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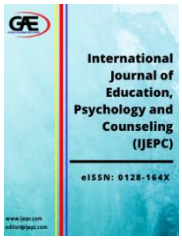

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CIRCADIAN RHYTHM DISRUPTION: CIRCADIAN RHYTHM ABNORMALITIES AND THEIR IMPACT ON STUDENTS

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Abstract:

Circadian rhythm abnormalities disrupt the 24-hour biological cycle, affecting sleep, wakefulness, and other physiological functions. These disruptions are increasingly common among students due to irregular sleep schedules, academic pressures, and lifestyle factors. This study examines the prevalence of circadian rhythm abnormalities among students and their impact on daily functioning, academic performance, and mental well-being. A systematic review of articles published within the last five years, and selected based on specific inclusion of criteria relevant to student populations, and a primary focus on circadian disruptions. The literature review highlights the negative effects of circadian rhythm abnormalities, such as poor sleep quality, increased stress, anxiety, and depression, which significantly impair students' academic success and mental health. Effective interventions like sleep hygiene practices, reducing screen time, and public health education are proposed to address these issues. From an Islamic perspective, the Quran emphasizes the balance of day and night (verse 28:73), with night for rest and day for productivity. Islamic teachings support practices like Qailullah (mid-day nap) and Tahajjud (night prayer), which align with circadian principles and have been linked to better mental health and overall well-being. This study highlights the importance of integrating scientific and spiritual approaches to mitigate circadian rhythm disruptions and promote holistic well-being.

Keywords:

Circadian Rhythm, Sleep, Mental Health, Academic Success, Academic Performance, Sleep Hygiene

Introduction

Circadian rhythms are natural, internal processes that follow a 24-hour cycle, regulating various physiological and behavioral functions, such as the sleep-wake cycle, hormonal activity, metabolism, and cognitive performance. It plays a crucial role in maintaining overall health and well-being. These 24-hour endogenous rhythms are synchronized by environmental cues like light and darkness, and regulate various physiological functions (Zee et al., 2013). However, circadian rhythm abnormalities in modern society have become increasingly common due to lifestyle factors, technological influences, and environmental changes. Disruptions in circadian rhythms are associated with cognitive impairment, mood disturbances, and increased risk of cardiometabolic disorders (Zee et al., 2013).

Students, especially those in higher education are particularly vulnerable to circadian rhythm abnormalities due to irregular sleep schedules, academic demands, social activities, and excessive exposure to digital devices. Research by Mohammadi et al. (2016) indicates that evening-type students are more likely to experience behavioral problems and sleep disturbances than their morning-type counterparts. Additionally, chronotype has been found to influence academic performance, with morning-type students generally achieving higher GPAs (Modna & Scott, 2017). Factors such as sleep quality and time management also show a positive correlation with academic success (Modna & Scott, 2017). Disruptions to circadian rhythms can significantly impact physical and mental health, leading to sleep deprivation, cognitive impairments, and emotional instability. Tao et al. (2021) found that students with circadian rhythm disturbances are more prone to symptoms of depression and anxiety, while evidence from Shareinia et al. (2021) links these disturbances to heightened stress levels.

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Understanding the impact of circadian rhythm disruptions on students is essential for developing effective interventions that promote healthier lifestyles and enhance overall well-being. This study examines the prevalence of circadian rhythm abnormalities among students and evaluates their effects on academic performance, mental health, and daily functioning. By exploring these dynamics, this writing aims to offer valuable insights into mitigating the negative consequences of circadian rhythm disruptions in this vulnerable population.

Methodology

A comprehensive and systematic search strategy was employed in the collection of literature through several academic databases. The main search engine used was Google Scholar along with other journal databases from valid and reliable publications. During the search, a few keywords were of interest such as "circadian rhythm," "the physiology of circadian rhythm," "sleep-wake cycle," "sleep disturbances," and "sleep quality." Additionally, Boolean operators (AND, OR) were used to expand and specify search results.

Inclusion and Exclusion Criteria

The literature was published between 2021 to 2024, all focusing on adolescent participants with one article focusing on mice subject to study the changes in physiological reaction once sleep was deprived. Further, the papers included were article reviews and original research with new findings. To avoid misinterpreting research results, this review excluded papers with non-English mediums.

Data Extraction

For the data extraction, a systematic form was created to extract relevant findings. This process allowed for the synthesis of information, including the background information of research, the effects of circadian disruption on students and the physiological mechanisms involved. Finally, the findings were organized in a meaningful narrative.

Findings

Circadian Rhythm Abnormalities and Mental Health

Circadian rhythms are natural biological processes that play a vital role in regulating our sleep-wake cycles, metabolism, hormone levels, and overall bodily functions. These rhythms, controlled by the suprachiasmatic nucleus (SCN) in the brain's hypothalamus, synchronize with environmental cues such as light and darkness. However, modern lifestyles—dominated by artificial lighting, irregular sleep patterns, and shift work—often disrupt these rhythms, leading to significant health challenges. This review highlights key findings from various studies to explore how circadian disruption affects students. The widespread use of artificial lighting has significantly altered the natural balance of light and darkness, disrupting circadian rhythms in the process. Davis et al. (2023) found that exposure to artificial light at night (ALAN) reduces melatonin production, delays sleep onset, and negatively impacts sleep quality. These disruptions are linked to mood disorders, metabolic issues, and heart disease. For example, students face unique challenges due to irregular sleep schedules and exposure to artificial light. Davis et al. (2023) reported that these behaviors can lead students to experience social jetlag, poorer academic performance, and long-term health risks. Disrupted sleep can impair cognitive functions like attention, memory, and problem-solving, making it more difficult for students to perform academically. Furthermore, circadian disruptions affect the release of hormones such as cortisol and melatonin, creating a feedback loop that exacerbates

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emotional instability and decreases emotional regulation. These disturbances can worsen over time, leading to chronic mood disorders and increased vulnerability to mental health issues. Students who experience circadian rhythm abnormalities have sleep disruption that leads to poorer memory and worse academic performance (Pifer et al., 2024).

Impact on Academic Performance

A study conducted by Tao et al. (2021), investigates the impact of circadian rhythm disruptions on the mental health of university students in China during the COVID-19 pandemic show a positive association between circadian rhythm abnormalities and mental health disorders. Students who experience circadian rhythm abnormalities tend to experience mental health issues, specifically depression and anxiety. In 2006, the National Sleep Foundation had proven that the majority of college students have problems with their academic performance like being drowsy at school, not paying attention in classes, and not being prepared for school. Students with circadian rhythm abnormalities had higher rates of prevalence of mild and moderate-severe depression by 17.2% and 8.7%. This shows that there is a strong relationship between circadian rhythm abnormalities and mental health problems. Furthermore, Crouse et al. (2021) found that this disruption of circadian rhythms can cause depression, which is particularly worrying to students, who may struggle with academic performance. More than 300 million people suffer from depression mainly in adolescence and early adulthood during critical developmental phases. Moreover, there is a correlation between sleep habits and depression especially among students. Students who tend to stay up late may be more likely to experience depressive symptoms (Crouse et al., 2021).

Although this research provides valuable insights into the relationship between behavior and biology, the lack of empirical evidence limits the practical application of the proposed strategies. The interconnected effects of circadian disruption—spanning physiological, environmental, and behavioral domains—emerge as a recurring theme across studies. Ayyar et al. (2021) highlighted the systemic importance of circadian rhythms at the molecular level. Davis et al. (2023) and Rea et al. (2008) demonstrated how environmental factors like artificial light exacerbate misalignment, with measurable health and behavioral consequences. Sharma et al. (2024) extended this understanding by exploring how circadian rhythms influence addiction risk. Together, these studies underscore the need for a holistic approach that addresses the multifaceted nature of circadian disruption.

In this sense, circadian rhythm abnormalities greatly affect mental health and academic performance of students. Disruption of the natural sleep-wake cycle can also lead to mental health problems such as depression and anxiety. Studies consistently show that there is a significant correlation between circadian rhythm abnormalities and mental health issues, especially in adolescence. This emphasizes that it is important to know the factors and the effects of these abnormalities to ensure the mental well-being of students. While existing research provides valuable insights and promising strategies, there is a clear need for more robust, multidisciplinary approaches to fill current knowledge gaps. By aligning interventions with circadian principles, we can enhance health outcomes and foster resilience in an increasingly demanding world.

Environmental Factors

Prolonged sleep deprivation may lead to metabolic dysregulation and other health problems. A study by Liu et al., (2024) on rats has shown the impact of sleep deprivation which results in

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weight loss and reduced locomotor activity after five days of sleep deprivation. This study underscores the importance of adequate sleep in maintaining good health and functionality in daily life. However, in the student context, sleep deprivation has become a common issue due to academic and extracurricular responsibilities which become a major factor in circadian rhythm disruption among students. Moreover, high academic demands and social pressure may increase stress levels and disrupt sleep patterns. Deng et al., (2021) study on the effect of academic stress on sleep quality found that academic stress is directly related to sleep quality. Another study by Noh et al., (2021) on sleep patterns between weekdays and weekends among Korean students describes the relationship between extracurricular tuition with later bedtime. Both studies emphasize how academic pressure can impact sleep quality and sleep patterns among students. In addition, prolonged sleep deprivation can disrupt their attention, memory, and decision making which are important for academic success (Mehta, 2022).

Furthermore, past research has consistently demonstrated a strong connection between circadian rhythm abnormalities and mental health, particularly among students. Disrupted circadian rhythms are often associated with mental health issues, such as depression, which can significantly impact students' overall well-being. These disruptions may also negatively affect academic performance by impairing cognitive functions critical for mood regulation and decision-making, emphasizing the importance of addressing this issue in the study of physiological psychology. As highlighted in the study by Course et al. (2021), the disruption of circadian rhythms can contribute to the onset of depression among students and negatively affect their mental well-being. It has also shown in this study, as well as in another, that one of the key factors contributing to this issue is environmental influence, particularly exposure to evening light from electrical home lighting or artificial devices at night, which disrupts natural circadian rhythms. This high exposure can suppress melatonin secretion, a hormone crucial for regulating sleep-wake cycles, negatively impacting sleep and ultimately contributing to depressive symptoms among students (Davis et al., 2023; Course et al., 2021). This disruption has also been linked to a misalignment of their internal biological clocks, contributing to mood instability and an increased risk of depression.

Discussion

Evidence-Based Interventions

Taking together the impacts of and factors pertaining to circadian rhythm disruption, a conclusion can be drawn that suitable treatments are needed to realign circadian abnormalities to ensure optimum circadian rhythm regulation and daily functionality. Firstly, the practice of mindfulness in daily life activities may help with stress regulation (Suh et al., 2021) by cultivating positive thoughts and expectations for academic achievements. This is increasingly important as academic pressure presents a significant factor in the dysregulated circadian rhythm among students. Fu et al. (2022) found a significant effect of mindfulness in improving sleep quality among university students in China after participating in eight wakefulness sessions. Many other studies have found similar results of practicing mindfulness in daily life as an intervention to help improve sleep quality and reduce sleep problems. Along this line, mindfulness-based stress reduction (MBSR) method has significantly improved sleep quality in cancer patients when compared to usual care (Suh et al., 2021). This demonstrates that non-pharmacological intervention that focuses on mindfulness techniques is an effective method in addressing sleep problems. However, there are a few limitations when it comes to this therapy, especially on the evidence of effectiveness. Limited studies have been done on the

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effectiveness of this intervention to student populations, which restrict the generalizability of the outcomes. Along this line, the study by Fu et al. (2022) limits the applicability to other cultures and populations since it focuses on Chinese students as well as a very small sample size. Additionally, most intervention studies focus on short-term sessions, failing to address the effects of long-term treatment and maintenance of treatment effectiveness.

Another potential intervention for future studies to explore in addressing this issue is appropriate light exposure during the morning and evening. Students are especially vulnerable to prolonged blue light exposure from looking at the screens since the use of digital and online platforms are more common to enhance learning experience. Instead of using hard copy materials as a medium to learning, most universities and schools are utilizing gadgets that emit blue light and thereby increasing late-night screen exposure and social media use among students. Pertaining to this, appropriate light exposure is important to maintain a normal circadian rhythm amidst technological infused learning practices. Accordingly, morning light exposure has been shown to improve mood and alertness (Yeom et al., 2024). This is because exposure to natural light in the morning plays a crucial role in resetting the circadian clock and promoting wakefulness. Conversely, minimizing light exposure in the evening or at night can enhance melatonin production and improve sleep quality among students. This includes reducing exposure to bright lights, particularly blue light emitted by electronic devices, as it signals the body to wind down for sleep, thereby improving sleep quality. This therapy works effectively since light exposure can affect the circadian rhythm as morning and night lights synchronize with the release of sleep-inducing hormone melatonin. In this sense, an appropriate exposure to light, that is high exposure during the day and gradually low exposure towards bedtime, will regulate the sleep-wake cycle and the circadian rhythm (Davis et al., 2023).

Based on this discussion, a combination of MBSR and light exposure therapy may conclude a more synergized effect to treat students with disrupted circadian rhythm. While MBSR mitigates emotional and cognitive distress regarding academic pressure, the light exposure therapy maintains a normal release of melatonin, synchronizing the sleep-wake cycle and regulating the innate biological clock. In line with these interventions, students can maintain normal circadian rhythm by developing a healthy sleep hygiene including consistent sleep-wake schedules, device curfews and regular exposure to morning light. Additionally, interventions should extend to relevant institutions, especially educational institutions, to ensure coordinated effort in mitigating this issue. Early preventive efforts that can be done involve, readjusting class schedules to align with the natural light, promoting sleep health and hygiene programs for students and providing mental health support services. Building on insights from past research on circadian rhythm disruptions and their effects on students' overall health, evidence-based interventions can be implemented to promote healthy circadian rhythms. These interventions have the potential to enhance students' academic performance, daily functioning, mental health, and quality of life. Moreover, they can encourage the adoption of self-care strategies and create a supportive environment that prioritizes quality sleep and overall well-being.

Islamic Perspective

The disruption of the circadian rhythm cycle would lead to numerous types of diseases. Hence, the paper highlights the reason why we should regulate our sleep-wake cycle. As Allah SWT mentioned in the Quran, verse 28:73 which emphasizes that the creation of night is solely for resting and the daytime for working to reach success in this life and the afterlife. This idea is

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supported by the melatonin secretion in the body that is sensitive to light, maintaining that the nighttime is for resting as the melatonin is released. Further, night prayers may enhance melatonin regulation as the body becomes less alert through mindful recitations and movements that mimic mindfulness meditation. In addition to that, Islamic culture highlights the sunnah of Prophet Muhammad (PBUH) that practices mid-day nap or known as Qailullah for a short therapeutic break in the day to improve productivity (Noor & Mohd, 2018). In relation to this, students are highly recommended to sleep and wake up earlier so that they can study effectively during the dawn or early in the morning due to increased brain activity at the time.

Furthermore, Allah SWT also encourages Muslims to follow the sunnah of His prophet to perform night prayer during two thirds of the night, as mentioned in the Quranic verse (73:20). This is in line with the research by Heidari et al. (2024) which recommends people to wake up during the night to perform Tahajjud prayer. This research mentioned that the melatonin hormone which keeps people aroused is closely related to the circadian rhythm. Melatonin is released more in people who are awake in the middle of the night to perform prayers compared to those who are awake but do not perform night prayer. Zare et al. (2023) also mentioned that a healthy sleep wake cycle is backed up by both scientific and spiritual aspects that benefit people. Hence, to supplement abovementioned interventions, students can apply mid-day naps, early sleep schedule and night prayer routines based on respective academic schedules to enhance sleep quality.

Conclusion

As a final point, a healthy circadian rhythm and sleep wake cycle are very important for everyone, especially for students. It helps them to live a healthy lifestyle while balancing their responsibilities. This paper highlights the integrative approach to understanding the impacts of circadian rhythm disruption and its causes, pointing to combined behavioral, environment, education and spiritual strategies as the way forward to develop intervention plans. While current research provides a solid framework to understand the issue, the reliance on self report measures, homogeneity of sample and cross-sectional analysis proves to limit extensive results. Therefore, future research should focus on controlled longitudinal intervention studies utilizing technology for monitoring sleep and evaluation of spiritual integrated frameworks.

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