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P D Gupta *

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Review Article

Review Article: Blue Light in Association with Health and Diseases

P D Gupta[1]*, Pushkala K[2]

[1] Former Director Grade Scientist, Centre for Cellular and Molecular Biology, Hyderabad, India.

[2] Former, Associate Professor, S. D. N. B. Vaishnav College for Women, Chennai, India.

***Correspondence Author:** P D Gupta, Former Director Grade Scientist, Centre for Cellular and Molecular Biology, Hyderabad, India

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Abstract

There is a sea change in human physiology due to light pollution which in turn caused by artificial light. Light pollution is less familiar cause of cancer; however, it is widely spread. It's a well-known fact that light regulates our biological rhyth ms. Because of exposed to high energy light (blue band) the property of bio photons changes and inhibit cell to cell communication. It looks like the amount and timing of high energy emission exposer to body makes all the difference in production /degradation and/or development/damage of cancer cell.

Keywords: cancer; light spectrum; bio photon; light pollution; photo repair system

Introduction

A variety of drugs can occasionally cause paradoxical reactions resulting in the induction or aggravation of the conditions they are being used to treat. They include drugs for anesthesia, analgesia, allergy, cardiac arrhythmias, arthritis, cancer, anticoagulation, epilepsy, diarrhea, hypertension, infection, bronchospasm, nasal congestion, Parkinson's disease, and sedation. Epidemiological evidence indicates several factors likely to have a major effect on reducing rates of cancer: reduction of smoking, increased consumption of fruits and vegetables, and control of infection [1]. Other factors are avoidance of intense sun exposure, increases in physical activity, and reduction of alcohol consumption and possibly red meat. Similarly, calcium is causative and protective element for cataract [2]. There are many paradoxical other substances for humans, such as, salt, sugar, alcohol, etc. which are needed to sustain life but on increasing uptake they become threat to life.

Understanding Blue Light:

Sir C V Raman showed for the first time that white light (sun light) is made up of red, orange, yellow, green, blue, indigo and violet light [3]. Each of these components has a different energy and wavelength. Rays on the red end have longer wavelengths and less energy. On the other end, blue rays have shorter wavelengths and more energy. (Figure.1).

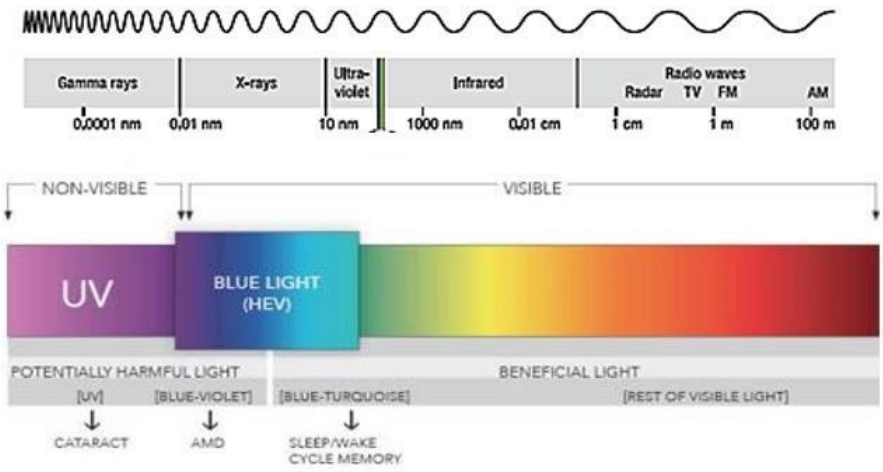

Figure 1: Part of the visible light spectrum, blue light is the high energy spectrum just beyond the UV light. Over exposure to the blue light may lead to harmful effects.

Part of the visible light spectrum, blue light is with high-energy wave length normally transmitted through the eye to the retina. Since it is a visible light, our eyes are designed to receive and trigger visual process and sight.

The largest source of blue light is sunlight, however, in addition there are many other man made sources for blue light, e.g. Fluorescent light, CFL (compact fluorescent light) bulbs, LED light, flat screen LED televisions, computer monitors, smart phones, and tablet screens. From screens, blue light exposure is small compared to the amount of exposure from the sun. Nevertheless, due to close proximity of the screens in addition to the length of time spent looking at them; we are more prone to effects of screen exposure. According to recent reports children's eyes absorb more blue light than adults from digital device screens [4, 5].

This light may affect vision and could premature aging of the eyes. Early research shows that too much exposure to blue light could lead to decrease contrast leading to digital eyestrain. Fatigue, dry eyes, bad lighting, and the posture in front of computer can cause eyestrain resulting in sore or irritated eyes and difficulty focusing. Studies suggest that retinal cells are damaged due to continued exposure to blue light over the time, causing vision problems such as macular degeneration. However an intraocular lens (IOL) naturally protects the eye from almost all ultraviolet light and some blue light.

The body has a lot of protective measures against lights that are too bright or too hot: blinking, pain, natural aversion from bright lights and pupil constriction, but damage can still occur as a result of overexposure. The oxidant compounds from chemical reactions due to visible light and UV, attack cells which are destroyed by antioxidants, pigments and other chemicals in the skin and the eye to slow down the damage and the amounts of products formed will be harmless. However the high doses of these toxic reactive chemicals will cause diseases.

Both UV and the blue components of light from natural and artificial light source can also disrupt the human body clock and the hormonal system leading to health problems [6].

Some studies suggest a link between exposures to light at night, such as working the night shift, to diabetes, heart disease, sleep disturbances, gastrointestinal, mood and cardiovascular disorders and obesity. Too much exposure to blue light late at night (through smart phones, tablets, and computers) can disturb the wake and sleep cycle, leading to problems sleeping and daytime tiredness.

Relations between blue light and cancer:

Exposure to light at night while awake, such as in shift work, may be associated with an increased risk of hormonal dependent cancer due disruption of the natural circadian rhythm. WHO's International Agency for Research on Cancer (IARC) has classified night shift work as probably carcinogenic to humans, since old candescent light has been replaced with Fluorescent light, CFL (compact fluorescent light) bulbs, LED light, at homes and street lights. Exposure to artificial bright light during the night time suppresses melatonin secretion, increases sleep onset latency (SOL) and increases alertness. Circadian misalignment caused by chronic ALAN (Artificial light at night) exposure may have negative effects on the psychological, cardiovascular and/or metabolic functions [7].

By exploiting the optical properties of materials, i.e. the interaction of light with materials, Albert Einstein postulated that these liberated electrons were ionized by the absorption of a quantum of light with an energy = hf. The intensity of the radiation field is then just proportional to the number of light quanta in it. These quanta were later dubbed photons. In other words when light strikes on certain substances, the substances gave out electrons and blue light does the maximum [8].

Most organic compounds do not absorb visible light, and thus appear as being colorless or white. Blue light is of concern because it has more energy per photon of light than other colours 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. During 1970 Popp and his group [9] examined two almost identical molecules: benzo[a]pyrene, a polycyclic hydrocarbon known to be one of the most lethal carcinogens to humans, and its twin with slight alteration in its molecular structure benzo[e] pyrene. He had illuminated both molecules with ultraviolet (UV) light in an attempt to find exactly what made these two almost identical molecules so different. To his surprise he found t benzo[a]pyrene (the cancer producing molecule) absorbed the UV light, and then re-emitted it at a completely different frequency -- it was a light "scrambler". On the other hand benzo[e] pyrene (harmless to humans), allowed the UV light to pass through it unaltered. Popp tried the same experiment with 37 different chemicals, some cancer-causing, some not. The results made him to predict which substances could cause cancer. Xeroderma pigmentosum patients with eventually die of skin cancer because their photo repair system can't repair solar damage. Photo repair works most efficiently at 380 nm -- the same frequency that the cancer-causing compounds react to and scramble.

Photons regulate living cells

Photons switch on the body's processes at different frequencies, they perform different functions. It was found that molecules in the cells responded to certain frequencies, and that a range of vibrations from the photons caused a variety of frequencies in other molecules of the body. Living processes depend on selective interactions between particular molecules, and that is true for basic metabolism to the subtle nuances of emotion. It's like trying to find a friend in a very big very crowded ballroom in the dark. Molecules in a cell are suspended in water and through bumping into one another by chance -- random collisions -- those molecules with complementary shapes lock onto to each other so the appropriate biochemical reactions can take place.

This lock and key mechanism is responsible for enzyme to recognize respective substrate, antigen antibodies reaction, proteins can 'dock' with different partner proteins, or latch onto specific nucleic acids to control gene expression, or assemble into ribosomes for translating proteins, or other multi-molecular complexes that modify the genetic messages in various ways. The 'biophoton emission', provided an ideal communication system for the transfer of

Information too many cells across the organism. When ethidium bromide is applied to samples of DNA, it insinuates itself in between the base pairs of the double helix, causing DNA to unwind. It was found that the greater the concentration of ethidium and the stronger the intensity of light more the DNA unravelled. It was also found that DNA could send out a wide range of frequencies, some of which seemed to be linked to certain functions. If DNA stored this light, it would naturally emit more light on being unzipped. Exactly the way it happens in the epigenetic process [9, 10].

There is evidence pointing to an association between exposure to artificial light at night, disruption of the circadian rhythm, due to which more chances for developing hormone dependent cancers. In our earlier epidemiological study we sought to determine whether night exposure to light in cities can affect the development of hormone dependent cancers. We surveyed 2060 menopausal blind women (risk age for breast cancer (BC) and compared with sighted women in the same geographical and social status and found visually impaired subjects are resistant to the disease because of their inability to allow light through eyes. Our blind menopausal women model provides strong evidence for light as a major contributory factor for the increased incidence of the disease worldwide. We have also reviewed possible light regulating mechanism. Three different epidemiological surveys resulted for understanding of causes of increased BC incidence, namely,

1. **Blind menopausal women,**
2. **Elevated incidence of BC in Scandinavian countries, and**
3. **Night shift workers**

These studies univocally proved that expose to light and no time to give chance for conversion of serotonin to melatonin which is a dark reaction raises incidence of BC [12, 15]. This may be due to lower levels of melatonin in the blood because serotonin is not able to get converted in to melatonin

and whole hormonal milieu changes. Light induced BC is not genetic; they are mostly phenotypic. Epigenetic plays an important role in such cases. Prolonged exposure to light and missing dark periods not only change melatonin levels in the body but may also bring about gene mutation and methylation which in turn change gene expression that may be responsible for higher incidence of BC cancers [11-19].

"We know that depending on its intensity and wave length, artificial light, particularly in the blue spectrum, can decrease melatonin production and secretion," says Martin Aubé, physics professor at CÉGEP in Sherbrooke, Canada and study co-author. Evaluating the association between artificial light-at-night exposure and breast and prostate cancer risk in Spain (MCC-Spain study) .The study was conducted within the framework of the MCC-Spain project and includes medical and epidemiological data of more than 4,000 people between 20 and 85 years of age in 11 Spanish regions. Indoor exposure to artificial light was determined through personal questionnaires, while outdoor levels of artificial light were evaluated for Madrid and Barcelona, based on nocturnal images taken by astronauts aboard the International Space Station. Results obtained for both cities show that participants exposed to higher levels of blue light had a 1.5 and 2-fold higher risk of developing breast and prostate cancer, respectively, as compared to the less-exposed population. Garcia-Saenz , researcher and first author of the study, says: "Given the ubiquity of artificial light at night, determining whether it increases or not the risk of cancer is a public health issue." At this point, further studies should include more individual data using for instance light sensors that allow measuring indoor light levels. It would also be important to do this kind of research in young people that extensively use blue light emitting screens." A Sánchez de Miguel, comments that "Currently, the images taken by the astronauts on the Space Station are our only way of determining the colour of outdoor lighting at a large scale, and the spread of blue light-emitting white LEDs in our cities," [20,21].

Protection from blue light at night

Use dim red lights for night lights. Red light is less likely to shift circadian rhythm and suppress melatonin. Avoid looking at bright screens beginning two to three hours before bed. If you work a night shift or use a lot of electronic devices at night, consider wearing blue-blocking glasses or installing an app that filters the blue/green wavelength at night. Expose yourself to lots of bright light during the day, which will boost your ability to sleep at night, as well as your mood and alertness during daylight.

Benefits of Blue Light

Since blue light is a regulator of internal circadian clock; it controls almost all major human activities. As part of the sleep/wake cycle, blue light triggers the suppression of melatonin in the brain, keeping us awake. When we have our phones and tablets 6 inches from faces, particularly when we are lying in bed with the TV on, melatonin is suppressed making it more difficult for a good night's rest and REM sleep. Two hours before sleep if electronic devices are turned off melatonin release is triggered, giving it a chance to increase just before dozing off into deep sleep [22].

Blue light is needed for good health:

It boosts alertness, helps memory and cognitive function and elevates mood. It regulates circadian rhythm – the body's natural wake and sleep cycle. Exposure to blue light during daytime hours helps maintain a healthy circadian rhythm. Not enough exposure to sunlight in children could affect the growth and development of the eyes and vision. Early studies show a deficiency in blue light exposure could contribute to the recent increase in myopia/nearsightedness [23].

Blue light therapy

Blue light therapy is a painless, non-invasive procedure to treat different conditions in an outpatient environment with limited long-term side effects, and only a few mild, immediate side effects. When photosynthesizing drugs are added, photodynamic therapy can be an effective alternative therapy for cancer that's found beneath the skin.

Blue light therapy is most frequently used to treat sun damage and premalignant or malignant skin cancer growths. This therapy was successfully used to prevent skin cancer and remove both precancerous skin lesions and cancerous skin lesions that haven't spread to other areas of the body (or metastasized). Blue light therapy is an FDA approved in- office treatment for Actinic Keratoses (precancerous lesions). During the treatment, a topical photosensitizing drug is applied on the skin. This medication is absorbed preferentially by the precancerous skin cells within one to three hours. The medication is then activated by blue light which is illuminated for about 17 minutes.

Once the medication is activated, it destroys the precancerous lesions [24]. Patients can leave immediately after the treatment is over. Following the treatment, limiting the amount of light that affects your skin, avoiding outdoors exposure and keep the area clean with soap and water are recommended.

References:

1. Sawicka B, Johor SRK, Sood PP, Gupta PD. Imbalance of gut microbiota induces cancer: a review. - Journal of cell and & tissue research.2017; 17:2: 6073-6084.
2. Gupta PD, Johar SRK, Vasavada A. Causative and preventive action of calcium in cataractogenesis.- Acta Pharmacologica Sinica, Acta Pharmacol Sin.2004; 25:10: 1250-1256 .
3. Raman CV.1922. Molecular Diffraction of Light. Calcutta: University of Calcutta, A., H. Molecular diffraction of light. Nature 1922; 110: 505–506.
4. Children's Eyes and Blue Light – Eye Just eyejust.com › blogsnews › children-eyes-blue-light © EyeJust 2020.
5. Chang AM, Aeschbach D, Duff JF and Czeisler CA. Evening use of light-emitting Readers negatively affects sleep, circadian timing, and next-morning alertness. Proc Natl Acad Sci. 2015; 112:4:1232-1237.
6. Cho YM, Ryu SH , Lee BR , Kim KH , Lee E, Choi J. Effects of artificial light at night on human health: A literature review of observational and experimental studies applied to exposure assessment. Chronobiol Int.2015; 32:9:1294-1310.
7. Effects of Artificial Light - European Commissionec.europa.eu scientific_committees › opinions_layman Exposure to light at night while awake, such as in shift work may be associated with an increased risk of breast cancer and also cause sleep, gastrointestinal, mood and cardiovascular disorders. However, these effects are due disruption of the natural circadian rhythm, regardless of the type of illumination.
8. Albert Einstein, Uber einen die Erzeugung und Verwandlung des ¨ Lichtes betreffenden heuristischen Gesichtspunkt, Annalen der Physik.1905; 17: 132148.
9. Popp FD, Potts KT, Armbruster R. The mass spectra of reissert compounds. †Organic Mass Spectrometry . 1970; 3: 8: 1075-1084.
10. Popp FA. Properties of biophotons and their theoretical implications. Indian J Exp Biol . 2003; 41:5:391-402.
11. Pushkala K, Gupta PD. Prevalence of breast cancer in menopausal blind Women. Int J Med Med Sci 2009; 1: 425- 431.
12. Pushkala K, Gupta PD. Dark side of the night light Monograph. LAMBERT Academic Publishing, GmbH & Co. KG, Saarbrücken, Germany 2011.
13. Gupta PD and Pushkala K. Clocks within us LAMBERT Academic Publishing, GmbH & Co. KG, Saarbrücken, Germany 2012.
14. Pushkala K, and Gupta PD. Light and breast cancer: Is there any relationship. BAOJ Cancer Res Ther. 2016; 2: 1.2: 026.
15. Gupta PD and Pushkala K. Increased Incidence of Breast Cancer Due to Long Exposure of Light. J. Anal Oncol. 2016; 5: 146-152.
16. Pushkala K, and Gupta PD. Missing Dark in Modern Life Aids in Developing Breast Cancer J Sci Discov 2017; 1:1:jsd17003.

17. Pushkala, K. Increased incidence of light regulated breast cancer. J. Cell Tissue Res. 2020; 20:2:6929-6934.
18. Rajput S, Naithani M, Meena K.Rana S. Light pollution: hidden perils in light and links to cancer. Sleep Vigilance (2021).
19. Jayne D, Paul Switzer P. Nighttime Blue Light Exposure and Breast Cancer. OFP 13; 1: 2021
20. Garcia-Saenz A, Sánchez de Miguel A, Espinosa A, Valentin A, Aragonés N, Llorca J. Evaluating the Association between Artificial Light-at-Night Exposure and Breast and Prostate Cancer Risk in Spain (MCC-Spain Study).Environmental health perspectives, 2018; 126: 4: 047011.
21. Cox DTC, de Miguel AS, Dzurjak SA, Bennie J, Gaston KJ. National Scale Spatial Variation in Artificial Light at Night. Remote Sensing, 12, (10), 1591. 2020.