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Social network site addiction, sleep quality, depression and adolescent difficulty describing feelings: a moderated mediation model

Jiale Wang[1], Ning Wang[2], Pingfan Liu[3*] and Yang Liu[1*]

Abstract

Background and objectives Social network site addiction is strongly correlated with sleep quality among adolescents. However, the underlying mechanisms driving these relationships require further exploration. This study aims to supplement the understanding of the psychological mechanisms linking social network site addiction and sleep quality by investigating depression as a mediating factor and difficulty describing feelings as a moderating factor.

Methods A self-report survey was conducted with 1,670 adolescents in China, assessing social network site addiction, sleep quality, depression, and difficulty describing feelings. Descriptive and correlational analyses were performed on these variables, followed by the construction of a moderated mediation model.

Results Social network site addiction was significantly positively correlated with sleep quality, depression, and difficulty describing feelings among adolescents. Difficulty describing feelings was also significantly positively correlated with depression. Depression partially mediated the relationship between social network site addiction and sleep quality, while difficulty describing feelings intensified the relationship between social network site addiction and depression.

Conclusion This study further elucidates the psychological mechanisms linking social network site addiction and sleep quality in adolescents. Depression acts as a mediating factor, while difficulty describing feelings strengthens the relationship between social network site addiction and depression. These findings highlight the role of difficulty describing feelings in the interplay between social network site addiction and sleep quality, offering valuable insights for a more comprehensive understanding and targeted interventions aimed at improving sleep quality in adolescents.

Keywords Social network site addiction, Sleep quality, Depression, Difficulty describing feelings, Adolescents

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Introduction

According to data from the National Institutes of Health, sleep is an essential component of daily human life, often considered, along with diet and exercise, one of the three fundamental pillars of health, and is crucial for maintaining life and overall well-being [1]. However, research indicates that poor sleep quality is a significant public health issue among adolescents [2], with its prevalence steadily increasing and affecting younger age groups [3]. The incidence of sleep disorders among adolescents is estimated to be around 25–30% [4]. As a vital physiological activity, sleep is closely tied to the growth and development of adolescents [5]. Adolescence is regarded as the second critical phase for foundational learning and neuroplasticity development, following infancy [6]. During this period, the brain undergoes substantial reorganization and maturation, contributing to the development of cognitive abilities, emotional regulation, and behavior patterns [7]. However, this developmental stage also makes adolescents more susceptible to the effects of poor sleep quality. Sleep is crucial for neuroplasticity, memory consolidation, and learning ability, and poor sleep quality can disrupt these critical physiological and psychological processes. This disruption may negatively impact adolescents' cognitive development, emotional health, and overall growth, leading to issues such as anxiety and depression [8], aggression [9], altered cognitive function [10], and even suicidal behavior [11]. Given these concerns, there is an urgent need to investigate the various factors that influence sleep quality in adolescents. Such research is essential not only for identifying key risk factors that may contribute to declining sleep quality but also for providing a scientific basis for developing effective intervention strategies.

The factors contributing to poor sleep quality are diverse and complex. Among these, social network site addiction has been found to be closely related to sleep quality in adolescents [12]. With the rapid development of smart electronic devices and social network sites, social network sites have gradually become an indispensable part of people's daily lives and an important platform for obtaining information and engaging in social interactions [13]. Research shows that 93–97% of adolescents use at least one social network site, spending approximately 3 h daily on social network sites [14]. Although social network sites bring many conveniences and pleasures to adolescents, they also make them susceptible to addiction [15]. One study found that the prevalence of social network site addiction in adolescents (35%) is higher than in university students (23%) and community adults (19%) [16]. Furthermore, studies have shown that adolescents are more likely to be influenced by social network sites, partly due to their greater focus on peer behavior and social feedback [17]. A meta-analysis revealed that the higher prevalence of social network site addiction is associated with younger age and living in collectivist countries [18]. Although social network site addiction has not been classified as an official diagnosis or health condition in the Diagnostic and Statistical Manual of Mental Disorders (DSM-5-TR) or the International Classification of Diseases, 11th Revision (ICD-11), and there is no consensus on its classification, with significant differences in the methods of categorization, excessive and compulsive use of social network sites can still significantly interfere with adolescents' daily lives, negatively affecting their physical health, social functioning, and mental well-being [19]. Given the prevalence of social network site addiction in adolescent populations and its potential negative impacts, societal attention to this phenomenon has been increasing. Social network site addiction refers to an individual's excessive preoccupation with social networks, characterized by a strong motivation to use these platforms and a significant amount of time and energy spent on them, which can negatively impact both physical and mental health [13]. Problematic and addictive social network behaviors are considered a form of online risk behavior, closely associated with reduced sleep duration, decreased sleep quality, and insomnia [20]. Adolescents with higher levels of social network site addiction and longer usage times, especially those who engage in passive social network use, typically exhibit poorer sleep quality [21]. Adolescents with poor sleep quality tend to spend more time on social networks than those with better sleep quality [22]. Research has shown that in individuals with social network site addiction, prolonged exposure to blue light can inhibit melatonin secretion, disrupt sleep and circadian rhythms, and subsequently lower sleep quality [23]. The predictive role of social network site addiction on poor subjective sleep quality has been validated in adolescent samples, with adolescents suffering from social network site addiction being 3.25 times more likely to report poor subjective sleep quality than those with normal social network use [24]. Based on the above review, this study hypothesizes that there is a significant positive correlation between social network site addiction and sleep quality in adolescents.

In the relationship between social network site addiction and sleep quality in adolescents, depression may serve as an important mediating factor. Depression is a significant public health concern among adolescents. A recent meta-analysis reported prevalence rates of mild to severe, moderate to severe, and severe depression at 21.3%, 18.9%, and 3.7%, respectively, with a rising trend over time [25]. Depression, as a high-risk psychological disorder in young populations, is characterized by symptoms such as lethargy and sadness [26]. Systematic reviews suggest that among various forms of psychopathology, depression may have the strongest association

with social networks [27]. Numerous studies have demonstrated a positive correlation between social network site addiction and depression [27, 28]. According to acceptance and commitment therapy (ACT), social network site addiction may lead individuals to adopt various avoidant emotional regulation strategies (such as rumination and thought suppression) to reduce the frequency, intensity, or duration of these unpleasant internal experiences [29]. This rigid response to internal emotions can be harmful, triggering more negative emotions and thoughts, and eventually leading to depression. Consistent with this view, research has found that individuals with social network site addiction are more likely to experience depression, especially when they engage in thought suppression. Social network site addiction is considered a core vulnerability factor for emotional distress [30]. According to the secondary addictive disorder hypothesis, addictive behaviors can trigger other mental health disorders, especially depression [31]. Addicted users may spend increasing amounts of time and energy in the virtual world, and when they leave the online environment to face reality, they often feel frustrated or depressed [32]. Moreover, depression is a key determinant of poor sleep quality in adolescents. Studies have found that over 90% of patients with severe depression have reported sleep problems [33] and there is a significant correlation between depression levels and sleep quality [34]. Sleep disturbances are considered a core secondary symptom of depression, while depression is often seen as a major risk factor for insomnia [35]. A study of 7,960 adolescents with sleep problems found that during a four-year follow-up period, depressive symptoms significantly predicted the development and persistence of sleep problems, with adolescents reporting significant depressive symptoms being 50% more likely to experience sleep problems than those without depressive symptoms [36]. The hyperarousal model of insomnia posits that poor sleep quality is a psychobiological disorder involving chronic psychological distress and physiological imbalance [37]. The presence of depressive emotions is associated with abnormal circadian activity of the hypothalamic-pituitary-adrenal (HPA) axis [38], and depression may affect sleep quality through its impact on psychological disorders (excessive worry, rumination) and biological mechanisms (neuroendocrine and immune systems). Based on the above review, this study hypothesizes that depression mediates the relationship between social network site addiction and sleep quality in adolescents.

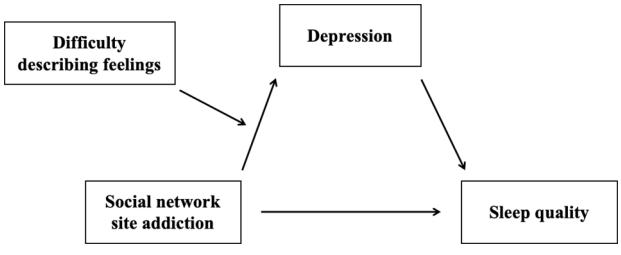

Fig. 1 Hypothesized a moderated and mediation model

However, the relationship between the aforementioned variables may be exacerbated in individuals with certain characteristics, leading to increased adverse behaviors or negative psychological outcomes. One such characteristic is the level of difficulty describing feelings, a key dimension of alexithymia [39]. The term alexithymia, introduced by Peter Sifneos, describes patients who have difficulty with insight-oriented psychotherapy [40]. It is now defined as the inability to identify and describe one's own or others' emotions [41]. Difficulty describing feelings is considered a manifestation of impaired emotional cognition, processing, and regulation [42], and it is a risk factor for the development of various psychological issues and maladaptive behaviors [43]. Research indicates that difficulty describing feelings is highly correlated with emotional problems such as depression [44]. Alexithymia can exacerbate negative emotions like depression due to its impact on emotional awareness and expression [45]. Moreover, it can lead to poor interpersonal relationships, thereby increasing psychological burdens. Difficulty describing feelings is associated with lower social competence and reduced peer popularity [46]. By affecting social interaction, emotional regulation, self-awareness, and social support, difficulty describing feelings significantly increases the risk of depression [47]. According to the "rich get richer" model, adolescents with social network site addiction and difficulty describing feelings may be more prone to depression [48]. Some authors even suggest that difficulty describing feelings and depression may be indistinguishable constructs [49]. Therefore, based on the above review, it is evident that difficulty describing feelings can enhance the relationship between social network site addiction and depression discussed in this study, further exacerbating the extent of negative psychological and behavioral outcomes. Consequently, we hypothesize that difficulty describing feelings amplifies the strength of the relationship between social network site addiction, depression, and sleep quality in adolescents.

Previous research has explored the relationship between social network site addiction and sleep quality in adolescents, as well as the predictive role of this relationship. However, research on this relationship in Chinese adolescents is limited. To further supplement research in this area and explore the underlying psychological mechanisms, this study introduces depression as a mediating variable and difficulty describing feelings as a moderating variable. Thus, this study constructs a hypothesized pathway model (Fig. 1).

Methods

Participants

The survey was conducted in March 2024, following a convenience sampling approach, with schools selected based on their willingness to participate. A cross-sectional survey was conducted among adolescents from 9 secondary schools across five provinces, including Shandong, Hebei, and Hunan, using class groups as the sampling basis. Prior to the distribution of the electronic questionnaires, the research team provided detailed information to the class teachers, including the purpose of the survey, its main content, data confidentiality measures, and the final use of the data. Upon obtaining consent, the survey information and the link to the electronic questionnaire were sent to the class teachers, who then distributed it to the class groups. The questionnaire was distributed electronically, and the informed consent form was attached to the homepage of the electronic questionnaire. Participants were only able to proceed with the questionnaire after clicking the "Agree" button; selecting "Decline" would automatically exit the survey page, ensuring voluntary participation and adherence to the informed consent principle. The questionnaire was designed to be anonymous to protect the participants' privacy and reduce the impact of social desirability bias on responses. Participation in the survey was entirely voluntary, and participants were free to withdraw at any time without providing any reason. The estimated completion time for the questionnaire was approximately 10 min to minimize participant burden.

The study received approval from the Medical Ethics Committee of the author's affiliated institution before its implementation, ensuring that the study design and data collection process complied with ethical and legal requirements. All procedures adhered to the standards and guidelines set by the ethics committee, which further enhanced the reliability of the study and the trust of the participants. Invalid questionnaires included those with patterned responses or those with response times that were either too short or too long. A total of 1,915 adolescents participated in the survey, and after excluding invalid responses, 1,670 valid questionnaires were obtained (693 boys, 997 girls; 767 in Grade 1, 803 in Grade 2, 100 in Grade 3; 110 with family monthly income below 3,000 RMB, 295 with family monthly income between 3,000 and 6,000 RMB, 407 with family monthly income between 6,000 and 10,000 RMB, 378 with family monthly income above 10,000 RMB, and 480 with unknown family income). The average age of the participants was 15.86 years (SD = 0.74).

Measures

Social network site addiction

To assess social network site addiction among adolescents, this study employed a questionnaire based on the scale originally developed by Elphinston et al. [50], which was later adapted, revised, and validated by Wei [51]. The scale includes eight items that measure aspects such as the feelings and frequency of social network use, its impact on daily life (including learning, social interactions, and sleep quality), and the presence of withdrawal symptoms. Each item is scored on a 5-point Likert scale ranging from 1 (completely disagree) to 5 (completely agree). The total score across items represents the level of social network site addiction, with scores ranging from 8 to 40, where higher scores indicate more severe social network site addiction. In this study, the Cronbach's α for the scale was 0.889. In this study, the McDonald's ω for the scale was 0.890. The scale has been widely studied in the context of Chinese adolescents [52, 53].

Sleep quality

A key goal when measuring any construct is to ensure that the measure is capturing the full conceptual domain of the construct of interest while not measuring things outside the purview of the construct domain [54]. To account for academic pressure among adolescents [55], reduce measurement costs [56], decrease respondent burden [57], and improve measurement efficiency [58], this study employed a two-item measure for sleep quality.Based on the National Health Interview Survey [59] and refined following Snyder's study [60], this research utilized a detailed tool for assessing sleep quality.Adolescent sleep quality was captured using two questions: "In the past 30 days, how many times have you (1) had trouble falling asleep and (2) felt like you were not getting enough sleep or rest." Response range was 1 (never) to 4 (almost always). The sum of the two questions is the sleep quality score of adolescents. The score ranges from 2 to 8. The higher the score, the worse the sleep quality of adolescents. This tool for measuring sleep quality has been validated and used in prior studies [61]. The McDonald's ω for this subscale in the present study was 0.844. In this study, the Cronbach's α for the scale was 0.612.

Depression

Depression levels among adolescents were assessed using the depression subscale of the Depression Anxiety Stress Scales (DASS), originally developed by Lovibond et al. [62] and later revised and validated by Gong et al. [63]. The depression subscale consists of seven items, each scored on a 4-point Likert scale ranging from 1 (completely disagree) to 4 (completely agree). The total score represents the level of depression, with scores ranging from 7 to 28, where higher scores indicate higher levels

of depression. The Cronbach's α for this subscale in the present study was 0.912. In this study, the McDonald's ω for the scale was 0.913. The scale has been widely studied in the context of Chinese adolescents [64, 65].

Difficulty describing feelings

The level of difficulty describing feelings among adolescents was measured using the Difficulty Describing Feelings subscale of the Toronto Alexithymia Scale (TAS), developed by Bagby et al. [66] and revised into a Chinese version by Zhu et al. [67]. The subscale includes five items, scored on a 5-point Likert scale ranging from 1 (completely disagree) to 5 (completely agree). Scores range from 5 to 25, with higher scores indicating more severe difficulty in recognizing and describing feelings. The Cronbach's α for this subscale in the present study was 0.747. In this study, the McDonald's ω for the scale was 0.771. The scale has been widely studied in the context of Chinese adolescents [68, 69].

Data processing and analysis

Statistical analyses were conducted using SPSS 26.0. First, we performed a method bias test, considering a threshold of less than 40% as an indication of no significant common method bias [70]. We then conducted descriptive statistics and correlation analyses for the demographic characteristics of the participants and the primary variables. Before further analysis, the data for the main variables were standardized. To test our hypotheses, we utilized the PROCESS macro in SPSS (Models 4 and 7) to examine the relationship between social network site addiction and sleep quality, as well as to explore the mediating role of depression and the moderating role of difficulty describing feelings [71]. We employed 5,000 bootstrap resampling iterations to assess model fit and estimate 95% confidence intervals (95% CI), ensuring robustness in the data analysis [72]. During the analysis, demographic variables such as gender, age, and socioeconomic status were controlled as covariates. A significance level of 0.05 was set for all tests.

Table 1 Correlation analysis

Variables	1	2	3	4	5
1 Gender	-				
2 Age	0.010	-			
3 Social network site addiction	0.076**	0.092***	-		
4 Depression	0.067**	0.038	0.465***	-	
5 Sleep quality	0.085**	0.063*	0.467***	0.637***	-
6 Difficulty describing feelings	0.005	0.057*	0.375***	0.575***	0.341***

*: $p<0.05$; **: $p<0.01$; ***: $p<0.001$

Results

Common method bias test

The common method bias test in this study identified two factors with eigenvalues greater than 1. The first factor accounted for 37.24% of the total variance, which is below the 40% threshold. This indicates that there is no significant risk of common method bias in this research.

Correlation analysis

Table 1 shows that social network site addiction is significantly positively correlated with depression ($r=0.465$, $p<0.001$), sleep quality ($r=0.467$, $p<0.001$), and difficulty describing feelings ($r=0.375$, $p<0.001$) among adolescents. Additionally, depression is significantly positively correlated with sleep quality ($r=0.637$, $p<0.001$) and difficulty describing feelings ($r=0.575$, $p<0.001$).

Mediation model test

After controlling for gender, age, and socioeconomic status, the results in Table 2; Fig. 2 indicate that social network site addiction directly and significantly predicts

Table 2 Mediation model test

Outcome variable	Predictor variables	β	SE	t	R^2	F
Sleep quality	Social network site addiction	0.233	0.024	9.765***	0.068	30.416***
	Gender	0.104	0.024	4.372***		
	Age	−0.026	0.024	−1.066		
	Socioeconomic status	0.009	0.024	0.391		
Depression	Social network site addiction	0.461	0.022	21.080***	0.218	116.175***
	Gender	0.032	0.022	1.480		
	Age	−0.009	0.022	−0.411		
	Socioeconomic status	−0.037	0.022	−1.672		
Sleep quality	Social network site addiction	0.068	0.025	2.663**	0.169	67.641***
	Depression	0.359	0.025	14.208***		
	Gender	0.092	0.022	4.110***		
	Age	−0.022	0.023	−0.985		
	Socioeconomic status	0.022	0.023	0.995		

**: $p<0.01$; ***: $p<0.001$

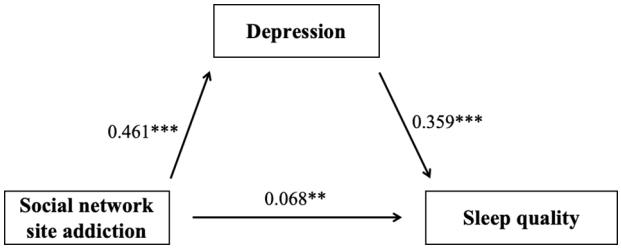

Fig. 2 Mediation model (**: $p < 0.01$; ***: $p < 0.001$)

Table 3 Path analysis of mediation model

Intermediary Path	Effect size	SE	Bootstarp 95% CI	Mediating effect ratio
Total Effect	0.233	0.024	0.186, 0.280	
Direct Effect	0.068	0.025	0.018, 0.117	
Indirect effects	0.165	0.015	0.136, 0.195	71.245%

sleep quality in adolescents (β = 0.233, $p < 0.001$). When the mediating variable is introduced, social network site addiction still significantly predicts sleep quality (β = 0.068, $p < 0.01$). Furthermore, in the mediation model test, social network site addiction significantly predicts depression (β = 0.461, $p < 0.001$), and depression, in turn, significantly predicts sleep quality (β = 0.359, $p < 0.001$). The proportion of mediation pathways is detailed in Table 3.

Moderated mediation test

The results from Table 4; Fig. 3, and Fig. 4 show that after including the moderating variable, the effect of social network site addiction on depression among adolescents remains significant (β = 0.285, $p < 0.001$). Additionally, difficulty describing feelings significantly predicts depression (β = 0.500, $p < 0.001$), and the interaction between social network site addiction and difficulty describing feelings also significantly predicts depression (β = 0.109, $p < 0.001$). Further analysis reveals that different levels (low, medium, high) of difficulty describing feelings significantly moderate the effect of social network site addiction on depression (Table 5). Simple slope plot illustrating the moderating effect of difficulty in describing feelings on the relationship between social network site addiction and depression. High, medium, and low levels of difficulty in describing feelings are represented by solid, dashed, and dotted lines, respectively (Fig. 4).

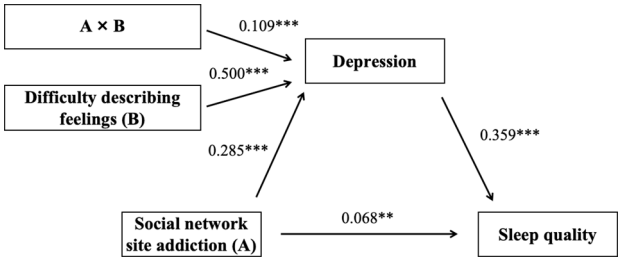

Fig. 3 Moderating mediation model (**: $p < 0.01$; ***: $p < 0.001$)

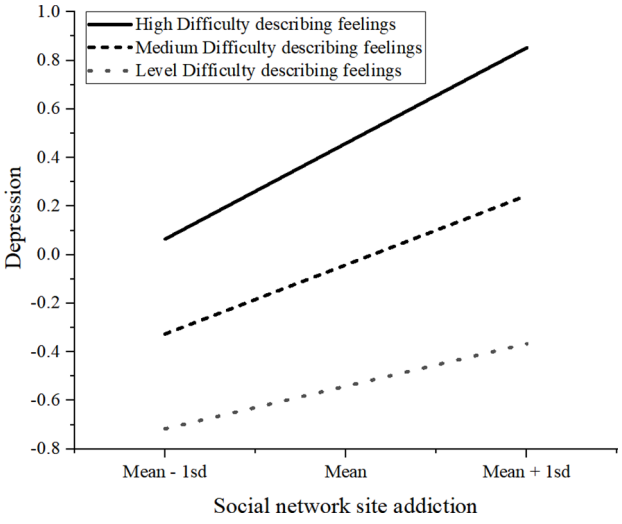

Fig. 4 A simple slope plot of the moderating effect of different levels of difficulty describing feelings on the relationship between social network site addiction and depression

Table 4 Tests the mediation model

Variables	Depression			Sleep quality		
	β	SE	t	β	SE	t
Social network site addiction (A)	0.285	0.020	14.013***	0.068	0.025	2.663**
Difficulty describing feelings (B)	0.500	0.021	23.983***			
A × B	0.109	0.018	6.171***			
Depression				0.359	0.025	14.208***
Gender	0.043	0.019	2.303*	0.092	0.022	4.110***
Age	−0.020	0.019	−1.048	−0.022	0.023	−0.985
Socioeconomic status	−0.034	0.019	−1.812	0.022	0.023	0.995
R^2	0.419			0.169		
F	199.986***			67.641***		

**: $p<0.01$; ***: $p<0.001$

Table 5 The moderating effect of different levels of difficulty describing feelings between social network site addiction and depression in adolescents

DDF Levels	Effect size	SE	t	Lower limit 95%CI	Upper limit 95%CI
Low	0.175	0.027	6.469***	0.122	0.228
Medium	0.285	0.020	14.013***	0.245	0.324
High	0.394	0.027	14.667***	0.341	0.447

DDF: Difficulty describing feelings; ***: $p<0.001$

Discussion

This study explores the interrelationships between social network site addiction, sleep quality, depression, and difficulty describing feelings. Additionally, we investigate the moderating role of difficulty describing feelings within the mediation model. Our findings reveal significant positive correlations between social network site addiction, sleep quality, and depression, all of which reach statistically significant levels. After controlling for demographic variables, depression was found to mediate the relationship between social network site addiction and sleep quality, while difficulty describing feelings significantly moderated the relationship between social network site addiction and depression, thereby confirming our initial hypotheses.

The study demonstrates a positive correlation between social network site addiction and sleep quality among adolescents, a finding consistent with similar research [12]. For instance, a systematic review highlighted a significant association between multiplayer online gaming and poor sleep quality [73]. A large-scale cross-sectional study of Canadian students reported a higher likelihood of reduced sleep duration associated with social network use and observed a dose-response relationship between social network use and reduced sleep duration [74]. The potential mechanisms by which social network site addiction affects sleep quality include psychological stimulation (i.e., increased arousal due to internet media use leading to difficulty falling asleep) [75], the impact of illuminated screens (i.e., light exposure suppressing sleep-promoting hormones such as melatonin) [76], and physical discomfort (e.g., excessive sedentary behavior associated with pathological social network use leading to cervical discomfort, which may affect sleep quality) [77]. Our study also supports the sleep displacement theory [78], which posits that social network use, as an unstructured leisure activity lacking clear start and end times, can easily displace sleep time, thereby affecting sleep duration and quality [79]. In summary, our findings indicate a significant correlation between social network site addiction and sleep quality among adolescents, supported by biological evidence.

This study supports the hypothesis that depression mediates the relationship between social network site addiction and sleep quality in adolescents, aligning with previous research [63, 64]. Prior studies have established a strong association between social network site addiction and depression [80]. Additionally, the relationship between depression and sleep quality has been robustly demonstrated [81]. According to the ACT (Acceptance and Commitment Therapy) model [29], social network site addiction, as a primary process of psychological inflexibility, reduces individuals' psychological flexibility and leads to severe psychological issues. When negative emotions are constrained by rigid thinking or when individuals consciously avoid experiences or situations that may elicit negative feelings, these issues are likely to intensify [82]. Individuals with social network site addiction may find that their efforts to avoid certain emotions and thoughts only amplify them, leading to an inability to effectively accept and process negative thoughts and emotions, thereby resulting in psychological problems such as depression and anxiety. Depression, as a negative emotion, often accompanies a range of issues in adolescents, such as introversion, reluctance to communicate with peers, reduced physical activity, and increased sedentary behavior, all of which contribute to poorer sleep quality [83]. Approximately 90% of individuals with depression experience symptoms of reduced sleep quality, such as prolonged sleep latency and increased frequency of awakenings during the night [84]. Numerous prior studies have also reported significant associations between depression and sleep quality, consistent with our findings [85]. On a biological level, this relationship is supported by evidence suggesting that depression is often linked to imbalances in cholinergic and monoaminergic neurotransmitters [86], which play crucial roles in regulating rapid eye movement (REM) sleep [87]. Another important factor influencing sleep quality is orexin (hypocretin) [88] a neuropeptide involved in both sleep-wake regulation and the modulation of emotions and depression [89]. In summary, our findings validate the initial hypothesis that depression mediates the relationship between social network site addiction and sleep quality in adolescents, with this conclusion further supported by biological evidence.

Our study also reveals that difficulty describing feelings moderates the relationship between social network site addiction and depression, consistent with our initial hypothesis. According to the cognitive-emotional model, individuals who struggle to perceive, understand, accept, and describe their emotions, or who fail to employ appropriate emotional management strategies, are at higher risk of experiencing negative emotions and developing depression [90]. Those with difficulty describing feelings may feel powerless to change their situation and experience overwhelming and confusing emotional information [91]. Conceptually, because difficulty describing feelings

and difficulty recognizing emotions are core components of alexithymia [92], these challenges may hinder or limit individuals with high levels of alexithymia from seeking out others and attempting to express their emotions (i.e., they are uncertain of their own feelings and how to accurately communicate with others) [93]. Difficulty describing feelings affects their insight into and understanding of their emotional states, making it hard to become aware of or correctly express their emotions [94]. This difficulty also impairs their ability to accurately understand others' emotions in daily life and hinders the communication of their feelings to others [95]. This limitation can lead to the accumulation of negative emotions that are not released or processed in a timely manner. According to the emotional cascade model [96], intense negative emotions trigger a ruminative process, which further amplifies the initial negative emotions, creating a vicious cycle that may result in progressively severe emotional chain reactions, potentially leading to depression [97]. General strain theory also explains that individuals with difficulty describing feelings may struggle to articulate and communicate their emotions [98]leading to misunderstandings and strained relationships, thereby increasing their stress in managing interpersonal relationships [99]. This exacerbates pre-existing feelings of isolation and loneliness, further contributing to depression. Individuals with difficulty recognizing emotions, when battling pervasive emotional detachment, may also experience high levels of anxiety and depression [94]. This situation may worsen due to the frustration of being unable to connect with their own and others' emotions. Previous research [92] has shown that difficulty describing feelings is closely related to depression, and individuals with this difficulty are more likely to develop depression in the future, a finding corroborated by other studies [100]. In summary, our results confirm the initial hypothesis that difficulty describing feelings can intensify the relationship between social network site addiction and depression.

In conclusion, our study further explores the relationship between social network site addiction and sleep quality in adolescents, and discusses the mediating role of depression and the moderating role of difficulty describing feelings. This study has several limitations. First, the research relied on self-reported survey data, which may lead to inaccuracies, especially due to potential biases such as subjective opinions, memory recall errors, or missing information, thereby affecting the objectivity and validity of the data. Although the use of self-reported data is common in psychological research, future studies could enhance data reliability by incorporating other objective measurement methods, such as behavioral observations or physiological assessments, to reduce the impact of these biases. Second, while the scales used in this study, including the Social Network Site Addiction Scale, the DASS (Depression, Anxiety, and Stress Scale), and the TAS (Difficulties in Emotional Regulation Scale), have been widely used in studies involving Chinese adolescents, they have not undergone specific validation for adolescent populations. Therefore, the generalizability of these results may be limited, especially since the cultural context and psychological characteristics of adolescents may differ from those of university students. Future research should further validate the applicability and psychometric properties of these scales in adolescent populations. Regarding the measurement of sleep quality, the two sleep quality items used in this study have been widely applied in previous research; however, their psychometric validation specifically for adolescents has not been clearly established. For scales consisting of only two items, Cronbach's α often underestimates internal consistency due to its sensitivity to the number of items, with this bias being particularly pronounced when the number of items is fewer than three. In contrast, McDonald's ω is more suitable for evaluating scales with fewer items but high content relevance, as it is based on factor analysis and provides a more reliable estimate of internal consistency. The Depression Scale, Social Network Site Addiction Scale, and Difficulty Describing Feelings Scale each include a larger number of items, and their internal consistency has been widely validated using Cronbach's α. In previous studies, Cronbach's α has been the standard metric for assessing the internal consistency of these scales; thus, this study adhered to this convention to ensure comparability with existing research in the field. Additionally, to address readers' concerns regarding methodological consistency, this study also calculated Cronbach's α for the Sleep Quality Scale and McDonald's ω for the other scales, with the results incorporated into the Methods section. It is important to note that both McDonald's ω and Cronbach's α are indices of internal consistency rather than measures of validity. Therefore, we acknowledge that the structural validity of these tools may have certain limitations. Finally, since this study employed a cross-sectional design, it does not allow for the determination of causal relationships between variables. While cross-sectional data can reveal associations between variables, the absence of a temporal dimension prevents causal inferences. Therefore, future research should consider adopting a longitudinal design to explore the causal relationships between variables.

Conclusion

This study examines the relationships between social network site addiction, sleep quality among adolescents, depression, and difficulty describing feelings. It constructs a mediation model where depression mediates the relationship between social network site addiction and sleep quality, with difficulty describing feelings serving as

a moderating factor. The findings underscore the importance for individuals, families, schools, and society to address the negative impacts associated with social network site addiction. Specifically, for individuals with high levels of difficulty describing feelings, it is crucial to conduct stratified and valence-specific assessments based on their measurement results, to provide targeted and personalized treatment interventions.

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Author contributions
Jiale Wang, Ning Wang and Yang Liu were contributed to Conceptualization, Methodology, Data curation, Writing - Review & Editing; Jiale Wang and Yang Liu were contributed to Writing - Original Draft; Yang Liu were contributed to Funding acquisition 1 Conceptualization; 2 Methodology; 3 Data curation; 4 Writing - Original Draft; 5 Writing - Review & Editing; 6 Funding acquisition.

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Not applicable.

Data availability
The datasets generated and/or analysed during the current study are not publicly available due [our experimental team's policy] but are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
The study was approved by the Biomedicine Ethics Committee of Jishou University before the initiation of the project (Grant number: JSDX−2024−0086). Informed consent was obtained from the participants and their guardians before the start of the program. We confirm that all the experiment is in accordance with the relevant guidelines and regulations such as the declaration of Helsinki.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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