

The Impact of Mobile Phone Addiction on Daily Memory and the Mediating Role of Sleep Quality: An Empirical Study based on Chinese and Filipino College Students

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Abstract: Frequent smartphone usage is contributing to a growing condition known as mobile phone addiction, which is harming users' sleep quality and may even create difficulties with daily memory decline. The purpose of this essay is to investigate how sleep quality influences daily memory and mobile phone addiction. A systematic psychological test was conducted on 250 college students from China and 200 college students from the Philippines, including a validated smartphone addiction scale, the Pittsburgh Sleep Quality Index, and a daily memory questionnaire. Mobile phone addiction significantly positively predicted daily memory ($\beta=0.27$, $t=3.82$, $p<0.001$), and sleep quality ($\beta=0.56$, $t=9.93$, $p<0.001$). Additionally, there was also a significant positive relationship between sleep quality and daily memory ($\beta=0.28$, $t=3.89$, $p<0.001$). The mediation effect analysis showed that the mediation effect value of sleep quality between mobile phone addiction and daily memory was 0.16, accounting for 37.2% of the total effect, and this effect did not show significant differences across different geographical and cultural backgrounds. Sleep quality mediates the relationship between mobile phone addiction and daily memory to a certain extent, revealing the potential impact of mobile phone addiction on daily memory function. It is also found that this relationship is universal across different geographical and cultural backgrounds, providing theoretical and empirical evidence for related fields concerning mobile phone addiction's effects on memory and sleep quality.

Keywords: Mobile Phone Addiction, Daily Memory, Sleep Quality, Chinese and Filipino College.

1. Introduction

In the era of Internet+, smartphones have become an essential component of college students' study, routine, and social interaction. Nowadays, almost every college student carries a compact yet powerful smartphone, accustomed to using it for online shopping, ordering food, making reservations, payments, and more, enjoying the convenience brought by digital life. At the same time, smartphones have also become an important tool for them to record life and express emotions, such as taking photos, shooting videos, and writing diaries. The existence of smartphones has not only greatly enriched college students' study and life, but also profoundly changed their social patterns and lifestyle. College students' dependence on smartphones has penetrated into every aspect of their daily life and study.

Mobile phone addiction, a new type of behavioral addiction, has become a prevalent behavioral problem in current society, causing life disturbances and impairments in social functioning [1]. Experimental data from neurobiology indicates that long-term indulgence in mobile phones can lead to changes in brain structure. This change is negatively correlated with the gray matter volume of the anterior cingulate cortex and the right fusiform gyrus, which may further result in abnormal gray matter volume in brain regions related to emotions [2]. The gray matter of the anterior cingulate cortex and the right fusiform gyrus is associated with memory, language, and emotions, and a decrease in their gray matter volume can have a negative impact on an

individual's memory ability.

Another study revealed the relationship between mobile phone use and sleep quality. The research shows that the light emitted from screens of electronic devices like mobile phones can potentially interfere with the secretion of melatonin [3]. However, melatonin is an essential factor in promoting sleep [4]. Therefore, there is a close relationship between excessive mobile phone use and decreased sleep quality.

For college students, the sleep process is not only crucial for physical and mental recovery, but also an important time for the brain to form, store, and consolidate memories. However, the increasingly common phenomenon of mobile phone addiction among college students has undoubtedly posed a potential threat to their memory function, leading to a significant decline in daily memory levels. To delve deeper into the mechanisms mentioned above and address the lack of research on cross-cultural differences in this field, this study aims to explore the mediating effect of sleep quality in the relationship between mobile phone addiction and daily memory in two different cultural contexts of China and the Philippines. It also attempts to construct an integrated model to better understand the complex relationship between mobile phone addiction, sleep quality, and daily memory. Hopefully, this research can enhance our understanding of mobile phone addiction among college students and provide scientific evidence for mental health education and interventions in cross-cultural settings.

2. Literature Review

2.1. Mobile Phone Addiction

2.1.1. Concept of Mobile Phone Addiction

Mobile Phone Addiction, also known as mobile phone dependency or mobile phone dependency syndrome, refers to a series of psychological or physiological problems caused by individuals' excessive reliance on mobile phones [5]. While there are still disagreements regarding the precise definition of mobile phone addiction in psychology, researchers generally describe it as an addictive behavior characterized by an individual's inability to control the use of mobile phones, resulting in significant impairment of physical, psychological, and social functions [6]. Mobile phone addiction includes three aspects: mobile phone relationship addiction, mobile phone entertainment addiction, and mobile phone information seeking addiction [7-8].

2.1.2. Measurement of Mobile Phone Addiction

Due to different research purposes and perspectives, scholars have varying definitions of mobile phone addiction, leading to a lack of a unified measurement scale for mobile phone addiction. This study adopts the "Smartphone Addiction Scale - Short Version for Adolescents" (SAS-SV) developed by Kwon, translated and validated in Chinese by Wang Caiyu et al., as a research tool to measure the degree of mobile phone addiction among adolescents [9]. The scale covers 10 evaluation items describing daily mobile phone usage habits and emotional issues, such as "Even though my daily life has been adversely affected by using my phone, I still can't stop using it" and "I try to monitor myself and set limits on phone usage, but I always exceed them." Based on a 5-point Likert scale (1=None, 5=Always), the data are quantitatively assessed, and the average of the 10 items is calculated to obtain an index of daily memory ($M = 2.26$, $SD = 0.95$, Cronbach's $\alpha = 0.840$). The higher the value, the more severe the mobile phone addiction. This scale has been proven to have good reliability and validity in the Chinese context, ensuring the accuracy and reliability of the study [10].

2.2. Daily Memory

2.2.1. Concept of Daily Memory

Memory is a fundamental function of human cognition, referring to the ability of an individual to recall and reproduce events or information after experiencing an event or learning some information. Daily memory refers to memory operations that frequently occur in an individual's daily environment [11]. Daily memory involves various aspects, such as remembering other people's names, remembering daily plans, recalling items to buy at the grocery store, remembering to take medication, and remembering phone numbers, routes, or recent news events. Therefore, the core of daily memory and related research lies in exploring how individuals naturally perform these memory tasks in the real world, i.e., examining our ability to store and reproduce information about language, behavior, and events in daily life.

2.2.2. Measurement of Daily Memory

In measuring daily memory, this study adopts the Everyday Memory Questionnaire- Revised (EMQ-R) [12], which includes 13 items describing daily activities to assess individuals' memory performance in daily life. For example, "Forgetting important details of what you did or happened the day before" and "Repeating what you just told someone or asking someone the same question twice." Based on a 5-point

Likert scale (1=None, 5=Always), the data are quantitatively assessed, and the average of the 13 items is calculated to obtain an index of daily memory ($M = 2.24$, $SD = 0.96$, Cronbach's $\alpha = 0.908$). The higher the value, the worse the daily memory.

2.3. Sleep Quality

2.3.1. Concept of Sleep Quality

Sleep is one of the most basic physiological needs of the human body, accounting for approximately one-third of a person's lifespan. Sleep quality refers to the degree of comfort and depth of sleep, as well as the continuity and recuperative ability of sleep. It comprises both objective and subjective aspects: objectively, it involves factors such as the duration and efficiency of sleep, possible sleep disorders, and a series of physiological indicators like respiratory rate and heart rate. Subjectively, it relies mainly on personal feelings and experiences, such as the ease of falling asleep, the depth of sleep, the number of awakenings during the night, the mental state after waking up in the morning, and daytime alertness and work efficiency.

2.3.2. Measurement of Sleep Quality

To assess sleep quality, the Pittsburgh Sleep Quality Index (PSQI) is adopted [13], which evaluates the quality of sleep over the past month from a multifaceted perspective, encompassing both subjective self-assessment and partial objective evaluation. The scale consists of 19 self-rated items and 5 other-rated items, but only the 18 self-rated items are scored. The measurement is based on a 4-point Likert scale. The PSQI covers seven dimensions: sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction. Each dimension is scored out of 3 points, and the total score is calculated to obtain the sleep quality index ($M = 7.44$, $SD = 2.68$, Cronbach's $\alpha = 0.837$). The total score ranges from 0 to 21, with different score ranges corresponding to different levels of sleep quality. Scores of 0-5 indicate excellent sleep quality; 6-10 indicate good sleep quality; 11-15 indicate average sleep quality; and 16-21 indicate poor sleep quality.

2.4. Relationships between Mobile Phone Addiction, Daily Memory, and Sleep Quality

2.4.1. Relationship between Mobile Phone Addiction and Daily Memory

Mobile phone addiction often involves prolonged sitting or lying down, lack of physical activity, and poor blood circulation, which can affect the overall functioning of the body, including the brain's memory and operational functions, resulting in memory decline. At the same time, individuals addicted to mobile phones tend to have irregular eating habits and incomplete nutritional intake. Long-term lack of balanced nutrition can lead to insufficient nourishment of the brain tissue, further increasing the risk of memory decline. Krause et al. found that although the microwave frequency of 902MHz emitted by mobile phones had no significant effect on resting electroencephalograms, it significantly interfered with the brain's memory response [14]. More importantly, to some extent, mobile phones function as external memory tools, reducing sensory stimulation to the brain, thereby impeding short-term and long-term memory.

2.4.2. Mediating Role of Sleep Quality

The light emitted from mobile phone screens can interfere with the natural secretion of melatonin, which is an essential factor in regulating sleep rhythm and promoting sleep. Therefore, there is a close relationship between excessive mobile phone use and decreased sleep quality. Mobile phone addiction often leads to irregular living habits, such as frequent late-night activities, which can significantly reduce sleep duration. Adequate sleep is crucial for memory, and severe sleep deprivation can lead to memory decline. Adolescent mobile phone dependence is particularly prevalent, not only reducing sleep quality but also affecting daily memory levels. Therefore, sleep serves as one of the indirect factors that influence adolescents' daily memory ability through mobile phone dependence [15].

3. Research Design and Methodology

3.1. Research Purpose

The purpose of this study is to investigate the mediating role of sleep quality in the relationship between mobile phone addiction and daily memory among university students from two different cultural environments, China and the Philippines. It aims to comprehensively examine the impact and mechanism of mobile phone addiction on sleep and memory among Chinese and Filipino university students. By establishing an integrated model, this study aims to provide a new theoretical perspective for the existing research field on the impact of mobile phone addiction on daily memory, as well as new insights into the importance of sleep quality.

3.2. Research Hypotheses

Hypothesis 1 (H1): Mobile phone addiction positively predicts the daily memory of university students.

Hypothesis 2 (H2): Mobile phone addiction positively predicts the sleep quality of university students.

Hypothesis 3 (H3): Mobile phone addiction indirectly affects an individual's daily memory through the mediating role of sleep quality.

Hypothesis 4 (H4): There is no difference in the mediating effect of sleep quality on the relationship between mobile phone addiction and daily memory among Chinese and Filipino university students.

3.3. Research Model

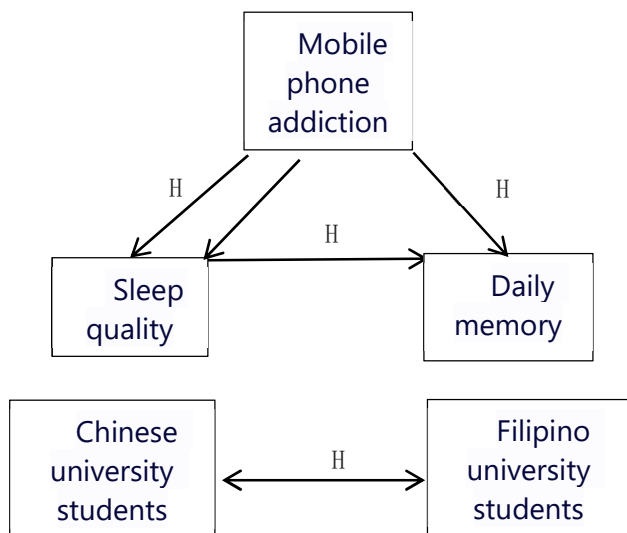


Figure 1. Research Model

Based on the aforementioned hypotheses, this study constructs the following model, as illustrated in Figure 1.

3.4. Research Participants

The study selected 450 college students from Guangdong Province in China and Manila, Philippines as the research participants, including 250 Chinese college students and 200 Filipino college students. Among them, there were 338 female students and 112 male students, with an average age of 21.76 years and a standard deviation of 2.58 years. Before participating in the study, all subjects were informed of the protocol content approved by the Research Ethics Committee of the Psychology Department and confirmed that there was no compensation for participating in the study. All subjects possessed smartphones and had no visual or auditory impairments. Among the 450 questionnaires, after excluding incomplete questionnaires and screening out regularly answered questionnaires, 373 valid questionnaires were finally recovered, with an effective recovery rate of 82.9%. The average daily smartphone usage time of the subjects was 7.86 hours, with a standard deviation of 4.05 hours. Among them, 45.8% of college students mainly used smartphones for social networking, followed by communication (31.7%) and entertainment (16.9%).

3.5. Research Method

At the beginning of the study, we sent questionnaire invitations to 200 students from the University of Christ the King in the Philippines via email and 250 students from Guangdong Medical University in China via the WeChat social application to understand their participation in the study. Finally, 156 Filipino students (76.0%) and 217 Chinese students (86.8%) participated in the study. We used two online questionnaire tools, Google Form in the Philippines and Wenjuanxing in China, and set up both English and Chinese versions. Data collection was conducted from March to May 2024.

3.6. Data Processing

Descriptive statistics and correlation analysis were performed using SPSS 26.0, and the mediation effect analysis test was conducted using the Process 4.1 program plugin developed by Hayes.

4. Results

4.1. Common Method Bias Test

In order to evaluate the potential common method bias in this study, we employed the Harman's one-factor test and performed an unrotated exploratory factor analysis on a total of 42 items from three scales. The results showed that there were 11 factors with eigenvalues greater than 1, and the first factor explained 13.59% of the total variance, which is less than the critical criterion of 40%. Therefore, this study does not suffer from severe common method bias [16].

4.2. Correlation Analysis of Research Variables

Through correlation analysis, we examined the relationship between three variables: mobile phone addiction, daily memory, and sleep quality. The results revealed a significant positive correlation between mobile phone addiction and daily memory, indicating that the higher the degree of mobile phone addiction, the worse the individual's daily memory performance. Simultaneously, a significant negative

correlation was found between mobile phone addiction and sleep quality, suggesting that the higher the degree of mobile phone addiction, the poorer the individual's sleep quality. Additionally, we discovered a significant positive correlation between sleep quality and daily memory, indicating that individuals with better sleep quality tend to have better daily memory performance (Table 1).

Table 1. Correlation between Mobile Phone Addiction, Sleep Quality, and Daily Memory Among Chinese University Students(r)

Item	M±SD	Mobile phone addiction	Sleep quality	Daily memory
Mobile phone addiction	24.25±6.46	1		
Sleep quality	28.6±6.38	0.561**	1	
Daily memory	33.43±8.28	0.432**	0.434**	1

p<0.01; *p<0.001.

4.3. Analysis of the Mediating Effect of College Students' Mobile Phone Addiction, Sleep Quality, and Daily Memory

Based on the above results, this study used mobile phone addiction, sleep quality, and daily memory as the main

research variables in the two-site measurement, with gender and grade as control variables. The Bootstrap analysis method was used to test the mediating effect of sleep quality between mobile phone addiction and daily memory, as shown in Tables 2 and 3.

The results show that this is a saturated model. A moderated mediation model is established, with sleep quality as a moderating variable that regulates the direct path of the model. Specifically: Mobile phone addiction significantly positively predicts daily memory $\beta=0.27$, $t=3.82$, $p<0.001$, with a 95% confidence interval of [0.13, 0.41]. Mobile phone addiction significantly positively predicts sleep quality $\beta=0.56$, $t=9.93$, $p<0.001$, with a 95% confidence interval of [0.58, 0.86]. Assumptions 1 and 2 are verified; sleep quality significantly positively predicts daily memory $\beta=0.28$, $t=3.89$, $p<0.001$, with a 95% confidence interval of [0.11, 0.32]; the mediating effect of sleep quality between mobile phone addiction and daily memory is 0.16, with a 95% confidence interval of [0.07, 0.26], and the value does not include 0, indicating that when sleep quality is assumed as a mediating variable between mobile phone addiction and daily memory, the mediating effect is significant. The total effect is 0.43, and the ratio of mediating effect to total effect is $ab/(ab+c')=37.2\%$. The mediating model is shown in Figure 4.1. Therefore, sleep quality plays a partial mediating role between mobile phone addiction and daily memory, and assumption 3 is verified.

Table 2. Test of the mediating model of sleep quality among Chinese college students

regression equation		fitting index			coefficient significance	
outcome variable	predictor variable	R	R-sq	F(df)	β	t
Daily memory	Mobile phone addiction	0.43	0.19	49.25***	0.43	7.02***
Sleep quality	Mobile phone addiction	0.56	0.31	98.54***	0.56	9.93***
Daily memory	Sleep quality	0.49	0.24	33.81***	0.28	3.89***
	Mobile phone addiction				0.27	3.82***

p<0.01; *p<0.001.

Table 3. Bootstrap analysis of the significance test of mediating effects for Chinese students

path	non-standardized indirect effect	95% CI upper limit	95% CI lower limit
total effect	0.43	0.31	0.55
Mobile phone addiction→Daily memory	0.27	0.13	0.41
Mobile phone addiction→Sleep quality→Daily memory	0.16	0.07	0.26

p<0.01; *p<0.001.

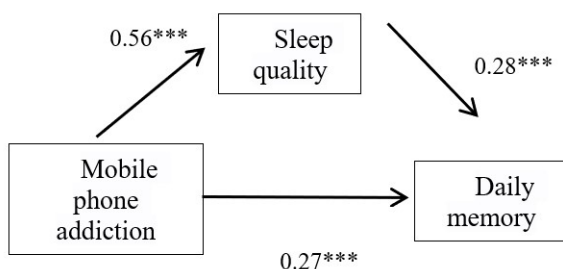


Figure 2. The mediating effect model of sleep quality

4.4. Comparative Analysis of the Mediating Effect of Sleep Quality between Mobile Phone Addiction and Daily Memory in Chinese and Filipino College Students

Table 4. Bootstrap analysis of the significance test of mediating effect on Filipino students

path	non-standardized indirect effect	95% CI upper limit	95% CI lower limit
total effect	0.40	0.26	0.54
Mobile phone addiction→Daily memory	0.24	0.08	0.40
Mobile phone addiction→Sleep quality→Daily memory	0.16	0.06	0.27

p<0.01; *p<0.001.

The results in Tables 3 and 4 show that the mediating effect of sleep quality on mobile phone addiction and daily memory among Chinese college students is 0.16, with a 95% confidence interval of [0.07, 0.26] and a total effect of 0.43, with a mediating effect ratio of $ab/(ab+c')=37.2\%$. The mediating effect of sleep quality on mobile phone addiction and daily memory among Philippine college students is 0.16,

with a 95% confidence interval of [0.06, 0.29] and a total effect of 0.40, with a mediating effect ratio of $ab/(ab+c')=40\%$. There is no significant difference in the mediating effect of sleep quality on mobile phone addiction and daily memory between Chinese and Philippine college students, which confirms hypothesis 4.

5. Discussion

5.1. Direct Effect of Mobile Phone Addiction on Daily Memory

The results in Table 2 reveal the negative impact of mobile phone addiction on college students' daily memory, indicating that individuals with higher levels of mobile phone addiction exhibit lower levels of daily memory ($\beta=0.27$, $t=3.82$, $p<0.001$). A possible reason for this is that mobile phone addiction can crowd out personal daily activities and rest time, thereby affecting the overall function of the body, especially the memory and operational functions of the brain, leading to memory decline.

5.2. Mediating Effect of Sleep Quality

Regarding the relationship between mobile phone addiction and sleep quality among college students, mobile phone addiction poses a significant negative risk to the respondents' sleep quality ($\beta=0.56$, $t=9.93$, $p<0.001$), indicating that the higher the level of mobile phone addiction, the worse the sleep quality. The data also show a significant positive correlation between sleep quality and daily memory ($\beta=0.28$, $t=3.89$, $p<0.001$). Further moderation effect analysis reveals that sleep quality plays a regulatory role between mobile phone addiction and daily memory. Bootstrap analysis confirms that the interaction between mobile phone addiction and sleep quality has a significant impact on daily memory, with the mediating effect value of sleep quality between mobile phone addiction and daily memory being 0.16. The total effect is 0.43, and the mediating effect size is 37.2%, indicating a significant mediating effect. The findings suggest that mobile phone addiction may negatively impact memory by affecting daily routines, such as staying up late frequently, leading to reduced sleep. For college students, good sleep quality is an essential factor for maintaining memory, and mobile phone addiction may be an indirect factor that affects sleep and memory.

5.3. Limitations and Prospects of the Study

This study has the following limitations. Firstly, as emerging fields, the measurement tools and conceptual definitions of mobile phone addiction and daily memory have not yet formed unified standards, which has affected the accuracy of the study to a certain extent. Secondly, due to the limited sample scope, this study only involved two universities with a total of 450 participants. The homogeneity of the sample type and the small sample size limit the representativeness and generalizability of the research results. Thirdly, this study only adopted the questionnaire survey method, and all scales were self-reported. Although no common method bias was found in the study, it cannot be excluded that individual subjective factors may potentially affect the survey results. Finally, the reduction in sleep quality and daily memory capacity may be influenced by various other factors that were not included in this study, requiring further exploration of their complex mechanisms. To improve the scientificity and accuracy of the research results, future

studies should refine the conceptual definitions of mobile phone addiction and daily memory, establish clear measurement standards for them, expand the sample size, introduce diverse research methods, and consider longitudinal designs to comprehensively collect more representative and generalizable data.

6. Conclusion

With the increasing popularity of smartphones, mobile phone addiction has become an increasingly serious public health issue among young people. Our study findings indicate that mobile phone addiction not only directly affects daily memory capacity but also indirectly impacts memory through the mediating factor of sleep quality, revealing the complex impact of mobile phone addiction on individual health, particularly in terms of cognitive function. Furthermore, the results suggest that sleep quality plays a crucial mediating role between mobile phone addiction and daily memory. This implies that improving sleep quality may be an effective way to mitigate the negative impact of mobile phone addiction on memory.

By examining the interaction between mobile phone addiction, sleep quality, and daily memory, this study provides theoretical support for developing prevention and intervention strategies for public health issues among youth populations, such as raising public awareness of the harms of mobile phone addiction, improving sleep quality, and providing psychological interventions to mitigate potential harms to memory.

Moreover, this is a cross-cultural study that explores the universality of the interactive effects of mobile phone addiction, daily memory, and sleep quality among different student groups. Although Chinese and Filipino students come from different cultural backgrounds, they did not show significant differences in the interaction between mobile phone addiction, sleep quality, and daily memory. This further demonstrates the universality of mobile phone addiction and its consequences, transcending cultural and geographical boundaries.

In summary, the study underscores the direct negative impact of mobile phone addiction on memory and sleep, emphasizing the bridging role of sleep quality. This impact holds universal significance globally. Given the soaring popularity of smartphones, mobile phone addiction has become an urgent public health issue, especially among young populations. Therefore, a profound understanding of cross-cultural differences is crucial for effective prevention and intervention.

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