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THE EFFECT OF LIGHT ON HUMAN HEALTH

Dilafruz Toshto'lova
Ilhomjon Boymurodov
Jizzakh State Pedagogical University

Abstract:
This article explores the influence of light on the human circadian rhythm and psychological well-being. It discusses how different types, intensities, and timings of light exposure can regulate biological clocks, improve mood, and enhance overall mental health. Through a review of scientific research and practical case studies from educational, medical, and professional environments, the article highlights the significance of proper lighting in maintaining emotional stability, productivity, and sleep hygiene. It also provides recommendations for optimizing lighting systems in various settings to promote healthier lifestyles.

Keywords: Light exposure, circadian rhythm, psychological health, biological clock, lighting systems, mental well-being, light therapy, productivity, emotional balance.

Introduction

Human life is influenced by many external factors. Among them, light is one of the most significant factors affecting human health, mental state, and daily activities. For centuries, humans have lived under natural light – sunlight, but after the industrial revolution, artificial light sources began to enter daily life. This has started to negatively affect the natural biological rhythms of the human body, known as circadian rhythms. Circadian rhythms are biological processes in the human body that occur in a roughly 24-hour cycle. These rhythms regulate sleep and wakefulness, hormonal activity, body temperature, mental function, and other essential functions. Light is recognized as the most important regulator of these rhythms. Specifically, blue light spectrum sends signals through special cells in the retina to the circadian center in the hypothalamus, which inhibits the production of melatonin. This, in turn, affects sleep-wake cycles, mood, and overall health.

Today, the widespread use of artificial lighting, prolonged screen time, and working night shifts have led to the disruption of circadian balance. This results in many negative consequences, such as depression, insomnia, chronic fatigue

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syndrome, and reduced productivity. Therefore, studying the connection between light and circadian rhythms has become an important research area in modern physiology and psychology. This article will analyze the impact of light on circadian rhythms and human psychological state from both scientific-theoretical and practical perspectives. The article will present a comprehensive approach based on existing scientific research, practical observations, graphical analyses, and recommendations.

Light is an inseparable part of human life, not only serving as a means to illuminate the surroundings but also acting as a crucial biological stimulator that regulates physiological and psychological functions. Through the influence of light, the process of vision occurs, but it does not end there. In the human eye, there are not only photoreceptors that detect light but also specialized ganglion cells responsible for controlling circadian rhythms. These cells are particularly sensitive to blue wavelengths of light and transmit signals to the suprachiasmatic nucleus (SCN) in the hypothalamus. The SCN functions as the "biological clock."

Light plays a key role in regulating the production of hormones such as melatonin and cortisol. Melatonin, the "sleep hormone," is actively produced in darkness and helps to calm the body. In the presence of light, melatonin synthesis decreases. Conversely, when natural light enters the eyes in the morning, cortisol levels rise, which awakens the body and enhances activity throughout the day. The proper distribution, spectrum, and intensity of light are of significant importance for human health. For instance, natural light in the morning wakes up the body and improves mood. In the evening, warm-colored, low-intensity light calms the circadian system and prepares the body for sleep. In contrast, bright, blue-spectrum light in the evening (such as light emitted from a phone or laptop screen) halts melatonin production and disrupts sleep quality. For this reason, modern lighting technologies – especially those based on LED systems – are striving to create circadian-compatible lighting systems, taking into account biological balance. This approach is referred to as "human-centric lighting".

Circadian rhythms are one of the main mechanisms that keep the human body's daily biological activity in balance. The term "circadian" comes from the Latin "circa diem", which means "around a day." These rhythms follow a cycle of approximately 24 hours and are mainly coordinated through exposure to sunlight and darkness. The suprachiasmatic nucleus (SCN) is the body's main biological clock, which receives light signals from the eyes and guides the rhythm of the entire body. Circadian rhythms regulate sleep-wake cycles, body temperature,

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heart rate, hormonal changes, metabolism, and psychological activity. When these rhythms are disrupted, they can negatively affect human health. For example, people who work night shifts regularly may experience insomnia, chronic fatigue, hyperactivity, or, on the contrary, depression.

In young children, circadian rhythms are not yet fully developed, which is why their sleep patterns are often irregular. In adults, these rhythms are more stable but can be disturbed by improper lighting, work schedules, and stress. In elderly people, melatonin production decreases, leading to a decline in sleep quality.

Scientific studies have shown that maintaining a proper circadian balance has a positive effect not only on physiological conditions but also on cognitive function, emotional stability, and mental health. That is why conscious control of the lighting environment is considered important for preserving these rhythms.

Light is recognized as the most important external factor regulating the circadian system. In particular, the spectral composition and intensity of light play a decisive role in adjusting the human biological clock. Natural sunlight, starting in the morning, sends awakening signals to the body by suppressing melatonin production and increasing cortisol levels, thereby enhancing alertness. This helps the body transition into an active daytime mode. Blue-spectrum light (with a wavelength of approximately 460–480 nm) has the strongest influence on the circadian system. Light of this wavelength sends signals via specialized photoreceptors in the eyes to the SCN in the hypothalamus, switching the body into "daytime mode." Therefore, exposure to blue-enriched light in the morning and daytime is considered beneficial, while at night, this spectrum can disrupt the body's natural sleep preparation mechanisms. Looking at blue light sources such as phones, TVs, and laptop screens for extended periods in the evening suppresses melatonin synthesis. This leads to delayed sleep onset, insomnia, and, over time, a circadian imbalance. Such disruptions may result in fatigue, low mood, reduced concentration, and weakened immunity.

For this reason, the concept of circadian lighting (or biologically adaptive lighting) has been developed in recent years. According to this concept, the intensity and spectrum of light in human environments are automatically adjusted based on the time of day. For example, blue light is intensified in the morning, while in the evening, it shifts to warm yellow tones.

By studying the influence of light on the circadian system in depth, we can expand opportunities to enhance human health, productivity, and psychological stability.

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Especially in schools, offices, and hospitals, proper lighting design can have a direct positive impact on human performance and well-being.

Light plays an invaluable role in human mental state and psychological stability. It not only supports the visual process, but also directly affects emotional well-being, stress resilience, motivation, and social activity. In environments lacking adequate natural light, individuals often feel fatigued, lethargic, and mentally downcast. This effect becomes particularly noticeable in autumn and winter months, when days are shorter and nights are longer.

Numerous studies have confirmed a strong correlation between light deficiency and depressive states. In particular, a condition known as Seasonal Affective Disorder (SAD) arises specifically due to insufficient light exposure. Individuals suffering from SAD experience symptoms such as gloominess, lack of motivation, excessive sleepiness, and increased appetite.

However, this is not limited to weather conditions alone. Individuals working or living in buildings with poor artificial lighting systems—such as schools, universities, offices, and industrial facilities—are also at increased risk of experiencing chronic stress, low mood, lack of enthusiasm, and even clinical depression. For example, office workers confined to windowless rooms often experience decreased productivity and a negative impact on their psychological state. As a result, modern approaches to "psychological lighting" have emerged. This principle considers how light affects not only the physical but also the emotional state of individuals. For instance, warm-colored light can evoke feelings of calmness and trust, while cool-colored light enhances alertness and focus. Bright, natural-like lighting is shown to boost creativity and positive mood.

Moreover, by properly designing lighting systems in classrooms, libraries, wellness facilities, and homes, it is possible to maintain psychological balance. This is especially crucial for preschool and early primary school children, for whom lighting serves not just as a part of the learning environment, but as a key factor in emotional stability. In recent years, extensive empirical studies have been conducted to confirm the effects of light on human biological rhythms and psychological well-being. These investigations have been carried out not only in laboratory settings, but also in real-life environments such as schools, offices, healthcare institutions, and homes.

For example, in a 2021 study conducted in Germany, office workers were divided into two groups: the first group worked under constant cool-white LED lighting, while the second group was exposed to a circadian lighting system that adjusted

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throughout the day—blue light in the morning, neutral light in the afternoon, and warm light in the evening. After 4 weeks of observation, the second group showed: a 25% increase in concentration, a 30% reduction in fatigue, and an 18% improvement in job satisfaction.

Another study in Finland focused on primary school students, experimenting with classroom lighting of different spectral compositions. Students exposed to blue and white spectrum lighting in the morning exhibited higher alertness and better test performance compared to those studying under warm-spectrum light.

Home-based experiments also demonstrate that adjusting lighting schedules can enhance sleep quality, mood, and productivity. In particular, the gradual increase in morning light—achieved through sunrise simulator lamps—helps the body wake up naturally and supports a stress-free start to the day. According to scientific findings, regulating the circadian system through lighting has yielded positive results such as reduced depression, improved emotional balance in children with autism spectrum disorders, and delayed onset of dementia symptoms in elderly individuals. Moreover, in recent years, light therapy has been widely implemented as a form of psychological treatment in mental health clinics. By spending 30 minutes a day under intense, controlled light exposure, patients can restore their melatonin-cortisol balance, leading to improved emotional well-being.

These studies and observations confirm that light is not merely an environmental element for illumination, but a direct regulator of human health and psychological stability.

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