



The Relationship Between Mobile Phone Addiction, Depression, Anxiety, and Sleep Quality among College Students: A Review of Literature

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ABSTRACT:

The relationship between mobile phone addiction (MPA), depression, anxiety, and sleep quality among college students is a topic of growing concern. This Literature review examines the literature to understand this complex relationship. Mobile phones have become essential communication tools, but excessive use can lead to addiction, affecting mental and physical well-being. Studies suggest a correlation between MPA and sleep disorders, with evidence indicating predictive links to depression and anxiety symptoms in college students. Definitions of MPA vary, but it's generally characterized by excessive use impairing daily functioning. Research highlights bidirectional relationships between MPA and negative emotions like anxiety and depression, while also linking MPA to poor sleep quality. Mechanisms including screen light, high arousal, and sleep displacement theories are proposed to explain this relationship. Understanding these dynamics is crucial for developing effective interventions to address MPA and its impacts on mental health and sleep quality among college students.

1. Introduction

Mobile phones have emerged as one of the most advanced and indispensable communication tools in today's world. With the expanding global reach of the Internet, mobile phones not only serve as means of communication and connection but also serve as the second-largest medium for transmitting information after the Internet. Especially in the rapidly evolving landscape of smartphone technology, they have quickly gained worldwide popularity upon their release^{1, 2}. The convenience brought by smartphones to modern human life is accompanied by a double-edged sword, as improper use can gradually lead to addiction, with severe cases resulting in MPA. Currently, there is no unified standard for defining MPA, and terms such as "problematic mobile phone use," "mobile phone dependency," and "excessive mobile phone use" are used interchangeably³. Billieux et al. proposed that MPA arises when individuals are unable to effectively regulate their smartphone usage, ultimately leading to adverse consequences on their physical and mental well-being⁴. Increasing evidence substantiates a correlation between MPA/IA and multiple forms of sleep disorders. In modern industrialized societies

characterized by a proliferation of information and technological devices, MPA has emerged as a prominent catalyst contributing to the onset and exacerbation of sleep disorders^{5, 6}, particularly among adolescent populations⁷⁻⁹. Longitudinal studies have revealed that MPA can serve as a predictive factor for the development of sleep disorders and various mental disturbances, including depressive symptoms, anxiety, and impulsivity, among college students. This association heightens the probability of these issues manifesting in the future¹⁰. Currently, there exists a dearth of consensus regarding the correlation between MPA and anxiety, depression, as well as sleep quality among college students. Therefore, this study will undertake a Literature Review of this relationship to lay down a dependable research groundwork for exploring the relationship.

2. Research on Sleep Quality

Throughout history, people have been deeply intrigued by sleep, and some of the greatest philosophers, including Aristotle, Hippocrates, Freud, and Pavlov, have attempted to explain its physiological and psychological mechanisms. Various disciplines, particularly neuroscience, medicine, physiology, and psychology, have long focused on the study of



sleep. As accumulated knowledge from historical civilizations has increased, humanity's understanding of sleep has evolved from idealism to materialism, from perception to reason, and from subjectivity to objectivity.

Before the discovery of electroencephalograms (EEGs), it was widely believed that sleep rendered the brain in a state of complete stillness. The rhythmic EEG activity in the brains of animals was first observed by Richard Caton in 1875¹¹. With the continuous development and use of technologies like electromyography and electrooculography (EOG), understanding of sleep has expanded. In 1928, German psychiatrist Hans Berger demonstrated the distinction between wakefulness and sleep rhythms by recording human brain activity, proving that sleep is not a process of complete cerebral inactivity but rather a functional state of the brain¹². During sleep, brain activity is at a low level, and the brain can be awakened after certain stimuli, signaling the end of the sleep state. Since then, there have been different perspectives on sleep in the research field. Generally, these perspectives can be classified into two categories: one considers sleep as an active process, while the other views it as a passive process.

According to some experts, sleep is a state of awakening termination caused by the passive attenuation of brain activity, occurring after a decrease in sensory input to the brain¹³. When the body is in an awake state, the cerebral cortex maintains a certain level of excitability. As sensory impulses diminish, there is a corresponding decrease in the activity of the ascending reticular activating system located within the brainstem reticular structure. This decrease in activity precipitates the initiation of the waking state. Conversely, when activity within this system diminishes and ceases in synchrony, the transition from wakefulness to sleep ensues^{14, 15}.

Simultaneously, the Pavlovian school of thought suggests that the process of sleep inhibition in the body is widespread in nature^{16, 17}. When the inhibitory process fills the entire cerebral cortex and extends to the subcortical centers, a complete sleep state is achieved¹⁸, which can be termed "awakening termination." The aforementioned perspectives on sleep oversimplify the sleep state, and as human understanding of the physiological processes of sleep deepens, these viewpoints have gradually been overturned.

In recent years, some researchers have concluded that sleep is an active process, primarily representing the termination of body alertness and the temporary restoration of body movement and sensory functions¹⁹. Following specific/appropriate stimuli, a low state of alertness can rapidly restore the body to an awakened state²⁰.

Similar viewpoints have been proposed in studies, suggesting that the central nervous system connected to the brain regulates body alertness and sleep states²¹. With an enhanced understanding of sleep, the significance of sleep content has become increasingly apparent. Currently, most people believe that circadian rhythms (CR) and the body's homeostatic mechanisms work together to regulate sleep. Sleep

is controlled by the sleep center, and sensory and motor activities in the body only temporarily decrease during this process, with the body immediately waking up after specific stimuli²².

There are various definitions of sleep quality currently in use, but the definition by Buysse is most representative. Sleep quality is defined as the level of sleep quality determined by changes in subjective or objectively measured indicators²³. Buysse formulated the Pittsburgh Sleep Quality Index (PSQI) as a tool for evaluating sleep quality, which comprises seven distinct components: subjective sleep quality, sleep onset latency, sleep duration, sleep efficiency, sleep disturbances, use of sleep medications, and daytime dysfunction.

As modern science and technology have progressed, individuals have increasingly employed a variety of precise instruments to translate physiological signals into metrics for evaluating sleep quality. These metrics include the percentage of rapid eye movement (REM) sleep, the duration of sleep onset latency, the amount of slow-wave sleep, among others²⁴. Additionally, several key characteristics of sleep quality have been delineated: (1) assessment of sleep quality can incorporate both objective and subjective criteria; (2) fundamental components of sleep quality encompass sleep duration, sleep efficiency, sleep disturbances, and overall impact; (3) individuals afflicted with sleep disorders such as insomnia tend to exhibit poor sleep quality²⁵.

Sleep is an essential physiological activity in natural life, with various effects on the body and mind. In recent years, the primary focus of sleep science research has been on the factors influencing sleep quality, particularly those affecting the physiological, psychological, environmental, and other factors before and after sleep²⁶. Research on factors influencing sleep quality is mainly concentrated in the field of epidemiological studies, primarily through comparing sleep disorders and sleep quality variables, identifying relevant influencing factors, and drawing conclusions through multifactorial logistic regression analysis²⁷⁻²⁹.

3. Research on Mobile Phone Addiction

In the past decade, mobile phones, as the most widely used mobile internet terminals, have fundamentally changed the way we communicate, browse information, work, manage household tasks, and entertain ourselves. The widespread use of mobile phones has made education, work, and daily life more convenient, but it also poses risks of mobile phone addiction. Numerous studies have demonstrated a significant association between mobile phone addiction and a range of adverse effects on both physical and psychological well-being. Notably, it has been found to be notably correlated with symptoms of anxiety and depression^{30, 31}, and excessive mobile phone use is related to forearm and finger injuries³².

Furthermore, certain studies have suggested that excessive smartphone usage among college students may result in inadequate sleep duration or diminished sleep quality³³⁻³⁵. It is



worth noting that in the 2014 World Health Organization conference report on the impact of excessive internet and other electronic device use on public health, excessive mobile phone use was identified as a public health issue. Therefore, in recent years, scholars from around the world have shown a strong interest in MPA. The excessive utilization of mobile devices has emerged as a prominent and highly researched area of investigation.

Within the domain of related research, various definitions of MPA abound, yet a unified consensus on its conceptualization remains elusive. MPA is typified by individuals' excessive engagement with mobile phones, resulting in observable detriments to physiological, psychological, and social functioning, consequently influencing routine learning, occupational tasks, and daily activities³⁶. This condition is referred to as mobile phone dependency, Problematic Mobile Phone Use (PMPU), or pathological mobile phone use. Many studies indicate a close correlation between internet addiction and MPA, with MPA considered a form of technology addiction or a broader internet addiction³⁷.

When describing MPA, many researchers use the definition of internet addiction because if the internet is considered a common technological addiction³⁸, then mobile phone usage becomes a potential source of addictive behavior^{39, 40}. Although MPA has not been confirmed as a distinct behavioral disorder and has not been excluded from the DSM, debates are ongoing worldwide regarding whether it should be classified as a "disease." Currently, most scholars consider mobile phone addiction as a form of behavioral addiction⁴¹.

Due to the diverse functionalities of mobile phones, individuals may have different preferences for how they use their phones. Some may become addicted to mobile games, while others may become completely engrossed in mobile social networks, and yet others may find it challenging to resist using their phones to gather various types of information. Even individuals displaying similar overall addiction levels may experience entirely different addiction problems. However, previous research has primarily investigated the overall extent of MPA without highlighting potential distinctions between various types of MPA.

Failing to thoroughly analyze heterogeneity differences within MPA and solely considering quantitative similarities may lead to biased research results. Theoretically, distinguishing different types of MPA can reveal the specific effects caused by each type of MPA, thereby increasing the distinction of MPA research results and providing theoretical support for understanding various types of MPA and implementing targeted intervention measures to improve intervention effectiveness. Therefore, attention to MPA must extend from assessing the severity of addiction to considering differences in addiction types.

On the other hand, only a minority of MPA studies have utilized longitudinal designs. Cross-sectional studies limit our

ability to infer causal relationships between study factors because the relationships between related factors may be reverse causal or bidirectional. Currently, most studies on pre-sleep mobile phone usage and MPA are cross-sectional. Therefore, conducting longitudinal studies on MPA is necessary.

4. The Relationship Between Anxiety, Depression, and Sleep Quality

Anxiety, within the scope of psychology, is an adaptive response of the body to stressful events or certain states. Anxiety disorder is a common mental disorder characterized by unfounded fear and anxiety, often accompanied by physical discomfort symptoms⁴². Depression is a prevalent psychological disorder, with its core symptoms mainly manifesting as the "three lows": significantly prolonged feelings of sadness, diminished interest, slowed thinking, and cognitive function, often accompanied by physical symptoms, with severe cases even experiencing suicidal thoughts and behaviors⁴³.

In recent years, studies on factors influencing sleep quality have mentioned anxiety and depression as prevalent negative emotions in today's society, which are important obstacles to the occurrence and development of sleep disorders. Long-term anxiety or depression among college students can lead to physiological or psychological changes.

Sing and Wong conducted a study aimed at exploring the prevalence of insomnia among university students in Hong Kong and its psychosocial associations. Their findings indicated a notable correlation between insomnia and stress, as well as depression, within Chinese college student populations. However, given the cross-sectional nature of the study design, it was unable to ascertain the temporal sequence between insomnia and the associated psychosocial factors. Thus, causal relationships cannot be inferred from this investigation.

Wallace et al. conducted a longitudinal survey on second-year college students to determine the causal relationships between stress, depression, and various sleep quality issues. The study found that depression is a more reliable predictor than stress, and both depression and stress are important predictors of sleep quality⁴⁴. Moreover, the study revealed an association between sleep quality and both intermittent and chronic depression, whereby poorer sleep quality was linked with more pronounced depressive symptoms.

Orsal's research centered on investigating the correlation between anxiety and sleep quality among college students. The study, comprising 803 participants, revealed a positive association between anxiety and sleep quality, and the study also elucidated the related mechanisms of anxiety and sleep disorders. Anxiety causes continuous brain activity, leading to difficulty falling asleep. On the other hand, a lack of high-quality sleep may lead to anxiety, resulting in decreased sleep quality⁴⁵. In essence, anxiety and sleep quality reciprocally influence each other; diminished sleep quality contributes to



heightened anxiety levels, while elevated or reduced levels of anxiety correspond to decreased sleep quality.

Chang conducted a study examining the sleep quality of 827 students from Nankai University. The findings indicated a positive correlation between sleep quality and levels of anxiety and depression, suggesting that heightened levels of anxiety and depression were associated with poorer sleep quality among college students⁴⁶. Huang et al. analyzed a survey of 1020 students from Henan University of Traditional Chinese Medicine and found that most students with poor sleep quality had symptoms of anxiety, depression, tension, irritability, and hostility⁴⁷.

In summary, negative emotions have a significant impact on sleep quality and may even lead to physical symptoms in individuals. However, many studies have shown that emotions and sleep mutually influence each other, with sleep quality exacerbating the growth of negative emotions, forming a vicious cycle. The research results on the relationship between emotions and sleep quality currently provide a reliable basis for improving sleep conditions. Whether reducing negative emotions or increasing positive emotions, both can greatly improve sleep quality and provide targeted intervention measures for clinically treating sleep disorders.

5. The Relationship Between Anxiety, Depression, and Mobile Phone Addiction

Anxiety and depression have been linked to detrimental health behaviors. Multiple studies have demonstrated a correlation between addictive smartphone usage and psychological distress, including symptoms of anxiety and depression.

Elhai conducted a comprehensive review of pertinent literature spanning the previous decade, focusing on exploring the statistical relationship between the severity of problematic smartphone use or MPA and the severity of anxiety and depression MPA severity and the severity of anxiety and depression⁴⁸. The review identified a significant association between anxiety and problematic smartphone use, with consistent moderate positive correlations observed between problematic smartphone use and the severity of depression.

In another study conducted by Elhai and colleagues, the investigation centered on assessing the role of Fear of Missing Out (FOMO) as a mediator between depression and anxiety and the severity of MPA⁴⁹. The study recruited 1034 Chinese undergraduate students via online surveys and examined smartphone usage frequency, MPA, depression, anxiety, and FOMO. Results indicated that FOMO could potentially serve as a significant mediating factor for certain types of mental disorders, particularly anxiety, associated with MPA. Additionally, Matar Boumosleh and Jaalouk's study discovered that even after controlling for confounding variables, depression and anxiety scores remained independent positive predictors of smartphone addiction⁵⁰.

Demirci et al. conducted a study to explore the association between the intensity of smartphone usage and sleep quality, depression, and anxiety among university students. The findings revealed that individuals classified under the high smartphone usage group exhibited elevated scores for depression, anxiety, and daytime dysfunction in comparison to those in the low smartphone usage group. The study postulated that excessive smartphone usage might be correlated with depression, anxiety, and compromised sleep quality. Furthermore, it suggested that such excessive usage could potentially precipitate depression and/or anxiety, both of which have the potential to disrupt sleep patterns⁵¹.

In a cross-sectional study involving Saudi university students, the objective was to ascertain the correlation between smartphone addiction and depression, as well as trait anxiety. Analysis results indicated that smartphone addiction emerged as a notable concern for the psychological well-being of Saudi university students, demonstrating associations with both depression and trait anxiety⁵².

Some scholars theoretically explain the relationship between individual differences in psychological factors and psychopathological symptoms (including anxiety, depression) and internet media use (including mobile phone use, smartphone abuse). The cognitive-behavioral theory proposes that cognition, emotion, and behavior interact and influence each other. Thus, we have reason to believe that MPA can affect individuals' emotions and cognition, and severe smartphone addiction can predict anxiety and depression. Unlike chemical addiction, the emotional impact of MPA on individuals can also occur indirectly through other variables, not just through direct effects.

Research indicates that relationship problems can indirectly lead young people to negative emotions (anxiety, depression) by affecting MPA behavior. Based on interpersonal relationship theory, individuals with high levels of MPA often neglect real-world interpersonal relationships, leading to reduced sources of social support and escalating anxiety and depression due to prolonged immersion in virtual networks⁵³.

Interestingly, MPA behavior and psychological factors can mutually influence each other, with psychological disorders also promoting the formation of MPA. The powerful internet capabilities of smartphones are often used by individuals with anxiety and depression as coping strategies to alleviate their own negative emotions^{54, 55}. In fact, the principle that psychological disorders can cause MPA is consistent with Billieux et al.'s view that "addictive behavior is an effective way to seek excessive comfort"⁵⁶.

In individuals with anxiety and depression, the phenomenon of excessive seeking comfort is very common, characterized by constantly and repeatedly checking smartphones, leading to addictive behavior⁵⁷. Considering the possible bidirectional causal relationship, there is a possibility of repeated interaction between MPA and psychological disorders, leading to a vicious cycle.



Currently, only two studies have focused on the relationship between smartphone addiction and psychological distress over time. One is a three-year longitudinal study focusing on college freshmen, which suggests a bidirectional predictive relationship between smartphone addiction behavior in the first year and depressive symptoms in the third year⁵⁸. Another study with a larger sample size indicated that MPA in adolescence is an important indicator for predicting future smartphone use patterns and also demonstrated that smartphone addiction behavior can predict future depressive symptoms, which can exacerbate the severity of smartphone addiction behavior³¹.

Furthermore, many studies have explored the relationship between smartphone addiction behavior and factors closely related to anxiety and depression emotions. One study assessed participants' anxiety sensitivity and found a positive correlation with the severity of smartphone addiction behavior⁵⁹. Additionally, two studies supported that habitual rumination increased the association between smartphone addiction behavior and anxiety and depression^{60, 61}. However, these studies exploring the relationship between smartphone addiction behavior and psychological distress still have limitations such as small sample size and a single type of psychological distress object.

6. The Relationship Between Mobile Phone Addiction and Sleep Quality

In recent years, research on the association between sleep quality and MPA has seen a notable expansion, resulting in significant findings. Accumulating evidence indicates a connection between MPA and diverse forms of sleep disorders. These findings are particularly relevant in contemporary industrial societies, MPA is becoming a major cause of increasingly severe sleep disorders^{6, 62}, a concern that is also prominent among adolescent populations^{7-9, 63}.

Okasha et al. conducted a study that unveiled a significant adverse correlation between smartphone addiction and sleep quality among Egyptian university students. Involving 1380 college students, the research demonstrated a noteworthy positive correlation between smartphone addiction and depression, anxiety, sleep disorders, smoking, and suicidal ideation⁶⁴.

Meanwhile, a study conducted by Chao et al. aimed to explore the interplay between smartphone use, sleep quality, self-perceived health, and exercise. This investigation involved 1575 undergraduate students from seven universities in Taiwan. The findings indicated that in comparison to problematic smartphone users, regular smartphone users were more inclined to perceive better physical health and experience improved sleep quality. The conclusion drawn from the study was that low physical activity and MPA negatively impacted the self-perceived health and sleep quality of undergraduate students⁶⁵.

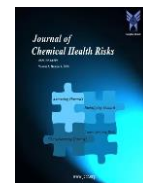
Furthermore, a study conducted by Chatterjee and Kar examined the correlation between smartphone addiction and sleep quality among medical students. Surveying 224 medical students, the findings indicated that 33.33% of females and 46.15% of males exhibited symptoms of smartphone addiction, while 63.39% of students reported poor sleep quality. The study concluded that excessive smartphone usage among medical students had adverse effects on their health and sleep quality⁶⁶.

Y. Li et al. conducted a comprehensive meta-analysis with the objective of examining the relationships between MPA and various psychological factors including anxiety, depression, stress, impulsivity, and sleep quality among college students. The meta-analysis incorporated forty studies with a total sample size of 33,650 college students. Results from the meta-analysis revealed a positive correlation between MPA and anxiety, depression, stress, impulsivity, and poor sleep quality. The findings suggested that individuals with MPA were more predisposed to experiencing heightened levels of anxiety, depression, impulsivity, and diminished sleep quality⁶.

Additionally, Kang conducted a study to explore the bidirectional relationship between MPA, psychological distress, sleep disorders, and sleep patterns. The study involved a total of 902 students who participated in both baseline and one-year follow-up assessments. Utilizing cross-lag analysis, the study revealed a bidirectional longitudinal relationship between the Mobile Phone Involvement Questionnaire (MPIQ) score and the total scores of the Pittsburgh Sleep Quality Index (PSQI) and the Epworth Sleepiness Scale (ESS)⁶⁷.

Currently, there are three main mechanisms explaining the impact of mobile phone addiction on sleep quality: (1) the screen light theory, which suggests that blue light emitted from screens may suppress the secretion of melatonin by the pineal gland, leading to prolonged sleep latency⁶⁸; (2) the high arousal theory, where the constant alerts or frequent checking of messages and content on phones during both day and night may induce physiological or psychological arousal, such as emotional or cognitive arousal, disrupting the sleep-wake cycle, which could be another reason for poorer sleep quality⁶; (3) the sleep displacement theory, where the leisure and entertainment aspects of mobile phones often lead individuals to become engrossed and lose track of time, resulting in the postponement of sleep time and ultimately causing changes in sleep timing or chronic sleep deprivation³⁰.

In summary, studies investigating the link between smartphone addiction and sleep quality indicate a direct association, wherein increased levels of smartphone dependence are linked with diminished sleep quality. However, this relationship appears to be influenced by numerous variables, suggesting that the connection between smartphone addiction and sleep quality is not straightforwardly linear. The impact of other variables may indirectly influence this relationship.



7. Conclusion

The relationship between MPA, depression, anxiety, and sleep quality among college students is intricate and multifaceted. A comprehensive review of literature underscores a significant correlation between MPA and various sleep disorders, as well as symptoms of depression and anxiety. However, further longitudinal studies are imperative to ascertain causality and delve into the bidirectional nature of these relationships. Furthermore, the heterogeneity within MPA and its diverse addiction behaviors necessitate more thorough examination in future research endeavors.

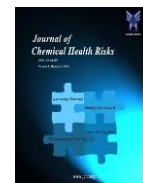
Moreover, comprehending the mechanisms underlying the impact of MPA on sleep quality, encompassing factors such as screen light exposure, arousal theory, and sleep displacement, is essential for developing targeted interventions aimed at mitigating the adverse consequences of excessive smartphone use on mental health and sleep patterns among college students. Future research should also prioritize exploring moderating and mediating factors that influence these relationships, while simultaneously implementing interventions designed to promote healthy smartphone usage habits and enhance sleep quality among college students.

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