (3.18 + 5.2 + 0.5). This is relatively greater than that of the global screen time, which was recorded at about 6.96 h/day.[13] Nevertheless, our results indicate that most of the students were aware of the need to take screen breaks and reduce the brightness of their screens. Sheppard et al. suggest a range of management approaches for digital eye strain caused by prolonged screen exposures, which includes regular screen breaks and the consideration

of accommodative problems.[14] Analogously, Smith et al. found that decreasing the brightness of the screen was effective in reducing blue light.[15] In our study, the majority of students reported that they experienced tired eyes and headache symptoms when using the screen for long hours. These results go side to side along the findings of Erdinest et al., where the computer vision syndrome was explained, including eye fatigue, eye strain, blurred vision and headaches.[16]

Additionally, in this study, the collected responses were further analyzed by comparing the responses of those in the medical field with those of respondents within other fields. According to the results, students in the medical field were more aware of the sleep problems caused by blue light (64.12%) than those in the other fields (49.39%). This might be due to the information taught within the curricula about the circadian rhythm and the effect of blue light on melatonin. On the other hand, students in the nonmedical fields have a slightly better background regarding the source of blue light (94.51% for phones, computers and TV and 26.82% for LED lights). The usage of blue light filters shows a similar pattern in terms of both criteria. More respondents from the medical field, however, stated that they use blue light filters at night (34.52%), which also demonstrates their understanding of the circadian cycle; as for the awareness about blue light filtering glasses, medical field respondents had much higher knowledge (75.33%) than nonmedical respondents (56.70%). In contrast way, nonmedical respondents (56.09%) seem more eager to use those glasses than those in the medical fields (49.77%), stating the fact that a higher percentage of the latter already uses blue light filtering glasses (27.8%).

In conclusion, our study is the first to investigate blue light awareness among university students, a population with high exposure. The results suggest moderate awareness of blue light and its potential negative effects but low awareness of protection methods. This highlights the need for increased public education on the risks of blue light. Healthcare professionals should lead efforts to educate the public about blue light sources and their effects. Public health campaigns and education programs are essential to raise awareness and promote protective measures. Recommendations include the use of blue light filters, protective eyewear, and limiting screen time before bedtime. This study provides valuable insights into students' knowledge and behavior regarding blue light exposure, which will inform future initiatives to promote the healthy use of electronic devices. These efforts will ultimately improve the quality of life.

Ethical Considerations: This cross-sectional survey study was conducted online after receiving ethical approval from the Ankara Bilkent City Hospital Ethics Committee (Approval number: E2-22-1502).

Conflict of Interest: The authors declare no conflict of interest.

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