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The mediating effect of rumination and fear of missing out between mobile phone addiction and sleep quality among college students

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The impact of mobile phone addiction (MPA) on college students' sleep quality (SQ) has received increasing attention in recent years. On this basis, the mediating roles of rumination and FOMO (fear of missing out) on MPA and SQ were examined in this study. In a cross-sectional study, preliminary data were gathered via questionnaires from 1401 college students (19.35 ± 0.81) from 5 universities in Jiangxi Province, China. Mobile Phone Addiction Tendency Scale, Rumination Response Scale, Fear of Missing Out Scale and Sleep Quality Scale were employed in the research. The mediation model was tested using SPSS 26.0, with FOMO and rumination acting as the mediating variables. Between MPA and SQ, rumination and FOMO each had their own unique mediation effect. Furthermore, rumination and FOMO function as a chain of mediators between college students' MPA and SQ. This study provided confirmation and clarification that in college students, the association between MPA and SQ was mediated by rumination and FOMO. This study improves our understanding of MPA, SQ and how MPA may affect SQ in college students. It also shows that the impact of MPA and SQ of college students should be given more consideration by educators, parents, and college students themselves.

Keywords College students, Mobile phone addiction, Rumination, Fear of missing out, Sleep quality

Since information technology is developing so quickly, we are using mobile phones more and more in our daily lives. In particular, as Internet technology has advanced, smartphones have become an essential component of peoples' lives[1]. The convenience of smart phones meets our various needs in daily life, such as traffic navigation, social interaction, online shopping and entertainment and leisure. As of June 2023, China had 1.092 billion Internet users, of which 1.047 billion were mobile users, making up 99.6% of all Internet users, according to the 50th Statistical Report on the Development of the Internet in China[2]. But as time goes by, overuse of smart phones can lead people to develop addiction—MPA. MPA, often referred to as problematic mobile phone use and mobile phone dependence, is an addictive behavior that impairs daily functioning and is unable to be controlled when using a phone[3]. Research has shown that MPA can lead to serious emotional, mental and physical problems, which means that a person's physical and mental health can be greatly affected by MPA, as well as our interactions with others and our work[4,5]. For instance, there is a substantial correlation between MPA and a number of issues, including depression, sleep deprivation, migraines, and visual impairment. It is challenging for someone who becomes dependent on a cell phone to regain control over their conduct[6–8]. It is interesting that several research have revealed that college students demonstrate a greater level of dependence on cell phones compared to other groups due to a lack of self-control and resistance[9,10]. According to the results of the studies, the proportion of MPA among college students in China has now reached 23%, and it is still growing.

Literature and hypothesis

Sleep quality and mobile phone addiction

A key component of helping college students do better academically is their sleep quality[11], that is, getting enough sleep is crucial to ensuring that college students' academic performance improves. Many studies have shown that good sleep is an important physiological and psychological guarantee for human survival, which affects our health in many aspects, such as promoting metabolism, improving cognitive ability, eliminating brain fatigue and maintaining mood[12]. Research by Rathakrishnan et al. found that MPA is associated with SQ, and excessive use of smartphones is associated with poor SQ in college students[13]. Studies have shown that students with poor SQ report significantly more psychological problems, that is, the overall SQ shows a linear downward

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trend[14]. Unfortunately, as MPA intensifies, college students' SQ problems are more serious. Poor SQ is also one of the multiple effects of MPA, in other words, the intensification of MPA will inevitably lead to the reduction of SQ[3]. Prior Studies have shown that teenagers' use of mobile phones for a long time or long time before going to bed will make sleep problems worse[15,16]. Surobhi et al. found through a survey of 224 medical students that another significant factor contributing to college students' declining physical function and low SQ was their excessive usage of mobile phones[17]. In summary, we propose the hypothesis that mobile phone addiction among college students positively predicts their poor sleep quality (H1).

Therefore, from the standpoint of MPA to explore the factors affecting the SQ of college students, in-depth analysis of the ways and conditions of influence, on this basis to protect and promote the SQ of college students to provide empirical support and practical inspiration, may have more obvious prevention and intervention effects. On the other hand, more attention is being paid to the direct correlation between MPA and SQ in the current study, and the mediating or moderating effect between MPA and SQ (how MPA affects SQ)[18]. Thus, the purpose of this study is to investigate how MPA affects SQ in college students as well as its mechanism. To more thoroughly examine the connection between MPA and SQ, the mediating mechanism between the two should be considered. This study hypothesizes that rumination and FOMO could be its mediating variables based on literature research.

Rumination as a mediator

Rumination is the cognitive process of continually reflecting on the experiences one has had[19]. The cognitive theory of insomnia suggests that rumination (repetitive, nonconstructive thinking about past events) leads to increased arousal before bed, thereby reducing SQ[20]. At the same time, people who ruminate more have poorer SQ than those who ruminate less[21]. It is reasonable to show how MPA affects rumination, even if few studies have examined the direct association between MPA and rumination. For example, studies have also proved that MPA in college students will also produce rumination. The reason is that when mobile phone addicts frequently participate in social networks, they will experience social comparison and thus induce or intensify rumination thinking[22,23]. Previous studies have suggested that adolescents suffering from MPA are prone to academic procrastination and interpersonal problems, leading to rumination[24]. In a study involving 1196 Chinese teenagers, Liu et al. discovered that rumination acted as an intermediate in the association between MPA and teenagers' SQ[18], indicating that MPA may be a significant factor influencing low SQ. Rumination still had negative impacts and negatively predicted SQ, even after adjusting for anxiety and sadness, according to a long-term study[25]. This was especially true for high-trait ruminants. As per the cognitive theory of insomnia proposed by Harvey, individuals with high quality rumination tend to have unfavorable adjustment to cognitive activities, and are easy to trigger autonomous arousal and painful emotions. This is consistent with studies showing that rumination and poor SQ are associated with anxiety[26,27]. Therefore, Our hypothesis was that rumination acted as a moderator between college students' MPA and SQ(H2).

FOMO as a mediator

FOMO refers to the unfavorable feelings such as unease and anxiety that occur when an individual thinks that he or she is missing out on beneficial things that others are doing or experiencing, and it has a strong dispersion[28]. The FOMO is essentially a negative state brought on by a person's need social communication, fear of being excluded from the group, and tendency to constantly check social media[29]. This negative emotion can damage personal behavior and physical and mental health, and is a common anxiety phenomenon among people, especially young people. Other studies have found that when people experience the FOMO, they will show a strong sense of unease. Thus, compared to women, men are more likely to use social media[30]. FOMO increases individual MPA and contributes significantly to social media addiction[31]. According to studies, those who experience a lot of negative emotions are more likely to experience a lot of FOMO and develop a smartphone addiction, and have poorer SQ[32]. According to the use and satisfaction theory, the FOMO originates from the lack of psychological needs, and social interaction can be established and maintained through smart phones[33]. Several researches have verified the existence of a direct or mediated correlation between FOMO and smartphone addiction[8]. Prior research has verified a positive correlation between FOMO and anxiety before going to bed, longer sleep latency and shorter sleep duration. It can also be said that FOMO will reduce the SQ of college students[13]. High sense of missing out individuals increased the likelihood of craving social media for information, extended bedtime, and decreased SQ. In conclusion, Our hypothesis is that FOMO acts as a moderator between college students' MPA and SQ(H3).

Rumination and FOMO as a chain mediator

A more thorough analysis of the literature showed that rumination levels can have a positive or negative impact on college students' overall FOMO, which is crucial for improving the quality of their sleep[34]. Actually, there is a correlation between rumination levels and FOMO. According to study, ruminating can make people feel more anxious about the future, which makes them more likely to experience FOMO[35]. The study also discovered a link between high frequency social media use and prolonged cell phone use and higher levels of rumination. This finding may be explained by people's ongoing reflection, exacerbated by FOMO, on whether or not they are missing out on crucial information or activities when using social media[36]. According to a study by Akbari et al., ruminating not only makes people feel more FOMO, but it also makes psychological stress worse by impairing their capacity to control their emotions[37]. In conclusion, rumination and FOMO may be a link in the chain that connects mobile phone addiction and poor sleep quality since addicts who engage in ruminating are more likely to experience anxiety and FOMO(H4).

Assume the following for the model Fig. 1:

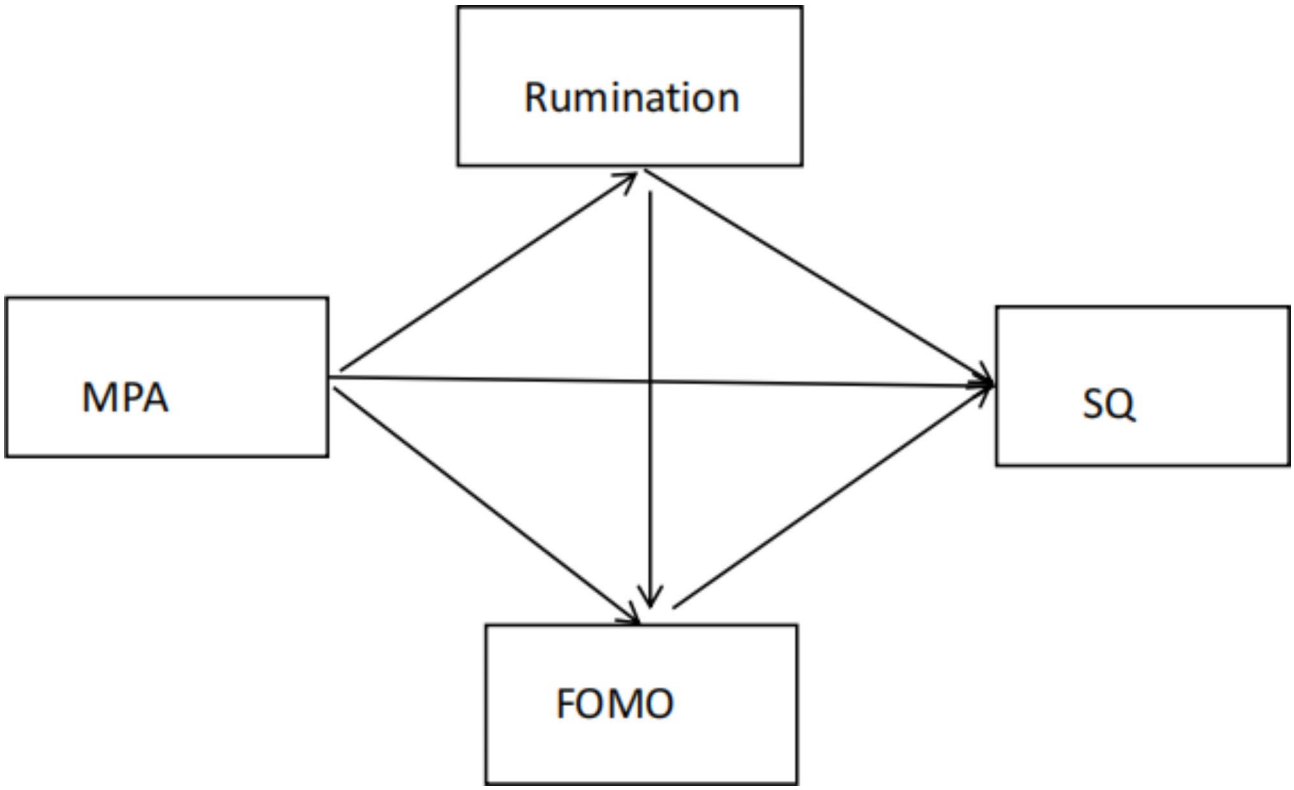

Fig. 1. Conceptual architecture diagram.

Methods

Subjects

An effective rate of 95.96% was achieved by deleting 59 invalid survey replies out of 1460 questionnaires collected from five universities and institutes in Jiangxi Province. This study was approved by the Human Ethics Committee of Science and Technology College, Nanchang Hangkong University, which was conducted from January 23 to March 13, 2024. All procedures were carried out in accordance with relevant guidelines, and informed consent was obtained from all participants. Among them, there were 585 freshmen, 391 sophomores, 228 juniors, and 197 seniors, accounting for 41.76%, 27.91%, 16.27% and 14.06%, respectively. There were 463 female students and 938 male students, making up 33.05% and 66.95% of the student body, respectively. 422 students majored in humanities and social sciences and 979 in science, agriculture and medicine, accounting for 30.12% and 69.88% respectively. There were 1084 persons living in rural areas and 317 residing in metropolitan areas, accounting for 22.63% and 77.37% respectively. Participants were 20.78 years old on average, with a standard deviation of 1.33 years.

Measures

MPA scale for college students

In order to test the degree of MPA among college students, this study adopted the MPA Index Scale compiled by Professor Liang Yongchi based on the American Diagnostic and Statistical Manual of Mental Disorders (Fourth edition)[38]. All 16 items were scored on a 5-point scale from "1" (very inconsistent) to "5" (very consistent), with a higher score indicating a higher propensity for mobile phone addiction among college students. The scale used in this investigation had a Cronbach's α coefficient of 0.91.

Sleep quality scale

Assessing college students' SQ, the Chinese version of Pittsburgh Sleep Quality Index (PSQD), which was translated by Liu et al., was adopted in this investigation[39]. This scale consists of 7 components and 18 items, each of which is calculated from the corresponding entry. The higher the total score, the worse the sleep quality. The scale's Cronbach's α coefficient in this investigation was 0.91.

Rumination scale

College students' rumination conditions were assessed using the ruminating scale, which was updated by Han Xiu and Yang Hongfei based on Nolen-Hoeksema[40]. With a total of 22 items, the measure has three dimensions: forced meditation, introspective meditation, and symptomatic rumination. The Cronbach's α coefficient, as determined by the Likert four-point scoring system (1 being never, 4 being always), is 0.96.

	M	SD	1	2	3	4
1. MPA	37.81	12.40	1			
2. Rumination	40.14	12.58	0.62**	1		
3. FOMO	15.27	5.58	0.55**	0.69**	1	
4. SQ	6.15	3.85	0.51**	0.65**	0.58**	1

Table 1. Descriptive statistics and correlation analysis among variables ($n = 1401$). **$p < 0.01$, the same below.

Variables		Overall fit index		95% CI			
Result	Predictor	R^2	F	β	LLCI	ULCI	t
Rumination	MPA	0.38	860.35***	0.62	0.58	0.66	29.33***
FOMO	MPA	0.50	703.44***	0.20	0.10	0.23	8.48***
	Rumination			0.57	0.52	0.61	23.46**
SQ	MPA	0.47	403.20***	0.12	0.07	0.17	4.70***
	Rumination			0.42	0.36	0.48	14.30***
	FOMO			0.22	0.17	0.28	8.01***

Table 2. Regression analysis of linking models. ***$p < 0.001$.

FOMO scale

College students' fear of missing out was measured using the Chinese version of Li Qi's updated Fear of Missing Scale (FOMOS)[41]. There are eight questions in total on this one-dimensional scale. Level 5 score (1 = "Completely inconsistent", 5 = "completely consistent"): the greater the score, the greater the person's level of FOMO. The scale's Cronbach's α coefficient in this investigation was 0.88.

Data statistics

The questionnaire was imported into SPSS 26.0 software, and descriptive statistics and correlation analysis were conducted on the data. The SPSS macro program prepared by Hayes was used to analyze the intermediary effect of PROCESS model 6 in the SPSS macro program, and Bootstrap deviation correction test of 95% confidence interval was carried out[42].

Results

Common method deviation

The bias effect of popular approaches was tested in this study using the Harman single factor test technique[43]. Eleven factors had feature roots larger than one, according to the data, and the maximum factor variance explanation rate was 34.58%, which was less than the 40% criterion. Thus, it may be concluded that this study did not exhibit a significant common method bias impact.

Descriptive statistics and correlation analysis among variables

Table 1 shows that MPA has a substantial positive correlation with SQ, FOMO, and rumination. Rumination, fear of missing out and sleep quality were positively correlated. The FOMO and SQ showed a strong positive association.

Regression analysis of mediation effects

According to regression analyses, there was a positive correlation between cell phone addiction and sleep quality ($\beta = 0.12$, $t = 4.70$, $p < 0.001$), indicating that individuals with high levels of addiction may have a negative impact on sleep quality; MPA was a positive predictor of both rumination ($\beta = 0.62$, $t = 29.33$, $p < 0.001$) and FOMO ($\beta = 0.20$, $t = 8.48$, $p < 0.001$), indicating that people with high levels of MPA are more likely to experience both the presence of stronger FOMO and rumination; rumination ($\beta = 0.57$, $t = 23.46$, $p < 0.001$) was found to be a strong predictor of FOMO, indicating that people who engage in a lot of ruminative thinking are highly likely to experience FOMO. Additionally, sleep quality was found to be positively correlated with both rumination ($\beta = 0.42$, t = 14.30, $p < 0.001$) and FOMO ($\beta = 0.22$, $t = 8.01$, $p < 0.001$), suggesting that people with high rumination and strong FOMO had poor sleep quality (see Table 2).

Further, the mediating impact was tested using the deviation-corrected percentile Bootstrap approach, which involves repeating the extraction process 5000 times[44]. Three paths make up the mediating effect test, according to the research results (Fig. 2; Table 3): Rumination was found to have an intermediary role between MPA and SQ, as evidenced by the relationship "MPA → rumination → SQ", 95% CI [0.21, 0.31] which accounted for 52% of the entire effect; "MPA → FOMO → SQ", 95% CI [0.03, 0.07], suggests that FOMO mediates the relationship between MPA and SQ. Rumination and FOMO act as a mediating factor between MPA and SQ, as shown by the relationship "MPA → rumination → FOMO → SQ", 95%CI [0.04, 0.11]. The mediating impact is estimated to be $(0.62) \times (0.57) \times (0.22) = 0.08$, or 16% of the total effect. The confidence intervals of the above three paths do not include 0, indicating significant effects of the three paths. H2, H3, and H4 are established separately.

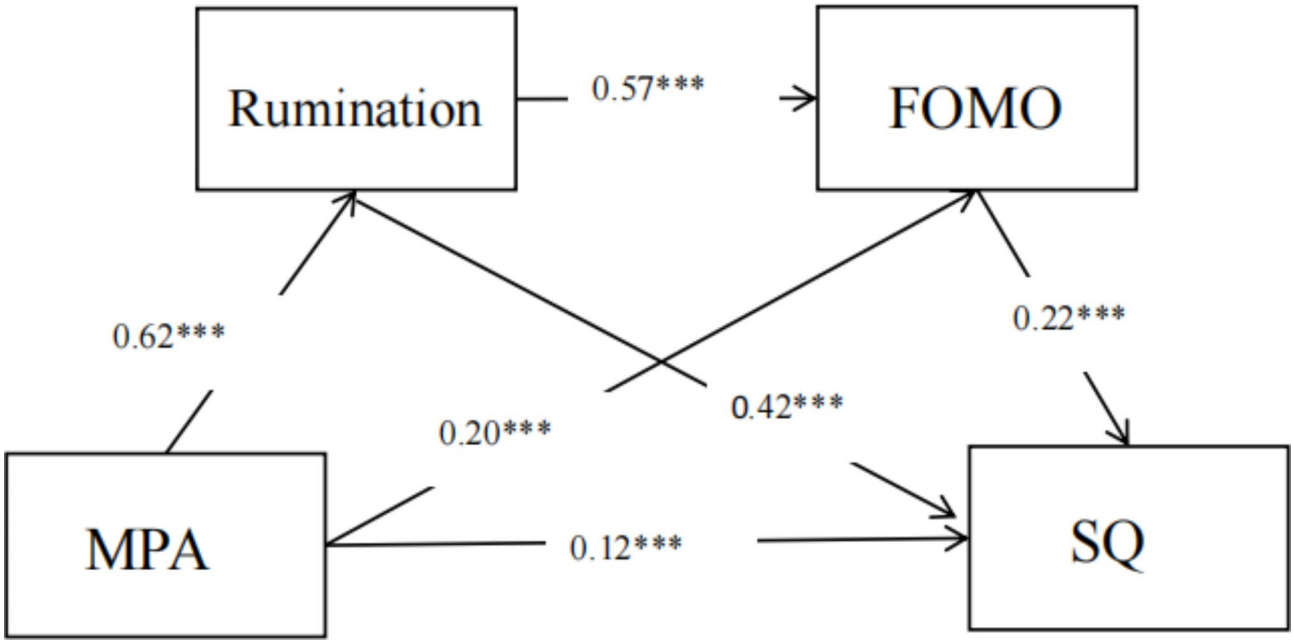

Fig. 2. Chain mediation effect diagram.

Path	Effect	Boot SE	BootLLCI	BootULCI	Effect ratio
MPA→SQ	0.12	0.03	0.07	0.17	
MPA→Rumination→SQ	0.26	0.03	0.21	0.31	0.52
MPA→FOMO→SQ	0.04	0.01	0.03	0.07	0.08
MPA→Rumination→FOMO→SQ	0.08	0.02	0.04	0.11	0.16

Table 3. Bootstrap analysis of mediation effect test.

Discussion

The direct effect of MPA on SQ of college students

According to the study's findings, college students' MPA and SQ have a substantial positive correlation and significantly positively predicts their poor SQ, which is in line with the findings of earlier study[45]. From the theory of technology addiction, it can be inferred that college students addicted to mobile phones will use mobile phones too much, which will inevitably shorten their sleep time. Meanwhile, some studies have found that excessive use of mobile phones at night will naturally affect the activity of individual pineal gland, thus affecting the secretion of melatonin, and thus negatively affecting the quality of sleep[46]. Excessive use of mobile phones will cause various stimuli for individuals, including various cognitive, behavioral and physiological stimuli, which will inevitably increase the arousal level and lead to the decline of SQ[47]. College students who are dependent on their phones may experience physical pain due to long-term use of mobile phones, such as limb numbness, cervical spine damage and even hearing loss, which will aggravate individual sleep difficulties[48].

The mediating role of rumination and FOMO on MPA and SQ

Firstly, MPA of college students can affect SQ through positive prediction of.

rumination, which is in line with earlier research[25]. Previous cross-sectional research found that by increasing over-seeking, rumination predicted MPA[49,50]. Rumination can be induced by stressful life experiences and low self-esteem, as per the stress response model[51]. As a result, rumination is a major trigger for those who abuse mobile phones, and they encounter more unfavorable life occurrences[52]. In addition, there is indeed one study confirming that teenagers with MPA may eventually experience more ruminating after using a phone[18] ,and it has been demonstrated that cell phone addiction can disrupt SQ through rumination. This study also showed that rumination significantly positively predicted the SQ of college students, and further confirmed that rumination functioned as a mediator in the relationship between MPA and college students' SQ.

Secondly, this study found that MPA of college students can affect SQ through missing fear. The results of the study once again confirmed that the FOMO and problematic mobile phone use, or MPA, are intimately associated[53], and also confirmed that the FOMO is related to poor SQ[35]. This is in line with other study findings, which showed that FOMO increased with MPA degree. For instance, the majority of college students currently use their phones to access social media before going to bed. At the same time, research indicates that college students who rely more heavily on their phones also spend more time on social media, which can lead to FOMO,

a delay in falling asleep, and a decrease in self-esteem. More studies have confirmed that FOMO mediates the relationship between MPA and SQ from both cognitive and behavioral aspects[54]. In particular, the use of social media through mobile phones by college students who are accustomed to staying up late exacerbates FOMO, delaying sleep time from a behavioral point of view, increasing cognitive arousal[55] ,and worse SQ.

Additionally, the study discovered that through the chain mediation of rumination and FOMO, college students' MPA can positively predict SQ. This finding in this study reflects the close link between rumination and FOMO, and no previous studies have explored this mechanism. These results indicate that the influence of MPA on SQ of college students can be formed through rumination and FOMO. As discussed above, The majority of college students who are dependent on their phones are more vulnerable to stressful situations such as study procrastination and interpersonal communication, and stressful events are even more inducements to rumination. Conversely, college students who are engrossed in rumination and fear missing out typically resort to social media, which blocks sleep activities and increases the bedtime time[56]. The technology addiction model theory also holds that negative emotions are easily perceived as internal triggers, thus generating emotional response (FOMO) and increasing attention to behavioral stimuli, naturally prolongs bedtime[34]. Although this study's chain mediation effect size is only 0.08, which is not very large, we still need to be concerned about how rumination and the FOMO chain effect affect college students' SQ. College students should simultaneously keep a calm and cheerful demeanor, sleep at a normal hour, and use their phones in an active and responsible manner.

Significance and deficiency of the study

Regarding the prevention and treatment of SQ among college students, this study is extremely important. First of all, the MPA of college students can positively predict their poor SQ. College students must be actively encouraged to put down their phones, deliberately control their need for them, limit how much they use them, ease MPA, and ultimately increase SQ. Secondly, this study also found that MPA of college students indirectly affects their SQ through rumination and FOMO. Therefore, schools can identify students with MPA symptoms through the observation of teachers and students or the test of relevant scales. Meanwhile, the level of rumination and FOMO can be reduced through positive and effective cognitive ways or emotional responses. Finally, while using mobile phones as little as possible, students themselves should also learn and train the ability to reduce rumination and FOMO, reduce self-focus and attention, and ensure adequate sleep time.

The shortcomings of this study are as follows: first, data is collected by questionnaire and all subjects are self-reported, which is subjective to a certain extent. Second, the cross-sectional design of this study can consider longitudinal follow-up research in the future. Third, the sampling range can be appropriately expanded, not only limited to college students, but also teenagers and elderly groups.

Conclusion

MPA will affect the SQ of Chinese college students. Meanwhile, rumination and FOMO can indirectly affect the SQ separately, and rumination and FOMO can also have a chain effect on the SQ.

Data availability

The corresponding author can make the raw data from this study available to anyone who requires it.

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Author contributions
Junliang Zhang and Yixuan Deng conceived and designed the the research. Junliang Zhang, Yixuan Deng carried out the protocol and the questionnaire survey.Shuang Zheng analyzed the data.Chuangang Wan and Junliang Zhang wrote the manuscript. Junliang Zhang and Shuang Zheng revised the manuscript. All authors have read and agreed to the published version of the manuscript.

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Declarations

Competing interests
The authors declare no competing interests.

Ethical approval
All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent
All authors have read and agreed to the published version of the manuscript.

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