

Consequences of Light Pollution on human health: a Global Environmental Issue

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ABSTRACT

Invasive new forms of environmental pollution like light pollution are emerging rapidly. An excessive and inappropriate direct or indirect introduction of artificial light into indoor and outdoor surroundings puts tremendous environmental stress on human health. Nighttime exposure to artificial light has been linked to a circadian system disruption, which has been shown to have negative consequences on health. Obesity, mental illnesses, sleep disorder, and cancer are the main diseases that light pollution can cause. A more thorough comprehension of the risks to health posed by light pollution might drive risk-taking and better artificial light control, resulting in a lighting environment that is healthier. In this short review, we have aimed to shed light on the consequences of light pollution on human health.

Keywords; Artificial light, Light pollution, Human health, Environmental pollution

I. INTRODUCTION

Light pollution is interpreted as the exaggerated and improper introduction of artificial light into outdoor and indoor environments by humans, either implicitly or explicitly (Fig.1)[1,2]. Increased light pollution has emerged from the enhanced use of electric lighting in recent years, as well as the inadequate construction of lighting fixtures. Light pollution has been distinguished as an emerging threat to global biodiversity[3]. Despite being a comparatively new form of environmental degradation, light pollution is already causing serious problems.

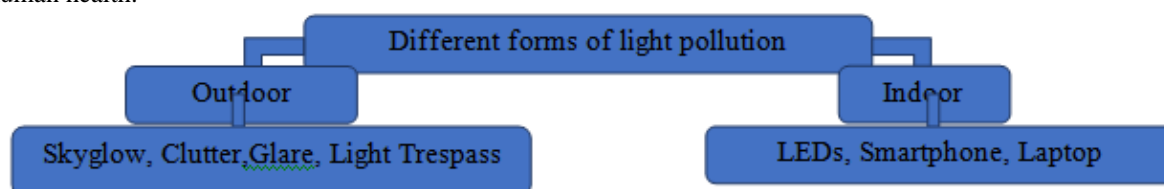


Fig. 1. Different forms of light pollution sources [4][5].

Several factors might cause light pollution, including (i) sky glow: a phenomenon that occurs when light projected into the sky is reflected by atmospheric matter, increasing sky brightness and making astronomical observation more difficult. (ii) light trespass— when unwanted light falls onto adjoining properties (iii) glare—unnecessary high-intensity lighting that can cause visual impairment, causing discomfort and reducing visibility for drivers and pedestrians (iv) over-illumination— excessive lighting levels above what the human eye can perceive (v) light clutter—

the improper or excessive grouping of light sources [3,6].

Light pollution has recently been identified as a growing interest not merely for astronomical observations but also for human life quality[7]. Light pollution is an alarming global environmental issue due to the detrimental consequences of artificial light on ecological systems and human health that are increasingly being acknowledged[1]. Fig.2 shows the rising trends in publications about light pollution, which demonstrates the increased motivation to address this problem.

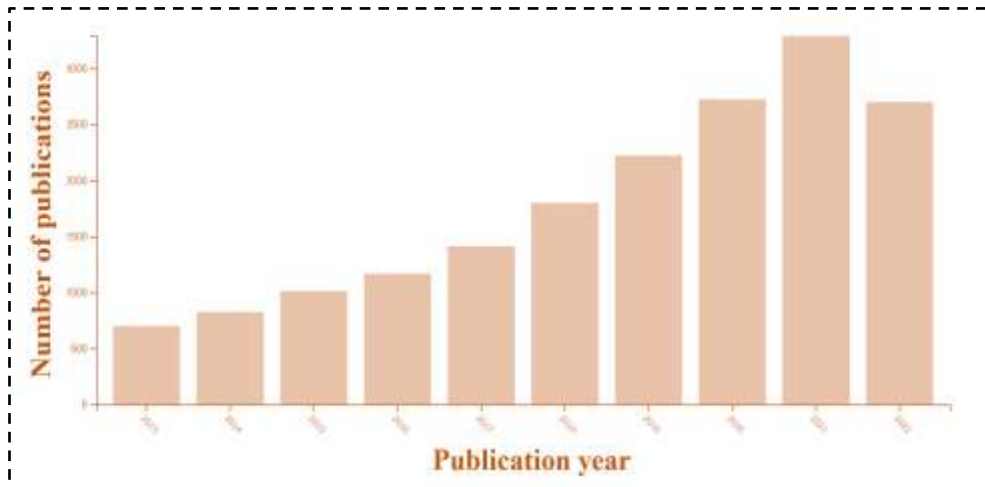


Fig.2. Publications on light pollution(<https://www.webofscience.com>): key words-light pollution; date of access: 10.11.2022

Photosensitive organisms are negatively influenced by light pollution. Artificial light can also affect fundamental biological processes in fish, such as pigmentation, growth, and development[8]. Light pollution is a nearly indispensable feature of human-altered landscapes and could be a factor in insect decline[9]. Dopaminergic neuron damage results from prolonged exposure to fluorescent artificial light in rodents and birds. Light pollution has a negative impact on wildlife as well. Human health may have a considerable detrimental impact owing to prolonged exposure to artificial light at night. Light pollution may cause changes in the production of melatonin, “a hormone critical for the inhibition of various cancer cells” in humans. The effect of light pollution on human health is taken into account in this paper.

CONSEQUENCES OF LIGHT POLLUTION ON HUMAN HEALTH

Light frequently coexists with chemicals and airborne particulate matter in the real environment due to combined pollution. In large cities, these pollution elements converge significantly in the late afternoon and evening. Indoors, light pollution is also a dilemma, which exacerbates human health risks[4]. In addition to the light that seeps in from the outside surroundings, people are also utilizing a growing number of digital devices that emit various types of light. At home, blue light-emitting gadgets like smartphones and laptops are frequently seen alongside white light-emitting lamps and ceiling lights. People are exposed to artificial light at night more frequently in modern life(ALAN)[10]. In addition to affecting astronomical observations, light pollution also has an impact on social and environmental sustainability[11]. Exposure to artificial light at night can pose several detrimental health impacts on human health (Fig.3)



Fig. 3. Consequences of light pollution on human health.

Brain and cardiovascular disorders could be potentially impacted by light pollution[1]. The correlation between artificial light and sleep disorders is quite obvious. Exposure to outdoor ALAN in industrialized areas is extremely widespread owing to nighttime light pollution and the necessity of the worker's engagement at night[12]. Home lights being left on at night and new sources of exposure (such as monitors, smartphones, etc.) have all contributed to a rise in indoor light exposure over the past few decades, which are exerting potential risks to human health[10].

Outdoor ALAN may also be able to reach indoor environments. Grant et al. identified prolonged exposure to high amounts of artificial light at night as the primary source of melatonin suppression in humans [13]. Low melatonin levels have been linked to an increased incidence of hormone-sensitive cancer [14]. Light pollution has evolved into an unavoidable risk factor for metabolic disorders as urbanization has accelerated[11]. The major health effects of light pollution are the disruption of circadian rhythms, alterations in hormone levels, and metabolic abnormalities[4,11,15].

The effects of light pollution are significantly influenced by light intensity, wavelength, and photoperiod[12]. The influence of light pollution on human health can also be affected by other variables, including diet, nutrition, and gender[15]. According to a study, light pollution spreads at a pace of 2.2% annually, indicating that pollution will likely increase quickly in the near future [16].

The correlation between human obesity and both indoor and outdoor ALAN has been confirmed in many investigations [17–19]. Various studies indicated the connection between high ALAN exposure with an increased risk of breast cancer[20,21]and obesity[22]. In one study, it was reported that mood and anxiety problems are positively linked with outdoor ALAN[23]. In another study, it was mentioned that LAN exposure may cause physiological and behavioral changes that have an impact on mood and mental health[24].

Numerous epidemiological studies have investigated the connection between circadian rhythm disruption and mental health in humans, particularly in night shift employees. A recent meta-analysis demonstrated that night-shift workers had a greater risk of depression than day-shift workers[25]. Hansen et al. investigated how ALAN affected the probability of developing diabetes in nurses working in different shifts who were

diabetes-free at recruitment [26]. According to reports, 4.4% of all nurses experienced diabetes over the 15-year follow-up period. In comparison to nurses who worked day shifts, nurses who worked night or evening shifts had a noticeably higher risk of developing the disease according.

Breast and prostate cancer risk may triggered due to night shift workexposure to blue light spectrum and ALAN[27]. Multiple epidemiological studies have connected higher outdoor LAN assessed from satellite photography to increased breast cancer incidence because LAN prevents melatonin production at night, a hormone that may influence the molecular processes involved in breast cancer carcinogenesis [28].

Additionally, Choi et al. reported that nighttime exposure to continuous light, such as from night shift employment or living a nocturnal lifestyle, is becoming a new risk factor for weight gain and obesity [29]. They investigated, how changes in the circadian rhythm and nocturnal melatonin synthesis could result from a single nighttime exposure to bright light (BL). Chronic BL exposure at night may increase the risk of obesity by interfering with circadian rhythms and the metabolism of macronutrients, according to research by Choi et al. that found acute BL exposure right before bedtime worsened circadian rhythms.

Koo et al. examined the link between obesity and ALAN [30].The results of this study offer epidemiological support that outdoor ALAN is highly correlated with obesity and that there is gender-specific differences in obesity prevalence. Additionally, Muscogiuri et al. reported a link between ALAN exposure and disease such as obesity and cancer[12]. Melatonin suppression can lead to changes in circadian rhythms that are harmful to controlling appetite, as well as dysfunctions in metabolic signaling and cancer cell proliferation.Both cross-sectional and longitudinal investigations, whether they were conducted indoors or outdoors, have shown a relationship between the negative effects of high LAN levels and weight gain and obesity in adults[31]. Due to the increased prevalence of dyslipidemia and preclinical atherosclerosis, LAN may increase the probability of acquiring cardiovascular illnesses[32].

In one study, LAN was reported to be positively associated with thyroid cancer risk[33]. Depressive symptoms and suicidal tendencies were discovered to be positively correlated with outdoor LAN in adult individuals[34]. According to Park et al., artificial light exposure at nighttime while sleeping was strongly linked to an elevated risk of

weight gain and obesity, particularly in women who slept with a light or a television on in the room [18]. Additionally, the effect of light pollution on people with bipolar disorder was looked into [17].

In another study on American people, outdoor ALAN was associated with a higher probability of reporting less than 6 hours of sleep [35]. Furthermore, it was reported that in older persons, exposure to artificial nighttime lighting outside was substantially correlated with hypnotic medication prescriptions [36]. When compared to the lowest quintile of ALAN, the probability of reporting short sleep elevated in both men and women by 16% and 25%, respectively.

Numerous localities have implemented restrictions to limit the wasteful loss of light into the sky and environment as a result of the ongoing proliferation of nighttime artificial lighting [12]. The metabolic abnormalities brought on by light pollution are fortunately partially reversible. A promising approach to reducing light pollution and offering treatments to alleviate the metabolic stress brought on by unavoidable light pollution includes the use of effective therapies like melatonin supplementation, wearing blue light-shielded goggles, bright morning light therapy, and voluntary exercise [11,15].

II. CONCLUSIONS

The advancement of humanity has undoubtedly been aided by artificial light. However, modern lighting technology's resource efficiency and lower operating costs have remarkably elevated the quantity of artificial lights to which we are exposed in our daily life. The introduction of exaggerated and inadequate artificial light, whether directly or indirectly, into indoor and outdoor environments has a detrimental impact on the environment. Future studies ought to concentrate on the traits and pathways of metabolic disruptions brought on by light pollution, preferably in relation to how a particular light parameter or kind of light pollution affects it. Even if it is impossible to completely eradicate LAN, it is necessary to identify the maximum level that may be tolerated as well as deeper strategies to reduce harm to human health and the environment. To ensure the proper use of lighting equipment and electronic devices and reduce the risk of light pollution, further efforts are required. Although there are laws and guidelines on light pollution, very few of them are founded on the possibility that poor lighting causes diseases. The current approach to light pollution prevention and reduction is predominantly based on the implementation of engineering and administrative measures at the

street or district level on individual light sources or individual installations. Owing to detrimental impact, light pollution must be regulated and the consequences on humans must be better understood. This dilemma should be addressed by the government agenda in order to introduce solutions. More awareness is demanded to bridge the void between existing regulations and the pursuit of better energy-efficient lighting. Light pollution decrement should be consistently included as a component of any territorial management strategy.

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