Survey and Statistical Analysis of Hangzhou Citizens' Awareness of Harmful Blue Light and Consciousness of Protection Against Blue Light

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Abstract. 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. We took the citizens of Hangzhou as the sample survey object and we got the cognition degree of the citizens of Hangzhou to the harmful blue light and blue light-proof mobile phone membrane with the methods of the questionnaire survey and SPSS data analysis. The results showed that most people were not aware of the dangers of blue light, and many people had more or less certain eye problems. At the same time, the use of blue light-proof mobile phone membrane was not popular. The public still needs to increase their awareness of the dangers of blue light as well as the awareness of blue light prevention.

1. Introduction
Blue light is a high-energy visible light with a wavelength of 400-500 nm and it is an important part of natural light. In recent years, the harm of blue light to human eyes is gradually being recognized and concerned. It has a very high energy, and its wavelength makes it able to reach the retina, thus causing irreversible damage to the vision[1].

Alarmingly, high-energy short-wavelength blue light is everywhere, and the risk of blue light hazards exists not only in lighting sources, but also in display products. Fluorescent lamps, light-emitting diodes (LEDs), liquid crystal displays (LCDs), mobile phone displays, modern flat-panel displays, etc. are all background light sources, which contain unusually high-energy short-wave blue light that is excited by a powerful electronic current. This high-energy short-wave blue light has become the number one eye killer of IT family and students. Studies have shown that excessive blue light from screens not only damages the retina of the human eye through photochemical effects, but can also affect the body's biological clock by affecting the secretion of hormones such as melatonin[2-5].

Today, smart phones have become an indispensable means of communication in modern life. In addition to the traditional means of dial-up, receiving calls and messages, smart phones can also provide services such as Internet access and payment. With the comprehensive functions of smartphones and the younger population, the popularity of smartphones will increase. While many of us struggle to keep our screens from crashing, few of us care about protecting our eyes from the blue lights that emit from the phone screens.

Reducing the amount of blue light is a direct way to reduce the harm caused by blue light. Blue light is an essential component of the spectrum of display products, and also a necessary color for
perfectly displaying the colorful real world to meet the demand for color temperature and color gamut of display products. Therefore, how to develop the technology of anti-blue light harm without lowering the standard of normal display is an important research direction. Many researchers have done more in-depth research on the blue light biosafety and blue light-proof technology[6-8].

Among them, blue light-proof glasses[9] and blue light-proof screen membrane[10] are the techniques that have been studied more and more to prevent blue light hazards. Blue-light-proof glasses filter all the light from outside into the eye indiscriminately, which will affect the visual quality to a certain degree. Therefore, blue light-proof treatment for electronic products with harmful blue light that is used for a long time, such as blue light-proof mobile phone membrane, may be a more appropriate way. The blue light-proof phone membrane has not only the characteristics of explosion-proof, fingerprint elimination, scratch-proof and other general screen protection membrane’s features, but also the use of blue light blocking technology to absorb and transform the blue light, thus effectively blocking the short-wave blue light rays, soft dazzling light source stimulation, and greatly reducing the blue light irritation harms to the eyes. Many people will first paste the phone membrane after buying a new phone, but few people will buy blue light-proof phone membrane to achieve anti-radiation and blue light-proof effect.

Based on the above situation, we would like to know the general public's knowledge about the harm of visible blue light, the understanding of blue light-proof technology and the use of blue light-proof mobile phone membrane through questionnaire survey and SPSS data analysis.

2. Survey instructions

2.1. Questionnaire design
The questionnaire is divided into two parts, the basic information of the respondents themselves and the cognition of the respondents to harmful blue light and blue light-proof mobile phone film.

2.2. Scope of the survey
The scope of the survey was 8 districts and 16 roads in Hangzhou, Zhejiang Province, and a total of 382 questionnaires were returned. There were 30 respondents in Gongshu district, 44 in Xihu district, 55 in Jianggan district, 18 in Binjiang district, 123 in Xiaoshan district, 64 in Yuhang district, 29 in Xiacheng district and 19 in Shangcheng district.

2.3. Quality control in research
The appropriate sampling method was selected before issuing the questionnaire. We chose the probability random sampling method of stratified sampling, according to the distribution of population in Hangzhou to carry out proportional stratified sampling. In each district, the exact number of questionnaires was determined and distributed strictly according to the results of the calculation. An isometric sample was also selected for each of the five individuals who met the survey requirements to conduct the questionnaire survey, rather than selecting the survey subjects artificially, to ensure the randomness of the survey subjects.

3. Survey results and analysis

3.1. Respondents' knowledge of blue light
Fig. 1 shows the percentage of respondents who knew the wavelength range of blue light. The data showed that 42.15% of the respondents thought that the wavelength of blue light was between 400-500 nm, 29.58% thought the wavelength was between 490-580 nm, 16.49% thought the wavelength was between 620-720 nm and 11.78% thought the wavelength was between 350-450 nm. This indicated that the respondents had a lower awareness of the wavelength of blue light, with less than half of them answering correctly.
Fig. 1 Statistics on the proportion of respondents who knew the wavelength range of blue light

Fig. 2 shows the percentage of respondents who knew about the hazards of blue light. The data showed that 47.91% of the respondents knew some about the hazards of blue light, 45.81% did not know about the hazards of blue light and 6.28% were fully aware of the hazards of blue light. This indicated that there was a low level of knowledge about the hazards of blue light among the respondents.

Fig. 2 Statistics on the proportion of respondents who knew about the hazards of blue light

Fig. 3 shows the number of respondents who believed that various products in their lives emitted blue light. The data showed that 75% of respondents believed that mobile phones, computers and televisions emitted blue light, 13% believed that printers emitted blue light, 22% believed that LED lights emitted blue light, 14% believed that bathroom heaters emitted blue light, 35% believed that gaming machines emitted blue light and 22% did not know where blue light existed. This indicated that respondents generally believed that electronics emitted blue light, with many citizens did not know where blue light came from.

Fig. 3 Statistics on the number of respondents who believed that products emitted blue light

3.2. Respondents' knowledge of blue light-proof phone membrane

Fig. 4 shows the percentage of respondents who has used a blue light-proof mobile phone membrane or not. The data showed that 45.03% of the respondents had not used the blue light-proof membrane, 28.01% did not know whether they used the blue light-proof mobile phone membrane and 26.96% had
used the blue light-proof membrane. This indicated that the majority of respondents did not pay much attention to the blue light-proof mobile phone membrane.

![Fig. 4 Statistics on the proportion of respondents who had used blue light-proof phone membrane or not](image)

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Fig. 5 shows the percentage of respondents who knew the principles of blue light-proof phone membrane. The data showed that 64.40% of the respondents had never known the principle of blue light-proof phone membrane, 29.32% knew a little about the principle and 6.28% had a rough understanding of the principle. This indicated that the respondents' knowledge of blue light-proof mobile phone membrane was poor.

![Fig. 5 Statistics on the proportion of respondents who knew the principles of blue light-proof mobile phone membrane](image)

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Fig. 6 shows the percentage of respondents who would use a blue light-proof phone membrane even if it was more expensive compared to a regular one. The data showed that 65.45% of the respondents thought that they would use the blue light-proof phone membrane if it was useful, even if this kind of membrane was more expensive, 18% said that they would not use the blue light-proof mobile phone membrane since they thought there was little difference between blue light-proof membrane and regular phone membrane and 16.49% believed that the blue light-proof membrane had no effect and would not use it. This indicated that the majority of investigators would use the blue light-proof membrane, but there were also some respondents had doubts about this and chose not to use it.

![Fig. 6 Statistics on the proportion of respondents who would use a blue light-proof membrane even if it was more expensive](image)

Fig. 6 Statistics on the proportion of respondents who would use a blue light-proof membrane even if it was more expensive

Fig. 7 shows the percentage of respondents who said they could accept the price of a blue light-proof membrane. The data showed that 50.79% of the respondents could accept the price of the blue light-proof membrane below ¥50, 32.46% could accept the price between ¥50-100, 9.95% could
accept the price between ¥100-200 and 6.81% could accept the price above ¥200. This indicated that half of the respondents had a heart price of ¥50 or less for a blue light-proof phone membrane, and nearly a third of the respondents could accept the price of ¥50-100. Although the respondents wanted to buy the blue light-proof phone membrane to improve their eye problems, they also wanted the price of the phone membrane to be more affordable.

Fig. 7 Statistics on proportion of respondents who could accept the price of blue light-proof mobile phone membrane

Fig. 8 shows the percentage of respondents who thought that blue light-proof mobile phone membrane to be useful or not. The data showed that 55.76% of the respondents thought the blue light-proof mobile phone membrane was not very useful, 38.48% thought the blue light-proof mobile phone membrane was useful and 5.76% thought the blue light-proof mobile phone membrane was useless.

Fig. 8 Statistics on the proportion of respondents who thought that blue light-proof phone membrane to be useful or not

3.3. Credibility analysis
Reliability refers to the consistency, stability and reliability of the measured data and conclusions in the questionnaire. The credibility of the questionnaire is generally studied by analyzing the value of Cronbach α coefficient, which is shown in the following Table 1.

| Credibility           | Cronbach α coefficient |
|-----------------------|------------------------|
| Not credible          | α < 0.3                |
| Barely credible       | 0.3 ≤ α < 0.4          |
| Credible              | 0.4 ≤ α < 0.5          |
| Very credible (most common) | 0.5 ≤ α <0.7       |
| Very credible (subcommon) | 0.7 ≤ α <0.9       |
| Very credible         | α ≥ 0.9                |

According to the data analysis of SPSS software, the total Cronbach α coefficient of this questionnaire was 0.790, a credibility value of very credible, which means that the results of this questionnaire were consistent, stable and reliable[11].
4. Conclusion
Through the survey, we learned that although blue light was very harmful to our eyes, people did not know much about it. Only 42.15% of respondents chose the right wavelength of blue light. Most people did not know much about what blue light was and the source of blue light.
Since most people did not know enough about the harms of blue light, they did not know much about the technology of blue light protection, such as blue light-proof mobile phone membrane, so they could not take good measures to reduce or prevent the harm of blue light. Many people were not sure whether they had used such a blue light-proof mobile phone membrane.
Mobile phones have become indispensable in our lives, and we hope that blue light-proof technology will be better applied to mobile phone membrane in the future. It can be made more effective so that the public can better protect their eyes. We believe that with the increasing concern for their own health issues, Hangzhou citizens are willing to use a truly useful blue light-proof mobile phone membrane to protect their eyes and to improve the quality of their life.

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