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Effect of mobile phone addiction on sleep quality in patients aged 18–45 years with acute myocardial infarction: a chain mediation analysis of coping style, anxiety, and depression

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Rising acute myocardial infarction (AMI) incidence in young adults coincides with increased mobile phone addictione, which has been connected to poor sleep quality. However, mechanisms linking mobile overuse to sleep disturbances, particularly the mediating roles of coping styles and psychological distress, remain underexplored. This study investigated the association between mobile phone addictione and sleep quality in AMI patients aged 18–45 years, examining coping styles, anxiety, and depression as potential mediators. In this study, a cross-sectional study (January 2023–January 2025) enrolled 125 patients via convenience sampling. The results showed that mobile phone addiction is positively associated with poor sleep in young patients with AMI, which may be related to coping styles and symptoms of anxiety/depression. Holistic interventions addressing digital habits, mental health, and coping strategies may improve the sleep quality in this population.

Keywords Myocardial infarction, Mobile phone use, Sleep quality, Coping behavior, Anxiety, Depression, Young adults, Mediation analysis

Acute myocardial infarction (AMI) is a common acute ischemic heart disease characterized by sudden onset and significant clinical severity[1]. Although AMI has traditionally been more common in older adults, its incidence among younger populations has increased in recent years, resulting in increased clinical and public health concerns[2,3]. Notably, impaired sleep quality has been associated with a 63% increased risk of cardiovascular events compared with individuals with normal sleep patterns[4]. As such, sleep quality has emerged as a critical prognostic factor in cardiovascular outcomes, and identifying factors that compromise sleep is essential for improving the clinical management and prognosis of AMI in younger patients[5].

Mmobile phone addiction refers to a persistent, often compulsive pattern of mobile phone use. In China, adults aged 18–45 years are the primary users of mobile devices and constitute the most active participants in the digital information landscape[6]. Mobile phone addiction may contribute to sedentary behavior, which in turn can worsen sleep quality[7]. For example, Wang et al. reported progressive deterioration in sleep quality as mobile phone addiction increased, highlighting the need for greater attention to this behavioral risk factor in clinical populations[8]. An Australian study also confirmed that excessive smartphone use by adults is related to depression, anxiety, stress, and sleep quality[9]. However, limited research has specifically addressed the relationship between mobile phone addiction, sleep quality, and psychological outcomes in AMI patients.

Understanding how mobile phone addiction affects sleep quality in younger AMI patients is crucial for identifying at-risk groups and developing effective intervention strategies. Coping style represents a key psychological mechanism that potentially mediates this relationship. AMI imposes substantial psychological

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stress, which may fundamentally alter an individual's illness-related coping strategies. Chen et al. found that sleep quality can indirectly impact cognitive impairment through both positive and negative coping strategies[10], whereas Van Hof et al. observed that positive coping was associated with reduced depressive symptoms[11]. These findings support the notion that coping styles may act as intermediaries in the relationship between mobile phone addiction and sleep quality.

Anxiety and depression have a significant clinical relevance. Individuals aged 18–45 years frequently experience multiple pressures from occupational and familial responsibilities, increasing their vulnerability to mental health disorders[12]. Anxiety mediates the relationship between sleep quality and psychological well-being in patients with chronic conditions. These psychosocial variables may function as critical mediators in the association between mobile phone use and sleep disturbance.

Although many studies have examined the effects of mobile phone addiction on sleep quality in the general population, few have focused on younger adults with AMI, a population with distinct biological and psychosocial vulnerabilities. Therefore, this study aimed to investigate the impact of mobile phone addiction on sleep quality in patients aged 18–45 years with AMI and examine the mediating roles of coping style, anxiety, and depression. These findings are expected to contribute to a deeper understanding of modifiable behavioral and psychological risk factors, ultimately informing strategies to improve sleep health and overall outcomes in this high-risk group.

Methods

Participants

This study was conducted between January 2023 and January 2025 at Jinan Central Hospital. Owing to practical constraints in recruiting eligible, first-time AMI patients within a short period at a single center, we utilized convenience sampling to maximize enrollment during the study period. Assuming that the effect size (f) was 0.15, the significance level (α) was 0.01, and the expected efficacy (1-β) was 80%, the calculation indicated a minimum required sample size of 92 participants. Accounting for a potential attrition rate of 15%, we aimed to recruit at least 106 participants. Our final sample size of 125 participants exceeded this target, ensuring adequate power for our analyses.

The inclusion criteria were as follows: (1) all of them met the relevant standards set by the ESC/ACC guidelines for the diagnosis of AMI, including both ST-segment elevation myocardial infarction (STEMI) and non-ST-segment elevation myocardial infarction (NSTEMI), based on standard clinical diagnostic criteria[13]; (2) age between 18 and 45 years; and (3) ability to maintain clear consciousness and effective communication to ensure reliable completion of survey instruments. Exclusion criteria included: (1) the presence of cognitive impairment that could interfere with survey completion; (2) incomplete medical history or poor coordination due to disease severity or lack of cooperation; (3) a diagnosed history of psychiatric illness; and (4) a previous history of AMI, coronary heart disease, or coronary stent implantation, to avoid confounding by prior disease adaptation (Fig. 1).

Clinical data collection

Demographic and clinical data were collected from the patient interviews and medical records. Collected variables included age, sex, body mass index (BMI), state of work (categorized as employed, unemployed, or other), smoking and alcohol consumption history, medical history of hypertension, diabetes mellitus, family history of coronary heart disease, and chronic kidney disease (CKD). Laboratory test data were obtained at the time of admission, including C-reactive protein (CRP), total cholesterol (TC), triglycerides (TG), low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), glycosylated hemoglobin (HbA1c), uric acid (UA), and serum creatinine (Cr) levels.

Research tools

Mobile Phone Addiction Index

The Mobile Phone Addiction Index (MPAI) is a 17-item self-report questionnaire designed to assess the degree of mobile phone addiction. It evaluates four dimensions of problematic use: runaway behavior, escapism, withdrawal symptoms, and inefficiency. Sample items included: "You have been told that you spend too much time using your mobile phone," "Your friends and family complain that you always use your mobile phone," "You try to spend less time on your mobile phone but fail," and "You occupy your sleep time because of using your mobile phone." Other items assessed feelings of anxiety when not using the phone, difficulties turning it off, and using the phone to relieve negative emotions, such as loneliness or depression. A 5-point scale was used: 1 = completely disagree, 2 = mostly disagree, 3 = uncertain, 4 = mostly agree, and 5 = completely agree. Higher total scores indicate greater levels of mobile phone addiction. Based on the cumulative scores, dependence levels were categorized as mild (34–51), moderate (52–68), or severe (69–85)[14]. In this study, Cronbach's α coefficient of the scale was 0.881.

Pittsburgh Sleep Quality Index Scale

The Pittsburgh Sleep Quality Index (PSQI) is a widely used instrument for evaluating sleep quality over a one-month period. It comprises 18 items divided into seven dimensions: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction. Each component is rated on a 0–3 scale, with higher scores indicating more severe impairment. The total PSQI score is the sum of all seven components, ranging from 0 to 21, with higher scores reflecting poorer sleep quality. A PSQI total score ≥ 5 was used to classify individuals as having a sleep disorder[15]. In this study, Cronbach's α coefficient for the scale was 0.755.

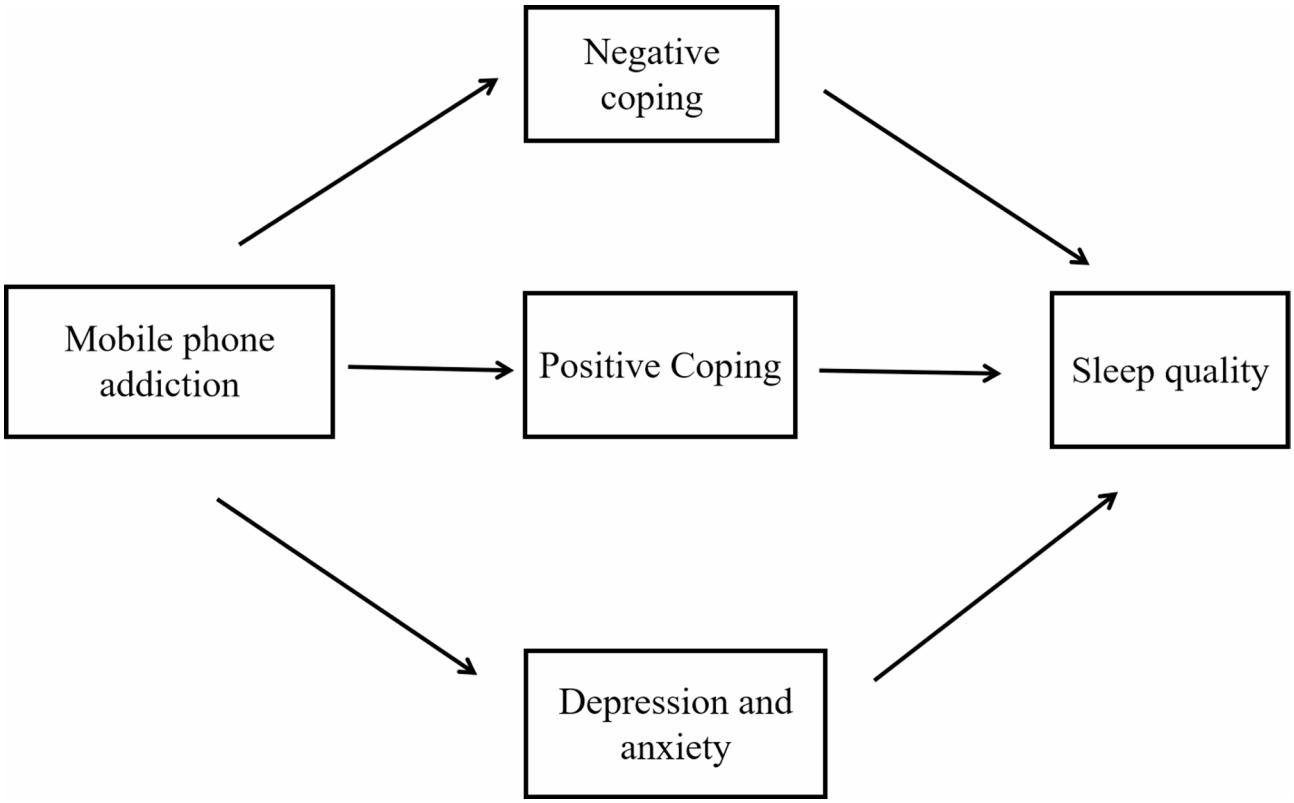

Fig. 1. A hypothetical model on the influence of mobile phone dependence on sleep status, coping style and anxiety/depression chain mediation of adolescent AMI patients.

Simplified Coping Style Questionnaire

The Simplified Coping Style Questionnaire (SCSQ) is used to assess individuals' typical coping responses to stress and adversity. It consists of 20 items that are divided into two subscales: positive and negative. Each item was rated on a four-point Likert scale ranging from 0 (never) to 3 (often), with higher scores indicating more frequent use of that coping style. A higher score on the negative coping subscale suggests a tendency to adopt avoidance or passive strategies, whereas a higher score on the positive coping subscale reflects a proactive and optimistic approach to dealing with stressors[16]. The total Cronbach'sαcoefficient of the scale is 0.90, and the Cronbach'sα coefficients of the negative coping and positive coping subscales are 0.78 and 0.89, respectively.

Hospital Anxiety and Depression Scale

The Hospital Anxiety and Depression Scale (HADS) is a self-assessment tool designed to screen for anxiety/depressive symptoms in patients with physical illness. It comprises 14 items divided evenly into two subscales, anxiety (HADS-A) and depression (HADS-D), with seven items each. In this project, 'A' denotes the anxiety scale and 'D' represents the depression scale. Each item was evaluated on a four-point scale ranging from 0 to 3. A score of 0 indicated the absence of symptoms. A score of 1 indicated the presence of mild symptoms that exerted minimal or no effect on subjects. A score of 2 reflected a conscious awareness of the symptoms that exerted a moderate influence on the subjects. A score of 3 signified conscious awareness of symptoms with high frequency and intensity, resulting in a significant impact on the subjects. When diagnosing anxiety or depression symptoms, the double-numbered items were summed. Scores were categorized as follows: 0–7 indicates asymptomatic status, 8–10 suggests suspected anxiety or depression, and 11–21 denotes confirmed anxiety or depression[17]. The scores of the two subscales, HADS-A and HADS-D, were used to obtain the total score on the HADS. In this study, Cronbach's α coefficient of the scale was 0.776.

Quality control

All questionnaires were distributed and collected by trained research staff. Prior to data collection, the purpose and significance of the study were clearly explained to each participant and informed consent was obtained. During the completion process, participants were provided with standardized instructions to ensure consistency. All questionnaires were completed independently by the participants and collected immediately to minimize data loss and ensure reliability.

Data processing

All statistical analyses were conducted using SPSS version 24.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize the demographic and clinical characteristics. Categorical variables were

Variable	Mean ± SD or *n* (%)
Age (years)	33.08 ± 4.31
Gender	
Male	69 (55.2%)
Female	56 (44.8%)
Body Mass Index (kg/m²)	24.97 ± 4.86
State of work	
Employed	94 (75.2%)
On leave	31 (24.8%)
Smoking history	74 (59.2%)
Drinking history	63 (50.4%)
History of hypertension	31 (24.8%)
History of diabetes	15 (12.0%)
Family history of coronary heart disease	17 (13.6%)
History of chronic kidney disease (CKD)	14 (11.2%)
CRP (mg/L)	3.36 ± 0.26
HbA1c (%)	5.95 ± 0.41
Total cholesterol (TC, mmol/L)	6.19 ± 0.32
Triglycerides (TG, mmol/L)	2.99 ± 0.58
Low-density lipoprotein cholesterol (LDL-C, mmol/L)	3.95 ± 1.14
High-density lipoprotein cholesterol (HDL-C, mmol/L)	1.25 ± 0.24
Uric acid (UA, μmol/L)	406.67 ± 97.38
Creatinine (Cr, μmol/L)	79.48 ± 3.65

Table 1. Sample size demographic information ($n = 125$).

Items	Scores (mean ± SD)
MPAI	69.32 ± 26.82
PSQI	10.24 ± 6.42
SCSQ	
Positive coping	14.19 ± 3.99
Negative coping	14. 10 ± 5.02
HADS-A	6.94 ± 2.39
HADS-D	7.31 ± 2.70
HADS total score	14.25 ± 4.56

Table 2. Scores of MPAI, PSQI, SCSQ, and HADS in AMI patients aged 18–45 years (mean ± SD).

reported as frequencies and percentages, while continuous variables were tested for normality using the Shapiro–Wilk test. Normally distributed data were expressed as mean ± standard deviation (M ± SD). Correlation analyses were conducted to assess the associations between key variables. To evaluate the mediation effects, a bootstrap resampling method with 5,000 iterations and bias-corrected confidence intervals was employed. The mediation effect was considered statistically significant if the 95% confidence interval did not include zero.

Results

General information of patients

In total, 136 questionnaires were distributed. After excluding 11 invalid or incomplete responses, 125 valid questionnaires were retained for analysis, yielding an effective response rate of 91.91%. The laboratory test results obtained on admission are summarized in Table 1. The key cardiovascular risk markers were outside the normal range in our cohort. The demographic and clinical characteristics of the study participants are summarized in Table 1.

MPAI, PSQI, SCSQ, and HADS scores of AMI patients

Among 125 patients, 83 (66.40%) met the criteria for mobile phone addiction. Sleep disorders were identified in 59 patients (47.20%), and 51 patients (40.80%) exhibited clinically significant symptoms of anxiety or depression. The mean total scores of the MPAI, PSQI, SCSQ (positive and negative coping subscales), and HADS are presented in Table 2.

Items	MPAI	PSQI	Positive coping	Negative coping	HADS total score
MPAI	1				
PSQI	0.77**	1			
Positive coping	− 0.72**	− 0.74**	1		
Negative coping	0.64**	0.72**	− 0.58**	1	
HADS total score	0.74**	0.76**	− 0.65**	0.67**	1

Table 3. Pearson correlation coefficient. $^{**}P < 0.01$.

Regression equation		Global fitting index			Coefficient of regression	Significance
Outcome variable	Predictor variable	*R*	R^2	*F*	*β*	*t*
Sleep disorder	Mobile phone addiction	0.11	0.10	15.08	0.49	5.69**
Negative coping	Mobile phone addiction	0.43	0.42	45.11	− 0.71	− 11.12**
Positive coping	Mobile phone addiction	0.35	0.34	65.28	0.36	0.35**
Anxiety/depressive	Mobile phone addiction	0.41	0.39	27.54	0.37	3.92**
Sleep disorder	Mobile phone addiction	0.21	0.18	7.81	0.49	5.69**
	Negative coping				− 0.32	− 4.41**
	Positive coping				0.42	5.72**
	anxiety/depressive				0.20	2.51**

Table 4. Regression analysis of the mediating effect. $^{**}P < 0.01$.

Effect	Path	Effect	Boot SE	BootLLCI	BootULCI	Effect value	Effect proportion
Direct effect	Mobile phone addiction→sleep disorder	0.17	0.02	0.14	0.09	0.12	28.72%
Mesomeric effect	Mobile phone addiction→Depression /anxiety→sleep disorder	0.03	0.03	0.02	0.15	0.17	27.90%
	Mobile phone addiction→Positive coping→sleep disorder	0.02	0.02	0.01	0.08	0.01	27.43%
	Mobile phone addiction→Negative coping→sleep disorder	0.01	0.01	0.01	0.03	0.03	15.95%
Total intermediary effect						0.25	71.28%
Total effect						0.37	100.00%

Table 5. Proportion of the mediating effect. Boot SE: Bootstrap standard error; BootLLCI: Bootstrap sampling 95% interval; BootULCI: Bootstrap sampling 95% interval upper limit.

Correlation analysis of mobile phone Addiction, sleep disordercoping Style, and anxiety and depression

Correlation analysis revealed that PSQI scores were positively correlated with the MPAI, negative coping scores, and HADS scores. Conversely, PSQI scores were negatively correlated with positive coping. All the correlations were statistically significant ($P < 0.01$). Sleep disorders are related to higher mobile phone addiction, negative coping, anxiety/depression symptoms, and lower positive coping. Detailed correlation coefficients of the variables are presented in Table 3.

Analysis of mediation effects

To evaluate the mediation effects, a bootstrap resampling method with 5,000 iterations and bias-corrected confidence intervals was employed. The total effect of mobile phone addiction on sleep quality was statistically significant ($\beta = 0.20$, $P < 0.01$), indicating that higher mobile phone addiction is associated with poorer sleep quality. Mobile phone addiction was negatively associated with positive coping ($\beta = -0.47$, $P < 0.01$) and positively associated with negative coping ($\beta = 0.27$, $P < 0.01$), anxiety, and depression ($\beta = 0.17$, $P < 0.01$). Additionally, positive coping significantly and negatively predicted sleep difficulties ($\beta = -0.12$, $P < 0.01$), while negative coping, anxiety, and depression positively predicted sleep disorders ($\beta = 0.16$ and $\beta = 0.18$, respectively; both $p < 0.01$). Table 4.

Mediation effect test

A mediation pathway analysis was conducted to explore the indirect effects of mobile phone addiction on sleep disorders. The tested pathways included mobile phone addiction→sleep disorder, mobile phone addiction→anxiety/depression →sleep disorder, mobile phone addiction→positive coping→sleep disorder, and mobile phone addiction→negative coping→sleep disorder. Although the 95% confidence intervals for all mediation effects excluded zero, all corresponding p-values were greater than 0.01, indicating that the mediation effects were not statistically significant. The detailed results are presented in Table 5 and illustrated in Fig. 2.

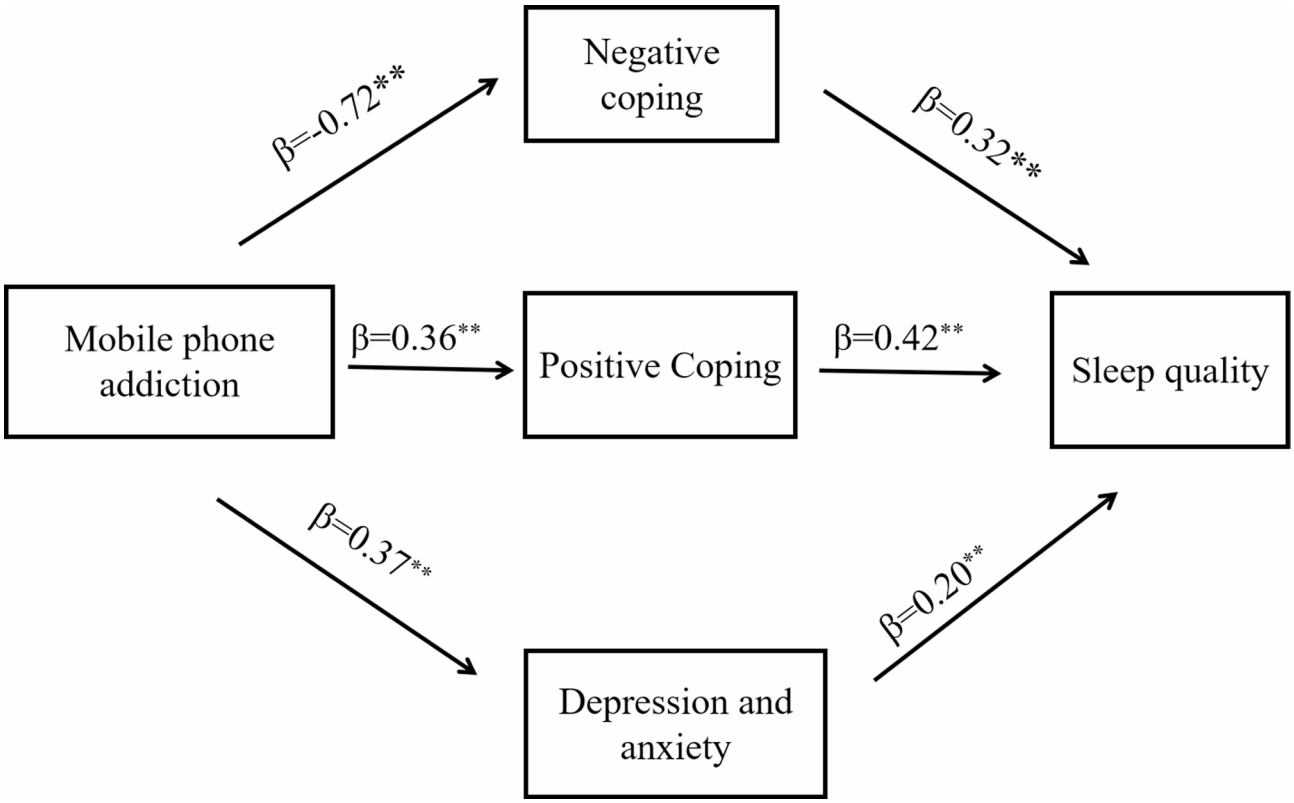

Fig. 2. Chain mediation model of mobile phone addiction, coping style, anxiety/depression, and sleep disorder in AMI patients aged 18–45 years. $^{**}P < 0.01$.

Discussion

In China, it is increasingly common for younger adults with AMI to use mobile phones extensively before bedtime[18]. The present study found a mean mobile phone addiction score of 69.32 ± 26.82 among patients aged 18–45 years with AMI, indicating a mild level of dependence in this population. Several factors may contribute to this behavior. Notably, 63.2% of the participants were employed, which likely increases their exposure to smart devices. Additionally, as primary income earners, many of these individuals face significant social and occupational stress, prompting them to use mobile phones for psychological relief and entertainment, particularly before sleep[19].

Mobile phone addiction is increasingly recognized as a maladaptive behavioral pattern that disrupts psychological functioning[20]. Evidence indicates that excessive smartphone use, particularly pre-sleep usage, can disturb emotional regulation, degrade the sleep environment, and induce physical fatigue, ultimately impairing sleep quality[21–23]. Correlation analysis revealed that sleep quality, as measured by the PSQI, was significantly associated with mobile phone addiction (MPAI), coping style, and psychological distress (HADS) ($P < 0.01$). Further mediation analysis demonstrated that mobile phone addiction had both a significant total effect and direct predictive effect on sleep quality ($P < 0.01$). Importantly, coping styles (both positive and negative), anxiety, and depression partially mediate this relationship[24–26]. Sleep disturbances in young patients with AMI may arise from complex interactions between behavioral and psychological factors.

Poor sleep quality in young AMI patients may extend beyond nocturnal rest to impact broader domains of health-related quality of life (QoL). As defined by the World Health Organization, QoL encompasses an individual's perception of their position in life, including physical, psychological, social, and emotional domains'[27]. Given that sleep disturbances exacerbate cardiovascular risk and mental health burdens, addressing mobile phone dependence could improve not just sleep but also multidimensional QoL—a critical patient-oriented outcome[28]. Pan et al. found that negative coping styles mediate the relationship between mobile phone addiction, anxiety, and depression among college students[21]. Individuals who engage in positive coping strategies tend to show lower levels of phone dependence, whereas those with negative coping styles are more likely to seek stress relief through digital communication and entertainment, thus reinforcing their dependence[22].

Individuals experiencing psychological distress may prefer mobile phone–mediated interactions over face-to-face communication as they feel more comfortable and reduce anxiety. Over time, this coping behavior may evolve into dependence. Jiang et al. reported that short-form video addiction was positively associated with both poor sleep quality and social anxiety in adolescents, with social anxiety serving as a partial mediator[29]. Similarly, Gong et al. and Tian et al. demonstrated that anxiety and depression mediate the relationship between mobile phone addiction and sleep quality in both younger and older populations[30,31].

This study proposed and tested a chain mediation model involving the following pathways: mobile phone addiction → positive coping → sleep quality; mobile phone addiction → negative coping → sleep quality; mobile phone addiction → anxiety and depression → sleep quality; and mobile phone addiction → positive coping → anxiety and depression → sleep quality. Although none of these mediating pathways were statistically significant, their directional consistency with prior literature (e.g., Dong et al. and Mahsa Nahidi et al.) supports their theoretical relevance[32,33]. This pattern suggests that pre-existing psychological distress and maladaptive coping tendencies may magnify the observed association between digital overuse and sleep-related issues[34].

The inclusion of coping styles and psychological symptoms in this study contributes to a clearer understanding of how mobile phone addiction affects sleep quality in patients with AMI aged 18–45 years. These findings have practical implications for clinical intervention and public health prevention strategies. Healthcare providers should address not only mobile phone overuse, but also their interaction with psychological distress and maladaptive coping patterns. First, patients should be guided to use mobile phones rationally by clarifying their purpose, methods of use, and underlying reasons. This approach maximizes the benefits of mobile devices while avoiding the adverse consequences of their excessive use. Second, a supportive therapeutic environment is created to help patients establish and maintain healthy interpersonal relationships.Third, psychological counseling, lectures, and consultation activities are implemented to enhance positive emotions, modify patients' coping styles, and ultimately reduce their dependence on mobile phones. Fourth, combining sleep hygiene education with QoL monitoring could reveal whether reduced mobile phone use translates to improved physical, social, and emotional well-being, domains critical to recovery in young AMI patients. In addition, future research should explore digital health interventions to mitigate mobile phone dependence and improve sleep quality. Artificial intelligence (AI)-driven tools offer real-time monitoring of sleep patterns and personalized behavioral feedback, similar to applications in bipolar disorder management[35]. Integrating such technologies could transform care for young patients with AMI by enabling early detection of sleep disruptions and adaptive coping strategies, ultimately enhancing quality of life.

Study limitations

Despite its strengths, this study had several limitations. First, the small sample size is a key limitation. Therefore, the results of this study should be considered preliminary. Second, no ex post efficacy analysis was performed. Third, the cross-sectional design limits causal inferences. Future studies should consider longitudinal or experimental designs to better examine the temporal and causal relationships. Fourth, Recruitment from one hospital may limit the variability in coping styles or distress, affecting the mediation results. To enhance the robustness and generalizability of these findings, future research should involve larger, multicenter cohorts across diverse populations. Fifth, inclusion of a priori power analysis and external validation is essential to confirm the observed associations. Furthermore, the study may be subject to residual confounding from unmeasured variables, such as detailed laboratory parameters, occupational stress levels, medication use, unmeasured infarction characteristics (e.g., location, severity, and Killip class), and in-hospital complications, all of which could influence sleep quality. Consequently, our findings should be interpreted as preliminary evidence suggesting an association rather than definitive proof of causality. Future prospective studies that systematically collect clinical data are warranted to verify our findings.

Conclusion

This study highlights the complex interplay between mobile phone addiction, sleep difficulties, coping style, and anxiety/depression in patients with AMI aged 18–45 years. Mobile phone addiction significantly predicted sleep difficulties, both directly and indirectly, through its association with coping styles and anxiety/depressive symptoms. The 95% confidence intervals excluded zero, suggesting potential indirect pathways, warranting further studies. Targeted clinical interventions that address not only excessive mobile phone use but also maladaptive coping mechanisms and anxiety/depression may contribute to improved sleep quality and overall health outcomes in this at-risk population.

Data availability

The original contributions this study are . Further inquiries can be directed to the corresponding author.

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Author contributions

Li Xu (First Author): Conceptualized the study, conducted experiments, analyzed data, Supervised the research and drafted the manuscript.Baoling Liu (Second Author): Designed experimental methods, assisted in data analysis, and revised the manuscript.Xiaoli Zhou (Third Author): Performed key experiments and contributed to data collection.Yun Liu (Fourth Author): Provided technical support, managed datasets, finalized the manuscript, Supervised the research and reviewed the manuscript.

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Declarations

Ethics approval
This study was conducted in accordance with the ethical guidelines and principles established by the Ethics Committee of Jinan Central Hospital. The experimental protocol was approved by the Ethics Committee of Jinan Central Hospital (Approval Number: JNCH2024015).

Experimental protocols statement
All experimental protocols were approved by a named institutional and/or licensing committee.

Informed consent
Informed consent was obtained from all subjects and/or their legal guardian(s).

Methods statement
The study protocol was approved by the Ethics Committee of Jinan Central Hospital (Approval Number: JNCH2024015). All participants provided informed consent before their inclusion in the study.

Competing interests
The authors declare no competing interests.

Additional information
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