Chapter

Artificial Light at Night and Breast Cancer

Redhwan Al-Naggar and Lutfi Al-Maktari

Abstract

An increased risk of breast cancer has been associated with light at night (LAN). Several risk factors have been identified that play a crucial role in causing most cancers such as the consumption of alcohol and smoking, and low fruit and vegetable intake. As a risk factor for cancer, environmental factors also play an essential role including indoor and outdoor air pollution. Light pollution has been found to be a risk factor for breast cancer in the form of artificial light at night, with melatonin being the mediator between environment and the epigenome. The risk of cancer in night shift workers can also amplify by artificial light at night. Light at night may also effects sleep disruptions and also considered as a risk factor of breast cancer.

Keywords: artificial, light, night, breast, cancer, melatonin

1. Introduction

1.1 Historical background

Biological adaptation to the sun light has advanced over billions of years. Historically, 200 years ago was the discovery of electric both lighting and power for the first time. In spite of the fact that this invention has been of incredible advantage for humankind, it has completely changed work environments, social, and home.

Light at night gave us the in-dependency from the normal daylight for living and to work longer hours and with a more income. The utilize of electric has not only been limited to night time but has also moreover made it conceivable to live and work independently of daylight during the day.

The contrast between artificial lighting and the sunlight. Sunlight is strong at all twelve visible wave-lengths which cresting within the yellow region. However, artificial light has either extreme characteristic wave-length crests like fluorescent or shows a monotonic increment in irradiance as wave-length protracts like radiant.

Night light sources have the ability to light the evening sky brighter than the new moon. Many voices has started to complain about increase the night light and its health effects. In spite of the fact that the global increasing of breast cancer rates is observed in industrialized countries [1, 2].

Over the past decade the speculation that night light inhibit melatonin production may act as a risk of breast cancer. This may due to that exposure to night light disturbs endogenous melatonin secretion. There is presently evidence that these changes have had great effect on health globally. Exposing to light after sunset is overriding the natural light–dark exposure pattern [3–5].

1.2 Electric lighting and human health

Whereas broad light night is needed for cutting edge society and business. There are a few regulations to overcome this modern phenomena. Therefore, it is crucial to appraise the adverse health effects of night light on the human health so that effective intercession can be formed to reduce harmful effects of exposure to night light.

1.3 Introduction to artificial light

Night light is a human-made light which can delivered from lighting that radiates from electric lamps. The increase of night light in cities has extended human human activity into the dark hours. It has been assessed that more than 80% of the world population is beneath light-polluted atmosphere that have an excessive artificial light [1, 6, 7].

Shifting to the light emitting diode (LED) technology in cities world wide has consequence in increasing in artificial light at night and especially blue-light because the use of white LED as the brand-new light standard in urban and rural areas [8]. Its well known that shift work affect circadian disruption is likely a carcinogenic risk factor to humans [9]. Most studies focused on breast cancer. However, there are studies focused on prostate cancer and night and showed that light night likely to increase risks for prostate cancer [10–12].

The possible explanation is that the night light inhibit the melatonin production which is a hormone usually produced at the dark, changes of sleep activities, and deregulation of circadian genes [13, 14]. Melatonin affects on estrogen-receptor positive human breast cancer cells [15–17].

In addition, several studies about day and night shift workers showed an interruption in both peak and lower melatonin levels in their urine compared to day workers. Furthermore, individuals reading using devices that produced blue light such as e-Book, surfing internet with their smart phones before going to bed compared with those who is reading a printed book will take longer to sleep [18].

Genetic background plays a role in changes in wake and sleep time [19]. For instance, a study showed that the lowest melatonin levels was reported among night-shift workers with the morning preference chronotype [i.e. The chronotype of a person is the individual's ability to sleep over a 24-hour cycle at a given time]. Other factors that may contributed are sex, age, living indoors, type of personality, nighttime illumination may also be related to chronotype [20].

2. Light pollution

The main achievement of the past century can be called artificial light. Nevertheless, while artificial lighting is extremely advantageous for modern society. It also poses a major drawbacks to human health and the ecological system of the environment in the form of pollution. It is possible to clearly describe light pollution as unnecessary and misdirected artificial lighting [21]. Light pollution defined as a situation where improper use of night light may hinder with people's comfort and health [22]. Other than the radical issue of sky glow caused by artificial lighting [23], a variety of known ecological problems are also caused by light pollution. Health problems in humans caused by exposure to night light are the most urgent among the known consequences. Via the eye, light is introduced to the human body. While the majority of the light mediates other biological processes in humans, such as light and dark cycles. The First Atlas of Artificial Night Sky Brightness, reported that about 99% of European and American populations, and about one-fifth of world is under polluted skies [24].

2.1 Indoor artificial light

Increase evening exposure to indoor short-wavelength light from LED lights, television, tablete, and smart-phons all these consider to disruptive to circadian function. Electricity system has been improved in the last century due to that the electricity became very cheap [25]. Moreover, artificial light today increased by the wide use of solar panels. This make the night light available in the remote areas. Thus, population exposure to night light in both indoors and out-doors has increased substantially [26]. Unlike the regular light which had fixed and known emission spectra.

2.2 Outdoor artificial light

The outdoor light is considered the modern world work and lives in. However, most of the people live now in dim light all the day without exploration to the sun light and undimmed light at night. Outdoor artificial lights includes lighting of: streets, advertising, architectural, security, domestic, vehicles, highways, railways, residential and commercial buildings, industries, shopping centers and sport facilities [27].

Light at night emitted from the above sources, is captured by the satellites through the sensors, circling around the Earth and transferral the captured information into the Defence Meteorological Satellite Program's database. This database incorporate yearly data after excluding moon and sun light, and other sources of light like fires and lightning. These images capture a small portion of the light arise from the earth's surface light, they symbolize the levels of night light at the ground level.

Outdoor light at night is considered as a permeant environmental threat by stressing the environment and human health [3, 28, 29]. Theories speculate that extreme exposure of night light is contributing to several health problems by interrupt the circadian rhythm [30].

2.3 Light and human physiology

The dark-and-light cycle provides the basic basis for life on our earth. Human adjustment to the solar cycle has consequence in fundamental molecular and genetic endogenous processes that correspond with an 24-hour period. The circadian genetic clock mechanism is closely involved in many cellular and organs function. While near 24-hours rhythms are produced spontaneously by the circadian system, human master clock must be readjust daily by the light–dark cycle to ensure proper temporal synchronization with the environment.

This everyday entertainment is mainly accomplished in humans by novel photoreceptors that project straight to the site of the circadian clock. The cycle production of a light-sensitive endogenous rhythm probably developed to permit for precise 24-hour control of activities and rest, and also to adapt to seasonal changes in night-length changes, while retaining the benefits of the underlying physiology that anticipates day and night.

3. Human physiology and light

Light is the most important trigger for human circadian rhythms to be controlled and is the key environmental time signal for the circadian clock. Light also triggers addition neuro-endocrine and neuro-behavioral responses, including restraint of melatonin production, directly alerting the brain, and improving alertness. The most popular biomarkers studied of the human physiological consequence to dark–light is melatonin. Melatonin is correlate with darkness and is produced at night only, irrespective of whether human is day or night active.

The synthesis and timing of the output melatonin includes a suprachiasmatic nucleus (SCN) afferent signal. Operation of this pathway, which happen in patients with damage of upper cervical spinal, wholly get rid of melatonin production. Some other circadian rhythms not rely on this pathway such as cortisol, body temperature, and sleep–wake cycles.

Increased in tumor development is related to light at night exposure in human [7, 10, 31, 32]. Several studies showed an increased incidence of breast cancer among those living in a heavy artificially lighted areas, due to the effects to circadian and thus suppression of melatonin. Animal study showed a higher tumor and more malignant tumors in female mice exposed to artificial light at night [33].

Three decades ago, a research showed that there was a greater risk of developing breast cancer in women with a history of night shift work. These results contributed to the consideration of light at night is a characteristics of developed nations [34].

3.1 Health effects of disrupted circadian rhythms

Epidemiological studies are a vital component part of the evidence base needed to determine night-time light exposure increase cancer risk. However, these studies are observational studies and cannot provide the mechanism.

4. Animal studies

Most animal experimental studies showed an accelerate onset of development of mammary tumors followed by continuous bright light at night compared to control animals maintained 12 hours of dark and 12 hours of light.

A dose-dependent suppression of melatonin levels is a consequence from exposure to bright, fluorescent night light. Exposure to the dimmest light intensity at night decreased the peak of circulating melatonin and thus enhancement of tumor growth rates and metabolic activity of linoleic acid.

A study showed that nocturnal melatonin inhibit the growth of both estrogen receptor negative and positive (ER- & ER+). The linoleic acid and poly-unsaturated fatty acid are essential for the alteration of (ER-) tumors. Therefore, and it can be used as a biomarker of cellular growth [35].

In rat hepatoma models, exposure to night light induce tumor growth has been replicated. The opposite is also true, the progressive restoration of circulating melatonin by decreasing exposure to night light is followed by a pronounce decrease in tumor growth.

Its worth mentioning that the growth of xenografts perfused with blood sample collected in the 12-hours dark time was markedly reduced. In addition, the addition of melatonin receptor antagonist blood obtained during darkness eliminated the blood's ability to suppress perfused tumor growth and metabolic activity.

Moreover, the addition of a melatonin receptor antagonist to the blood obtained during dark time eliminated the ability to suppress perfused tumors growth and metabolic activity. There is also Some evidence that circadian disruption by chronic phase advancement may increase cancer growth in laboratory animals.

Melatonin exhibits anti-proliferative and antioxidant properties modulates both cellular and humoral responses and control epigenetic responses and play a role in the apoptosis of cancer cells and in inhibition of tumor angiogenesis [36–40].

5. Human studies

Experimental evidence from animal studies have linked circadian rhythm disruption and circulating melatonin concentrations to disease progression. However, there is indirect human data and it focused on epidemiological research. These epidemiological research, however, have strengths and limitations, particularly in exposure evaluation and suitable comparison groups. Breast cancer has received the most research has been conducted on breast cancer. The idea was first articulated that the increase of night light may connected to high risk of breast cancer in the developed nations. Thus rising incidence and mortality rate in the developed nations.

Potential mechanisms involve suppression of melatonin and circadian gene activity. This hypothesis would predict that non-day shift work would increase the risk, blind women would be at lower risk, risk would be inversely correlated with recorded sleep length, and the amount of nighttime light in the population would co-distribute with the incidence of breast cancer.

Based on non-day shift occupations studies and breast cancer, it was concluded that shift work involving circadian disturbance is likely to be carcinogenic to humans. Several studies supporting this findings and the WHO has defined shift work as a potential carcinogen due to the chronobiological disturbance [9, 41].

Numerous research about the relationship between breast cancer and light night have been reported mixed findings [42–45]. Two studies found no association between night work shift and breast cancer [44, 45]. A significant increased risk was found a case control study in Norwegian people with a history of regularly working five nights [42, 43, 46].

Another study showed that a lower risk of breast cancer was associated with increased urinary excretion of melatonin [47]. Non-shift staff with a regular sleep and wake cycle often experience exposure to light at night got disruption of circadian rhythms [48].

After bedtime lights out, it is not yet clear if the ambient background light could affect the circadian system from weak sources in the bedroom or outside light. A brief exposure at these levels does not have a noticeable effect in a laboratory setting, but long-term chronic exposure may.

Four studies have identified an association with a risk of breast cancer of any components of night light level in the bedroom [49–51]. The elevated risk estimate was statistically significant in two of them [50, 51].

In addition to the limitation of recall error, there is also the potentially important limitation of recall bias as a case–control design. There is a possibility that even a very low of light night exposure may have an effect over a long period of time is significant. Few people in the western world sleep in a complete darkness. The circadian cycle can be disrupted by repeated awakenings with low light exposure in the bedroom but any associated health effects are unknown [52].

6. Light pollution and breast cancer

The most common cancer among women is breast cancer [53]. Breast cancer incidence rates is increasing rapidly worldwide. The breast cancer incidence increasing rapidly in Western nations such as: Europe, North America, Canada, Australia and New Zeland.

7. Night light and breast cancer

Excessive exposure to night light may raise the risk of breast cancer and there are several mechanisms. The retrieval of non-image-forming photo-receptors in the retina is transferred to the pineal gland as neural information where it suppressing the melatonin secretion. Then changing in the affinity of the estrogen receptor and an increased susceptibility to hormone-dependent cancers like breast cancer [26, 54].

The other possible mechanism is that human can suffer from circadian rhythms disruption by engaging in night time activities which activated by night light contributing to increased susceptibility to breast cancer [26, 55].

According to the third possible mechanism, light at night can function as a general stressor and endocrine disruptor, this is another possible mechanism, particularly when changes in night light intensity are suddenly and unexpected [26, 56]. It was also proposed that melatonin is a mediator between the epigenome and environment [28, 57].

A study found that women exposed to extensive night light are vulnerable to a 12% rise in breast cancer risk. The areas also with the highest night light had a higher rate of occurrence of breast cancer compared to the areas with the darkest environments [31].

In a global study showed that Artificial light at night is significantly correlated for breast cancer. Immediate practical steps should be taken to ban artificial lighting at night in the major cities around the world and also in homes as well [10].

A Nurses' Health Study reported a small increased breast cancer risk among pre-menopausal women associated with exposure to residential outdoor light at night [30].

A study concluded in Georgia showed that there is a positive associations between breast cancer risk and exposure to night light. This is consistency with the previous research which showed that there is a biological associations between night light exposure to and breast cancer risk. Studies have indicated that disruption of circadian cycle may result in breast tissue carcinogenic. About 30 to 50% higher risk of breast cancer in developed countries with the highest versus lowest light night levels [31, 58].

Blue light exposure before sleeping has been shown to inhibit the development of nocturnal melatonin, which may be associated with an increased risk of breast cancers [13, 59, 60].

All documented reported an environmental impacts of artificial night light, like melatonin production are due to the spectrum of the light [61]. These physiological changes may influence the circadian cycle, sleep timing, control of blood pressure, seasonal reproduction and the role of melatonin as an antioxidant with implications for the prevalence of some certain cancers [15, 62].

The results were not related to a specification lighting technology, but to artificial night light. Studies showed an association between patterns of night light and the incidence of breast cancer and obesity [10, 31, 58, 63].

Blask and colleagues famously showed that a key factor in the connection is melatonin, a hormone produced in nighttime darkness that promotes sleep [64]. They found that when the tumors were perfused with melatonin rich human blood collected during the night, the development of cancer slowed down.

Some studies have concentrated on the CLOCK gene. Stevens and his colleagues found that healthy women displayed lower CLOCK gene expression than women with breast cancer. Switching on or off of genes as a result of artificial light at night may play an important role [65].

7.1 Melatonin

Melatonin was first discovered in 1917, indicating that an extract of the bovine pineal gland given to frogs whitened their seed coat (McCord and Allen 1917). Melatonin is a pleiotropic neuro-hormone produced through the darkish section of the 24 hours cycle and secreted by the endocrine gland called pineal gland. Even when the period of light is short with low intensity, melatonin secretion remains to be inhibited by light [37, 64, 66].

About 40 years later chemical extracted from the pineal gland identify and called it melatonin [67]. Since its discovery, melatonin existence has been noted in all studied organisms, ranging from single-cellars to all plants and animals [68].

Various central and peripheral tissues, including the heart and arteries, breast, lung, small intestine, liver, kidney, adrenal gland, ovaries, gallbladder, prostate, and skin. Melatonin also serves as an anti-inflammatory and antioxidant that functions as a free radical scavenger during inflammations and injuries. The rhythmic release of melatonin from the pineal gland helps organize circadian rhythms and neuroendocrine processes by activating pairs of MT1 and MT2 G-protein receptors. Melatonin triggers fatigue, sleepiness and a diminution of sleep latency [69].

Furthermore, it has been demonstrated that inhibition of melatonin in humans by light depends on wavelength, with illumination of shorter wavelengths which is greener and more blue, being more effective at suppressing melatonin than yellow–redness of longer wavelengths [62]. Overall, exposure to artificial light by disrupting melatonin production, interferes with our temporal organization, possibly leading to cell dysfunction, and promoting the abnormal proliferation of altered cells.

Several research showed that melatonin plays a significant role in numerous functions of living human and can be an antioxidant and anti-oncogenic agent [70, 71].

The production and secretion of pineal melatonin increases after dusk and, in humans, it resumes between 2 am and 4 am, while after this period, its production slows down and stops about 3 h after sunrise [72]. As we additionally know today, light disturb melatonin creation and secretion.

8. Melatonin functions

The immune system exhibits rhythms and disturbance daily. Association between serum melatonin and phagocyte activity was documented. The presence of lymphocytes melatonin receptors is another significant point for connection between melatonin, and changes in the immune system [73].

Among its different capacities, melatonin moves the dark sign to all body cells and tissues keeping up the first essential capacity of a photoreceptor creation, recognizing photophase and scotophase, while the relations between them is likewise moved by melatonin subsequently flagging irregularity to the cells and tissues.

In young people melatonin is known to stifle the development and activation of the reproductive system, thus delaying sexual maturity. Melatonin is also known as a direct anti-oncogenic agent In regards to breast cancer, several mechanisms are suggested for its role, including. Melatonin is also known as anti-oncogeneic agent for breast cancer and prostate cancer. Concerning breast cancer, modification of estrogen receptors is the key that melatonin play its role.

9. Melatonin and breast cancer

Clinical studies showed a relationship between melatonin levels and metastatic of breast cancer, where a decrease in melatonin were noted in breast cancer

patients, when compared with healthy ladies, bigger tumors also related with lower melatonin levels.

Melatonin synthesis and release happens in response to darkness and inhibited by light. Melatonin peak levels normally occur during sleep after midnight. These levels decrease and become minimal when we are exposed to day light.

A call for additional investigation of the connection between night light and shift workers and cancer that might be melatonin depended. This call is as yet applicable for shift workers, urban and rural populations exposed to light at night, electronic gadgets with LED lights become a well known source of light pollution [36].

It has been showed that high melatonin levels at day time result in seasonal affective disorder which is very common in northern America and in northern Europe. This disorder is managed primarily mental doctors, and additionally by chrono-scholars, as a typical solution for Seasonal Affective Disorder is presenting the subjects to short frequency light which stifles melatonin. This demonstrating the significance of timing, the decrease of melatonin secretion at day time is also important for human well-being, while disturbance that may rise out of a deficient amount of light at day time will likewise have negative well-being impacts.

The importance of exposure to natural day light is of great importance for the resetting of melatonin production. The short light wavelength suppresses melatonin production and skin produces vitamin D. Because of the modern life, many individuals around the world are not exposed to natural light as they venture out form home for work before sunshine and come back after sunset. This way of life result in the way that melatonin production isn't totally smothered, suppressed, while vitamin D production is stifled. As a result of night light exposure, environmental temporal cues are not transferred correctly to the cells for adjusting our temporal organization.

Driven brightening in electronic gadgets encompasses us and goes with us even while sleeping. Therefore, children exposed to such brightening for a long time during the dark period during the time melatonin is to be created under dim conditions. As melatonin levels are not tested consistently, a large portion of people are unconscious of the risks involves.

Several studies suggested the existence of the "immune-pineal" axis. The pineal gland serves as an inflammation mediator to synthesis melatonin, where pro-inflammatory mediators inhibit the production of melatonin while anti-inflammatory mediate potentiate melatonin production [74–76].

Mechanisms of many diseases can be explaned by understanding the relationship between the pineal gland and immune response. In addition to being a photoperiodic information transducer, the pineal gland is also a constitutive participant in the intrinsic immune response [76].

10. Light, sleep and breast cancer

As a likely mechanism, sleep would possibly affects circulating hormones such as melatonin, cortisol, growth hormone, prolactin and insulin levels, which can be key factors in many disease processes, including breast cancer [77]. Thus, many studies have examined the association between sleep period and breast cancer incidence [78–81].

10.1 Circadian, sleep disruption and mammary oncogenesis

Circadian and sleep disruption might also additionally act on molecular, immunologic, cellular, neuroendocrine, and metabolic levels in methods that make contributes to development of breast cancer.

Mammary carcinogenesis stars with mutation of a healthy cell through alterations in immune and cellular processes, including:

1. Oxidative nuclear DNA damage.

2. Changes in cellular apoptosis.

3. Changes in innate immune function.

Mutated cells are capable to survive despite the innate tumor suppressor mechanisms through inactivation of the p53 gene which could reduced apoptosis of aberrant cells [82]. Steroid hormones play an important role in the growth of breast cells, and estrogen considered an oncogenic agent is well known. The availability and timing of melatonin is adversely affected by sleep disturbance and circadian disruption.

Continual inflammation can stimulate genetic instability that can result in cell mutations. Disruptions in sleep and circadian cycle have affect on predispose the organism and metabolic processes to increased adiposity, which increase the risk of breast cancer.

11. Inflammation and the immune system

Repeated sleep and circadian cycle have an impact on innate and acquired immune function. Several studies have shown that decreased circulating NK cell numbers and NK cytotoxicity are associated with a single night of sleep deprivation [83, 84].

Sleep disruption may also causes a shift in cytokine creation from Th-1 cytokines to Th-2 cytokines, including IL-10, that may permit tumor cells to escape from immune surveillance and this may increased breast cancer risk [85]. Healthy sleep is associated with pre-myeloid dendritic cells production, which produce IL-12 a cytokine related to the delay of tumor onset [86].

Chronic inflammation is implicated in the oncogenic pathway, and both circadian disruption and sleep disruption were confirmed to have pro-inflammatory effects [87]. Certain lymphocytes are able to produce melatonin and in turn, melatonin has been proven to moderate the function of many immune functions [83].

Repeated disruptions in melatonin synthesis as a consequences of nightly circadian and sleep disruption might also additionally have negative effects on healthy immune functioning [88].

Sleep disruption is associated with increased glucocorticoid production and several studies indicated that short sleep duration and sleep deprivation are both associated with altered cortisol profiles and raised evening cortisol levels [89]. Glucocorticoid input from the adrenal gland has suppressive impacts on the amplitude of circadian cycle within the pituitary gland and hypothalamus [90].

12. Oxidative stress and DNA damage

Oxidative stress is known to cause DNA damage and is related with increased risk of breast cancer. On the other hand, antioxidants decrease DNA damage. Oxidative stress-induced DNA damage may be an essential pathway by which sleep disturbance may have effects on breast than circadian disruption [91].

Sleep have antioxidant impacts, giving an opportunity for the body to expel oxidants produced during alertness [92].

Many studies showed that sleep disturbance may increases reactive oxygen species (ROS) [93, 94]. ROS can lead to DNA damage by binding to neighboring molecules with unpaired electrons, causing strand breaks and its formation link between circadian cycle and sleep hardship [95].

Sleep disturbance contribute to oncogenesis through damage cellular, and disrupting the circadian cycle. Oxidative stress play an important role as a mediator of cellular apoptosis [96]; sleep deprivation-induced oxidative stress can permit the mutated cells to elude apoptosis. Circadian cycle also involved in this pathway.

13. Melatonin and estrogen

It has been proposed that the circadian cycle formed as a result of counteracting oxidative damage caused by radiation. Melatonin may be a powerful free radical forager that impacts quinine reductases to decrease oxidative damage [97].

14. Melatoin suppression

Studies showed that animals whose melatonin generation was disrupted by pineal or SCN ablation were prone to increased rates of mammary carcinogenesis. In another study, showed that melatonin suppression is related with increased hyperplastic processes and tumorigenesis in the mammary gland [98–100].

Several hormones, such as estrogens, progesterone and prolactin influence the etiology of breast cancer. Melatonin has an inhibitory effect on the receptors of estrogen and can counteract the estrogen's tumor-promoting impact. In addition, melatonin can increase the cell cycle length and avoid progression. These actions oppose the estradiol pathways, which promote cell proliferation and progression of cells [101, 102].

Sleep also impacts hormone levels.

Partial sleep deprivation among healthy women results in increases in Luteinizing Hormone (LH) and estradiol and elevated levels of prolactin levels [103]. Besides, there's conversely association between sleep hardship with levels of pestradiol. These indicated that regular sleep disturbance and short sleep at night may be related with chitinous elevation of estrogen levels which considered a risk factor of breast cancer. Ladies sleeping more than nine hours decreased the breast cancer risk compared to ladies sleeping seven hours [104].

15. Conclusions

The natural 24-hour cycle of light and darkness make a difference to preserve exact arrangement of circadian biological cycle, the main activation of the central nervous system and several cellular and biological processes, and pineal gland release of melatonin. All future outdoor lighting must be of energy efficient designs to reduce light pollution. The disturbance of the sleep–wake cycle and melatonin suppression may be due to to more direct health effects of night light. Even low intensity nighttime light has the capability of hinder melatonin release. Melatonin suppresses tumor growth and serves as a circulating anticancer signal. Many epidemiological studies back the theory that night light increases breast cancer risk. The quality and length of sleep and darkness affect several biological processes that

are currently under investigation. Further information is required to assess the role of sleep versus the period of darkness on cancer. Due to the nearly present exposure to night light at improper times relative to endogenous circadian cycle, there is an urgent need for multidisciplinary research to address the assocation between night light and cancer.

Conflict of interest

There is no conflict of interest.

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