A Statistical Analysis of Smartphone Use and Public Eye Health Based on the Survey in Hangzhou, Zhejiang Province

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Abstract. In terms of the way of information dissemination, mobile phone has become an essential tool of communication in people's daily life. In this paper, 382 valid questionnaires were collected and SPSS data analysis was conducted to investigate the situation of smartphone use and eye health of Hangzhou citizens. The results of the survey and analysis showed that most people had very bad habits of using mobile phones, which were harmful to their eyes. Many people more or less had certain eye problems, and there was a long way to go to protect their eyes.

1. Introduction

Today, smartphones have become an essential communication tool in contemporary life. In addition to the traditional ways of making and receiving calls and messages, smartphones can also provide services such as Internet access and payment. With the comprehensive functions of smartphones and the younger population using them, their penetration rate will increase.

Research has shown that LED-based digital displays, such as mobile phones and tablets, emit high-energy blue light that can penetrate the cornea and lens of a mobile phone user and reaches the macular area of the eye, known as harmful blue light[1-2].

Harmful blue light with a wavelength of 400-455 nm has shorter wavelength and extremely high energy. Long-term exposure of blue light will not only make eyes dry fatigue, but also cause retinal cell atrophy or even death, leading to vision loss, eye diseases and even blindness. At the same time, blue light suppresses melanin production, disrupts the body clock and affects sleep[3-6].

It is an indisputable fact that playing with mobile phones hurts the eyes, and data show that 63.5% of Chinese Internet users have suffered from eye diseases such as vision loss, cataracts and blindness due to blue light radiation. Ma Biao et al[7] measured the luminous spectrum of different types of mobile phone display screen with spectrograph, and the change of the spectrum intensity with the detection distance. The possible hazards of these devices to human eyes are discussed.

In light of the above, it is imperative to investigate the public's use of smartphones and eye health. Through this survey, we can learn about people's eye health, and promote the importance of eye protection, which can further reduce the harms of Electronics to the eyes and improve the health of our eyes.

2. Methods of investigation

2.1. Questionnaire design
The questionnaire was divided into four parts: the basic information of the respondents themselves, their use condition of smartphones, their health condition of eyes and the eye care measures taken by the respondents.

2.2. Scope of investigation
A total of 382 questionnaires were collected from 8 districts and 16 roads in Hangzhou, Zhejiang Province. Among them, 30 were from Gongshu district, 44 from Xihu district, 55 from Jianggan district, 18 from Binjiang district, 123 from Xiaoshan district, 64 from Yuhang district, 29 from Xiacheng district and 19 from Shangcheng district.

2.3. Quality control in research
We selected the appropriate sampling method before distributing the questionnaire. We chose the stratified sampling method of the probabilistic random sampling method, and carried out proportional stratified sampling according to the population distribution in Hangzhou. The exact number of questionnaires was determined for each district, 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 respondents.

3. Survey results and analysis

3.1. Basic information analysis of respondents
Table 1 shows the basic information of the respondents in the eight districts of Hangzhou that we surveyed. The ratio of male respondents to female respondents was about 1:1, with 46.34% being male and 46.34% being female. An analysis of the age profile of the respondents showed that 20 to 39 year olds were the most frequent users of mobile phones, accounting for about 54.17%, while other age groups were surveyed in relatively small numbers. The occupations of the respondents showed that 46.86% were students, 37.17% were workers, 8.38% were retirees and 7.59% were other occupations. The occupational distribution of the respondents was mainly concentrated in workers and students, who belonged to the group that uses mobile phones in general.

|   | Sex | Age (years) | Occupation |
|---|-----|-------------|------------|
|   | Male | Female | 6-19 | 20-39 | 40-59 | ≥ 60 | Students | Workers | Retirees | Others |
| Numbers | 177 | 205 | 95 | 209 | 56 | 22 | 179 | 142 | 32 | 29 |
| Ratio (%) | 53.66 | 46.34 | 24.87 | 54.71 | 14.66 | 5.76 | 46.86 | 37.17 | 8.38 | 7.59 |

3.2. Statistical analysis of smartphone usage
Fig. 1(Left) shows the percentage of people exposed to smartphones for different lengths of time during the day. 59.69% of respondents spent more than 4 hours per day using a smartphone, and 18.32% spent 2-4 hours, 9.69% spent 1-2 hours, while 12.30% spent less than 1 hour per day. More than half of the respondents spent more than four hours a day on their smartphones, indicating that the vast majority of respondents spent too much time using their smartphones on a daily basis, which could have a greater impact on their eye health.

Fig. 1(Right) shows the percentage of respondents using their smartphones after lights out. 62.30% of the respondents still used their smartphones after lights out, indicating that most of respondents had unreasonable habits of using electronics, even after lights out. This may have some effect on the eye health of the respondents.
3.3. Statistical analysis of the Public's eye health situation

Fig. 2 shows the number of respondents who had various types of eye problems. The data showed that only 19.1% of the respondents did not have eye health problems, 22.5% had problem with blurred eye, 51.3% with fatigue eye, 33.0% with dry eye, 30.1% with astringent eye, 38.2% with dark eye circle and 12.8% had puffy eye. Most of the respondents had eye health problems, with fatigue eyes, dry eyes, astringent eyes and dark eye circles being the most obvious problems, and some of them had more than one kind of eye problems, showing that Hangzhou citizens' eye health problems cannot be ignored.

Fig. 3 Statistics on the number of respondents who believed that factor being contributed to eye problems
Fig. 3 shows the number of respondents who believed that factor being contributed to eye problems. The data showed that there were 7.6% of the respondents believed their eye problems were hereditary, 30.4% believed their eye problems were caused by sitting incorrectly when learning, 70.4% believed their eye problems were caused by long hours of learning to read and long hours of using electronics, 8.9% believed their eye problems were caused by the harsh light from driving and 25.7% believed their eye problems were caused by poor eye hygiene. A further 13.6% of the respondents believed that there were other causes. This indicates that although some respondents perceived more than one cause, the majority believed that their eye problems were caused by spending too much time reading and using electronics.

3.4. Statistical analysis of eye protective measures taken by the respondents

Fig. 4 shows the number of respondents who have taken various measures about their eye problems. The data showed that 26.4% of the respondents had not done anything, 45.5% wore glasses or corrective lenses to improve their eye problems, 39.0% used eye drops to improve their eye problems, 11.8% did daily eye exercises to improve their eye problems, 3.1% had eye surgery to improve their eye problems, 14.9% improved their eye problems by paying attention to eye hygiene, 21.7% improved their eye problems by eating more food that was good for their eyes, 12.6% strictly controlled the use of mobile phones, computers and other electronics to improve their own eye problems, 11.0% used eye care products to improve their own eye problems and 1.3% took other measures to improve their eye problems. The high number of respondents who wore glasses or corrective lenses and used eye drops indicated that the majority of respondents were concerned about their own eye problems and had taken a number of different treatments for their own eye problems. But the number of respondents who did nothing was also high, coming in third.

![Fig. 4 Statistics on the number of respondents taking protective measures for their eye problems]

![Fig. 5 Percentage of respondents who rate the usefulness of the above measures]
Fig. 5 shows the percentage of respondents who rated the effectiveness of the above measures. The data showed that 51.31% of the respondents agreed that the above treatment measures were slightly effective in improving their eye problems, 35.08% thought that the above treatments were not effective, 12.04% believed that the above treatments were effective and 1.57% thought the above treatment could solve their eye problems completely. This showed that the above treatment measures cannot solve the respondents' eye problems absolutely, the above measures still had shortcomings.

3.5 Reliability analysis

The reliability of questionnaires is generally studied by analysing the value of the Cronbach $\alpha$ coefficient, the comparison table of Cronbach $\alpha$ coefficient is shown in Table 2 below.

| Reliability                  | Cronbach $\alpha$ coefficient |
|------------------------------|-------------------------------|
| Unreliable                   | $\alpha < 0.3$                |
| Barely reliable              | $0.3 \leq \alpha < 0.4$      |
| Reliable                     | $0.4 \leq \alpha < 0.5$      |
| Very reliable (most common)  | $0.5 \leq \alpha < 0.7$      |
| Very reliable (less common)  | $0.7 \leq \alpha < 0.9$      |
| Very reliable                | $\alpha \geq 0.9$            |

According to the analysis of the data by SPSS, the Cronbach $\alpha$ coefficient of this questionnaire was 0.790. By the $\alpha$ coefficient table we can know that it falls within a very reliable range, meaning that the results of this questionnaire have good consistency, stability and reliability.$[8]$.

4. Conclusions and recommendations

4.1. Summary

With the development of science and technology, the electronics represented by the mobile phone are thundering to occupy our lives. In our survey, we found that the average daily use time of mobile phones in Hangzhou was generally more than four hours. Among all the respondents, the average daily use time of mobile phone for more than four hours accounted for more than 59.69%, the number of people who still use mobile phones after lights out accounted for more than 62.30%. Excessive use of the eye has led to an increase in eye problems among citizens. In this survey, we found that Hangzhou citizens generally had eye problems, fatigue eyes, dry eyes, astringent eyes, and dark eye circles occupies a larger percentage. Excessive time spent studying, reading, and using electronics was a major factor in these eye problems.

4.2. Advice

We should keep a certain amount of sleep every day, so that our eyes get adequate time to rest. Usually when there is free time, we can do more eye exercises so that our eyes are not easily tired. We should usually stay in some relatively bright place, try not to use the mobile phone after lights out, do not use electronics in the driving car, to reduce the damage to our eyes to some extent. Sometimes we can go outside to participate in some sports activities, instead of always staring at the screen to prevent blue light from doing great damage to our vision.

We should usually pay more attention to supplement nutrition on a regular basis, such as vitamins. Long-term use of electronics may cause damage to the retina in the eyes, and Rhodopsin, which is mainly synthesized by vitamin A, will be consumed. Therefore, a certain supplement of vitamin A can protect the eyes. We can also drink more tea, tea polyphenols and other active substances in tea can resist the absorption of radioactive substances.
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