Different Characteristics of Psychological and Sleep Symptoms Across Social Media Addiction and Internet Gaming Disorder in Chinese Adolescents- A Network Analysis

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Objective Previous research has explored a variety of mental disorders associated with Internet Gaming Disorder (IGD) and Social Media Addiction (SMA). To date, few studies focused on the network characteristics and investigated mood and sleep symptoms across SMA and IGD of adolescence at a group-specific level. This study aims to identify different characteristics of IGD and SMA and further determine the group-specific psychopathology process among adolescents.

Methods We conducted a cross-sectional study to recruit a cohort of 7,246 adolescents who were scored passing the cutoff point of Internet Gaming Disorder Scale-Short Form and Bergen Social Media Addiction Scale, as grouped in IGD and SMA, or otherwise into the control group. Patient Health Questionnaire-9, Generalized Anxiety Disorder 7-item, and Pittsburgh Sleep Quality Index were assessed for the current study, and all assessed items were investigated using network analysis.

Results Based on the analytical procedure, the participants were divided into three groups, the IGD group (n=789), SMA group (n=713) and control group (n=5,744). The edge weight bootstrapping analysis shows that different groups of networks reach certain accuracy, and the network structures of the three groups are statistically different ($p_{\text{control-IGD}}=0.004$, $p_{\text{control-SMA}}<0.001$, $p_{\text{IGD-SMA}}<0.001$). The core symptom of SMA is “feeling down, depressed, or hopeless”, while IGD is “feeling tired or having little energy”.

Conclusion Although IGD and SMA are both subtypes of internet addiction, the psychopathology processes of IGD and SMA are different. When dealing with IGD and SMA, different symptoms should be addressed.

Keywords Internet gaming disorder; Social media addiction; Sleep quality; Anxiety; Depression.

INTRODUCTION

Internet addiction (IA) is a broad concept discussed contentious.1 It is characterized by impaired control, an increased priority, and escalating activity for IA activities, including online gaming; use of social network services, such as chats; surfing sites providing pornographic material; participation in gambling; collecting as well as streaming videos or movies; excessive shopping; or aimless gathering or searching for information.2

Received: May 3, 2023 Revised: December 13, 2023 Accepted: May 15, 2024

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Internet Gaming Disorder (IGD), a subtype of IA, was included in the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5), which is defined as using internet games that must result in clinically significant impairment rather than engaging in sexual internet sites, online gambling, or any other kind of internet use. The prevalence of IGD varied across studies, ranging from 0.21%–57.50% in general populations. Among Chinese adolescents, the incidence of IGD is 17%. Social Media Addiction (SMA) is another subtype of IA. An increasing number of studies have suggested that SMA should be considered a behavioral addiction. According to a study by Bányai et al., the prevalence rate of SMA among adolescents is 4.5%.

IGD and SMA have been reported to be associated with various psychological problems. IGD had been linked to depression, social difficulties, and sleep abnormalities. In addition, multiple studies indicated that adolescents’ time spent on social media is associated with depression, decreased academic achievement, dissatisfaction with body image, risky behaviors, and disordered eating behaviors. IA stands for a broad concept and is widely accepted. It was supported by Montag et al. that generalized and specific IAs have different characteristics. Online gaming and social media use need to be viewed as separate concepts, which should not be combined into a unique category of generalized internet use. This study found that the correlation between specific types of IA and general IA (online video gaming, online shopping and online pornography) varies across cultures, with the exception of online social network, which showed the strongest association with general IA across all cultural contexts. Then the authors concluded that specific and generalized IA can be distinguished. Thus, it appears crucial to identify different characteristics of IGD and SMA among adolescents.

In clinical practice, the diagnosis of mental diseases largely depends on the disease classification and diagnosis system. Categorical approaches like DSM assume an underlying biological condition as the main cause of mental disorders in which all symptoms within a category have the same diagnostic weight. From the perspective of network approaches, disorders are conceptualized as systems of causally connected symptoms rather than as effects of an assumed underlying biological condition. In recent years, the application of network analysis in psychiatry has received extensive attention. Psychological networks consist of nodes representing observed variables, connected by edges representing statistical relationships. Network analysis may help identify informative or key symptoms associated with the clinical status or the prognosis of patients rather than relying on global scores from scales or categorical diagnoses.

Although previous studies have found many psychological problems related to IGD and SMA, several studies have also applied network analysis to identify core symptoms and symptom relationships of IA (i.e., less sleep, feeling depressed, loss of control). However, few studies have discussed the core symptoms and the connection between symptoms of IGD and SMA in contrast to those without IGD and SMA, i.e., those in a control group.

Network analysis was conducted in the present study to determine the group-specific psychopathology process further. Using Internet Gaming Disorder Scale-Short Form (IGDS9-SF), Bergen Social Media Addiction Scale (BSMAS), Patient Health Questionnaire-9 (PHQ-9), Generalized Anxiety Disorder 7-item (GAD-7), and Pittsburgh Sleep Quality Index (PSQI), our study focused on the core symptoms of IGD and SMA and the differences between them.

**METHODS**

**Participants**

The current research adopted a cross-sectional design, which comprised a sample of adolescents. All validated participants (n=7,246; mean age [standard deviation]=17.98 [1.03]) in Luzhou, Sichuan province, China, from October to December in 2020.

The study was approved by the ethics committee of the affiliated hospital of southwest medical university (SWMU-FY-220), and all recruits provided written consent before they answered the questionnaires. Participants were firstly asked to complete a checklist of demographic information (including age, sex, myopia, only-child, twins, left behind, and residence), subsequently applying the IGDS9-SF and BSMAS to identify students whether they addicted and grouped. By using three scales (PHQ-9, GAD-7, and PSQI) to assess the mood and sleep problems. Based on the permission and support of local educational government, the data was collected through online psychological assessments. Invalidated responses were excluded due to providing incomplete data, then responses from a total of 7,246 participants were included in further analysis, and which valid rate of response finally was up to 98.4 %.

**Assessment of IGD and social media addiction**

**IGDS9-SF**

IGDS9-SF was used in the present study to assess IGD in adolescents. IGDS9-SF contains 9 items, with each scored from 1 (never) to 5 (very often). The higher the score, the higher degree of problematic gaming use.
BSMAS
To assess social media addiction in adolescents, BSMAS was used. Which was developed by Schou Andreassen et al.\(^{24}\) and contains 6 items scored from 1 (very rarely) to 5 (very often). The higher the score, the greater the risk of social media addiction.

Assessment of mood and sleep problems

PHQ-9
To assess depressive symptoms in adolescents, a 9-item PHQ-9 scale was used.\(^{25}\) Each item on the scale is scored with four points from 0 (not at all) to 3 (nearly every day). The higher the score, the more serious the symptoms are.

GAD-7
To assess anxiety symptoms in adolescents, a 7-item GAD-7 scale was used in this study.\(^{26}\) Each item on the scale is scored with four points from 0 (not at all) to 3 (nearly every day), with higher scores indicating more severe symptoms.

PSQI
To assess sleep quality in adolescents, a 19-item PSQI scale was used in this study. It consists of seven sleep components: subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction, which were calculated according to a previous study.\(^{27}\) Each scale component is scored with four points from 0 to 3, yielding total scores ranging from 0 to 21.

Analytical procedure
This study’s cutoff thresholds of IGDS9-SF and BSMAS refer to previous studies.\(^{28,29}\) Participants were divided into three groups, IGD group (score of IGDS9-SF ≥21 and BSMAS <9), SMA group (score of BSMAS ≥19 and IGDS9-SF <21), and the control group (score of BSMAS <19 and IGDS9-SF <21). Based on the purpose of this study to compare the psychological characteristics of two different behavioral addictions, 258 participants who showed IGDS9-SF ≥21 and BSMAS ≥19 were excluded in the follow-up analysis. The characteristics of the three groups are described in Table 1. The scores of PHQ-9, GAD-7, and PSQI scales in the three groups were analyzed by t-test.

The network analysis conducted on the three groups involved the utilization of R software (version 4.2.2; https://www.r-project.org/), and the methodology closely followed previously established approaches as outlined in studies.\(^{30-33}\) Each node within the network represents a specific symptom, and the edges connecting these nodes signify the relationships between the symptoms.\(^{33}\) To evaluate the associations among

| Table 1. Sample characteristics of the IGD group and SMA group (N=7,246) |
|-----------------|-----------------|-----------------|
|                | IGD group (N=789) | SMA group (N=713) | Control group (N=5,744) |
| Age (yr)       | 18.0±1.2         | 16.6±1.7         | 18.0±1.0               |
| Sex            |                  |                  |                        |
| Male           | 292 (37.0)       | 122 (17.1)       | 1,024 (17.8)           |
| Female         | 497 (63.0)       | 591 (82.9)       | 4,720 (82.2)           |
| Only-child     |                  |                  |                        |
| No             | 690 (87.5)       | 604 (84.7)       | 5,104 (88.9)           |
| Yes            | 99 (12.5)        | 109 (15.3)       | 640 (11.1)             |
| Twins          |                  |                  |                        |
| No             | 706 (89.5)       | 681 (95.5)       | 5,321 (92.6)           |
| Yes            | 83 (10.5)        | 32 (4.5)         | 423 (7.4)              |
| Left behind    |                  |                  |                        |
| No             | 585 (74.1)       | 477 (66.9)       | 5,321 (92.6)           |
| Yes            | 204 (25.9)       | 236 (33.1)       | 423 (7.4)              |
| Residence      |                  |                  |                        |
| City           | 186 (23.6)       | 248 (34.8)       | 1,102 (19.2)           |
| Rural          | 232 (29.4)       | 213 (29.9)       | 1,870 (32.6)           |
| Village        | 371 (47.0)       | 252 (35.3)       | 2,772 (48.3)           |

Values are presented as mean±standard deviation or number (%). IGD, Internet Gaming Addiction; SMA, Social Media Addiction

IGD, SMA, depression, anxiety, and sleep quality within the network, a sophisticated approach was adopted. Specifically, a sparse Graphical Gaussian Model was employed, which is a statistical model capturing the conditional independence relationships between variables. This model was augmented with the graphical Least Absolute Shrinkage and Selection Operator (LASSO) method, a regularization technique that aids in estimating a sparse network by selecting the most relevant connections while setting others to zero. The detailed implementation of this combined methodology is outlined in the present study.\(^{34}\) In order to characterize the overall structure of the network, various centrality measures were computed. These included betweenness, indicating the degree of connectivity and the frequency with which a symptom acts as a bridge between other symptoms; closeness, representing the distance centrality and measuring how easily information can flow from one symptom to all others; and strength, reflecting the degree centrality and indicating the number of direct connections a symptom has with others within the network. The computation of these centrality measures provides insights into the importance and influence of specific symptoms within the broader network structure.\(^{30,35}\)
Table 2. Mood and sleep characteristics in adolescents with IGD and SMA (N=7,246)

<table>
<thead>
<tr>
<th></th>
<th>IGD group (N=789)</th>
<th>SMA group (N=713)</th>
<th>Control group (N=5,744)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHQ-9</td>
<td>9.62±4.780*</td>
<td>10.56±5.081*</td>
<td>5.70±4.129</td>
</tr>
<tr>
<td>GAD-7</td>
<td>7.36±3.783*</td>
<td>8.67±4.351*</td>
<td>4.44±3.319</td>
</tr>
<tr>
<td>PSQI</td>
<td>8.39±2.872*</td>
<td>8.42±2.848*</td>
<td>6.72±2.709</td>
</tr>
</tbody>
</table>

Values are presented as mean±standard deviation. *p<0.001, compared with the control group. IGD, Internet Gaming Addiction; SMA, Social Media Addiction; PHQ-9, Patient Health Questionnaire-9; GAD-7, Generalized Anxiety Disorder 7-item; PSQI, Pittsburgh Sleep Quality Index

RESULTS

Demographic characterization of adolescents with IGD and SMA

We show the descriptive statistics and groups comparison for the study variables in Table 1. The current study includes 7,246 individuals divided into three groups (IGD, SMA, and control) based on the cutoff thresholds of IGDS9-SF and BSMAS. In the IGD group (n=789), 37.0% are male, with a mean age of 18.0. Meanwhile, non-only child and non-left behind children are 87.5% and 74.1%, respectively. In the SMA group (n=713), the mean age is 16.6, including 82.9% of females. Most individuals in the SMA group are not only-child (84.7%), not left-behind (66.9%). The control group consisted of 5,744 participants, with a mean age of 18.0, including 82.2% females. Most individuals in the control group are not only-child (88.9%), not left-behind (92.6%). The proportion residing in villages is 47.0%, 35.3%, and 48.3% for the IGD, SMA, and control groups, respectively.

Adolescents with IGD and SMA show significant anxiety, depression and sleep disorders

As shown in Table 2, compared with the control group, the scores of PHQ-9, GAD-7, and PSQI of adolescents with IGD and SMA were significantly higher (p<0.001) and indicated that adolescents with IGD and SMA have more severe mood and sleep problems.

Adolescents with IGD and SMA show different network structure

The total number of edges is 703 in the three networks. The number of non-zero edges was 171, 212, and 349 in the SMA, IGD, and control groups, respectively. As shown in Figure 1, although the overall structure is similar, nodes’ connection mode and the edges’ strength are different among the three networks.

In the SMA group, the strength of PHQ2 "feeling down, depressed, or hopeless" is highest (Figure 2). PHQ3, "trouble falling or staying asleep or sleeping too much," displays the highest value of closeness and betweenness (Figure 2). In the IGD group, values of strength and closeness of PHQ4 “feeling tired or having little energy” are higher than other symptoms, PSQI7 “daytime dysfunction” shows the highest value of betweenness (Figure 2). In the control group, the values of all three centrality indexes of PSQI7 “daytime dysfunction” are highest (Figure 2), which indicated that “daytime dysfunction” not only had a significant and rapid effect on other symptoms but also was highly correlated with the entire symptom network.

Network accuracy and stability

The result of edge weight bootstrapping (Supplementary Figure 1 in the online-only Data Supplement) shows that different groups of networks have certain accuracy. The centrality stability coefficient (Figure 3) shows that the centrality index of the SMA group was 0.75 (strength), 0.75 (closeness), and 0.05 (betweenness). The IGD group was 0.67 (strength), 0.13 (closeness), and 0.05 (betweenness). The control groups were 0.75 (strength), 0.75 (closeness), and 0.36 (betweenness). The results of the poor node centrality test are shown in Supplementary Figure 2 (in the online-only Data Supplement).

Network comparison

The network differences among the three groups were compared. Global differences were found between networks among the three groups (pcontrol-IGD=0.004, pcontrol-SMA<0.001, pIGD-SMA<0.001), which indicated that the network structure of the three groups is different.

The overall intensity invariance test showed that the intensity of the anxiety-depression-addiction-sleep disorder network was significantly different in three groups (control group=16.06, IGD group=12.76, SMA group=12.03, pcontrol-IGD<0.01, pcontrol-SMA<0.01, pIGD-SMA=0.159).

Compared with the control group, the IGD group showed a statistically significant difference in edge GAD6-IGD2 (p=0.013), PHQ6-IGD4 (p=0.013), PHQ4-IGD5 (p=0.024), and PHQ4-IGD2 (p=0.042) of the anxiety-depression-addiction-sleep disorder symptoms network (Supplementary Table 1 in the online-only Data Supplement). Compared with the control group, the SMA group showed a statistically significant difference in edge SMA2-PSQI2 (p=0.001) and edge SMA5-PSQI5 (p=0.030) of the anxiety-depression-addiction-sleep disorder symptoms network (Supplementary Table 2 in the online-only Data Supplement). The networks of the symptoms in the IGD group and SMA group were compared, and it found the influential edges in IGD were GAD1 (p=0.022), GAD2 (p<0.001), GAD5 (p=0.018), GAD6 (p<0.001), PHQ3 (p=0.006), and PHQ4 (p=0.007), while in SMA were GAD7
Figure 1. Networks of anxiety-depression-addiction-sleep disorder symptoms in SMA group (N=713) (A), IGD group (N=789) (B), and control group (N=5,744) (C). Nodes represent anxiety-depression-addiction-sleep disorder symptoms, and edges represent partial correlations between symptoms. Edge thickness indicates the strength of the partial correlations (minimum and maximum edge values are set to be equal across networks), and edge color indicates the correlation valence (blue=positive; red=negative). Symptoms in the same symptom clusters are shown in the same color (orange=GAD; sky-blue=IGD; green=PHQ; yellow=PSQI; purple=SMA). See Supplementary Table 4 for detailed descriptions of anxiety-depression-addiction-sleep disorder items. PHQ1–9 refers to the items of PHQ-9, GAD1–7 refers to the items of GAD-7, IGD1–9 refers to the items of IGDS9-SF, SMA1–6 refers to the items of BSMAS, and PSQI1–7 refers to the seven factor score in scale. PHQ-9, Patient Health Questionnaire-9; GAD-7, Generalized Anxiety Disorder 7-item; IGDS9-SF, Internet Gaming Disorder Scale-Short Form; BSMAS, Bergen Social Media Addiction Scale; IGD, Internet Gaming Addiction; SMA, Social Media Addiction.
DISCUSSION

The preceding research has illuminated various mental health statuses and interpersonal relationships associated with IGD and SMA. Numerous studies have underscored the correlation between IA and various mental disorders, including major depressive disorder, anxiety, and sleep abnormalities. As depicted in Table 2, the scores of PHQ-9, GAD-7, and PSQI in both IGD and SMA groups significantly surpass those in the control group, aligning with existing evidence that teenagers in IGD and SMA groups indeed grapple with more severe mood and sleep problems.

Core symptoms of SMA, IGD, and control group

Utilizing network analysis, the core symptoms of IA were found to vary between subtypes (SMA and IGD). In the SMA group, “feeling down, depressed, or hopeless” (PHQ2) emerged as a central symptom, consistent with previous findings highlighting depression as a pivotal symptom triggering other problems, including sleep and mental health. Additionally, “Trouble falling or staying asleep or sleeping too much” (PHQ3) not only exhibited the strongest transmission between symptoms but also acted as a bridge symptom in the overall network. This finding correlates with reports indicating a strong association between social media use and depression.
In sum, expanding the analysis to the item-level network, a significant body of evidence links sleep disorders in young adults to computer and internet use, with increased internet use associated with shorter sleep duration, delayed bedtimes, longer sleep latencies, and increased daytime tiredness in adolescents. Therefore, further investigation is crucial to understanding how to mitigate the adverse effects of internet use on adolescents’ mental health and sleep quality.

In contrast, online gaming, often involving collaboration with strangers, may impact sleep patterns differently. While expressing inner feelings might be challenging in a gaming platform, social media platforms offer ease in emotional expression, possibly contributing to heightened feelings of depression in SMA.

**Differences in networks across SMA, IGD, and control group**

The study highlighted mood and sleep characteristics in adolescents with IGD and SMA, indicating that adolescents with these conditions experience higher levels of depression, anxiety, and sleep problems compared to the control group. Interestingly, the SMA group exhibited higher scores in PHQ-9, GAD-7, and PSQI than the IGD group, suggesting a higher prevalence of depression, anxiety, and sleep disorders in adolescents with social media addiction.

Examining the edge-level network, the SMA group exhibited a significant disparity compared to the control group, particularly in the edge connecting “feeling the urge to use social media more and more” (SMA2) to “sleep latency” (PSQI2), as indicated in Supplementary Table 3 (in the online-only Data Supplement). Sleep latency refers to “how long it usually takes you to fall asleep each night, and the reply cannot get to sleep within 30 minutes.”

**Figure 3. Centrality stability for anxiety-depression-addiction-sleep disorder symptoms network in SMA group (A), IGD group (B), and control group (C).** The x-axis illustrates the sample decrease from 95% to 25% of the original sample. The y-axis depicts the changes in correlation estimates between the subsample and the original sample. Lines indicate the means, and areas indicate the range from the 2.5th quantile to the 97.5th quantile. SMA, Social Media Addiction; IGD, Internet Gaming Addiction.
ing social media” (SMA5) to “sleep disturbances” (PSQI5) underscored the pivotal role of social media restrictions in contributing to subjective physical problems related to sleep. Previous research supported the positive relationship between SMA severity and sleep disturbances, linking it to circadian clock phase delays and subsequent cognitive and emotional consequences.54

Comparatively, specific edges between IGD and the control group revealed interconnections in Supplementary Table 2 (in the online-only Data Supplement). For instance, the edge linking “feeling more irritable, anxiety, or even sadness when you try to either reduce or stop your gaming activity” (IGD2) to “becoming easily annoyed or irritable” (GAD6), “systematically failing when trying to control or cease your gaming activity” (IGD4) to “feeling bad about yourself or that you are a failure or have let yourself or your family down” (PHQ6), and the edge connecting “have you lost interests in previous hobbies and other entertainment activities as a result of your engagement with the game” (IGD5) to “feeling tired or having little energy” (PHQ4) highlighted the intricate relationship between gaming-related behaviors and mood symptoms. Echoing previous research, the escape from real-world worries and difficulties into online gaming could lead to heightened negative emotions, such as anxiety, anger, and sadness, ultimately culminating in depression.50,56

The distinct cognitive reappraisal and expressive suppression patterns observed in individuals with IGD may contribute to the potential development or exacerbation of depression.56

Despite both IGD and SMA being associated with mood and sleep problems, adolescents with IGD exhibited greater interrelatedness to anxiety, nervousness, worrying, and irritability, as reflected in items such as “feeling nervous, anxious, or on edge” (GAD1), “not being able to stop or control worrying” (GAD2), “being so restless that it is hard to sit still” (GAD5), and “becoming easily annoyed or irritable” (GAD6). Concurrently, depression-related symptoms in IGD comprised “trouble falling or staying asleep, or sleeping too much” (PHQ3) and “feeling tired or having little energy” (PHQ4). Combined with the core symptom of IGD, namely “daytime dysfunction,” the mental and sleep mechanisms in adolescents with IGD predominantly revolved around anxiety leading to poor sleep.40 Conversely, adolescents with SMA were more prone to exhibit emotional states such as “feeling afraid, as if something awful might happen” (GAD7) and “trouble concentrating on things, such as reading the newspaper or watching television” (PHQ7) during social media use. In SMA, the core symptoms involving psychological and sleep aspects were encapsulated in “feeling down, depressed, or hopeless,” which was intricately linked to “sleep latency and sleep disturbances.”

In essence, the associations between IGD/SMA and sleep appear to be driven by different factors. For SMA, the associations primarily revolve around depression and sleep, whereas IGD is characterized by associations with anxiety and sleep. This finding suggests that SMA and IGD may have different psychopathological mechanisms. Furthermore, the distinctive nature of sleep disorders between these two conditions emphasizes the need for tailored interventions targeting specific mood and sleep problems associated with different subtypes of IA in adolescents.

**Limitations and future directions**

While this study offers valuable insights into the nuanced connections between IA subtypes and mood and sleep symptoms, certain limitations must be acknowledged. The cross-sectional and group-level nature of the data poses challenges in establishing causal relationships among variables, necessitating future longitudinal and intraindividual network analyses. The relatively small sample sizes for IGD and SMA, along with a non-clinical cohort, may limit the generalizability of findings. The reliance on self-report instruments introduces the potential for social desirability and recall biases. Moreover, the study’s cross-sectional design precludes making causal inferences. Therefore, longitudinal intraindividual network analyses, such as dynamic networks,57 should be conducted on the research of core symptoms of IGD and SMA and the differences between them to further explore the interactions of which.

**Conclusion**

This pioneering study explored mood and sleep symptoms across SMA and IGD in adolescence, offering significant insights into symptomatology changes across these conditions. The core symptoms differ in SMA and IGD, offering critical insights for tailored clinical interventions. Targeting the symptom of depression characterized by “feeling down, depressed, or hopeless” may prove to be the most effective approach in preventing the onset, progression, and persistence of substance misuse and abuse during adolescence. Considering the treatment of IGD, the symptom “feeling tired or having little energy” should be the primary target. Moreover, recognizing the distinct sleep characteristics between IGD and SMA provides a foundation for developing targeted interventions for diverse mood and sleep problems associated with different IA subtypes in adolescents.

**Supplementary Materials**

The online-only Data Supplement is available with this article at https://doi.org/10.30773/pi.2023.0103.

**Availability of Data and Material**

The datasets generated or analyzed during the study are available from
the corresponding author on reasonable request.

Conflicts of Interest
The authors have no potential conflicts of interest to disclose.

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Funding Statement
This study was supported in part by a grant from National Natural Science Foundation of China (82001414, BX), Sichuan Provincial Department of Science and Technology (2023NSFSC0124, and 2022YFS0615), Luzhou Science and Technology Bureau-Southwest Medical University (2021LZXNYD-D04), Luzhou Science and Technology Bureau (2022-SYF-96, 2022-ZRK-186), Ziqong Science and Technology Bureau (2021YXY03, 2022ZCNKYO2), High quality development project of Zigong City Hospital (ZG-KY-2023-047, ZG-PT-2023-026), Youth Project of Southwest Medical University (2021ZKQN064), Youth Project of Affiliated Hospital of Southwest Medical University (2017-9, 2011 [37] and 16009) and Central Nervous System Drug Key Laboratory of Sichuan Province (20029015Z).

Acknowledgments
None

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