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**The Influence of Virtual Learning on
the Rise in Screen Time Usage and Blue
Light Exposure, Ultimately Expanding
Sleep Disturbances Among Students**

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Abstract

With the exposure to all colors of light, a natural sleep cycle or circadian rhythm is disrupted by the blue light projected from digital screens. With the progression of virtual learning, the additional use of computers, phones, and tablets have correlated with difficulty in regards to sleep initiation and maintenance. On average, students who spend 5-8 hours remote learning are exposed to blue light that blocks the melatonin hormone responsible for proper sleep. With the progressive development of technology, newspapers are replaced with devices as the ultimate source of information. Web surfing, social messaging, and digital calls expand the rise in insomnia symptoms and difficulties regarding sleep duration. The influx in virtual learning ultimately proliferates screen usage hours and blue light exposure. Students are steered away from traditional learning and are obligated to adhere to the guidelines instructed with remote learning. The emission of unnatural blue light wavelengths at night can alter the brains natural behavior and create the effect of daylight. This daylight alternative creates sleep disturbances amongst students who are exposed to constant screen usage during school hours and evenings. Insomnia symptoms such as mood swings, fatigue, and behavioral disorders evolve from irregular sleep schedules and poor sleeping habits. The increase in virtual learning has influenced the rise in screen time usage and the blue light effect, ultimately expanding sleep disturbances and insomnia amongst students.

Keywords: Sleep disturbances, screen usage, remote learning

Disturbances of Screen Time

The innovative technology of computers and telephones have allowed media presence to advance and replace newspapers as the most reliant source of information. Widely used in all countries across the globe, the captivating nature of technological advancements can be relevant to individuals of all age groups and social standings. Higher exposure to screen time, internet, and social media have been associated with psychological symptoms amongst adolescents, such as lower self-image and higher scores on depression and anxiety scales (Vandendriessche et al, 2019). With difficulty maintaining sleep intervals, screen time is correlated with sleep quality and quantity. In the study conducted by Vandendriessche, Ghekiere, Cauwenberg, Dhondt, DeSmet, Verloigne, and Deforche, it was found that an extra hour of screen time per day was associated with increased psychological symptoms by 0.04 on a 5-point scale. In relation to sleep, the percentage mediated by sleep duration on weekend days was 4.5% while the percentage mediated by sleep duration on weekdays was 22.2% (Vandendriessche et al, 2019). This study implies that with children being at school during the weekdays, with more screen time usage in the evening, the weekend provides more time for screen time usage throughout the entire day. A positive association between sleep quality and screen time is implied as sleep onset difficulties were also a substantial mediator in the connection between psychological symptoms and screen time (Vandendriessche et al, 2019). The progression of these psychological symptoms are apparent through the influence of social standards and platforms where expectations of a false reality are portrayed.

Technological advancements have initiated the increase in screen time and the use of digital devices for communication. By gaining a substantial audience, companies have increased

their revenues by processing and computing faster devices at lower costs. The development of virtual communication has influenced many individuals to access computers, tablets, and phones as a necessity rather than a preference. Screen usage and media are ubiquitous features of early childhood and technological advancements have raised concerns about possible relations with youth well-being and the occurrence of sleep disruptions. Studies conducted on young children demonstrate that age, ethnicity, and body mass are positively associated with daily screen-based media exposure (Przybylski et al, 2019). With various components correlated with the time spent on devices, household income and the level of education of caregivers are not supplementary to the relation to digital screen time. As daily digital screen use increases with age, studies indicate that digital engagement is higher in males with demanding occupations when compared to men of all social standings (Przybylski et al, 2019). These technological developments are greatly utilized by workers whose labor consists of accessing online resources for communication. With the expected incline of screen time following technological improvements, modern society has influenced the normality of screen usage amongst all age groups.

Electronic devices that emit blue light during the evening can lead to sleep disturbances due to the suppression of the melatonin hormone. Studies have found that reading on a tablet for two hours can abolish the inhibitory effects of evening light stimulus (Rangtall et al, 2016). By testing the electroencephalographic power spectral density during slow-wave sleep, this test was used to track and record brain wave patterns (Rangtall et al, 2016). Reading on a digital tablet in place of a physical book for students can result in poor test scores, concentration, and emotional disturbances. The rise in technology has ultimately decreased critical thinking and problem solving skills because of the accessibility of web surfing and the internet. In educational

environments where there is a strong emphasis on standardized testing, when using computers in place of paper and pencil, the consistent screen usage can lead to the lack of concentration and attentiveness (Rangtell et al, 2016). Problem solving and analytical thinking requires focus and concentration where technological advancements strip students away from the process of self-reflection and self-observation.

Physiological Consequences of Virtual Learning

With the rise in remote learning and decline in face-to-face interaction, the goal of virtual learning is to provide students with a learning experience similar to the classroom. Opinions on remote learning varies as some believe it lowers academic stress while others find it challenging to maintain the work load. Traditional learning consists of a typical 5 to 8-hour school day in the United States where this traditional form of learning takes place in a classroom setting with a teacher moderating the flow of knowledge for their students. For face-to-face learning, an instructor who regulates information is the students primary source of material and course work. For remote learning, the use of technology has provided students with alternatives when seeking for help rather than relying solely on the instructor. The use of media and the internet has provided learners with access to outside sources when trying to understand the material presented. Working at the pace set by teachers, digital screens have allowed students with flexible schedules to work without misguided rules about technology or dress code.

With web-based resources and media technology, there are advocates who are for and against the increased proliferation of online courses. With traditional perspectives, old-fashioned correspondence classes provide students with face-to-face instruction which some individuals

find that remote learning cannot supplement (Mukhopadhyay et al, 2020). Without necessary regard for quality, others strongly prefer virtual learning as the attraction to technology expands resources and digital accessibility. Remote learning environments are placed into three categories: fully web based, hybrid learning, and traditional classes with web based supplements. The Office of Educational Technology conducted a survey in 2002 to gain insight into the prevalence of distance learning in public school and found that 5,500 out of 15,040 public school districts had at least one student enrolled in a distance learning format (Setzer & Lewis, 2005). Following the COVID-19 pandemic, the numbers from this survey conducted in 2002 have dramatically increased as precautions were set in place, such as distance learning, primarily to avoid possible exposure to the virus (Mukhopadhyay et al, 2020). The upsurge in the necessity of remote learning has created a reality for students where the use of classrooms have shifted to the atmosphere of one's home.

With many interruptions in school settings, tasks such as taking notes and tests can become distracting when in the presence of peers. Students can feel a level of discomfort in classrooms due to the unfamiliar environment giving uneasiness and distress. The multimedia-type learning can be beneficial for students maintaining a job, family, and balancing a college career while others believe that virtual learning strips students away from the classroom and interpersonal relationships with professors. This indicates that depending on individual focus, there is ample evidence that online learning is a full-fledge alternative for traditional classroom learning. Using computers and tablets for classes, remote learning requires focus and direct concentration towards a digital screen. With a range from headaches to the lack of sleep, human

physiologically has evolved to gain sensitivity for the projection of blue light emission which can lead to mental and emotional discomfort.

Blue Light Exposure

The effects of blue light on the cornea that lies at the front end of the eyeball is the initial structure that light passes through. Studies have shown that the corneal epithelial cells survival rates decrease after Blue-ray irradiation (Zhao et al, 2018). As blue light increases reactive oxygen species production, this indicates that the apoptosis and oxidative damage lead to further ocular inflammation. Blue light is associated with the development of dry eye proven by improving the clinical symptoms of the eye surface in an eye mouse model (Zhao et al, 2018). Niwano et al conducted a study regarding the photo toxicity on corneal epithelial cells and by using an in vitro cell culture they found that blue light, near the ultraviolet region, causes distress in the mitotic phase of the corneal epithelial cells (Niwano et al, 2019). The high-energy light that passes through the lens to the retina can inhibit melatonin secretion, ultimately enhancing adrenocortical hormone production. The massive production of this hormone affects sleep quality because it destroys the body's proportional hormonal balance.

Blue-light blocking spectacle lenses are used to improve visual performance by protecting the eyes from retinal phototoxicity by attenuating short-wavelength light. The various colors that make up sunlight have different energy and wavelengths while blue rays have shorter wavelengths and more energy. The exposure to a higher amount of wavelength from the blue end of the spectrum can impair macular health and the sleep-wake cycle (Lawrenson et al, 2017).

With the mass amount of blue light emitted from the sun, screen usage leads to concerns over the long-term effects of the proximity of screens. The extent of the time spent viewing digital device screens allows visible blue light to pass through the lens and cornea of the eye and reach the retina (Lawrenson et al, 2017). Retina damage and digital strain can lead to the eyes being irritated, dry, and cause damage in retinal cells. Studies have shown that 90% of users periodically experience eyestrain, headaches, ocular discomfort, and blurred vision (Lawrenson et al, 2017). The commonality of these asthenopic symptoms have progressively amplified with digital screen usage where the rays on the blue end of the spectrum have been found to be the closest wavelengths to ultraviolet light which is known to be harmful for human vision. These rays that contain more energy at shorter lengths accelerate blindness by damaging the eye's retina causing visual complication such as age-related macular degeneration.

There are limited benefits of blue light that can elevate cognitive function and alertness. Although intense UV light is frowned upon, the blue light within sunlight is essential for the growth and development of the eyes and vision of children. When exposed to blue light late at night, it increases the possibilities of disturbances in the circadian rhythm; the sleep and wake cycle. A study conducted by Burkhart and Phelps recruited participants who wore blue-blocking lenses to report sleep difficulties. Wearing these blue light glasses while on various digital devices for three hours prior to sleep for two weeks, the participants reported that high blue light blocking lenses had significant improvements in their sleep qualities based on a 10-point Likert scale (Lawrenson et al, 2017). This study indicates that blue light glasses improve the possible side effects of extensive blue light exposure for students and employees whose work are

mediated through computer screens. This exposure to blue light through screen usage significantly increases with the necessary use of technology in modern society school and professional atmospheres.

The Effects of Insomnia Amongst Students

In the study observing sleep mediated between adolescent screen time and depressive symptoms, minors completed surveys regarding sleep duration and insomnia symptoms. The typical daily duration web surfing, social messaging, gaming, and TV/movie watching were tested to identify the effects of these media platforms on sleep routines (Li et al, 2019). After constructing a multiple mediation model to represent the association between sleep and the screen usage in students aged 15, the sleep variables facilitated the positive association between screen time and sleep disturbances (Li et al, 2019). A study conducted by Angelika Schlarb, Anja Friedrich, and Merle ClaBen revealed that up to 60% of all college students suffer from poor sleep quality with 7.7% meeting all the criteria of an insomnia disorder (Schlarb at al, 2017). With the excessive emission of light from digital screens, the melatonin hormone created by the brain can trick the body to believe that it is not ready for sleep regardless of the time spent awake. With the progression of insomnia symptoms amongst younger generations; parents, educators, and health care professionals are encouraged to regulate screen time usage to reduce possible sleep troubles (Schlarb at al, 2017). These insomnia symptoms have been associated with blue light exposure resulting in college students suffering from sleep troubles as a cost of increased screen time.

When questioned, “How many nights out of seven in a typical week do you have: (1) problems falling asleep throughout the night? and (2) problems staying asleep throughout the night?” the responses varied with higher scores reflecting more insomnia symptoms and higher frequencies of problems falling asleep and staying asleep (Li et al, 2019). Pearson’s correlations indicate that all types of screen activity are positively correlated with insomnia and depression symptoms. Used as screen-time activity variables: web surfing, social messaging, gaming, and TV/movie watching were all associated with shorter weekday sleep duration, problems falling asleep and staying asleep (Li et al, 2019). The rise of sleep disturbances and insomnia amongst students are influenced by remote learning where excessive blue light exposure significantly alters the release of melatonin for proper sleep. The limitless motivations for using screen-time activity variables create opportunities for all age groups to use online resources for extensive periods of time.

Scholars suggest that the variety of sleep disorders are found to be closely related to visual impairments. This finding suggests that sleep quality is closely related to eye diseases that can cause an increase in corticosteroid production (Niwano et al, 2019). Reducing tear secretion and parasympathetic nerves, dry eyes symptoms can be caused by the reduction of the body’s androgens, necessary for the eyelids gland function. A study based on the excessive evaporation of dry eyes was conducted and found that screen reading can lead to the development and occurrence of poor eye sight within schoolchildren (Niwano et al, 2019). Screen reading, communication, and learning have all increased blue light exposure, impairing the circadian sleep rhythm. When compared to traditional learning, students are exposed to natural light before

and after classes, allowing short-wave blue light to illuminant and reduce strain in the eye. Studies suggest that the exposure to white light, such as natural sun light, is vital in the development of a child for Vitamin D, known as the sunlight vitamin, to promote proper growth in a child's bones, teeth, and mental performances (Rucker at al, 2018). With limited benefits of blue light exposure, the natural emission of this light assists children with proper development and growth.

Why is Sleep Essential for the Human Body?

Sleep is vital for promoting growth, cognitive development, and maintaining overall health. In 2014, *Health behavior in school-aged children* reported that 30% of boy and 49% of 15-year-old girls in England experienced difficulties sleeping. These results found that 36% of the participants reported the lack of sleep, ultimately making it difficult to concentrate on school work and remain attentive throughout the day (Bruce et al, 2017). Adolescents typically have a biological delay in the timing of sleep onset because of the change in the two processes; the intrinsic circadian timing system and the homeostatic sleep-wake system. Issues within these processes involved in sleep regulation reveal possible sleep disorders and causes for sleep deprivation. Feeling refreshed and recharged after a night of sleep can allow the body and mind to avoid diseases, lower blood pressure, and decrease risk of heart disease (Bruce et al, 2017). These health-related problems can be detrimental to the necessity of sleep because of the symptoms following these complications taking away from a proper sleep schedule.

Feeling fatigued during young adulthood and puberty is common where there are physical, educational, and occupational demands associated with growth and maturation. In a study that predicted adult sleep disturbances in regards to adolescent sleep troubles, it was found that one third of studied 16-year-olds still had problems with sleep at age 23 and 10% at 42 years (Bruce et al, 2017). If sleep disturbances remain unrecognized by physicians or the individuals themselves, the underlying problems will consistently result in ineffective treatment strategies. Sleep is linked with several brain functions for promoting enhanced mental functioning in areas including cognitions, concentration, and productivity. For those who suffer from chronic sleep disturbances, the act of sleeping can cause stress levels and anxiety to increase where the memory of sleeplessness can remain the focus when attempting to fall asleep. The association between screen usage and the obligation of proper sleep can be significantly affected with remote learning and constant blue light emission.

Sleep is referred to as a physical battery for humans where it is vital to reduce stress, improve mental health, and recharge physical strength. For healthy daily functioning, sleep plays a crucial role to avoid impaired memory and hyperactivity. Results of extreme sleep deprivation include mood swings, poor impulse control, and hallucinations. The body's ability for proper sleep can be manipulated by caffeine, diet, and alcohol consumption where these variables can impair the stages of the sleep cycle. The sleep cycle begins with stage 1, which is non-REM sleep where there is a changeover from wakefulness to sleep. This stage is followed by the period of light sleep before entering a deeper sleep (Bruce et al, 2017). Stage 3 of the sleep cycle is the period of deep sleep where muscles are relaxed and brain waves decline. Following this

stage, REM sleep occurs 90 minutes after falling into a deep sleep where mixed frequency brain activity resembles the brain activity when one is awake. Dreaming occurs during this final stage of the sleep cycle where one's arms and legs are temporarily paralyzed to prevent one from acting out their dreams (Bruce et al, 2017). Consequences for disturbances in this sleep cycle for students include low test scores, lack of concentration, and the progression of abnormal circadian rhythms. The progression of sleep disorders and insomnia can lead to severe underlying health problems where the chronic lack of sleep can result in high blood pressure, depression, and cardiovascular disease.

Conclusion

The rise of blue light emission amongst students during the upsurge of remote learning has influenced sleep disturbances and insomnia patterns. Blocking the artificial light from electronics at night can reduce blue wavelengths which can trick the brain by thinking it is daylight reflection. For optimal health, the brain's natural sleep cycle and internal clock is regulated and the body is primed for waking up and sleeping for certain periods of time. Melatonin suppression in the evening can impact daytime dysfunction and behavior due to the signals sent to the brain's internal clocks. Opposing the blue light factors that can be detrimental to the circadian sleep cycle, sunlight and white light contain a mixture of wavelengths that emit a significant amount of blue light that can be beneficial during daylight. The rise in remote learning alongside the progression of technology has influenced the exposure to blue light wavelengths that interfere with the brains primary function at night.

With a limited range of healthy blue light emission, excessive exposure to these wavelengths through the cornea of the eye can influence a variety of health-related issues. This impacts insomnia symptoms amongst students where students are more likely to experience daytime tiredness and difficulty focusing on tasks. This is significant for the future of education and teaching because student interactions and higher cognitive thinking will adjust to the use of computers and tablets. With the expected rise of screen usage following technological developments, modern society has influenced the normality of screen time amongst all age groups. The growth in screen time has influenced the lack of human interaction and contact as the main source of communication shifts towards the use of technology. The goal of distance learning has been to maintain adequate education while mitigating the detrimental effect of being on a screen for multiple hours. To obviate the issues that arise from screen time, limits can be set on the use of apps, notifications can be disabled, and the auto-lock setting on technological devices can be activated.

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