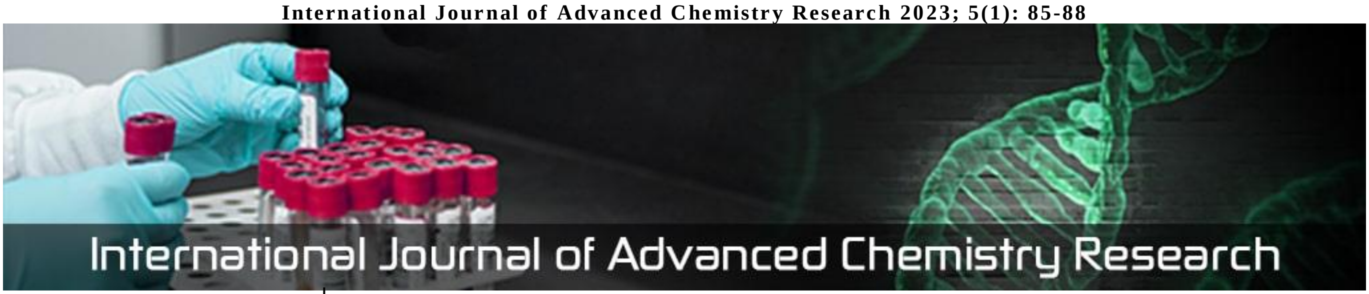

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Review on the study of potential health hazards caused by blue light due to Melanopsin activity

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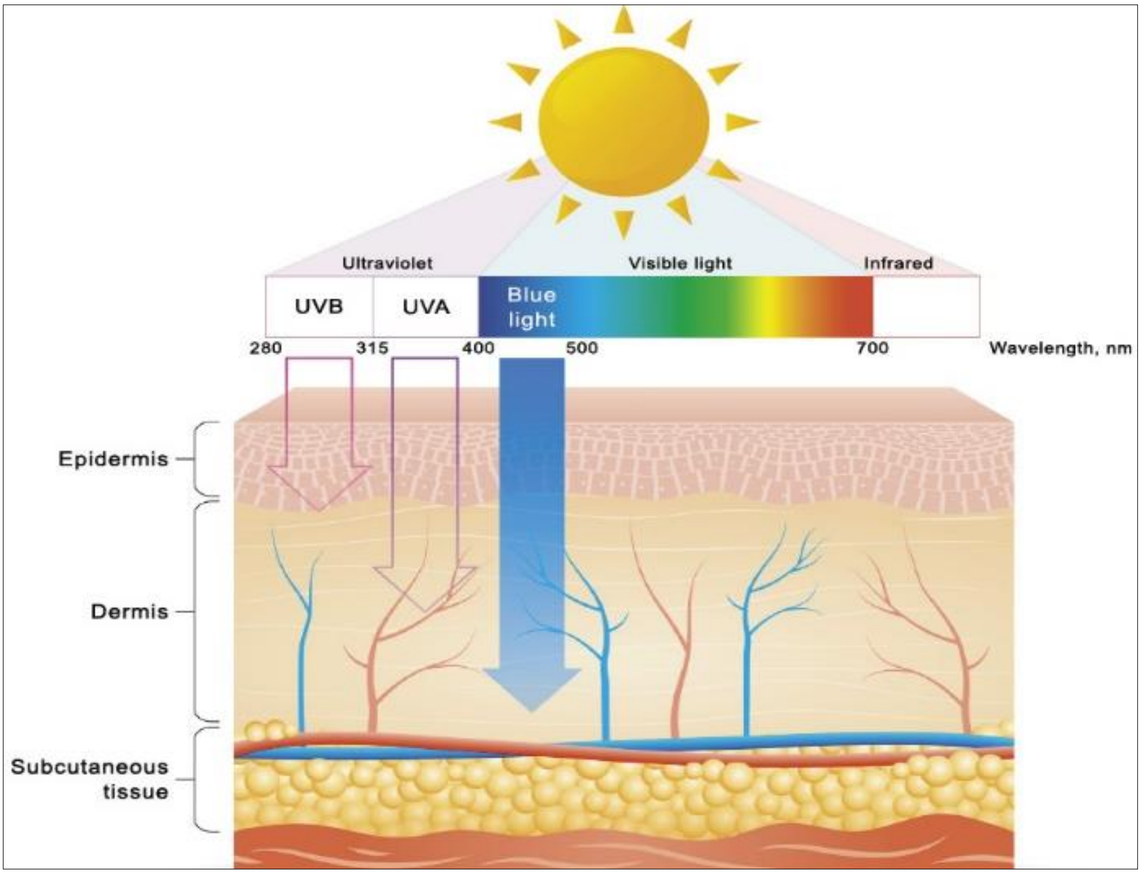
Abstract
Humans live in a 24-hour environment, in which light and darkness follow a diurnal pattern. In humans, the known effects of light on circadian rhythms and sleep are all, without exception, mediated by the retina. The retina is a fine layer of nerve tissue at the back of our eyes, containing specialized photoreceptors. Melanopsin RGCs are extremely sensitive to blue light and even exposure to light levels as low as the one from a smart-phone or light emitting e-readers are associated with disruptions of circadian rhythm. Melanopsin absorbs light in the short-wavelength range of the visible spectrum, with λ_{max} at or near 480 nm. High-intensity blue light from any source is potentially hazardous to the eye. Industry sources of blue light are purposely filtered or shielded to protect users. However, it may be harmful to look directly at many high-power consumer LEDs simply because they are very bright. When Melanopsin is activated by the short wavelength component of light, it suppresses Melatonin synthesis. This action is controlled mainly by light could affect several functions including the regulation of intraocular pressure. Blue light or blue-violet light can be damaging to delicate retinal cells deep in the eye. No one knows exactly what causes dry macular degeneration. Research indicates that it may be a combination of family genes and environmental factors, including smoking, obesity and diet. The condition develops as the eye ages. Additionally, our studies have shown blue light is a risk factor for the onset of age-related macular degeneration, which is a progressive condition that can lead to vision loss over.

Keywords: Blue light, mobile devices, screen protector

Introduction
With the improvement in working and living conditions and the changes in people's life styles, more and more exposure to blue light has occurred. The prevention and control of blue light damage is becoming more and more important, and the anti-blue light products are constantly emerging. The refractive medium of the human eye's different tissue characteristics have different permeation effects on light when the wavelength is <300 nm. A wavelength between 300 and 400 nm can penetrate the cornea and be absorbed by the iris or the pupil. High energy short wave blue light between 415 and 455 nm is the most harmful. Direct penetration of crystals into the retina causes irreversible photochemical retinal damage [1]. As the harmful effects of blue light are gradually realized by the public, eye discomfort related to blue light is becoming a more prevalent concern. Because of blue light's short wavelength, the focus is not located in the center of the retina but rather in the front of the retina, so that the long exposure time to blue light causes a worsening of visual fatigue and nearsightedness. Symptoms such as diplopia and inability to concentrate can affect people's learning and working efficiency [2]. What is the specific damage mechanism of Blu-ray? This article will review the mechanisms causing damage to the cornea, lens, and retina by Blu-ray light in order to have a better understanding of Blu-ray-induced ocular injury.
Some research has shown blue light may increase the risk of macular degeneration, a disease of the retina. Research shows blue light exposure may lead to age-related macular degeneration, or AMD. One study found blue light triggered the release of toxic molecules in photoreceptor cells. Lighting sources and technology have experienced a revolution in the last 15-20 years. Lighting sources and technology, especially in non-commercial or industrial illumination applications, have traditionally been slow to change [3]. In most homes, the incandescent bulb and Edison socket have been omnipresent. In the past 10 years, we have seen significant use of other technologies, such as compact fluorescent lamps (CFLs), replacing incandescent sources.

However, this transition has often been driven by legislation, which has focused on energy-efficient sources instead of consumer desire for different light sources. The general user quickly noted the difference in the quality of CFL source but not necessarily in the specifics of its power spectrum. Simultaneously, the development and performance of high brightness light-emitting diodes (LEDs) have experienced tremendous advances [4]. The coupling of a blue-light LED with a phosphor has also been used to produce a white light source, the white-light LED. This solid-state fluorescent analog has become known as solid-state lighting (SSL). This approach is now considered the next generation of illumination due to the many inherent and potential advantages over current technologies.



Blue light is defined as light within the wavelength range of 400 nm (violet) to 500 nm (cyan) (Fig. 1) [5]. Blue light has lower energy than ultraviolet (UV) radiation (280-400 nm) and can reach further into the dermis, up to the depth of 1 mm [5-6]. However, while the effects of UV radiation on skin have been widely studied, less is understood regarding the effects of blue light [7].

Direct and Indirect Effects of Blue Light Exposure on Skin

Blue light is visible light with a wave length between 400 and 450 nanometers (nm). As the name suggests, this type of light is perceived as blue in color. However, blue light may be present even when light is perceived as white or another color. Blue light is of concern because it has more energy per photon of light than other colors in the visible spectrum, i.e. green or red light. Blue light, at high enough doses, is therefore more likely to cause damage when absorbed by various cells in our body.

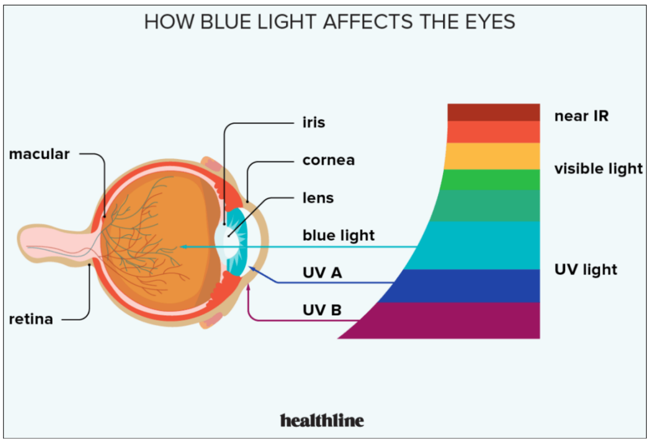
The results of *in vitro*, *in vivo*, and clinical studies show that blue light produces direct and indirect effects on the skin. The most significant direct effects are the excessive generation of re- active oxygen and nitrogen species, and hyper pigmentation. Reactive oxygen and nitrogen species cause DNA dam- age and modulate the immune response. Indirect effects of blue light include disruption of the central circadian rhythm regulation via melatonin signaling and local circadian rhythm regulation via direct effects on skin cells. Antioxidants and sunscreens containing titanium dioxide, iron ox- ides, and zinc oxide can be used to protect against the detrimental effects of blue light as part of a strategy that combines daytime protection and night-time repair.

Effect of blue light on eyes

The amount of blue light from electronic devices, including smart phones, tablets, LCD TVs, and laptop computers, is not harmful to the retina or any other part of the eye. It all comes down to this: consumer electronics are not harmful to the retina because of the amount of light emitted. For example, recent iPhones have a maximum brightness of around 625 candelas per square meter (cd/m^2). Brighter still, many retail stores have an ambient illumination twice as great. However, these sources pale in comparison to the sun, which yields an ambient illumination more than 10 times greater! High-intensity blue light from any source is potentially hazardous to the eye. Industry sources of blue light are purposely filtered or shielded to protect users. However, it may be harmful to look directly at many high-power consumer LEDs simply because they are very bright. These include "military grade" flashlights and other handheld lights.

Furthermore, although an LED bulb and an incandescent lamp might both be rated at the same brightness, the light energy from the LED might come from a source the size of the head of a pin compared to the significantly larger surface of the incandescent source. Looking directly at the point of the LED is dangerous for the very same reason it is unwise to look directly at the sun in the sky.

Compared to the risk from aging, smoking, cardiovascular disease, high blood pressure, and being overweight, exposure to typical levels of blue light from consumer electronics is negligible in terms of increased risk of macular degeneration or blindness. Furthermore, the current evidence does not support the use of blue light-blocking lenses to protect the health of the retina, and advertisers have even been fined for miss. It all comes down to this: consumer electronics are not harmful to the retina because of the amount of light emitted. For example, recent iPhones have a maximum brightness of around 625 candelas per square meter (cd/m^2). Brighter still, many retail stores have an ambient illumination twice as great. However, these sources pale in comparison to the sun, which yields an ambient illumination more than 10 times greater.



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Compared to the risk from aging, smoking, cardiovascular disease, high blood pressure, and being overweight, exposure to typical levels of blue light from consumer electronics is negligible in terms of increased risk of macular degeneration or blindness. Furthermore, the current evidence does not support the use of blue light-blocking lenses to protect the health of the retina, and advertisers have even been fined for misleading claims about these types of lenses.

Blue light from electronic devices is not going to increase the risk of macular degeneration or harm any other part of the eye. However, the use of these devices may disrupt sleep or disturb other aspects of your health or circadian rhythm. If you are one of the large numbers of people who fall into this category, talk to your doctor and take steps to limit your use of devices at night, when blue light is most likely to impact your biological clock. Intensity of light between 420 and 490nm measured for several devices and compared to sun intensity in the same wavelengths. The sensor of the spectroradiometer was placed at 20 cm of the screen (excepted for the cell phone).

Table 1: Comparison of intensity of light emitted by devices and by the sun at wavelengths between 420 and 490 nm [8]

Source	Intensity µ W/cm^2	Intensity mW/cm^2	Ration intensity sun/device
Sun	7700	7.7	-
TV LED (Philips 55POS9002)	78	0.078	99
Laptop LED N°1 Inspiron 17 (DELL)	7.2	0.0072	1069
Laptop LED N°2 Inspiron 24 (DELL)	15	0.015	513
Computer screen Samsung P2270H	22	0.022	350
Cell phone (at 10cm) Samsung SG7	11	0.011	700

Phones Screens & Digital Eye Strain

One of the most common concerns caused by phone screens and digital devices is digital eye strain. Digital eye strain, also known as computer vision syndrome, is a group of symptoms caused by intense visual focusing on digital screens. On average, people spend 10.5 hours on digital devices every day, and 70% experience symptoms of digital eye strain. The most common symptoms of prolonged screen use are: Eye strain, Dry eyes, Eye pain, Headaches, Blurry vision, Double vision, Watery eyes, Eye irritation. Most symptoms of digital eye strain cause temporary changes. However, symptoms can increase or continue without treatment, reducing visual abilities.

Protect our Eyes

20-20-20 Rule: The 20-20-20 rule is a reminder to take breaks from screen time. For every 20 minutes of screen time, you should take a 20-second break and look at an object 20 feet away (approximately 6 metres).

The screen protector decreased the intensity of blue light from 30% to 60% depending on the setting and the device. This was accomplished without changing the appearance of the screen. This study evaluated the ability of this specific screen protector to block blue light in comparison to a device without a screen protector. Future research can focus on comparing the screen protector to other screen protectors that claim to block blue light. In addition, future research could delineate the health benefits from using screen protectors. However, comparing the screen protector against other screen protectors that do and do not claim to block blue light would also be prudent. Future research should focus on comparing these screen protectors to other screen protectors in their ability to block blue light. While the screen protector consistently provided a percent reduction in blue light intensity, the effect this has on ocular or general health is unknown. Reducing blue light intensity may provide benefits of better sleep and protection against retinal diseases such as macular degeneration, but further research is needed to investigate this potential health risk [14-17].

Conclusions

1. The objectives of this review were to describe the evi- dence on the impact of blue light on the skin, understand the quality of evidence provided by existing medical re- search, and consider options for how the skin might be protected from the detrimental effects of blue light.
2. The use of blue light is becoming increasingly prominent in our society, and a large segment of the world population is now subjected to daily exposure (from a few minutes to several hours) of artificial light at an unusual time of the day (night). Because light has a cumulative effect and many different characteristics (e.g., wavelength, intensity, duration of the exposure, time of day), it is important to consider the spectral output of the light source to minimize the danger that may be associated with blue light exposure. Thus, LEDs with an emission peak of around 470-480 nm should be preferred to LEDs that have an emission peak below 450 nm. Although we are convinced that exposure to blue light from LEDs in the range 470-480 nm for a short to medium period (days to a few weeks) should not significantly increase the risk of development of ocular pathologies, this conclusion cannot be generalized to a long-term exposure (months to years). Finally, we believe that additional studies on the safety of long-term exposure to low levels of blue light are needed to determine the effects of blue light on the eye.
3. The screen protector decreased the intensity at 450 nm for every setting other than those at 0% brightness. Decreasing brightness and applying NS mode were more effective in reducing blue light. More research is needed to determine the benefits of decreasing blue light exposure from electronic devices.
4. Digital devices and smartphones aren't going away, but you can protect our vision with better eye health habits.

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