Digital Eyestrain: Blue Light Exposure And Eye Fatigue

Huniya Qaiser

1st Year MBBS, Islamabad Medical and Dental College, Islamabad, Pakistan

Key points:

- Introduction
- Sources
- Mechanism
- Effects
- Protective Strategies

Introduction

Due to its short wavelength and strong energy, blue light can cause oxidative stress, inflammation, and DNA damage to eye tissue.[1] Blue light is found everywhere around us ,emitted by the sun and artificial sources. It is necessary for the body's natural balance and health and is also important for maintaining human behavior, but too much blue light exposure is very dangerous and can cause a lot of harmful effects. It can lead to eye strain and can cause imbalance in human sleep- wake cycle as well. Since the arrival of LED lights, the use of blue light has increased ,which seriously affects ocular health. Excessive exposure to blue light from digital devices may cause serious symptoms of eye fatigue.[2]

Sources

- Natural Source:
  Sunlight is the most common natural source of blue light. During daytime, blue light wavelength spreads more easily giving sky its blue color.
- Artificial sources:
  They include modern lighting systems and digital devices such as LEDs which are used commonly in household which produce higher percentage of blue light as compared to traditional bulbs. With the increasing use of digital devices such as smartphones, television etc., blue light exposure has risen. Fluorescent lights also produce blue light, however, less than LEDs.[3]

Mechanism

Excessive blue light exposure may induce retinal stress and contribute to eye fatigue. Blue light can increase the formation of reactive oxygen species in retinal cells. The accumulation of ROS leads to activation of C-C chemokine receptors CCR2 and CCR3 and promotes the release of inflammatory mediators such as interleukin-1. These changes play a role in inflammation and can disturb the integrity of blood retinal barrier.

Blue Light cell damage is associated with activation of NLRP3 inflammasome in retinal pigment epithelium cells. It also involves activation of microglial cells as a result macrophages are accumulated in choroid region which results in vascular damage and photoreceptor death.[4]

Mitochondria are essential organelles responsible for energy and play role in apoptosis. Recent studies show that mitochondria are a target of blue light induced damage. Following exposure to blue light, mitochondria may become swollen and their inner cristae are lost. Increase of ROS leads to oxidative

stress which directly affects mitochondrial structure and function .[4]

Effects

- Digital Eyestrain
  In recent years , digital eye strain is increasingly recognized as an important ocular health problem. DES is a collection of vision related symptoms which are caused by digital devices such as computers, smartphones, and e-readers. Screen time has increased in today's lifestyle which includes reduced blinking ability, visual fatigue, migraine headache, memory loss, dry eye. Recent data suggests that DES ranges about 15% to 30% in the youth. The disordered physiology of DES includes meibomian gland dysfunction, inflammation of the ocular surface, neurosensory abnormalities and hyper osmolarity. The clinical studies of blue light exposure include dryness, burning sensation, foreign body sensation, disturbed vision, and photophobia, all of which compromise quality of life, productivity, and academic performance. Despite growing problems, awareness of DES and its preventive measures among young adults is limited.[5]

- Circadian Rhythm:
  Circadian rhythm is a fundamental aspect of a human being's ability to adapt to the environment and is a cycle that controls human body's processes. Blue Light pollution is linked to serious health problems including disturbed circadian rhythms and melatonin secretion. The SCN (suprachiasmatic nucleus) cells controls circadian rhythms and sleep wake cycle. When exposed to blue light, SCN may be disrupted leading to loss of normal endocrine rhythm and behavioral rhythms as see in animal studies, such as rats .The retina, which acts as the imaging screen of the eyes, located in the back wall of the eye can be severely damaged when exposed to specific intensities of light. Blue Light plays an important role in the phase shifting of circadian rhythms by influencing the expression of clock genes.[6]

Protective Strategies

Studies have shown that glasses and lenses with blue light filters affect the secretion of hormones responsible for regulating circadian rhythms and the sleep-wake cycle , such as melatonin and dopamine. Smart phone manufacturers have made night mode features, which help increase sleep quality. Reduced blue light exposure may decrease the photochemical damage to the retina that can be caused by prolonged exposure to sources of blue light, such as digital devices. Blue light filters are also implemented in medicine and surgical equipments.[7]

Conclusion

In conclusion, the use of smartphones and digital devices is growing, which is the reason for an increase in blue light exposure. Therefore, awareness and preventative strategies are important to reduce digital eye strain and maintain ocular health.

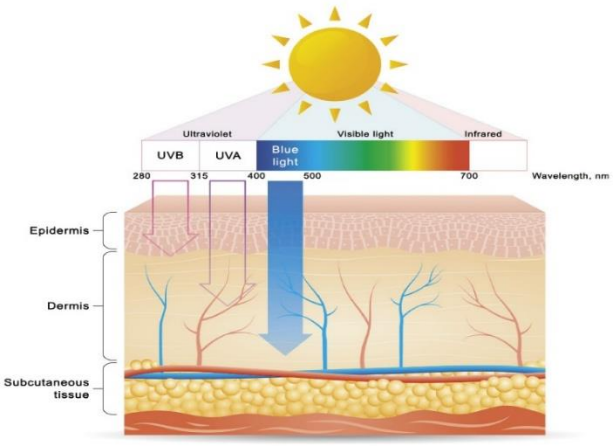


Figure 1*: Radiation spectrum and depth of skin penetration. UV, ultraviolet.*[8]

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