ORIGINAL ARTICLE

The Role of Smartphone Addiction as a Mediator between Psychological Resilience and Insomnia in Medical Students at a University

Fan Li[1,2] (ID)

[1]*Department of Management and Human Resources, Hohai University Business School, Nanjing, China;* [2]*Career Development Teaching and Research Office, Dalian Medical University, Dalian, China*

ABSTRACT

Background: To explore the mediating effect of smartphone addiction between psychological resilience and insomnia among university students.

Methods: This study included 581 clinical medical students from the Dalian Medical University, enrolled between September 2020 and May 2023. The Smartphone Addiction Scale (SAS-SV), Insomnia Severity Index (ISI), and Connor–Davidson Resilience Scale (CD-RISC) were used to assess smartphone addiction, insomnia, and psychological resilience among the students. The Process macro and Bootstrap methods were employed to analyze the mediating effect of smartphone addiction between psychological resilience and insomnia.

Results: The detection rate of smartphone addiction was 28.06% (163/581), and the detection rate of insomnia was 26.17% (152/581). The total SAS-SV score was 27.60 ± 14.27, the total ISI score was 6.60 ± 5.33, and the total CD-RISC score was 72.86 ± 6.88. There was a significant negative correlation between the total CD-RISC score and the total SAS-SV score (r=−0.4129, P < .0001), and a significant negative correlation between the total CD-RISC score and the total ISI score (r = −2.942, P < .0001). The total SAS-SV score and the total ISI score were significantly positively correlated (r=0.5687, P < .0001). Psychological resilience was used as the independent variable, insomnia as the dependent variable, and smartphone addiction as the mediating variable in the mediation effect analysis. Psychological resilience negatively predicted insomnia ($β$=−0.0940, P < .0001), smartphone addiction positively predicted insomnia ($β$=0.1564, P < .0001), and smartphone addiction mediated the relationship between psychological resilience and insomnia (effect value=−0.1339, 95% CI: −0.1680 to −0.1034), with an effect size of 58.75%.

Conclusion: Psychological resilience directly affects insomnia and also indirectly affects insomnia through the mediating effect of smartphone addiction.

INTRODUCTION

Sleep disorders, or insomnia, refer to abnormalities in sleep quality or quantity, including difficulty falling asleep, difficulty maintaining sleep, and early awakening.[1] According to current research in China, sleep problems are common among university students, with insomnia detection rates ranging from 13.0% to 30.3%.[2,3] Medical students, as a special group within the student population, have characteristics such as longer academic programs, heavier academic burdens, and less leisure time. Additionally, the increasingly tense doctor-patient relationships in recent years have led to greater academic and employment pressures for medical students, making them more prone to sleep problems.[4]

Psychological resilience refers to the psychological trait that enables individuals to maintain a positive emotional state and adaptive capacity when facing stress, setbacks, and challenges. It can help individuals cope with various life challenges, improving their quality of life, and their sense of well-being. In recent years, many studies have suggested that psychological resilience can directly affect insomnia.[5,6] The 21st century is the era of information technology, where portable smartphones provide constant access to the internet. This has significantly impacted young people's excessive use of digital products and sleep quality. Smartphone addiction, a recently proposed concept, is defined as the excessive use of

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smartphones, characterized by a strong, persistent craving and dependence on their use, leading to a series of physiological and psychological issues.[7] A foreign survey shows that mobile phone addiction can also directly affect insomnia.[8] In addition, a study in China has proved that psychological resilience can directly affect individual mobile phone use habits, and individuals with low mental resilience may be more likely to fall into mobile phone addiction.[9] From the above studies, it can be seen that psychological resilience and mobile phone addiction can directly affect insomnia, and psychological resilience can directly affect mobile phone addiction. Therefore, this study aims to investigate 581 clinical medical students at Dalian Medical University, using smartphone addiction as a mediating variable, to construct a chain mediation model between psychological resilience and insomnia. This in-depth exploration seeks to provide a theoretical basis for addressing smartphone addiction and sleep problems among university students.

MATERIAL AND METHODS

Study Subjects

In this study, 581 clinical medical students from the Dalian Medical University voluntarily participated in the survey. The study was approved by the Ethics Committee of Dalian Medical University (Approval Number: 2021-010). Inclusion criteriaon: students using smart phones. Exclusion criteria: (1) students with cognitive impairment; (2) students with mental illness; and (3) students who have recently taken psychiatric medications. All the doctors who participated in the study signed the Helsinki Declaration. All patients and control groups who agreed to participate in the study were given detailed information about the study. Their written and verbal consent was obtained and an informed consent form was signed. After obtaining consent from the school's student management department, a collective survey was conducted by class. Several psychiatrists guided the completion of all questionnaires and conducted interview diagnoses. The questionnaires were collected on the spot after completion, with a filling time of 30 minutes. Anonymity was ensured to protect the privacy of the respondents. A total of 600 online questionnaires were distributed, and after excluding invalid responses, 581 valid questionnaires were retained, with an effective rate of 96.83%. Basic information is shown in Table 1.

Assessment Scales

In this study, all participants completed the short version of the Smartphone Addiction Scale (SAS-SV), the Insomnia Severity Index (ISI), and the Connor–Davidson Resilience Scale (CD-RISC) under the guidance of psychiatrists. These three scales have been translated into Chinese and validated in various populations in China, demonstrating good psychometric properties.[10-12]

Table 1. Basic Information of University Students

Variable		n	%
Sex	Male	289	49.74
	Female	292	50.26
Place of domicile	Rural area	275	47.33
	Cities and towns	306	52.67
Only child	Yes	305	52.50
	No	273	46.99
Living expenses	1000-1500 yuan/month	11	1.89
	1500~<2000 yuan/month	135	23.24
	2000~<2500 yuan/month	329	56.63
	≥2500 yuan/month	106	18.24
Grade	Freshman	119	20.48
	Sophomore	119	20.48
	Junior	116	19.97
	Senior	115	19.79
	Fifth year of college	112	19.28
Age	<18	160	27.54
	18~<19	90	15.49
	19~<20	95	16.35
	20~<21	92	15.83
	≥21	144	24.78

The SAS-SV is used to assess smartphone addiction. The scale contains 10 items closely related to smartphone dependence, rated on a 6-point scale. A score of 1 indicates "strongly disagree," and a score of 6 indicates "strongly agree." The total score ranges from 10 to 60, with higher scores indicating a stronger tendency toward smartphone addiction. A total score of 32 or above is considered indicative of smartphone addiction.

The ISI is used to assess subjective insomnia over the past two weeks among college students. The scale consists of 7 items, each rated on a 5-point scale. A score of 0 indicates "no symptoms," 1 indicates "mild symptoms," 2 indicates "moderate symptoms," 3 indicates "severe symptoms," and 4 indicates "very severe symptoms." The total score ranges from 0 to 28, with higher scores indicating more severe insomnia. A total score of 8 or above suggests the presence of insomnia symptoms.

The CD-RISC is used to evaluate the psychological resilience of college students. The scale consists of 25 items, covering three dimensions: optimism, resilience, and strength, rated on a 5-point scale. A score of 0 indicates "not true at all," and a score of 4 indicates "true nearly all the time." The total score ranges from 0 to 100, with higher scores indicating higher levels of psychological resilience. This scale does not have a cut-off score.

CONSTRUCTING THE MEDIATION MODEL

In this study, we selected psychological resilience as the independent variable, smartphone addiction as the

mediator, and insomnia as the dependent variable. The rationale for this sequence is as follows:

Temporal precedence of psychological resilience: Psychological resilience is a relatively stable individual trait, typically forming and changing before behavioral issues (such as smartphone addiction) and health problems (such as insomnia).

Mediator role of smartphone addiction: Individuals with lower psychological resilience are more prone to behavioral issues (such as smartphone addiction), which may subsequently lead to health problems (such as insomnia).

Insomnia as the outcome variable: Insomnia is usually the result of prolonged behavioral and psychological issues, making it reasonable to consider it as the dependent variable.

Statistical Analysis

All survey results in this study were entered into Excel and analyzed using SPSS 27.0. Since all data were collected at the same time point, there is a high likelihood of common method bias. The similarity in data sources and collection methods can introduce systematic errors, exaggerating or obscuring the actual relationships between variables. Detecting and controlling for common method bias ensures that the measurement results reflect the true relationships between variables, rather than artifacts created by using the same measurement method. This study used the "Factor Analysis" function in SPSS to analyze common method bias. All measurement data were tested for normality using the Kolmogorov-Smirnov test and were found to be normally distributed. Measurement data were expressed as mean ± SD (X ± SD). The t-test and analysis of variance (ANOVA) were used for component comparisons. The total scores of SAS-SV and ISI are continuous variables and normally distributed. Given the assumption of potential linear relationships among the three variables, Pearson correlation analysis was used for validation. The mediating effect of smartphone addiction between psychological resilience and insomnia was analyzed using the Process macro program and Bootstrap method (10 000) in SPSS. A P-value < .05 was considered statistically significant.

RESULTS

Common Method Bias Test

In this study, there were five factors with eigenvalues greater than 1, and the variance explained by the first factor was 20.46%, which is less than 40%. This indicates that there is no significant common method bias in this study.

General Information and Detection of Sleep Disorders Among University Students

Among the 581 university students, the detection rate of smartphone addiction was 28.06% (163/581), and the detection rate of insomnia was 26.17% (152/581). The total SAS-SV score was 27.60 ± 14.27, with a statistically significant difference in the total SAS-SV score between different genders (P < .05). The total ISI score was 6.60 ± 5.33, with statistically significant differences in the total ISI score between different genders and household registrations (P < .05). The total CD-RISC score was 72.86 ± 6.88, with a statistically significant difference in the total CD-RISC score between different grades (P < .05) (Table 2).

Table 2. Total Scores of CD-RISC, SAS-SV, and ISI Among 581 University Students

Variable		Total Score of SAS-SV	Total Score of ISI	Total Score of CD-RISC
Sex	Male	25.67 ± 13.58	5.01 ± 4.10	73.34 ± 6.98
	Female	29.51 ± 14.70	8.18 ± 5.92	72.37 ± 6.76
F/t		–3.27	–7.52	1.70
P		**.001**	**<.001**	.090
Place of domicile	Rural area	26.79 ± 14.47	7.55 ± 5.91	72.59 ± 6.99
	Cities and towns	28.32 ± 14.07	5.75 ± 4.59	73.09 ± 6.79
F/t		–1.29	4.07	–0.87
P		.196	**<.001**	.384
Only child	Yes	27.28 ± 13.89	6.61 ± 5.48	73.16 ± 6.69
	No	27.95 ± 14.69	6.59 ± 5.17	72.52 ± 7.08
F/t		–0.56	0.04	1.12
P		.576	.965	.261
Living expenses	1000-1500 yuan/month	30.45 ± 16.90	5.82 ± 4.98	73.09 ± 8.85
	1500~<2000 yuan/month	26.90 ± 15.03	6.75 ± 5.39	73.10 ± 7.08
	2000~<2500 yuan/month	27.74 ± 14.06	6.62 ± 5.38	72.58 ± 6.68
	≥2500 yuan/month	27.73 ± 13.79	6.42 ± 5.20	73.39 ± 7.08
F/t		0.27	0.15	0.45
P		.849	.928	.719
Grade	Freshman	27.10 ± 15.03	6.08 ± 5.11	71.51 ± 6.65
	Sophomore	27.67 ± 14.14	7.11 ± 6.03	72.76 ± 7.04
	Junior	28.66 ± 14.62	6.85 ± 5.37	74.06 ± 6.36
	Senior	27.10 ± 14.49	6.37 ± 4.81	72.46 ± 7.07
	Fifth year of college	27.46 ± 13.13	6.58 ± 5.25	73.54 ± 7.11
F/t		0.23	0.67	2.42
P		.92	.616	**.048**
Age	<18	26.64 ± 14.22	6.08 ± 5.11	72.91 ± 6.90
	18~<19	27.62 ± 14.63	7.11 ± 6.43	72.31 ± 6.32
	19~<20	27.75 ± 14.94	6.78 ± 4.59	72.61 ± 7.35
	20~<21	27.71 ± 12.88	6.78 ± 5.71	73.34 ± 7.05
	≥21	28.47 ± 14.62	6.63 ± 5.05	72.99 ± 6.84
F/t		0.32	0.65	0.30
P		.867	.628	.879

Smartphone Addiction Scale (SAS-SV), Insomnia Severity Index (ISI), and Connor–Davidson Resilience Scale (CD-RISC)

Table 3. Correlation Between Total Scores of CD-RISC, SAS-SV, and ISI

Variable	Total Score of SAS-SV		Total Score of ISI	
	r	P	r	P
Total score of ISI	0.5687	<.001	–	–
Total score of CD-RISC	–0.4129	<.001	–2.942	<.001

Smartphone Addiction Scale (SAS-SV), Insomnia Severity Index (ISI), and Connor–Davidson Resilience Scale (CD-RISC)

Correlation Analysis

There was a significant negative correlation between the total CD-RISC score and the total SAS-SV score (r = –0.4129, P < .0001). Similarly, there was a significant negative correlation between the total CD-RISC score and the total ISI score (r = –2.942, P < .0001). In contrast, there was a significant positive correlation between the total SAS-SV score and the total ISI score (r = 0.5687, P < .0001) (Table 3).

Mediation Effect

The mediation effect between psychological resilience and insomnia was analyzed. Using psychological resilience as the independent variable and insomnia as the dependent variable, smartphone addiction was introduced as a mediating variable. The results showed that psychological resilience negatively predicted insomnia (β = –0.0940, P < .0001), and smartphone addiction positively predicted insomnia (β = 0.1564, P < .0001). Smartphone addiction mediated the relationship between psychological resilience and insomnia, with an effect value of –0.1339 (95% CI: –0.1680 to –0.1034), accounting for 58.75% of the total effect. See Table 4 and Figure 1 for details.

DISCUSSION

Sleep is one of the most basic human needs. Good sleep quality not only makes individual learning and work more efficient but also promotes physical and mental health. With the rapid development of society, sleep problems have garnered significant attention and have become a public health issue worldwide.[13] Data indicates that there is a widespread phenomenon of late-night sleeping among university students, with more than 30% experiencing insufficient sleep or insomnia.[14] In this study, the detection rate of insomnia was 26.17%. The total ISI score was 6.60 ± 5.33, with statistically significant differences in scores between different genders and household registrations. Male students and those with urban household registrations tend to have lower ISI scores, which may be attributed to their higher self-assessment of sleep quality and their tendency to approach and manage sleep issues with a more positive attitude. There are two possible reasons for women's higher ISI scores. First, physiological factors play a role; women's menstrual cycles and hormonal fluctuations (such as during menstruation) can impact sleep, leading to higher rates of insomnia. Second, psychological factors are significant.[15] Women may exhibit higher emotional sensitivity and stress in response to academic pressure and interpersonal relationships, increasing the risk of insomnia. Additionally, we speculate that rural students experience greater economic pressure and difficulty adapting to their environment, resulting in higher ISI scores. As societal and economic development progresses, university students' lifestyles have also changed, with unhealthy habits such as smartphone addiction becoming a significant cause of insomnia.[16] Although smartphone addiction has not yet been classified as a clinical disorder, its symptoms are similar to those described in

Table 4. Mediation Effect of Smartphone Addiction Between Psychological Resilience and Insomnia

Step	Effect size	SE	t	P	LLCI	ULCI	Effect size
Total effect	–0.2279	0.0308	7.407	**<.0001**	0.2883	–0.1675	–
Direct effect	–0.0940	0.0310	–3.032	**.0025**	–0.1549	–0.0331	41.25%
Mediation effect	–0.1339	0.0167	10.46	**<.0001**	–0.1680	–0.1034	58.75%

Standard Error (SE), Lower Limit Confidence Interval (LLCI), and Upper Limit Confidence Interval (ULCI).
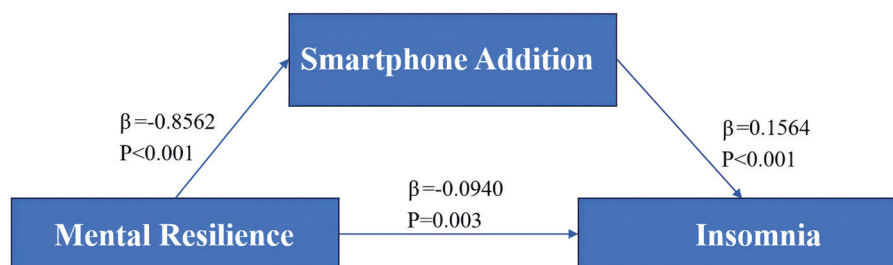
Figure 1. Mediation effect of smartphone addiction between psychological resilience and insomnia. ***P < .0001, **P < .001.

the Diagnostic and Statistical Manual of Mental Disorders for internet gaming addiction and substance abuse.[16] The detection rate of smartphone addiction among Chinese university students is approximately 38.20%-47.29%.[17,18] In this study, prevalence of smartphone addiction was found to be 28.06%, with a total SAS-SV score of 27.60 ± 14.27. A significant gender differences was observed in the scores, with females scoring higher on the SAS-SV than males, consistent with findings reported in other literature.[4] The adverse effects of smartphone addiction on individual health span multiple dimensions, including physiological, psychological, and social functions. The impact of smartphone addiction on the sleep quality of university students has attracted widespread attention. Excessive use of smartphones, especially before bedtime, can delay sleep onset, disrupt sleep rhythms, and shorten total sleep time. A study has shown that excessive smartphone use increases exposure to blue light, which suppresses melatonin secretion, leading to circadian rhythm disturbances and sleep problems, and may also be closely related to mental disorders such as depression and anxiety.[19] A study involving 1181 university students found that baseline smartphone addiction significantly predicted delayed sleep onset and poor sleep quality.[20] The results of this study also show that smartphone addiction affects insomnia in college students.

Psychological resilience, also known as mental toughness or psychological recovery, is usually assessed based on an individual's emotional regulation ability, coping strategies, and social support.[21] Tafoya et al[22] reported a significant negative correlation between psychological resilience and sleep quality. Zhang et al[9] reported that psychological resilience plays a partial mediating role in the relationship between sleep quality and anxiety symptoms. Additionally, a recent study suggests that individuals with higher levels of psychological resilience are less likely to exhibit smartphone dependency behaviors.[9] Other research has found a significant negative correlation between psychological resilience and smartphone dependency, indicating that higher psychological resilience predicts lower levels of smartphone dependency.[23] In this study, psychological resilience among college students was found to negatively affect smartphone addiction. This means that lower psychological resilience is associated with a higher tendency toward smartphone addiction. Individuals with high levels of psychological resilience are less likely to use negative, avoidant coping strategies to face life's challenges, such as immersing themselves in their phones to escape from real-world problems. Instead, they tend to use positive ways to cope with difficulties. The total score of CD-RISC is significantly negatively correlated with the total score of ISI. Psychological resilience also negatively affects insomnia among college students, meaning that lower psychological resilience is associated with more severe the insomnia. This could be because students with low psychological

resilience feel overwhelmed by academic, social, or personal pressures, making it difficult for them to relax and rest, thus leading to trouble falling or staying asleep. Additionally, students with low psychological resilience may have difficulty regulating their emotions, making them more prone to experiencing negative emotions such as anxiety, depression, or worry. These emotions can increase the difficulty of falling asleep and affect sleep quality. Combining previous research results, which showed that smartphone addiction also affects insomnia among college students, we believe that both psychological resilience and smartphone addiction are related to insomnia. Smartphone addiction may serve as a negative, avoidant coping strategy, with lower levels of psychological resilience among university students indirectly affecting sleep health through smartphone addiction.

Exploring the mediating role of smartphone addiction in the relationship between psychological resilience and insomnia among college students revealed that psychological resilience negatively predicts insomnia, while smartphone addiction positively predicts insomnia. Smartphone addiction mediates the relationship between psychological resilience and insomnia. These findings suggest that universities should enhance students' psychological resilience by providing mental health education, helping students use smartphones appropriately, and improving their insomnia conditions.

This study integrates three important psychological health indicators: psychological resilience, smartphone addiction, and insomnia, providing a comprehensive assessment of the overall mental health status of medical students. This approach enhances the understanding of the relationships between these variables and their impact on medical students. As a high-stress group, medical students are particularly prone to issues with smartphone addiction and insomnia. Investigating these issues can aid in developing more effective interventions, thereby improving both the mental health and academic performance of medical students. The study utilized validated scales (SAS-SV, ISI, CD-RISC), ensuring the reliability and validity of the data. Additionally, SPSS software was employed for data analysis, including factor analysis and the Kolmogorov-Smirnov test, to control and detect common method bias, thus ensuring the accuracy of the research results. However, there are some limitations to this study. The study is limited to students from the university, and the sample is geographically homogeneous, which may not be representative of students from other regions. Data collection mainly relies on self-reported questionnaires (such as SAS-SV, ISI, CD-RISC scales), which may have social expectation bias and recall bias, affecting the accuracy and reliability of data.

In summary, psychological resilience directly affects insomnia and also indirectly affects insomnia through the mediating effect of smartphone addiction.

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Appendix A. Detailed Subgroup Comparisons for CD-RISC

Comparison Groups	p-Value
Freshman vs Sophomore	0.1604
Freshman vs Junior	0.003
Freshman vs Senior	0.2907
Freshman vs Fifth year of college	0.0259
Sophomore vs Junior	0.1391
Sophomore vs Senior	0.7453
Sophomore vs Fifth year of college	0.4032
Junior vs Senior	0.0718
Junior vs Fifth year of college	0.5608
Senior vs Fifth year of college	0.2524