Knowledge, Attitudes, and Practices Towards Blue Light in Thai General Population

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Abstract

We are surrounded by wavelengths of blue light everywhere. The sun emits blue light, and so do electronic devices, and fluorescent and incandescent light bulbs. In an era where electronics are heavily utilized, there has been an increased interest in the subject. Therefore, this study aims to explore the knowledge, attitudes, and practices towards blue light among Thai general population. A cross-sectional survey using a self-administered questionnaire was conducted amongst 462 subjects. The questionnaire consisted of 5 parts: informed consent, sociodemographic data, knowledge, attitudes and practices towards blue light. The mean knowledge score indicates an overall fair knowledge of the topic. Only 10% of the participants were able to correctly identify that the main source of blue light is the sun. The majority of correctly responded questions were that electronic devices emit blue light and that blue light has effects on the eyes. For the attitude part of the survey, results indicated that participants were more concerned about blue light from electronic devices than that from the sun. Furthermore, the group with higher knowledge tended to have more awareness and concern towards blue light from all sources. Over 75% of the participants apply sunscreen products, however over two thirds of the sunscreen users stated that their purpose of sunscreen wasn't to protect against blue light. Though results from this study showed that the majority were concerned about blue light from electronic devices, preventive measures such as blue light filtering lenses and screen filters are not practiced to minimize the risks. The study reported a high prevalence of misunderstanding regarding the main source of blue light. Therefore, interventions and policies should be developed to share knowledge and correct misconceptions about blue light in order to keep a positive attitude and raise awareness, and subsequently leading to good practices.

Keywords: *Blue Light, Digital Devices, Knowledge, Attitudes, Practices*

1. Introduction

The global outbreak of the corona virus has led millions of people into a worldwide lockdown and social isolation. The forced social distancing and the limitations of outdoor activities to mitigate viral transmission has prompted an increase time spent on digital devices (Chetty, Munsamy, Cobbing, Van Staden, & Naidoo, 2020). Through these devices, from televisions to tablets, mobile phones to laptops or computers, most people are being exposed to blue light more than ever (Salfi et al., 2021). As screen time increases during pandemic, there is a rising concern regarding the harmful effects of blue light from these artificial sources. It has become a topic increasing interest among researchers and health professionals.

Occasional media claims that light sources emitting blue light may be damaging, especially to the eyes, raise public concerns. Despite the fact that blue light is often linked to digital devices, light emitting diodes (LED) lamps, and fluorescent light bulbs, sunlight is the largest source of blue light. Though almost every day light sources emit blue light, these sources do not all emit the same amount of blue light, nor do they all emit it at the same intensity. The reference equations developed from effective biological spectra for different types of devices and sun radiation showed that the sun is the primary source of effective irradiance for immediate and persistent pigmentation, as well as oxidative stress in our skin (de Gálvez et al., 2022). Based on the effective irradiance calculated for PPD, IPD, and oxidative stress from the sun and various artificial light devices, it is concluded that sources other than the sun contribute less than 1% to PPD and IPD effects and less than 5% to oxidative stress effects.

Blue light, also known as high-energy visible (HEV) light, has the highest energy and shortest wavelength, 400 - 500 nm, in the visible light spectrum. This wavelength can penetrate up to the depth of 0.07 - 1 mm. Studies have linked blue light exposure to pigmentary changes, erythema, cellular dysfunction, DNA injury, as well as sleep quality and eye damage (Campiche et al., 2020; Zhao, Zhou, Tan, & Li, 2018). The effects of blue light on the skin are highly dependent on the interactions with different chromophores (Sadowska, Narbutt, & Lesiak, 2021). There is a correlation between the spectrum of blue light and the increase in pigmentation in people with darker skin phototypes, whereas erythema or skin reddening was observed more easily in those with lighter skin tones (Duteil et al., 2014).

While the negative impacts of chronic exposure to low-intensity blue light before bedtime on health and well-being have been the primary focus, it is equally important to consider exposure to blue light during the day. Biological and psychological rhythms are internally synchronized by short wavelengths, perceived as blue color. The beneficial effect of blue light exposure on circadian synchronization, sleep quality, mood, and cognitive performance depends not only on the spectral composition of the light but also on the timing and intensity of exposure (Wahl, Engelhardt, Schaupp, Lappe, & Ivanov, 2019).

Blue light has been shown to have anti-inflammatory and anti-proliferative effects, and thus may be effective in treating various chronic inflammatory skin diseases. In addition, a growing number of studies has shown that blue light therapy is beneficial in treating acne vulgaris and in promoting hair growth. According to some studies, there is also a reduction of itching, which may have a significant impact on the treatment of patients suffering from skin diseases (Sadowska, Narbutt & Lesionk, 2021). In the future, blue light therapy may serve as an alternative to ultraviolet therapy, especially in situations where safety from long-term use of UV is a primary concern.

Given the importance and potential effects associated with blue light exposure, it is crucial to explore people's knowledge, attitudes, and practices towards blue light. This research aims to investigate the current level of knowledge and attitudes about blue light and its effects on health, and the practices that individuals employ to reduce their exposure to blue light among Thai general population. By understanding these factors, it can help provide insights that can inform public health strategies aimed at educating people about blue light and enhancing and applying appropriate protection methods for blue light exposure.

2. Objectives

1) To assess knowledge and attitudes regarding blue light
2) To evaluate practices about blue light protection
3) To address conceptual misconceptions about blue light

3. Materials and Methods

This is a cross-sectional study using a self-assessment electronic questionnaire via Google Forms®. A recruitment poster with the quick response (QR) code of the questionnaire was posted and reposted on the authors' social networks. Thai nationals who were aged 18 years or above, understood Thai, and agreed to take part were asked to click on the link or scan the QR code to complete the anonymous survey questionnaire. At the beginning of the questionnaire, participants were informed about the purpose of the study and their right to withdraw or decline at any time without consequences.

The study was conducted in accordance with the Declaration of Helsinki. Ethical approval for this study was obtained from Thammasat University's Human Research Ethics Committee (MTU-EC-OO-0-042/66). Electronic informed consent was obtained from each participant before filling out the questionnaire. After completing the questionnaire, a pamphlet about blue light will be sent to the participants to provide and increase knowledge and clarify misconceptions about the topic.

The survey questionnaire consists of 5 parts: informed consent, sociodemographic data, knowledge, attitudes and practices towards blue light and its protection. The questionnaire is in Thai (national language). Participants' sociodemographic information—age, gender, level of education, occupational status, skin color, skin conditions, and average time spent outdoor and on screens, were all obtained. The knowledge part of the questionnaire consists of 14 questions, each with 3 possible response options: "True", "False", and "Not sure". Each correct answer received a score of 1, while incorrect or uncertain answer was given 0 points. Therefore, the cumulative knowledge score ranged from 0 to 14, with higher scores indicating greater knowledge of the topic. The participants' overall knowledge was categorized as good, fair, and poor if the total score was 10 - 14, 5 - 9, and 0 - 4, respectively. In order to assess the attitudes towards blue light, a 7-point Likert scale was used to rate the level of agreement with the statements. For measuring the participants' practices regarding blue light protection, 9 close-ended questions were asked.

SPSS version 28 was used for statistical analysis of the data. Categorical variables were expressed as numerical values and percentage, while continuous data were described as mean with standard deviation. Categorical data were analyzed using X^2 test. One-way ANOVA was performed for continuous data.

4. Results and Discussion

4.1 Results

A total of 471 individuals were asked to fill out the survey questionnaire. After excluding 4 individuals that were younger than 18 years old and 5 individuals that decline to participate, the final sample consisted of 462 participants.

The sociodemographic characteristics of 462 participants are shown in Table 1. Majority of the participants were female (67.3%). There was a wide range of age among the participants, with a mean age of 36.63 ± 10.43 years old (ranged 18-76). Most of the participants held Bachelor's degree or higher (97%). The majority of the participants (53%) had Fitzpatrick skin type III. The most common skin conditions in the study group are wrinkles (67.3%) and enlarged pores (66.2%). Almost half of the sample (45.5%) reported less than an hour a day spending outdoors. For screen time on mobile phones and/or tablets, 28.4% averages more than 9 hours of screen time per day and 27.9% spent an average of 7 - 9 hours. Therefore, more than half of the sample reported an average screen time of 7 hours or more a day.

Table 1 Sociodemographic characteristics of the participants (n=462)

Characteristics	n	%	Mean (SD)
Gender			
Male	150	32.5	
Female	312	67.5	
Age (years)			36.63 (10.44)
Level of education			
Upper secondary or lower	14	3	
Bachelor's degree	278	60.2	
Master's degree	159	34.4	
Doctorate doctor's degree	11	2.4	
Indoor/outdoor workers (80% of working hours spent indoor/outdoor)			
Indoor workers	432	93.5	
Outdoor workers	30	6.5	
Occupation			

Characteristics	n	%	Mean (SD)
Government officer	19	4.1	
Teacher/Professor	5	1.1	
Student	21	4.5	
Programmer	19	4.1	
Graphic designer	11	2.4	
Salesperson	35	7.6	
Office employee	223	48.3	
Business owner	48	10.4	
Healthcare personnel	70	15.2	
Others	11	2.3	
Skin phototypes			
Skin phototype I	19	4.1	
Skin phototype II	55	11.9	
Skin phototype III	245	53	
Skin phototype IV	98	21.2	
Skin phototype V	43	9.3	
Skin phototype VI	2	0.4	
Facial skin conditions			
Acne	213	46.1	
PIH/PIE	298	64.5	
Melasma, photoaging	195	42.2	
Wrinkles	311	67.3	
Enlarged pores	306	66.2	
Average time spent outdoor per day			
< 1 hour	210	45.5	
1 - 3 hours	197	42.6	
3 - 5 hours	41	8.9	
5 - 7 hours	8	1.7	
7 - 9 hours	2	0.4	

Characteristics	n	%	Mean (SD)
> 9 hours	4	0.9	
Average time spent on electronic devices per day			
< 1 hour	5	1.1	
1 - 3 hours	22	4.8	
3 - 5 hours	77	16.7	
5 - 7 hours	98	21.2	
7 - 9 hours	129	27.9	
> 9 hours	131	28.4	
Average time spent watching television per day			
< 1 hour	209	45.2	
1 - 3 hours	160	34.6	
3 - 5 hours	58	12.6	
5 - 7 hours	17	3.7	
7 - 9 hours	9	1.9	
> 9 hours	9	1.9	
Electronic devices usage 2 hours before bedtime			
Yes	402	87	
No	62	13	

PIH; postinflammatory hyperpigmentation, PIE; postinflammatory erythema

The mean knowledge score regarding blue light was 6.38 ± 2.76, with scores ranging from 0 to 13. According to Table 2, only 30% of the participants knew blue light can be seen by human eyes. When asked about the sources of blue light, the majority (92%) of the participants agreed that electronic screens emit blue light. However only 27.7% and 53.2% were aware that the sun and fluorescent lights, respectively, can also emit blue light. Approximately one tenths of the participants were able to identify that the largest source of blue light is the sun rather than digital devices, and that blue light constituted a greater portion of the total solar output than ultraviolet light. Roughly, two thirds of the participants knew that blue light has effects on skin. Approximately 42% believed that sunscreens can protect against blue light. However only 54.8% of those who held this belief were aware that only tinted mineral sunscreens provide protection against blue light. Furthermore, 20.3% of the participants believed that being in the shade can protect against blue light. A little more than one third of the participants (34.4%) were knowledgeable about the protective clothing available for safeguarding the skin against blue light. About 72.5% of the participants correctly responded that blue light have a negative impact on sleep, and 82.7% of them agreed that blue light can negatively impact sleep. Furthermore, the majority (92%) of the participants believed that blue light has an effect on the eyes.

Table 2 Participants' knowledge towards blue light (n=462)

Questions (Correct answer)	Correct n (%)
Blue light is visible to the naked eyes	139 (30.1)
The sun emits blue light	128 (27.7)
Electronic screens emit blue light	427 (92.4)
Fluorescent lights emit blue light	246 (53.2)
The sun emits more of ultraviolet rays than blue light	56 (12.1)
The biggest source of blue light is digital devices, not the sun	51 (11)
Blue light has effects on the skin	303 (65.6)
Sunscreens can protect against blue light	197 (42.6)
Tinted sunscreens can protect against blue light	108 (23.3)
Being in the shade can protect against blue light	94 (20.3)
Clothing that covers the skin can protect against blue light	159 (34.4)
Blue light affects sleep	335 (72.5)
Blue light helps fall asleep faster and sleep better	277 (60)
Blue light affects your eyes	426 (92.4)

The attitudes of participants towards blue light were shown in Table 3, using 7-point Likert scale with an overall average attitude score of 5.2673 ± 1.24144. A higher mean attitudes score indicated that the participants were concern and aware of blue light and its effects on health. The means score for the statement, "it is necessary to protect ourselves from blue light" was the highest. While most participants somewhat agreed on attitude statements, the mean score of statement "you are concern about blue light from the sun" was the lowest of all 4.52 ±1.91. The statement, "you are concern about blue light from electronic devices" received a highest mean score of 5.74 ± 1.52.

Table 3 Participants' Attitudes Towards Blue Light (n=462)

Participants' attitude and concern	Mean (SD)
It is necessary to protect ourselves from blue light	6.26 (1.23)
You are concern about blue light from electronic devices	5.74 (1.52)
You are concern about blue light from the sun	4.52 (1.91)
It is necessary to wear sunscreen when using electronic devices	4.54 (2.20)
Overall average attitude score	5.2673(1.24144)

According to Table 4, a group of participants with poor knowledge about blue light obtained attitude score of 1-5, on the other hand a group of participants with fair to good knowledge about blue light received attitude score of 3-7. The results indicated that the higher the knowledge of participants, the more awareness or concern they seem to have towards blue light.

Table 4 Association between attitude and knowledge regarding blue light

Knowledge group	n (%) Attitude score 1-3	n (%) Attitude score 3-5	n (%) Attitude score 5-7	P-value
Poor (n=185, 40%)	100 (54.1)	85 (45.9)		0.001*
Fair (n=212, 45.9%)		31 (14.6)	181 (85.4)	
Good (n=65, 14.1%)			65 (100)	

Table 5 One-way ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Attitude	Between groups	41.000	2	20.500	14.055	0.000
	Within groups	669.487	459	1.459		
	Total	710.486	461			

In order to examine the difference in attitudes towards blue light among participants with different levels of knowledge, one-way ANOVA test was conducted and the result was shown in Table 5. The findings revealed a statistically significant difference in the attitudes towards blue light among the different groups of knowledge (F= 14.055, sig. value =0.000). As there were three groups, post hoc LSD was chosen to uncover significant differences between groups. The LSD post hoc tests indicated that the attitude scores of each knowledge group differed significantly from those of the other groups (p<0.05).

Table 6 Post Hoc LSD test

					95% Confidence Interval	
Knowledge group (I)	Knowledge group (J)	Mean differences (I-J)	Standard Error	Sig.	Lower Bound	Upper Bound
Poor	Fair	-.45839*	0.12151	0.000	-0.6972	-0.2196
	Good	-.84678*	0.17414	0.000	-1.1890	-0.5046
Fair	Poor	0.45839*	0.12151	0.000	0.2196	0.6972
	Good	-0.38839*	0.127123	0.024	-0.7249	-0.0519
Good	Poor	0.84678*	0.17414	0.000	0.5046	1.1890
	Fair	.38839*	0.17123	0.024	0.0519	0.7249

*The mean difference is significant at the 0.05 level

The findings from the survey's practical component revealed that 75.5% of the participants use sunscreen. Of the sunscreen users, 68.5% reported that their primary reasons for using sunscreen did not include protection against blue light from electronic devices. Only 22.1% of those sunscreen users noticed blue light protection on sunscreen products. With regard to the amount of sunscreen applied per application on the face, only 25.2% applied 2 fingertip units of sunscreen, while 67.9% applied less than 2 fingertip units, and the remaining 6.9% applied more than 2 fingertip units. Roughly half of the sunscreen users (50.7%) applied sunscreen daily regardless of whether they are indoor or outdoor. The majority (95.7%) applied sunscreen once a day. Furthermore, approximately half of the sunscreen users (46.1%) did not use sunscreens when in front of electronic screens. In addition, only about a third of the participants use blue light filter on their screens (32.5%) and wore blue light-blocking glasses when using electronic devices (37.4%).

4.2 Discussion

Our extensive use of electronic devices and LED lighting, as well as time spent outdoors, results in daily exposure to high doses of blue light. Given its widespread presence, it is important to have a correct understanding towards blue light. To our knowledge, this is the first study to examine the knowledge, attitudes, and practices (KAP) of Thai general population towards blue light. The findings revealed some misconceptions regarding blue light and its effects.

Although the majority of the participants were well-educated, it was unexpected to find that their overall knowledge about blue light was only fair. The findings of this study indicated that most were knowledgeable about artificial sources of blue light and its effects on the eyes. This was likely due to the widely advertised products marketed to reduce and prevent the eye and vision-related symptoms associated with prolonged use of digital devices, despite the lack of a clear connection between blue light and 'computer vision syndrome' (Downie et al., 2019). Most participants mistakenly believed that digital devices were the main source of blue light rather than the sun. Blue light has become more widely known with the introduction of digital devices. The high prevalence of this misunderstanding was identified in a knowledge item. In recent years, there has been an effort to raise awareness about blue light among the general public, with several established brands implementing blue light filters in their lenses to eliminate blue light. However, a number of advertisements from lens manufacturers may contribute to this misconception, misleading consumers into believing that digital devices are the only source of blue light and can cause serious harm, especially to the eyes.

The mean attitude score indicates a high level of awareness towards blue light. Results showed that the respondents agreed that it is necessary to protect themselves from blue light. The lowest attitude score was the concern about blue light from the sun. Results showed higher attitudes score towards blue light from digital screens. This revealed that the participants were more concerned about blue light from electronic devices than that from the sun. It can again be most likely explained which can be explained by the knowledge part in which the majority believed that the blue light is emitted mainly by digital devices. Positive relationship was also found between the knowledge and attitudes among the participants. The results from simple linear regression analysis show that the greater the knowledge and understanding lead to a significantly higher level of concern and awareness ($<p<0.001$).

Although only 42.6% of the participants agreed that sunscreens can protect against blue light, three-fourths of the participants use sunscreen. This implies that the purpose of sunscreen use among these participants is not to protect against blue light, which is supported by the fact that roughly two-thirds of the sunscreen users said they do not use sunscreen to protect against blue light. The current study population demonstrates a lack of awareness regarding the benefits of using sunscreen and the proper amount for its application. It is recommended to apply around two to three fingertip units of sunscreen (on the face and neck) to achieve the SPF indicated on the label. The adult fingertip unit (FTU) is measured by the amount of ointment that is applied from the crease of the distal skin of the index finger to the tip of the palmar aspect of the finger dispensed from a tube with a 5mm diameter nozzle (Long, Mills & Finlay, 1998). This study has revealed the underapplication of sunscreen on the face.

Though there is a misconception in this study stating that the sun does not emit blue light and blue light from electronic devices are more harmful, fewer than half of the participants use blue light filters or wear blue light blocking glasses when using electronic devices. Duteil et al. (2020) conducted a study and measured the intensity of light emitted by several sources with the spectroradiometer sensor distanced at 20 cm (or at 10cm for mobile phones). Comparing with the intensity of sunlight in the same spectrum, the intensity from these assessed sources is 100 to 1000 time less.

The majority (87%) use electronic devices two hours before bedtime. With numerous functions and easy accessibility, electronic devices have become an integral part of our daily lives. Exposure to the light from digital screens, which contain short length, high energy blue light, is no different than exposing to morning sunlight. Blue light exposure at nighttime can trigger the suppression of melatonin production, disrupting the internal circadian clock. Therefore, it is recommended to stop using electronic devices at least 30 minutes prior to bedtime in order to get a good sleep (Pham et al., 2021). About half of the participants (45%) spent less than one hour outdoor per day and more than half (56.3%) spent more than 7 hours using electronic devices. Additionally, because Thailand is a tropical and human climate country, people are more inclined to engage in indoor activities.

Data were gathered online via self-reported questionnaires, depending on the authors' social networks. Thus, some can result in bias in responding. Additionally, the sample may not accurately represent the general population. The results from this study emphasize the need for public education to clear up existing misconceptions and influence the public in adopting and maintaining healthy practices.

5. Conclusion

In summary, this study offers insights into the Thais knowledge, attitudes and practices towards blue light. It is evident that there is a substantial amount of knowledge that needs to be filled in. There are health consequences associated with exposure to blue light, including photoaging and hyperpigmentation. It appears that blue light can have both beneficial and harmful effects. There is a misconception that the sun does not give off blue light and blue light from digital screens is potentially more hazardous than that of the sun. This misconception can most likely be explained by the heavily marketed advertising campaigns of blue light filter lenses, which mislead people into thinking that blue light from digital screens is more harmful than that from the sun. Blue light exposure from natural sources should be given more attention. Blue light can be reduced by wearing tinted sunscreen and protective apparel. Though wearing sunscreen in front of screens may not be necessary, visible light can pass thorough glass windows, thus wearing (tinted) sunscreen indoor may be beneficial especially in those with visible-light induced photodermatoses and dark skin phototypes. One of the physiological benefits of blue light is its effect in synchronizing the human circadian rhythms. Getting daily exposure to natural blue light coming from the sun is as important as to reduce screen time at least 30 minutes before bedtime. There is still a need for further research on the chronic long-term safety of exposure to low levels of blue light emitting devices. The focus should be on promoting public awareness of the blue light from natural sources, as well as the significant of sunscreen and other photo protective methods against blue light. More emphasis should be placed to correct false understanding.

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