

Anxiety symptoms and suicidal ideation in adolescents with major depressive disorder and bipolar disorder: the mediating effect of internet addiction

yu zhuang

Chaohu Hospital of Anhui Medical University

yinghan tian

Chaohu Hospital of Anhui Medical University

yuanbo liu

Bozhou People's Hospital

xianlin sun

Chaohu Hospital of Anhui Medical University

lewei liu

Chaohu Hospital of Anhui Medical University

na wang

Chaohu Hospital of Anhui Medical University

yuhang li

Anhui Medical University

jie cheng

Anhui Medical University

runcheng zhang

Anhui Medical University

lei xia

Chaohu Hospital of Anhui Medical University

huanzhong liu

huanzhongliu@ahmu.edu.cn

Chaohu Hospital of Anhui Medical University

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Abstract

Background

Major depressive disorder (MDD) and bipolar disorder (BD) in adolescents are associated with substantial suicide risk. Anxiety symptoms together with internet addiction (IA) represent key contributing factors to suicide risk. This research examined differences in suicidal ideation (SI) between adolescents with MDD and those with BD, and whether IA mediated the anxiety-SI link differently between groups.

Methods

A total of 192 adolescents with MDD and 120 adolescents with BD were enrolled in this cross-sectional study. Participants' SI, IA, and anxiety symptoms were assessed using the Positive and Negative Suicide Ideation Inventory (PANSI), the Young's Internet Addiction Test (YIAT), and the anxiety-somatization factor score (anxiety factor) of the 24-item Hamilton Depression Rating Scale (HAMD-24). Manic symptoms were evaluated with the Young Mania Rating Scale (YMRS).

Results

BD patients had significantly higher scores on the PANSI, YIAT, HAMD-24 total score, and anxiety factor (all $P < 0.05$). Anxiety, IA, and SI were positively correlated in both groups (all $P < 0.05$). Mediation analyses indicated that IA partially mediated the anxiety-SI relationship in the BD group (indirect effect: $B = 0.662$, 95% CI = 0.135 to 1.404), explaining 14% of the total effect. No significant mediating effect was found in the MDD group (indirect effect: $B = 0.158$, 95% CI = -0.109 to 0.511).

Conclusion

Relative to their MDD counterparts, adolescents with BD demonstrate greater severity of SI, IA, and anxiety symptoms. In BD patients alone, IA functions as a partial mediator of the anxiety-SI link, implying that clinical efforts aimed at reducing suicide risk should target both anxiety symptoms and IA in this population.

Highlights

1. Suicidal ideation, internet addiction, and anxiety are more severe in bipolar disorder (BD) than major depressive disorder (MDD).
2. Anxiety and internet addiction positively correlate with suicidal ideation in both MDD and BD.

3. Internet addiction mediates anxiety and suicidal ideation in BD, but not in MDD.

4. Targeting anxiety and internet addiction may reduce suicide risk in BD adolescents.

1. Introduction

In adolescence, major depressive disorder (MDD) represents a frequent mental disorder whose core features include depressed mood and anhedonia, resulting in significant functional impairment. According to statistical data, the global rate of MDD among adolescents is around 3.7%, whereas in China, the corresponding rate for those aged 6 to 16 years is 2.0% [1, 2]. Bipolar disorder (BD) constitutes a severe psychiatric condition characterized by repeated swings between depression and mania/hypomania, usually emerging during late adolescence or early adulthood. Data derived from the 2019 Global Burden of Disease Study (GBD) showed BD prevalence estimates for individuals aged 15 to 19 years and 20 to 24 years were 0.58% and 0.72%, respectively [1]. Within China, the prevalence of BD among school-aged children and adolescents aged 6 to 16 years reached 0.86% [3]. Both MDD and BD profoundly impair the academic and social functioning of adolescents, while also substantially elevating their suicide risk [1, 4]. Given these substantial impacts, a precise grasp of the epidemiological features and disease burden associated with adolescent MDD and BD is critical to developing effective intervention and prevention measures targeting mental disorders.

Worldwide, suicide ranks among the most critical mental health concerns and stands as a primary cause of mortality. According to the World Health Organization (WHO), around 700,000 individuals worldwide die from suicide each year, which constitutes about 1.4% of total deaths [5, 6]. Among adolescents, suicide is the second leading cause of death globally [7]. Unlike earlier perspectives that regarded suicide as an isolated occurrence, it is now understood as a continuum that starts with suicidal ideation (SI), moves on to suicide attempts, and eventually ends in suicide death. Hence, early detection of SI and prompt intervention are critically important for the prevention of suicidal behavior [8]. Epidemiological evidence shows that the suicide attempt rates among people with MDD are markedly elevated relative to their healthy counterparts of comparable age [9–11], and the two-week prevalence of SI among Chinese adolescents diagnosed with MDD was 42.1% [12]. Furthermore, the suicide risk among individuals with BD is generally considered higher than that in MDD [13–15]. Nevertheless, whether the fundamental mechanisms of SI differ between people with MDD and BD remains unknown, a gap that impedes progress in both preventive efforts and clinical care.

Furthermore, anxiety symptoms are a common yet often overlooked clinical feature among adolescents with MDD and BD [16]. Based on the GBD study in 2021, the absolute number of anxiety disorders in China has increased substantially from 1990 to 2021, indicating a rising burden over the past three decades [17]. A meta-analysis focusing on Chinese adolescents revealed a positive association between anxiety and later suicide risk [18]. Ayvaci and colleagues observed that, among adolescents diagnosed with MDD, the prevalence of anxious depression reached 59.5%, accompanied by generally elevated suicide risk [19]. Sanches et al. noted that, in patients with mood disorders, those exhibiting co-occurring

anxiety symptoms face a markedly elevated suicide risk compared to those without anxiety [20]. According to relevant reviews, anxiety disorders are frequently comorbid among adolescents with BD and substantially raise suicide risk [21–23]. This may be attributed to anxiety-induced avoidance behaviors leading to reduced quality of life, impaired social functioning, and social isolation in adolescents, which in turn contributes to suicidal behavior. Concurrently, dysregulation of the corticotropin-releasing factor (CRF) system and reduced levels of 5-hydroxyindoleacetic acid (5-HIAA) in cerebrospinal fluid also contribute significantly to the link between anxiety and SI [18]. Although some investigations have confirmed a connection between anxiety symptoms and SI, the precise mechanisms that link these two phenomena still require additional exploration.

IA might act as a mediator in the link connecting anxiety symptoms and SI. In recent years, IA has garnered widespread attention from all sectors of society as an increasingly common behavioral problem among adolescents. Statistical data show that the prevalence of IA among adolescents falls between roughly 12.8% and 23.7% [24, 25], whereas among those suffering from MDD, figures may reach up to 46.8% [26]. Additionally, studies have found that approximately 30.9% of IA patients across all age groups have comorbid BD, and adolescents with IA are 3.05 times more likely to exhibit BD symptoms than their peers and exhibit significantly elevated levels of SI [27, 28]. A network analysis conducted by Ma and colleagues revealed that, in adolescents, IA is chiefly and directly linked to anxiety symptoms rather than depressive symptoms [29]. Tan and colleagues additionally observed that IA serves as a mediator of the connection between social anxiety and SI among Chinese college students [30]. These observations imply that the presence of anxiety symptoms could indirectly elevate SI risk through the induction or worsening of IA. However, current research examining this mechanism in adolescents with MDD and BD remains insufficient.

Accordingly, this research was conducted with three objectives: (1) to compare how the degree of SI differs between adolescents diagnosed with MDD and those with BD, (2) to explore the associations linking SI with both anxiety symptoms and IA, and (3) to assess, separately for adolescents with MDD and those with BD, whether IA has a mediating effect on the connection from anxiety to SI.

2. Methods

2.1. Study design and participants

The Fourth Affiliated Hospital of Anhui Medical University served as the site for this cross-sectional study, which took place between April 2024 and April 2026. Eligible participants were required to satisfy the following inclusion criteria: (1) age ranging from 12 to 18 years. (2) a diagnosis of either MDD or BD, made by two senior psychiatrists via a structured clinical interview based on the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5). (3) the ability to comprehend and complete the assessments. Individuals with other mental disorders, intellectual disabilities, neurological diseases, or severe physical illnesses (e.g., severe infections, cancer, and thyroid dysfunction) were excluded. The study protocol received approval from the Medical Ethics Committee of the Fourth Affiliated Hospital of

Anhui Medical University (Approval No: KYSM-202410-029). After fully understanding the purpose and content of the study, all participants and their legal guardians signed informed consent forms. Every procedure in the study strictly followed the principles set forth in the Declaration of Helsinki.

2.2. Measures

2.2.1. Socio-demographic Characteristics

A pre-designed questionnaire served to gather socio-demographic and clinical information, encompassing age (years), gender (“male” or “female”), age at illness onset (years), illness length (months), only-child status (reported as “yes” or “no” when asked “Are you the only child in your family?”), parental marital status (normal, separated, divorced, or other), academic performance (good, fair, or poor), family relationships (good, fair, or poor), and perceived family economic standing (good, moderate, or poor).

2.2.2. Assessment of SI severity

To evaluate SI severity, the Positive and Negative Suicide Ideation Inventory (PANSI) was employed, a 14-item measure that includes 6 positive SI items and 8 negative SI items [31]. Each item is scored on a 5-point scale ranging from 1 (never) to 5 (always), with a higher aggregate score reflecting more severe SI. Previous investigations have shown that the Chinese adaptation of the PANSI represents a reliable and valid instrument for assessing SI severity among adolescents, and its use has been widespread [32, 33]. Within the present study’s sample, Cronbach’s alpha values for the PANSI were 0.861 and 0.842, in the MDD group and the BD group, respectively.

2.2.3. Assessment of IA symptoms

The Young’s Internet Addiction Test (YIAT) was adopted in this study for the assessment of IA symptoms [34]. This instrument comprises 20 items, each of which is rated on a 5-point scale from 1 (rarely) to 5 (always). Prior research has established that the Chinese adaptation of the YIAT possesses satisfactory reliability and validity when used with Chinese adolescents [35]. In the present sample, Cronbach’s alpha coefficients for the YIAT equaled 0.900 for MDD patients and 0.923 for BD patients.

2.2.4. Assessment of depressive and anxiety symptoms

The 24-item Hamilton Depression Rating Scale (HAMD-24) served as the instrument for evaluating patients’ depressive symptoms. This scale was originally proposed by Hamilton [36]. Based on the factor structure of Cleary and Guy, the “anxiety-somatization factor” (henceforth “anxiety factor”) was extracted and calculated [37]. The anxiety factor of the HAMD-24 includes psychic anxiety, somatic anxiety, gastrointestinal symptoms, general somatic symptoms, hypochondriasis, and impaired insight, and serves as a measure of patients’ anxiety symptoms [38]. Currently, the Chinese adaptation of the HAMD-24 is extensively employed among individuals with depression in China [39, 40]. In the present study, Cronbach’s alpha values for the HAMD-24 were 0.730 for those with MDD and 0.777 for those with BD.

2.2.5. Assessment of manic symptoms

The Young Mania Rating Scale (YMRS) served as the instrument for evaluating patients' manic symptoms. This scale was originally proposed by Young et al. [41]. It comprises 11 items, each rated on a 0 to 4 scale, with four items (irritability, speech, thought content, and disruptive/aggressive behavior) rated on a 0 to 8 scale, yielding a total score from 0 to 60, where higher scores indicate more severe manic symptoms. The Chinese version of the YMRS has been widely used in China among patients with BD [42]. The YMRS was administered only to patients with BD, as manic symptoms are not expected in MDD. In the present sample, Cronbach's alpha value for the YMRS was 0.887 for those with BD.

2.3. Statistical analysis

SPSS version 23.0 was used to conduct the statistical analysis. Continuous variables are presented as mean $\pm$ standard deviation (SD), and normality was evaluated with the Kolmogorov-Smirnov test. To compare sociodemographic characteristics and clinical data between the MDD and BD groups, chi-square test and Mann-Whitney U test were applied. Following adjustment for demographic and clinical variables that differed significantly between the two groups, analysis of covariance (ANCOVA) was performed to compare SI levels across the MDD and BD groups. t-test, Mann-Whitney U test, Kruskal-Wallis H test, and Spearman's correlation analysis served to explore the relationships between SI severity in each diagnostic group (MDD and BD) and demographic variables, IA levels, depression severity, and anxiety symptoms. To control for multicollinearity between the HAMD total score and the anxiety factor score, and to eliminate the influence of overall depression severity on anxiety symptoms, this study employed the regression residual method to obtain a corrected anxiety indicator (anxiety factor score-revised) [43–45]. Subsequently, a multiple linear regression model was used to examine variables that showed significant correlations ($P < 0.05$) in the univariate analysis and correlation analysis. Mediating effects were tested using the SPSS macro PROCESS (Model 4) [46]. A nonparametric bootstrapping procedure with 5,000 resamples was employed to evaluate indirect effects. An indirect effect was deemed significant if its 95% confidence interval (CI) did not contain zero. The threshold for statistical significance was established at a two-sided α of 0.05.

3. Results

3.1. Sociodemographic and clinical characteristics

According to Table 1, 330 adolescents diagnosed with MDD or BD were initially enrolled; of these, 312 finished the assessment and were entered into the statistical analysis, yielding a response rate of 94.5%. With respect to sociodemographic features, the percentage of patients reporting "good" academic performance was greater in the MDD group (40.1%) relative to the BD group (33.3%), whereas the percentage reporting "poor" academic performance was higher in the BD group (26.7%) compared to the MDD group (14.6%) (all $P < 0.05$). Concerning clinical features, the share of first-episode cases in the MDD group (59.4%) was markedly greater than that observed in the BD group (46.7%). Relative to the MDD group, the BD group showed substantially elevated scores on the PANSI total, IA total, HAMD total, and the anxiety factor (all $P < 0.05$). ANCOVA revealed that, after controlling for first-episode status,

academic performance, IA level, depression, and anxiety, the SI level between the two groups was marginally statistically significant ($F = 3.885$, $P = 0.050$). Moreover, the YIAT total score ($F = 12.610$, $P < 0.001$), the HAMD-24 total score ($F = 112.097$, $P < 0.001$), and the anxiety factor score ($F = 10.296$, $P = 0.001$) each emerged as independent correlates of SI, while academic performance ($P = 0.978$) and first-episode status ($P = 0.822$) failed to reach statistical significance.

Table 1
Socio-demographic and clinical characteristics.

Variables	MDD (n = 192) N (%)	BD (n = 120) N (%)	Statistics	
			χ^2	P
Sex			2.899	0.089
Male	69 (35.9)	32 (26.7)		
Female	123 (64.1)	88 (73.3)		
One-child families			2.438	0.118
Yes	81 (42.2)	40 (33.3)		
No	111 (57.8)	80 (66.7)		
First episode			4.809	0.028
Yes	114 (59.4)	56 (46.7)		
No	78 (40.6)	64 (53.3)		
Academic performance			6.991	0.030
Good	77 (40.1)	40 (33.3)		
Fair	87 (45.3)	48 (40.0)		
Poor	28 (14.6)	32 (26.7)		
Family relationships			0.533	0.766
Good	51 (26.6)	28 (23.3)		
Fair	116 (60.4)	74 (61.7)		
Poor	25 (13.0)	18 (15.0)		
	Median (IQR)	Median (IQR)	Z ^a	P
Age (years)	15 (14–17)	15 (14–16)	−0.919	0.358
BMI (kg/m ²)	21.09 (18.51–23.06)	21.43 (18.39–24.92)	−1.489	0.137
Age at onset (years)	14 (12–15)	13 (12–15)	−1.410	0.158
Duration of illness (months)	18 (7–30)	24 (10–36)	−1.018	0.309
YMRS total score	-	16(9.5–22)	-	-
PANSI total score	47 (39–54)	51.5 (43–58)	−3.018	0.003

Variables	MDD	BD	Statistics	
	(n = 192)	(n = 120)	χ^2	<i>P</i>
	<i>N</i> (%)	<i>N</i> (%)		
YIAT total score	51 (42–62)	56.5 (47–69)	-2.566	0.010
HAMD-24 total score	27 (23–31)	29 (23–34)	-2.247	0.025
Anxiety factor score	6 (5–8)	7 (6–9)	-2.173	0.030
MDD, Major Depressive Disorder; BD, Bipolar Disorder; BMI, Body Mass Index; YMRS, Young Mania Rating Scale; PANSI, Positive and Negative Suicide Ideation Inventory; YIAT, Young's Internet Addiction Test; HAMD-24, 24-item Hamilton Depression Rating Scale; ^a Mann-Whitney U test; IQR, Interquartile Range (i.e., first and third quartiles); Bolded <i>P</i> value < 0.05.				

3.2. Analysis of factors associated with the severity of SI

According to Tables 2 and 3, within the MDD group, the PANSI total score correlated significantly with gender ($Z = -2.336$, $P = 0.020$), indicating that female patients had higher SI levels than males. It was also negatively correlated with age and age at onset, and positively correlated with illness duration and family relationships (all $P < 0.05$), implying that worse family relationships were associated with more severe SI. Furthermore, the PANSI total score was positively correlated with YIAT total scores, HAMD total scores, and anxiety factor scores (all $P < 0.05$). Among BD patients, the PANSI total score was also higher in female patients ($Z = -3.094$, $P = 0.002$), and showed a positive correlation with family relationships ($H = 19.319$, $P < 0.001$), meaning that the poorer the family relationships, the higher the SI level. Significant positive correlations also emerged with YIAT total scores, HAMD total scores, and anxiety factor scores (all $P < 0.05$). In contrast to the MDD group, the correlation between PANSI total scores and age in the BD group did not reach statistical significance ($P = 0.058$), whereas a significant positive correlation was observed with academic performance ($r = 0.191$, $P = 0.022$).

Table 2
Univariate analyses of factors associated with PANSI total score.

Variables	MDD		BD			
	Mean (SD)	t/Z/H	P	Mean (SD)	t/Z/H	P
Sex ^a		-2.336	0.020		-3.094	0.002
Male	43.72 (10.39)			44.41 (11.78)		
Female	47.76 (11.08)			51.66 (10.86)		
First episode ^b		-0.989	0.324		-1.442	0.152
Yes	46.96 (10.53)			51.34 (10.43)		
No	45.36 (11.61)			48.31 (12.31)		
Academic performance ^c		2.777	0.249		4.342	0.114
Good	44.91 (11.79)			46.55 (12.69)		
Fair	47.62 (10.19)			50.40 (11.04)		
Poor	46.07 (10.95)			52.69 (9.99)		
Family relationship ^c		14.703	< 0.001		19.319	< 0.001
Good	41.59 (10.77)			41.36 (13.45)		
Fair	47.41 (10.60)			51.22 (10.02)		
Poor	50.80 (10.32)			56.61 (6.03)		
MDD, Major Depressive Disorder; BD, Bipolar Disorder; Bolded <i>P</i> value < 0.05; SD, standard deviation. ^a Mann-Whitney U-test. ^b Independent samples t-test. ^c Kruskal-Wallis H-test.						

Table 3
Correlations between PANSI total score and demographic and clinical variables.

Variables	MDD		BD	
	<i>r</i>	<i>P</i>	<i>r</i>	<i>P</i>
Age (years)	-0.248	0.001	-0.173	0.058
BMI (kg/m ²)	0.014	0.849	-0.090	0.327
Age at onset (years)	-0.250	< 0.001	-0.161	0.078
Duration of illness (months)	0.174	0.016	-0.020	0.832
YMRS total score	-	-	0.158	0.085
YIAT total score	0.195	0.007	0.334	< 0.001
HAMD total score	0.558	< 0.001	0.502	< 0.001
Anxiety factor score	0.279	< 0.001	0.254	0.005
MDD, Major Depressive Disorder; BD, Bipolar Disorder; PANSI, Positive and Negative Suicide Ideation Inventory; BMI, Body Mass Index; YMRS, Young Mania Rating Scale; YIAT, Young's Internet Addiction Test; HAMD-24, 24-item Hamilton Depression Rating Scale; Bolded <i>P</i> values < 0.05.				

3.3. Independent factors associated with the severity of SI

According to Table 4, multiple linear regression (with the PANSI total score as the dependent variable) indicated that, within the MDD group, the following factors emerged as independent predictors of the PANSI total score: age ($\beta = -0.125$, $P = 0.032$), family relationships ("fair": $\beta = 0.145$, $P = 0.043$, "poor": $\beta = 0.147$, $P = 0.041$), YIAT total score ($\beta = 0.177$, $P = 0.003$), and the anxiety factor score-revised ($\beta = 0.458$, $P < 0.001$). For the BD group, gender ($\beta = -0.183$, $P = 0.013$), family relationships (fair: $\beta = 0.195$, $P = 0.033$, poor: $\beta = 0.213$, $P = 0.026$), YIAT score ($\beta = 0.200$, $P = 0.013$), and the anxiety factor score-revised ($\beta = 0.397$, $P < 0.001$) each showed independent associations with the PANSI total score.

Table 4
Independent correlates of PANSI total scores.

Variables	MDD				BD			
	B	β	<i>t</i>	<i>P</i>	B	β	<i>t</i>	<i>P</i>
Sex (ref. female)	-2.545	-0.105	-1.806	0.073	-4.752	-0.183	-2.538	0.013
Age (years)	-0.925	-0.125	-2.158	0.032	-	-	-	-
Duration of illness (months)	0.010	0.004	0.214	0.830	-	-	-	-
Family relationship (ref. good)								
Fair	3.130	0.145	2.036	0.043	4.594	0.195	2.153	0.033
Poor	4.684	0.147	2.058	0.041	6.846	0.213	2.252	0.026
YIAT total score	0.138	0.177	2.959	0.003	0.14	0.200	2.53	0.013
Anxiety factor score-revised	5.033	0.458	7.546	< 0.001	3.751	0.397	5.206	< 0.001
<i>F</i>	13.897				17.193			
<i>R</i> ²	0.378				0.430			
MDD, Major Depressive Disorder; BD, Bipolar Disorder; PANSI, Positive and Negative Suicide Ideation Inventory; YIAT, Young's Internet Addiction Test; ref, reference; Bolded <i>P</i> values < 0.05.								

3.4. The mediatory function of IA

Using the PROCESS macro (Model 4), we evaluated how IA mediates the link between anxiety severity and SI, separately for adolescents with MDD and BD. The results are shown in Table 5 and Fig. 1. Among patients with MDD, the direct pathway from anxiety severity on SI was significant ($B = 5.379$, 95% CI = 4.089–6.669). However, the mediating effect of IA did not achieve significance (indirect effect, $B = 0.158$, 95% CI = -0.109-0.511), implying that IA did not act as a mediating role in the anxiety-SI relationship. For BD patients, a significant indirect effect of IA emerged (indirect effect, $B = 0.662$, 95% CI = 0.135–1.404), explaining 14% of the total effect. The direct effect of anxiety on SI was 4.154 (95% CI = 2.746–5.562). These results suggest that, in patients with BD, IA partially mediates the effect of anxiety on SI.

Table 5

Mediating effect of internet addiction on the relationship between anxiety and suicidal ideation.

Paths		B	SE	95% CI		Ratio
				LLCI	ULCI	
MDD	Anxiety severity → IA → SI					
	Indirect effect	0.158	0.154	-0.109	0.511	-
	Direct effect	5.379	0.654	4.089	6.669	-
	Total effect	5.537	0.667	4.222	6.852	
BD	Anxiety severity → IA → SI					
	Indirect effect	0.662	0.329	0.135	1.404	14%
	Direct effect	4.154	0.711	2.746	5.562	86%
	Total effect	4.817	0.721	3.389	6.244	
MDD, Major Depressive Disorder; BD, Bipolar Disorder; Anxiety severity, refers to the anxiety factor score-revised described in Table 4; IA, Internet Addiction; SI, Suicidal Ideation; B, Unstandardized Regression Coefficient; SE, Standard Error; CI, Confidence Interval; LLCI, Lower-Limit Confidence Interval; ULCI, Upper-Limit Confidence Interval.						

4. Discussion

First, our analysis revealed that SI levels were significantly higher in BD than in MDD, consistent with previous research [13, 14]. A meta-analysis by Serra et al. of children and adolescents with MDD and BD reported that BD patients had an annual suicide attempt incidence of 7.44%, significantly higher than the 6.27% in MDD patients, providing indirect support for the findings of this study [47]. Furthermore, functional magnetic resonance imaging (fMRI) investigations had observed abnormal brain activity in the precuneus and posterior cingulate cortex among BD patients with SI, which may play a role in the development of SI [48, 49]. BD patients also exhibited significantly higher levels of IA. This may be related to the higher comorbidity of substance use disorders and greater impulsivity observed in BD patients [50]. Finally, significantly higher levels of anxiety symptoms were observed in BD patients compared to those with MDD, consistent with a report by Inoue et al. among outpatients with depressive episodes in Japan (BD 53.2% vs. MDD 37.2%) [51]. In contrast, a network analysis of anxiety symptoms found that, relative to the BD group, the MDD group showed stronger interconnections among core anxiety symptoms [52]. This may be due to significant differences in anxiety comorbidity between the two diagnostic subtypes, BD-I and BD-II [53]. However, ANCOVA revealed that, after controlling for related variables such as IA levels, depression, and anxiety, the two groups showed a marginally significant difference in SI levels. This observation is consistent with the trend from Sanches et al., who demonstrated no group differences in suicide risk among patients with mood disorders after controlling for related variables such as anxiety and depression severity. This suggests that the high SI levels in BD

patients may not stem entirely from the disease diagnosis itself, but are more closely associated with their more severe anxiety, depression, and IA [20].

Further correlation and regression analyses indicated that age served as an independent predictor of SI in the MDD group, whereas it was not statistically significant within the BD group. This difference may stem from the fact that MDD typically has an early-adolescent onset, when emotional regulation capacities in adolescents remain immature, making them more prone to negative thoughts. In contrast, SI in BD patients is more closely associated with mood fluctuations and impulsive behavior, with age itself playing a relatively minor role [13, 54]. Conversely, regarding gender, female sex was an independent predictor of SI only in the BD group, while in the MDD group, the association between gender and SI was only marginally significant. This may be because females with BD are more sensitive to interpersonal stress and emotional fluctuations, and gender differences in late adolescence undergo dynamic changes with age [55, 56]. This study also found that, in both adolescents with MDD and BD, poor family relationships were significantly associated with higher severity of SI. This result suggests that the quality of family relationships is an important factor influencing suicide risk in adolescents with mood disorders. This finding aligns with the results of Sewall et al., who found that in adolescents with BD, both long-term and short-term deterioration in parent-child relationships elevate the risk for both SI and suicidal behavior, and this effect is independent of psychopathological symptoms [55]. Hammond et al. further confirmed that negative parenting behaviors (e.g., scolding, punishment) and family dysfunction (e.g., conflict, poor cohesion) can predict SI and self-injurious behaviors among adolescents, even after adjusting for individual psychiatric symptoms [57]. Grossberg and Rice also noted that family conflict, abuse, and neglect serve as key suicide risk factors for depressed adolescents, whereas family support exerts a protective effect [58]. In summary, for MDD adolescents, we should give special consideration to the emotional regulation abilities of younger patients, while for female patients with BD, emotional and social support should be strengthened. At the same time, improving family relationships should be adopted as a common intervention approach for both groups of patients to effectively reduce the risk of SI.

With regard to clinical manifestations, the present results indicate that both anxiety symptoms and IA were independently and positively associated with SI in adolescents with MDD and BD, suggesting that both are common clinical risk indicators for MDD and BD. This result aligns with the findings of many earlier investigations. For example, Busby Grant et al. found that anxiety manifestations such as excessive worry significantly predicted new-onset SI 18 months later [59]. When Li et al. used machine learning to identify factors linked to SI within Chinese adolescents, they found that anxiety ranked first among numerous associated factors [60]. A network analysis study further indicated that the anxiety symptom “uncontrollable worry” occupies a central position in the network of depressive and suicidal symptoms [61]. Anxiety-related symptoms not only have a strong predictive influence on SI [62] but are also closely associated with suicidal behavior [63]. This may be because persistent excessive worry and anxiety about the future weaken adolescents’ ability to think through and cope with problems [59, 61]. At the same time, issues such as physical and mental exhaustion and difficulty concentrating caused by anxiety further deplete emotional regulation capacity, thereby making SI more likely to occur [63, 64].

Regarding IA, a study by L. Liu et al. involving 502 adolescents with MDD demonstrated that higher degrees of IA correspond to a greater risk for SI, and this relationship is independent of other factors such as the severity of depression [12]. As for patients with BD, although direct evidence is currently lacking, relevant reviews indicate that IA is significantly correlated with BD diagnosis in terms of clinical manifestations (e.g., impulsivity, insomnia) and neurobiological bases (e.g., prefrontal dysfunction, abnormalities in the dopamine system), suggesting that IA may also contribute to elevated SI levels in patients with BD [65]. These findings suggest that when clinically assessing and intervening in suicide risk among adolescents with MDD, particular attention should be paid to evaluating anxiety symptoms and IA behaviors, and targeted measures should be developed to address these risk factors in order to reduce the risk of SI.

Most importantly, the present results indicated that IA served as a mediator between anxiety and SI, and this effect was significant in adolescents with BD. Similarly, a study of Chinese middle school students found that social anxiety exerted direct as well as indirect influences upon SI, with problematic internet use acting as a partial mediator [30]. However, this mediating effect was not significant in adolescents with MDD. A plausible explanation for the difference in mediating effects between these two groups is that BD patients exhibit higher levels of impulsive behavior compared to MDD patients [66]. Relevant neurobiological mechanisms suggest that in BD patients, brain regions including the prefrontal cortex, insula, and anterior cingulate cortex show abnormal activation in response to emotional stimuli, leading to difficulty in inhibiting impulsive behavior and a preference for immediate rewards [67, 68]. Excessive internet use before bedtime among IA patients increases the risk of insomnia, and impaired sleep further increases susceptibility to SI [69]. In contrast, MDD patients exhibit lower levels of impulsivity compared to BD patients, tending to internalize emotions rather than use behavioral addictions to alleviate anxiety [70]. Furthermore, the link between anxiety and SI in MDD patients may be mediated more by cognitive factors such as negative cognitions and feelings of hopelessness, rather than behavioral-level IA [71].

Several limitations of the present investigation should be acknowledged. First, the study employed a cross-sectional design, making it impossible to determine the causal sequence among variables. Future longitudinal research will be required to further validate the direction of IA's mediating role between anxiety symptoms and SI. Second, the study sample originated from one institution, a factor that might introduce selection bias. Therefore, care must be taken when applying these findings to other regions. Furthermore, the study assessed patients' anxiety symptoms using the anxiety-somatization factor of the HAMD-24 rather than a scale specifically designed for anxiety, such as the Hamilton Anxiety Scale (HAMA). This approach may not provide a comprehensive evaluation of anxiety symptoms. Future studies should incorporate specialized anxiety assessment tools, such as the HAMA, to enhance the comprehensiveness and accuracy of anxiety symptom measurement. Additionally, this work was limited exclusively to the mediation of IA and did not examine other potential mediating variables, such as emotional regulation ability, social support, sleep disturbances, or childhood trauma. Future studies could construct multiple mediation models to more comprehensively elucidate the pathways through which anxiety relates to SI. Finally, the study did not conduct subgroup analyses by BD subtypes (BD-

and BD- $\square$), although previous research suggests that there may be significant differences in the prevalence of anxiety comorbidity across these subtypes.

5. Conclusion

In this study, relative to those with MDD, adolescents with BD exhibited higher overall risk levels of anxiety symptoms, IA, and SI, and both anxiety symptoms and IA showed significant correlations with SI. Furthermore, IA partially mediated the link from anxiety symptoms to SI in adolescents with BD, whereas this mediating effect was not significant among those with MDD. Thus, in light of the harmful consequences of SI among adolescents with BD, future strategies directed at IA, such as routine screening, cognitive-behavioral therapy alongside mindfulness-based approaches, may be considered to mitigate anxiety-driven SI and its accompanying risks.

Declarations

Ethics approval and consent to participate

The current study was reviewed and approved by the Ethics Committee of the Fourth Affiliated Hospital of Anhui Medical University (KYSM-202410-029). Written informed consent was obtained from all participants and their parents or guardians prior to study enrollment.

Declaration of competing interest

The authors declare that they have no competing interests.

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CRedit authorship contribution statement

Yu Zhuang: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing - original draft, Writing - review & editing, Visualization. **Yinghan Tian**: Data curation, Formal analysis,

Investigation, Methodology. **Yuanbo Liu**: Data curation, Formal analysis, Investigation, Methodology. **Xianlin Sun**: Data curation, Formal analysis, Investigation, Methodology. **Lewei Liu**: Data curation, Formal analysis, Investigation, Methodology. **Na Wang**: Data curation, Formal analysis, Investigation, Methodology. **Yuhang Li**: Data curation, Formal analysis, Investigation, Methodology. **Jie Cheng**: Data curation, Formal analysis, Investigation, Methodology. **Runcheng Zhang**: Data curation, Formal analysis, Investigation, Methodology. **Lei Xia**: Conceptualization, Project administration, Supervision, Writing - review & editing. **Huanzhong Liu**: Conceptualization, Funding acquisition, Project administration, Supervision, Writing - review & editing.

Data Availability

The datasets generated and/or analysed during the current study are not publicly available due to patient privacy and ethical restrictions, but are available from the corresponding author on reasonable request.

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Figures

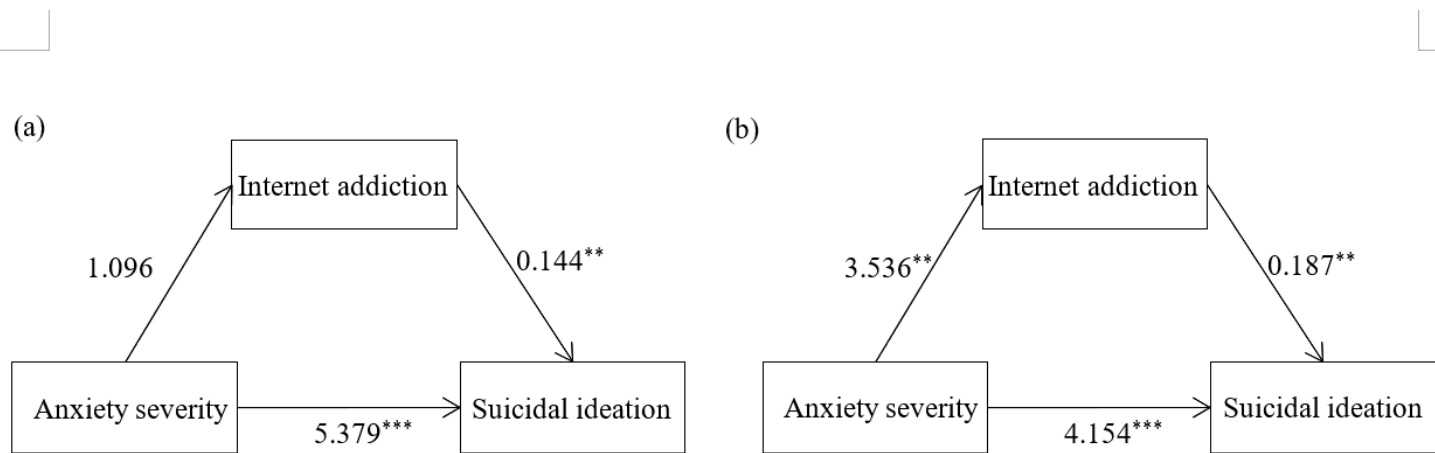


Figure 1

Mediation model of internet addiction between anxiety severity and suicidal ideation in patients with MDD (a) and BD (b).

Anxiety severity, refers to the anxiety factor score-revised described in Table 4; Unstandardized coefficients are reported. * $P<0.05$, ** $P<0.01$, *** $P<0.001$.