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A review of the effect of phone use on sleep and methods to sleep better

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Abstract. The use of mobile phones has risen in the last decades exponentially. People, particularly young adults, spend the majority of their time on phones every day. Many studies have shown the negative impacts of electronic device use on sleep. Inappropriate mobile phone use affects sleep by making it harder to sleep, reducing mean sleep time, and diminishing sleep quality. This review focuses on how smartphone use affects sleep through biological and psychological aspects. The paper also provides insights on changing phone use habits to acquire better sleep and prevent developing sleep disorders.

Keywords: Sleep, Mobile Phone, Bluelight, Circadian Rhythm, Melatonin Suppression.

1. Introduction

Sleep is one of the most crucial parts of everyone's life. Good sleep benefits both physical and psychological health. Insufficient sleep leads to adverse outcomes, including reduced quality of life and increased vulnerability to disease [1]. Despite its necessity, sleep problems, such as decreased sleep duration, disrupted sleep cycle, and reduced sleep quality, occur in a large percentage of the modern population [2]. Many recent studies point out the association between the extensive use of smartphones and corresponding sleep problems in people [1, 3, 4]. Smartphone use is widespread among most people for its portability, accessibility, and convenience. However, excessive use also leads to health problems. Excessive use of mobile phones correlates with a high prevalence of sleep problems and poor body health conditions [5, 6]. The review aims to discover the underlying mechanism of how mobile use affects human sleep and provide possible advice on maintaining good sleep.

2. Analysis of the underlying mechanism that affects sleep

2.1. How light affects sleep

People are continually changing from dozing to waking consistently. The framework that controls the typical timing and capability of the cycle shift is known as the circadian framework.

The retina, a fragile layer of nerve tissue at the back of our eyes, is a crucial design that decides how light influences rest and circadian beat. It contains photoreceptors known as poles and cones. Cones empower us to see tones and movement during the daytime. Conversely, poles just become dynamic at nightfall or in more obscure circumstances. Another photoreceptor in the retina is the retinal ganglion cells (RGCs). RGCs express the photopigment of melanopsin to incorporate visual data and send it to

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the cerebrum through the optic nerve. Melanopsin is a short-frequency delicate color with a pinnacle responsiveness of around 480 nm [7]. RGCs with such awareness are called inherently photosensitive RGCs(ipRGCs), and these ipRGCs intercede with most light impacts on the circadian clock [8].

After passing the visual stimuli through the optic nerve, the retina-generated light information reaches the retinohypothalamic tract (RHT) and arrives at the suprachiasmatic nucleus (SCN). SCN is a paired structure in the hypothalamus and acts as the central master clock in humans. The diurnal alternation pattern produces a corresponding mechanism to balance the two phases—the accumulated drive for sleep and the need to be awake. SCN functions to counterbalance the pressure from both sides. Prolonged time of wakefulness will increase the drive for sleep, and accumulated sleep time will decrease the tendency for sleep.

The SCN likewise gets non-light-related data starting from inside the body. The pathways incorporate the genicular-hypothalamic plot (GHT), which conveys both light-free and light-subordinate data using the intergeniculate handout (IGL) and the raphe-hypothalamic parcel (raphe-HT). The action of the SCN is additionally impacted by different synapses or chemicals like serotonin, melatonin, and signs from various tissues [9]. The SCN likewise ventures to the pineal organ where melatonin is delivered and frames a criticism circle including the SCN-serotonin-creating raphe cores (RN)- SCN circle and the SCN-melatonin-delivering pineal organ SCN circle [10]. Light balances the musical example among attentiveness and rest by changing light data over completely to signals accessible in the humoral and autonomic sensory systems.

Before the invention of artificial light devices, humans strictly adhered to the natural 24-hour solar day cycle. Natural light plays a role in maintaining the balance of the daily rhythm and the internal biological clock. Daytime differences across seasons produce seasonal effects and change the human circadian cycle accordingly. During the winter, shorter daylight exposure makes the body experience a longer biological night and produces less melatonin, reducing the sleep duration [11]. This mechanism may account for better sleep quality during the summer since exposure to long periods of high-frequency natural light will benefit sleep by advancing sleep time, increasing sleep duration, and improving sleep quality. Roenneberg and his colleagues used questionnaire data and found that a one-hour increase in outdoor activities will advance sleep by about 30 minutes [12]. More prolonged daytime exposure to short-wavelength light is also related to increased evening sleepiness, decreased sleep-on-set latency, and increased slow-wave sleep [13, 14].

Light exposure at inappropriate times with unusual frequency affects sleep in two ways. The first is the change in melatonin release, and the second is the shifting in the circadian phase. Usually, when light is absent, SCN will signal the visual pathway to release melatonin. Melatonin will help the brain release the feeling of sleepiness and make it easier to fall asleep. When light is available at night, it will give SCN a false signal and suppress the release of melatonin. Without the help of melatonin, it becomes harder to feel sleepiness and, thus, more difficult to fall asleep.

The circadian phase shifts differently to light exposure at different times. The phase response curve created in the 1960s showed that the amount of phase shift differently corresponds to various amounts of light exposure. Usually, morning light advances the circadian clock, whereas evening light delays it. The circadian system can even integrate multiple brief light exposures to produce a shift in the circadian phase [15]. The total amount of light exposure during the day is referred to as “photic history” and functions to mediate both melatonin suppression and circadian phase shifts [16].

2.2. How artificial lighting and mobile phone use affect sleep

At night, our eyes and circadian system become more sensitive to light. After the invention of electronic light sources, the change in light availability throughout 24 hours has also led to disruptions in the sleep-wake cycle and the emergence of related sleep problems.

Compared with other artificial lighting, devices like mobile phones emit short-wavelength-enriched light. The blue short-wave light peaks at 452 nm, while broad-spectrum light (white light) peaks at 612 nm [3]. The light under this blue spectrum range can reduce sleepiness and disturb the circadian cycle by reducing melatonin.

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Chang and partners, for instance, found that perusing a book from a tablet for four hours before rest expanded rest beginning idleness, decreased melatonin emission and next-morning sharpness, and deferred the natural clock [3]. Münch and associates tracked down that openness to short-frequency light for two hours three hours before normal sleep time diminishes slow wave movement (SWA) and prompts shallower rest [17].

A few investigations have revealed that cell phone proprietorship and use before sleep time might be related to more self-detailed rest issues, including diminished rest proficiency, longer rest beginning idleness and unfortunate rest quality, deferred rest, and abbreviated rest span [2]. Many high-level cell phones can change to "night mode" and change the variety balance at night hours [18], however, no investigation tests its particular advantages on rest.

2.3. Effect of phone-induced alertness on sleep and mental health

In the human nervous system, two major types of neurons are excitatory and inhibitory neurons. They counterbalance each other and work together to maintain a relatively balanced body state. Media devices give humans of all ages more access to diverse content from the Internet. Viewing excitatory content or exciting video games, sometimes including violent images or videos, may disturb psychological and somatic arousal [19]. The over-activation of the cognitive system may reduce sleep quality by making it harder to fall asleep.

As the popularity of mobile phone games in the younger generation increases, the impairment of playing games has become something we cannot ignore. According to the Pew Research Center, as of 2020, around 90% of teens in the United States play video games, with a significant portion playing games daily. The World Health Organization (WHO) included "gaming disorder" in its International Classification of Diseases (ICD-11) as a recognized mental health condition [20]. A beta analysis investigating the relationship between problematic gaming and sleep-related outcomes shows that problematic gaming, especially at night, adversely impacts people's sleep duration, sleep quality, and daytime sleepiness and causes sleep problems. Problematic gaming may also lead to adverse outcomes, including depression, anxiety, loneliness, somatization, reduced quality of life, and poor academic achievement [20]. More time on phones browsing or gaming also means less time spent outdoors doing physical activities and less exposure to light, adversely affecting sleep by making it harder to fall asleep [20].

Light exposure has also been shown to affect mood, which affects emotional state and arousal level before sleep. Serotonin is much involved in mood regulation, and light illumination mediates its availability [21]. The phone produces disruptive light and interferes with circadian rhythm stabilization by influencing neurotransmitter production.

Media content may also influence people's moods and mental states. People are easily cheated on or hurt mentally by information overload online. Media users may have reliance or addiction and even develop more severe mental disorders under extreme conditions, exacerbating sleeping problems simultaneously. An extreme form of sleep problem is insomnia disorder, which affects about 50 million to 70 million people in the U.S. Most patients do not develop the disorder alone because insomnia is mostly the accompanying symptom of more severe mental disorders like depression and bipolar disorders.

3. Discussion

Based on the review, the paper has shown that mobile overuse has many adverse effects on sleep. It reveals that excessive mobile device usage can reduce sleep quality and disrupt the circadian system, making it hard to fall asleep and wake up at the desired times. Moreover, it is linked to increased daytime fatigue, reducing working efficiency. Additionally, excessive mobile use can also elevate vulnerability to insomnia disorders, ultimately diminishing overall life quality. Thus, people should use their mobile phones and electronic devices properly. Here are some tips for better sleep based on the research results we have discussed.

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First, we should reduce phone use time before sleep to let our body build a healthy circadian clock. A stable biological clock consistent with the environment can help us reduce daytime sleepiness and increase alertness. The increased sleep duration and quality can also improve our work efficiency by boosting memory consolidation and stabilizing the emotional state.

Second, we should have some outdoor activities and maintain some physical activities to keep our body in a homeostatic balance. These habits benefit sleep by sustaining a steady schedule and a healthy circadian clock.

Research has also shown that appropriate light use can help us improve our sleep quality and even treat other psychiatric diseases. Light is often used with exogenous melatonin to treat circadian rhythm sleep-wake disorders (CRSWD), including jet lag, shift work, and irregular sleep-wake phase disorder [22]. Bright light therapy (BLT) can provide an alternative treatment for patients suffering from depressive moods due to a lack of exposure to natural daylight. BLT, combined with selective serotonin reuptake inhibitors (SSRIs), can also be used for mood disorders like Seasonal Affective Disorder (SAD), a subtype of depression, and showed clinical improvement in symptoms [23]. Recently, light therapy has been implemented as a subsidiary therapy for ADHD, or even schizophrenia for its boosting effect on mood and sleep-wake disruption [24, 25].

4. Conclusion

This paper systematically reviews the effect of phone use on sleep. The discussion includes how light can influence sleep by modulating the circadian system on the molecular level and by affecting the overall arousal state involved in the sleep-wake cycle. Beyond that, the influence on the mood and emotional state has also been considered an effect on sleep by phone.

This paper only focuses on two aspects of how light relates to sleep, and there might be more mechanisms on how light affects sleep. Some questions still need to be figured out. We are still trying to understand how sleep is generated on the whole-body scale. Also, since the low frequency of light sometimes helps relieve sleep, and excessive and intensive lighting will adversely affect sleep, we need to design experiments to test the threshold amount of light one person can receive to facilitate sleep and not disrupt it. Thus, we can better use light as a therapy to improve our sleep and health.

The paper concludes that the overuse of mobile phones, especially during the night before sleep, will adversely influence the onset, duration, and quality of sleep, negatively impacting the circadian system and physical health. Controlled phone use, scheduled natural light exposure and physical activities, and well-arranged light therapy can help improve sleep quality and overall health.

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