

Sex differences in the association between insomnia and empathy in adolescents with major depressive disorder

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Abstract

Background

This study aimed to estimate the prevalence and associated factors of insomnia in adolescents with major depressive disorder (MDD), and to examine the association between insomnia and empathy, including potential sex differences.

Methods

A cohort of 374 adolescents diagnosed with MDD was enrolled. Demographic information was collected via a self-report questionnaire. The Center for Epidemiological Studies Depression Scale (CES-D), the Interpersonal Reactivity Index (IRI), and the Insomnia Severity Index (ISI) were used to assess depression, empathy, and insomnia, respectively. Logistic regression analyses were used to identify the independent correlates of insomnia.

Results

Our study found that 35.8% of adolescents with MDD had insomnia. The rate was 37.2% in females and 32.4% in males, with no significant sex difference ($\chi^2 = 0.773$, $P = 0.379$). Significant differences were observed between the insomnia and non-insomnia groups in academic pressure, parental marital status, suicide attempts, CES-D score, and IRI score (particularly on the Fantasy and Personal Distress subscales) (all $P < 0.05$). Logistic regression analyses showed that empathy was independently associated with insomnia in females (OR = 1.038, 95% CI: 1.009–1.068, $P < 0.05$), but not in males. Finally, receiver operating characteristic (ROC) analyses indicated that the combination of academic pressure, parental marital status, CES-D score, and IRI score demonstrated high sensitivity and specificity for identifying insomnia (AUC = 0.785, 95% CI: 0.738–0.833, $P < 0.001$).

Conclusion

Insomnia was prevalent in adolescents with MDD, and a significant association was observed between insomnia and empathy in this population, particularly among female patients. Future research should further investigate the underlying mechanisms linking empathy and insomnia, and develop targeted interventions to effectively improve sleep quality and overall mental health outcomes in this population.

1. Introduction

Major depressive disorder (MDD) ranks among the leading contributors to global disease burden. In recent years, its onset has shifted toward younger ages, making it the most prevalent affective disorder in adolescents. Approximately one in five children and adolescents worldwide experience depression or

depressive symptoms, with prevalence rates continuing to increase[1]. China's national epidemiological investigation documented an overall mental disorder prevalence rate of 17.5% among pediatric and adolescent populations, with MDD affecting 2.0% of this population[2]. It is worth highlighting that insomnia exhibits a notably high prevalence in individuals with MDD[3]. A survey of the United States adult population found that insomnia occurred in 85.2% of those experiencing an MDD episode[4]. A large-scale survey in China reported a prevalence of sleep problems of 70.7% in adolescents with MDD[5]. Insomnia comorbid with MDD significantly exacerbates clinical severity, reduces quality of life, impairs productivity and daily functioning, and markedly increases economic burden[6, 7]. Moreover, depressed adolescents with sleep disorders are at a heightened risk of suicidal ideation[8]. Therefore, it is imperative to systematically investigate the prevalence of insomnia and its associated factors in adolescents with MDD.

Recent research has confirmed that insomnia correlates with a variety of factors, such as age, sex, life stressors, environmental conditions, and depression severity. For example, a study showed that female adolescents were more prone to insomnia[9]. Moreover, the severity of MDD was positively linked to the degree of insomnia[10]. Notably, a recent study has shown that prolonged nighttime sleep and fewer sleep disruptions are linked to more mature empathy among preschool children[11]. This association was especially pronounced among children with higher baseline empathy levels and exhibited significant sex differences: the link between sleep and affective empathy was driven primarily by females, whereas the association with cognitive empathy was more evident in males.

Empathy refers to the ability to perceive and resonate with others' emotions, needs, and experiences, and consists of two primary components[12]. Affective empathy refers to "feeling what another feels," whereby one directly experiences the other's emotional state as if one were in the same situation. Cognitive empathy denotes "putting oneself in another's place," involving the rational understanding of others' emotions and perspectives without necessarily experiencing those feelings oneself[13]. Moreover, females generally exhibit higher levels of empathy compared to males[14]. However, empathy is not uniformly beneficial. It can act as a double-edged sword. Excessive empathic capacity can lead to emotional over-engagement with others, impairing one's ability to regulate personal emotional load, and thereby raising the risk of MDD. Research has found that self-directed affective empathy is significantly correlated with heightened negative emotions[15, 16]. A meta-analysis has further shown that affective empathy is positively associated with MDD, and this link is especially pronounced during adolescence[17]. Empathy is closely linked to insomnia. A study found that the higher the empathy trait score, the worse the sleep quality[18]. However, another study has found that adolescents with poorer sleep exhibited lower empathy scores[19]. Therefore, further investigation into the association between empathy and insomnia is warranted.

Nevertheless, research on the association between empathy and insomnia in adolescents with MDD remains limited. Moreover, although significant sex differences in empathy have been observed among adolescents, it remains unclear whether such differences moderate the association between insomnia and empathy. Thus, this study aimed to estimate the prevalence and associated factors of insomnia in

adolescents with MDD, and to examine the association between insomnia and empathy, including potential sex differences.

2. Methods

2.1. Study design and participants

This cross-sectional study was carried out between August 2021 and December 2022. A total of 374 adolescents with a confirmed diagnosis of MDD were recruited from eight tertiary-level hospitals in Anhui Province (The Fourth Affiliated Hospital of Anhui Medical University, Hefei Fourth People's Hospital, The Second Affiliated Hospital of Anhui Medical University, Bozhou People's Hospital, Suzhou Second People's Hospital, The Second Affiliated Hospital of Bengbu Medical College, Ma'anshan Fourth People's Hospital, and Fuyang Third People's Hospital). Inclusion criteria: (1) aged 12–18 years; (2) a clinical diagnosis of MDD based on Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) criteria, independently confirmed by two attending psychiatrists or those of higher rank; (3) willingness to cooperate with all assessments. Exclusion criteria: (1) presence of any other DSM-5 psychiatric diagnosis (including intellectual developmental disorder); (2) significant somatic, infectious, or immune system conditions; (3) inability or unwillingness to complete the required evaluations. The study protocol was approved by the Ethics Committee of the Fourth Affiliated Hospital of Anhui Medical University (No. 202009-KYXM-04). Written informed consent was obtained from both participants and their legal guardians after a comprehensive explanation of the study procedures.

2.2. Measures

2.2.1. General information

A researcher-developed questionnaire was administered to collect general information, including sex, age, body mass index (BMI), education level, academic pressure, parental marital status, first occurrence of MDD, antidepressants use, age of illness onset, disease duration from onset to assessment, and history of suicide attempts (yes/no).

2.2.2. Depressive symptoms

The severity of depressive symptoms was assessed with the Center for Epidemiologic Studies Depression Scale (CES-D)[20]. The scale comprises 20 items rated on a 4-point Likert scale reflecting the frequency of the indicated symptom during the past week. The scale comprises four dimensions: depressive affect, positive affect, somatic symptoms, and interpersonal problems. Higher scores indicate greater depressive symptom severity. The CES-D has demonstrated satisfactory reliability and validity among Chinese adolescents[21].

2.2.3. Empathy

Empathy was assessed using the Interpersonal Reactivity Index (IRI)[22]. The scale comprises 28 empathy-related items rated on a 5-point Likert scale. Higher scores indicate stronger empathy. The scale comprises four dimensions: perspective taking (PT), fantasy (FS), empathic concern (EC), and personal distress (PD). Based on previous research, the PT subscale was regarded as an index of cognitive empathy, whereas the EC and PD subscales were taken to represent the positive and negative facets of affective empathy, respectively[23, 24].

2.2.4. Insomnia

The Insomnia Severity Index (ISI) was used to evaluate the severity of insomnia experienced by participants over the past two weeks[25]. The scale comprises seven insomnia-related items rated on a five-point scale. Higher scores indicate greater insomnia severity. In this study, an ISI total score of 15 or higher was defined as the presence of insomnia[26].

2.3. Statistical analysis

Data were analyzed using IBM SPSS Statistics 26.0. Continuous variables were tested for normality with the Kolmogorov-Smirnov test and were presented as mean $\pm$ standard deviation (SD) or median (quartiles) [M (P₂₅, P₇₅)]. Categorical variables were summarized as frequencies (percentages). Univariate comparisons between participants with and without insomnia were conducted using independent-samples t-tests, Mann–Whitney U tests, or χ^2 tests. In the stepwise logistic regression, variables with $P < 0.05$ in the univariate analyses were selected as independent variables, with the presence of insomnia as the dependent variable. The predictive utility of each factor was further evaluated by receiver operating characteristic (ROC) curve analyses, and the area under the curve (AUC) was calculated. All statistical tests were two-tailed, and a significance level of $P < 0.05$ was adopted.

3. Results

3.1. Comparison of general information and clinical features between groups

A total of 374 adolescents with MDD were finally included, of whom 266 (71.1%) were female, and the mean age was 15.35 ± 1.66 years. Overall, 134 participants (35.8%) exhibited insomnia, with a prevalence of 37.2% among females and 32.4% among males. Univariate analyses for the total sample, female patients, and male patients were presented in Table 1, Table 2, and Table 3, respectively. Univariate analyses revealed that, compared to those without insomnia, individuals with insomnia reported significantly greater academic pressure, a higher proportion of parents with poor marital status, and a markedly increased prevalence of previous suicide attempts. With regard to clinical measures, the insomnia group scored significantly higher on the CES-D and IRI (Table 1). Notably, the between-group difference in IRI scores was especially pronounced among female patients (Table 2 and Table 3).

Table 1

Comparison of general information and clinical features in insomnia and without insomnia groups

Variables	Insomnia (n = 134)	Without insomnia (n = 240)	Statistics	
			<i>t/Z/χ²</i>	<i>P</i>
General information				
Sex			0.773	0.379
Females, n (%)	99 (73.88)	167 (69.58)		
Males, n (%)	35 (26.12)	73 (30.42)		
Age (years), mean (SD)	15.34 (1.74)	15.36 (1.61)	0.150	0.880
BMI (kg/m ²), mean (SD)	21.05 (3.99)	20.86 (3.78)	-0.460	0.650
Education level			0.742	0.389
Junior high school, n (%)	58 (43.28)	115 (47.92)		
High school, n (%)	76 (56.72)	125 (52.08)		
Academic pressure			18.394	< 0.001
Low, n (%)	8 (5.97)	7 (2.92)		
Average, n (%)	41 (30.60)	128 (53.33)		
High, n (%)	85 (63.43)	105 (43.75)		
Parental marital status			10.352	0.001
Normal, n (%)	89 (66.42)	195 (81.25)		
Abnormal, n (%)	45 (33.58)	45 (18.75)		
Suicidal attempts, n (%)	102 (76.12)	137 (57.08)	13.509	< 0.001
First occurrence of MDD, n (%)	55 (41.04)	101 (42.08)	0.038	0.845
Antidepressants use			0.362	0.834
None, n (%)	45 (33.58)	88 (36.67)		
SSRIs, n (%)	77 (57.46)	132 (55.00)		
Others, n (%)	12 (8.96)	20 (8.33)		
BMI, Body Mass Index; MDD, major depressive disorder; CES-D, Center for Epidemiologic Studies Depression Scale; IRI, Interpersonal Reactivity Index; FS, Fantasy; EC, Empathic concern; PT, Perspective taking; PD, Personal distress; SD, Standard Deviation; ^a , Mann-Whitney U-test; Bolded <i>P</i> value: < 0.05				

Variables	Insomnia (n = 134)	Without insomnia (n = 240)	Statistics	
			<i>t/Z/χ²</i>	<i>P</i>
General information				
Age of illness onset (years), mean (SD)	13.72 (1.83)	13.81 (1.85)	0.450	0.660
Duration of illness (months), median (P ₂₅ , P ₇₅)	16.00 (12.00, 30.00)	12.00 (8.00, 24.00)	-1.369 ^a	0.171
Clinical features				
CES-D score, mean (SD)	43.05 (9.17)	32.01 (13.07)	-9.550	< 0.001
Depressed affect score, mean (SD)	17.22 (4.70)	12.54 (6.11)	-8.279	< 0.001
Positive affect score, mean (SD)	9.74 (2.02)	8.39 (3.02)	-5.174	< 0.001
Somatic symptoms score, mean (SD)	12.82 (3.19)	8.73 (4.28)	-10.482	< 0.001
Interpersonal problems score, mean (SD)	3.27 (1.86)	2.35 (1.95)	-4.417	< 0.001
IRI score, mean (SD)	68.77 (10.67)	64.53 (11.53)	-3.500	< 0.001
FS score, mean (SD)	17.36 (4.44)	15.98 (5.03)	-2.640	0.010
EC score, mean (SD)	16.29 (4.65)	15.77 (4.65)	-1.050	0.300
PT score, mean (SD)	15.08 (3.50)	14.57 (3.58)	-1.350	0.180
PD score, mean (SD)	20.04 (4.24)	18.22 (4.39)	-3.900	< 0.001
BMI, Body Mass Index; MDD, major depressive disorder; CES-D, Center for Epidemiologic Studies Depression Scale; IRI, Interpersonal Reactivity Index; FS, Fantasy; EC, Empathic concern; PT, Perspective taking; PD, Personal distress; SD, Standard Deviation; ^a , Mann-Whitney U-test; Bolded <i>P</i> value: < 0.05				

Table 2

Comparison of general information and clinical features in insomnia and without insomnia groups of female patients

Variables	Insomnia (n = 99)	Without insomnia (n = 167)	Statistics	
			<i>t/Z/χ²</i>	<i>P</i>
General information				
Age (years), mean (SD)	15.04 (1.76)	15.29 (1.68)	1.140	0.255
BMI (kg/m ²), mean (SD)	20.54 (3.27)	20.61 (3.39)	0.187	0.852
Education level			0.366	0.545
Junior high school, n (%)	53 (53.54)	83 (49.70)		
High school, n (%)	46 (46.46)	84 (50.30)		
Academic pressure			14.175	0.001
Low, n (%)	4 (4.04)	5 (2.99)		
Average, n (%)	31 (31.31)	92 (55.09)		
High, n (%)	64 (64.65)	70 (41.92)		
Parental marital status			10.179	0.001
Normal, n (%)	64 (64.65)	137 (82.04)		
Abnormal, n (%)	35 (35.35)	30 (17.96)		
Suicidal attempts, n(%)	76 (76.77)	109 (65.27)	3.880	0.049
First occurrence of MDD, n (%)	39 (39.39)	72 (43.11)	0.354	0.552
Antidepressants use			0.049	0.976
None, n (%)	34 (34.34)	56 (33.53)		
SSRIs, n (%)	55 (55.56)	95 (56.89)		
Others, n (%)	10 (10.10)	16 (9.58)		
Age of illness onset (years), mean (SD)	13.44 (1.79)	13.78 (1.88)	1.425	0.155
Duration of illness (months), median (P ₂₅ , P ₇₅)	12.00 (11.00, 30.00)	12.00 (10.00, 24.00)	-0.290 ^a	0.772

BMI, Body Mass Index; MDD, major depressive disorder; CES-D, Center for Epidemiologic Studies Depression Scale; IRI, Interpersonal Reactivity Index; FS, Fantasy; EC, Empathic concern; PT, Perspective taking; PD, Personal distress; SD, Standard Deviation; ^a, Mann-Whitney U-test; Bolded *P* value: < 0.05.

Variables	Insomnia (n = 99)	Without insomnia (n = 167)	Statistics	
			<i>t/Z/χ²</i>	<i>P</i>
General information				
Clinical features				
CES-D score, mean (SD)	44.41 (9.24)	32.82 (12.95)	-8.489	< 0.001
Depressed affect score, mean (SD)	18.1 (4.56)	13.06 (5.87)	-7.817	< 0.001
Positive affect score, mean (SD)	9.69 (2.13)	8.41 (3.02)	-4.037	< 0.001
Somatic symptoms score, mean (SD)	13.12 (3.31)	8.88 (4.31)	-9.008	< 0.001
Interpersonal problems score, mean (SD)	3.51 (1.89)	2.47 (1.98)	-4.175	< 0.001
IRI score, mean (SD)	69.92 (10.25)	64.87 (11.83)	-3.534	< 0.001
FS score, mean (SD)	17.31 (4.34)	15.93 (5.23)	-2.211	0.028
EC score, mean (SD)	16.41 (4.82)	15.66 (4.63)	-1.258	0.210
PT score, mean (SD)	15.26 (3.64)	14.62 (3.54)	-1.411	0.159
PD score, mean (SD)	20.93 (3.98)	18.65 (4.16)	-4.398	< 0.001
BMI, Body Mass Index; MDD, major depressive disorder; CES-D, Center for Epidemiologic Studies Depression Scale; IRI, Interpersonal Reactivity Index; FS, Fantasy; EC, Empathic concern; PT, Perspective taking; PD, Personal distress; SD, Standard Deviation; ^a , Mann-Whitney U-test; Bolded <i>P</i> value: < 0.05.				

Table 3

Comparison of general information and clinical features in insomnia and without insomnia groups of male patients

Variables	Insomnia (n = 35)	Without insomnia (n = 73)	Statistics	
			<i>t/Z/χ²</i>	<i>P</i>
General information				
Age (years), mean (SD)	16.17 (1.40)	15.53 (1.44)	-2.175	0.032
BMI (kg/m ²), mean (SD)	22.50 (5.35)	21.41 (4.51)	-1.102	0.273
Education level			9.172	0.002
Junior high school, n (%)	5 (14.29)	32 (43.84)		
High school, n (%)	30 (85.71)	41 (56.16)		
Academic pressure			6.268	0.044
Low, n (%)	4 (11.43)	2 (2.74)		
Average, n (%)	10 (28.57)	36 (49.32)		
High, n (%)	21 (60.00)	35 (47.95)		
Parental marital status			0.856	0.335
Normal, n (%)	25 (71.43)	58 (79.45)		
Abnormal, n (%)	10 (28.57)	15 (20.55)		
Suicidal attempts, n(%)	26 (74.29)	28 (38.36)	12.216	< 0.001
First occurrence of MDD, n (%)	16 (45.71)	29 (39.73)	0.349	0.555
Antidepressants use			1.559	0.459
None, n (%)	11 (31.43)	32 (43.84)		
SSRIs, n (%)	22 (62.86)	37 (50.68)		
Others, n (%)	2 (5.71)	4 (5.48)		
Age of illness onset (years), mean (SD)	14.51 (1.72)	13.89 (1.78)	-1.720	0.088
Duration of illness (months), median (P ₂₅ , P ₇₅)	20.00 (12.00, 30.00)	12.00 (6.00, 24.00)	-1.977 ^a	0.048

BMI, Body Mass Index; MDD, major depressive disorder; CES-D, Center for Epidemiologic Studies Depression Scale; IRI, Interpersonal Reactivity Index; FS, Fantasy; EC, Empathic concern; PT, Perspective taking; PD, Personal distress; SD, Standard Deviation; ^a, Mann-Whitney U-test; Bolded P value: < 0.05.

Variables	Insomnia (n = 35)	Without insomnia (n = 73)	Statistics	
			<i>t/Z/χ²</i>	<i>P</i>
General information				
Clinical features				
CES-D score, mean (SD)	39.20 (7.87)	30.15 (13.25)	-4.429	< 0.001
Depressed affect score, mean (SD)	14.74 (4.26)	11.34 (6.50)	-3.247	0.002
Positive affect score, mean (SD)	9.89 (1.68)	8.34 (3.02)	-3.407	0.001
Somatic symptoms score, mean (SD)	11.97 (2.71)	8.38 (4.23)	-5.326	< 0.001
Interpersonal problems score, mean (SD)	2.60 (1.63)	2.08 (1.86)	-1.406	0.163
IRI score, mean (SD)	65.51 (11.29)	63.77 (10.85)	-0.773	0.441
FS score, mean (SD)	17.49 (4.78)	16.10 (4.59)	-1.453	0.149
EC score, mean (SD)	15.94 (4.19)	16.00 (4.72)	0.061	0.951
PT score, mean (SD)	14.57 (3.06)	14.44 (3.70)	-0.185	0.854
PD score, mean (SD)	17.51 (3.97)	17.23 (4.75)	-0.303	0.762
BMI, Body Mass Index; MDD, major depressive disorder; CES-D, Center for Epidemiologic Studies Depression Scale; IRI, Interpersonal Reactivity Index; FS, Fantasy; EC, Empathic concern; PT, Perspective taking; PD, Personal distress; SD, Standard Deviation; ^a , Mann-Whitney U-test; Bolded <i>P</i> value: < 0.05.				

3.2. Stepwise logistic regression analyses

Findings from the multivariate stepwise logistic regression analyses were presented in Table 4 and Table 5. Model 1 included general information variables that were significant in univariate analyses, along with the total CES-D and IRI scores. Among the total sample, academic pressure (OR = 0.558, 95% CI = 0.337–0.926, *P* = 0.024), parental marital status (OR = 2.075, 95% CI = 1.189–3.622, *P* = 0.010), CES-D score (OR = 1.082, 95% CI = 1.056–1.109, *P* < 0.001), and IRI total score (OR = 1.026, 95% CI = 1.003–1.049, *P* = 0.025) were independent correlates of insomnia. Among female patients, academic pressure (OR = 0.542, 95% CI = 0.297–0.991, *P* = 0.047), parental marital status (OR = 2.299, 95% CI = 1.166–4.534, *P* = 0.016), CES-D score (OR = 1.088, 95% CI = 1.055–1.121, *P* < 0.001), and IRI total score (OR = 1.038, 95% CI = 1.009–1.068, *P* = 0.010) were independent correlates of insomnia. Among male patients, education level (OR = 0.192, 95% CI = 0.055–0.670, *P* = 0.010), suicide attempts (OR = 7.603, 95% CI = 2.411–23.976, *P* = 0.001), and CES-D score (OR = 1.068, 95% CI = 1.018–1.119, *P* = 0.007) were independent correlates of insomnia. Model 2 included significant general information variables along

with subscale scores from the CES-D and IRI that showed significance in univariate analyses. Among the total sample, somatic symptoms score (OR = 1.308, 95% CI = 1.216–1.407, $P < 0.001$), and FS score (OR = 1.069, 95% CI = 1.014–1.126, $P = 0.012$) were independent correlates of insomnia. Among female patients, somatic symptoms score (OR = 1.277, 95% CI = 1.172–1.391, $P < 0.001$), and PD score (OR = 1.096, 95% CI = 1.015–1.184, $P = 0.020$) were independent correlates of insomnia. Among male patients, somatic symptoms score (OR = 1.296, 95% CI = 1.122–1.498, $P < 0.001$) was an independent correlate of insomnia.

Table 4
Independent factors associated with insomnia by multivariate logistic stepwise regression analysis
(Model 1)

Variables	B	SE	Wald χ^2	OR	95% CI	<i>P</i>
Total sample						
Academic pressure						
High	Ref	-	-	-	-	-
Average	-0.583	0.258	5.096	0.558	0.337–0.926	0.024
Low	1.133	0.613	3.418	3.105	0.934–10.317	0.064
Parental marital status						
Normal	Ref	-	-	-	-	-
Abnormal	0.730	0.284	6.593	2.075	1.189–3.622	0.010
CES-D score	0.079	0.012	40.889	1.082	1.056–1.109	< 0.001
IRI score	0.025	0.011	5.019	1.026	1.003–1.049	0.025
Female patients						
Academic pressure						
High	Ref	-	-	-	-	-
Average	-0.612	0.307	3.961	0.542	0.297–0.991	0.047
Low	1.059	0.785	1.817	2.882	0.618–13.436	0.178
Parental marital status						
Normal	Ref	-	-	-	-	-
Abnormal	0.833	0.346	5.773	2.299	1.166–4.534	0.016
CES-D score	0.084	0.015	29.858	1.088	1.055–1.121	< 0.001
IRI score	0.037	0.014	6.693	1.038	1.009–1.068	0.010
Male patients						
CES-D, Center for Epidemiologic Studies Depression Scale; IRI, Interpersonal Reactivity Index; SE, Standard Error; OR, Odds Ratio; CI, Confidence Interval; Bolded <i>P</i> value: < 0.05.						
Model 1 included sociodemographic variables that were significant in univariate analyses, along with the total CES-D and IRI scores.						

Variables	B	SE	Wald χ^2	OR	95% CI	<i>P</i>
Total sample						
Academic pressure						
Education level						
High school	Ref	-	-	-	-	-
Junior high school	-1.652	0.638	6.700	0.192	0.055–0.670	0.010
Suicidal attempts	2.028	0.586	11.983	7.603	2.411–23.976	0.001
CES-D score	0.065	0.024	7.379	1.068	1.018–1.119	0.007
CES-D, Center for Epidemiologic Studies Depression Scale; IRI, Interpersonal Reactivity Index; SE, Standard Error; OR, Odds Ratio; CI, Confidence Interval; Bolded <i>P</i> value: < 0.05.						
Model 1 included sociodemographic variables that were significant in univariate analyses, along with the total CES-D and IRI scores.						

Table 5
Independent factors associated with insomnia by multivariate logistic stepwise regression analysis
(Model 2)

Variables	B	SE	Wald χ^2	OR	95% CI	<i>P</i>
Total sample						
Academic pressure						
High	Ref	-	-	-	-	-
Average	-0.544	0.264	4.248	0.581	0.346–0.974	0.039
Low	0.867	0.600	2.091	2.381	0.735–7.715	0.148
Parental marital status						
Normal	Ref	-	-	-	-	-
Abnormal	0.671	0.290	5.352	1.957	1.108–3.455	0.021
Somatic symptoms score	0.269	0.037	52.111	1.308	1.216–1.407	< 0.001
FS score	0.067	0.027	6.249	1.069	1.014–1.126	0.012
Female patients						
Academic pressure						
High	Ref	-	-	-	-	-
Average	-0.618	0.311	3.948	0.539	0.293–0.992	0.047
Low	0.786	0.780	1.015	2.194	0.476–10.123	0.314
Parental marital status						
Normal	Ref	-	-	-	-	-
Abnormal	0.719	0.343	4.396	2.052	1.048–4.017	0.036
Somatic symptoms score	0.244	0.044	31.200	1.277	1.172–1.391	< 0.001
PD score	0.092	0.039	5.437	1.096	1.015–1.184	0.020
Male patients						
FS, Fantasy; PD, Personal distress; SE, Standard Error; OR, Odds Ratio; CI, Confidence Interval; Bolded <i>P</i> value: < 0.05.						
Model 2 included significant sociodemographic variables along with subscale scores from the CES-D and IRI that showed significance in univariate analyses.						

Variables	B	SE	Wald χ^2	OR	95% CI	<i>P</i>
Total sample						
Academic pressure						
Education level						
High school	Ref	-	-	-	-	-
Junior high school	-1.862	0.663	7.895	0.155	0.042–0.569	0.005
Suicidal attempts	1.650	0.537	9.454	5.208	1.819–14.913	0.002
Somatic symptoms score	0.259	0.074	12.386	1.296	1.122–1.498	< 0.001
FS, Fantasy; PD, Personal distress; SE, Standard Error; OR, Odds Ratio; CI, Confidence Interval; Bolded <i>P</i> value: < 0.05.						
Model 2 included significant sociodemographic variables along with subscale scores from the CES-D and IRI that showed significance in univariate analyses.						

3.3. Predictive value of independent factors for insomnia

Table 6 and Fig. 1 summarized the results of ROC curve analyses of Model 1. In Model 1, for the total sample, the predictive utility of each independent factor for insomnia was as follows: academic pressure (AUC = 0.617, 95% CI = 0.559–0.676, $P < 0.001$), parental marital status (AUC = 0.574, 95% CI = 0.513–0.636, $P = 0.017$), CES-D score (AUC = 0.755, 95% CI = 0.706–0.804, $P < 0.001$), and IRI score (AUC = 0.598, 95% CI = 0.539–0.657, $P = 0.002$). Compared with these individual predictors, the combined index showed better discrimination for insomnia (AUC = 0.785, 95% CI = 0.738–0.833, $P < 0.001$). Among female patients, the predictive utility of each independent factor for insomnia was: academic pressure (AUC = 0.620, 95% CI = 0.551–0.689, $P = 0.001$), parental marital status (AUC = 0.587, 95% CI = 0.515–0.659, $P = 0.018$), CES-D score (AUC = 0.772, 95% CI = 0.715–0.830, $P < 0.001$), and IRI score (AUC = 0.609, 95% CI = 0.540–0.677, $P = 0.003$). Compared with these individual predictors, the combined index demonstrated better discrimination for insomnia (AUC = 0.803, 95% CI = 0.748–0.858, $P < 0.001$). Among male patients, the predictive utility of each independent factor for insomnia was: education level (AUC = 0.648, 95% CI = 0.542–0.754, $P = 0.013$), suicide attempts (AUC = 0.680, 95% CI = 0.573–0.787, $P = 0.003$), and CES-D score (AUC = 0.718, 95% CI = 0.622–0.813, $P < 0.001$). Compared with these individual predictors, the combined index showed better discrimination for insomnia (AUC = 0.817, 95% CI = 0.737–0.897, $P < 0.001$). Table 7 and Fig. 2 summarized the results of ROC curve analyses of Model 2. In Model 2, for the total sample, the predictive utility of each independent factor for insomnia was as follows: somatic symptoms score (AUC = 0.774, 95% CI = 0.726–0.822, $P < 0.001$), and FS score (AUC = 0.572, 95% CI = 0.512–0.631, $P = 0.021$). Compared with these individual predictors, the combined index showed better discrimination for insomnia (AUC = 0.800, 95% CI = 0.754–0.846, $P < 0.001$). Among

female patients, the predictive utility of each independent factor for insomnia was: somatic symptoms score (AUC = 0.780, 95% CI = 0.724–0.836, $P < 0.001$), and PD score (AUC = 0.664, 95% CI = 0.598–0.731, $P < 0.001$). Compared with these individual predictors, the combined index demonstrated better discrimination for insomnia (AUC = 0.808, 95% CI = 0.755–0.861, $P < 0.001$). Among male patients, the predictive utility of each independent factor for insomnia was: somatic symptoms score (AUC = 0.763, 95% CI = 0.673–0.853, $P < 0.001$). Compared with these individual predictors, the combined index showed better discrimination for insomnia (AUC = 0.828, 95% CI = 0.748–0.907, $P < 0.001$).

Table 6
Predictive value of each independent influence for insomnia (Model 1)

Variables	Sensitivity	Specificity	AUC	95% CI	<i>P</i>
Total sample					
Academic pressure	0.694	0.533	0.617	0.559–0.676	< 0.001
Parental marital status	0.336	0.812	0.574	0.513–0.636	0.017
CES-D score	0.761	0.642	0.755	0.706–0.804	< 0.001
IRI score	0.754	0.400	0.598	0.539–0.657	0.002
Combined ^a	0.634	0.829	0.785	0.738–0.833	< 0.001
Female patients					
Academic pressure	0.687	0.551	0.620	0.551–0.689	0.001
Parental marital status	0.354	0.820	0.587	0.515–0.659	0.018
CES-D score	0.828	0.617	0.772	0.715–0.830	< 0.001
IRI score	0.485	0.677	0.609	0.540–0.677	0.003
Combined ^b	0.717	0.814	0.803	0.748–0.858	< 0.001
Male patients					
Education level	0.857	0.438	0.648	0.542–0.754	0.013
Suicidal attempts	0.743	0.616	0.680	0.573–0.787	0.003
CES-D score	0.857	0.575	0.718	0.622–0.813	< 0.001
Combined ^c	0.600	0.863	0.817	0.737–0.897	< 0.001
CES-D, Center for Epidemiologic Studies Depression Scale; IRI, Interpersonal Reactivity Index; AUC, Area Under the Curve; CI, Confidence Interval; Bolded <i>P</i> value: < 0.05; ^a , Combination of academic pressure, parental marital status, CES-D score and IRI score; ^b , Combination of academic pressures, parental marital status, CES-D score and IRI score; ^c , Combination of education level, suicidal attempts and CES-D score.					
Model 1 included sociodemographic variables that were significant in univariate analyses, along with the total CES-D and IRI scores.					

Table 7
Predictive value of each independent influence for insomnia (Model 2)

Variables	Sensitivity	Specificity	AUC	95% CI	<i>P</i>
Total sample					
Academic pressure	0.694	0.533	0.617	0.559–0.676	< 0.001
Parental marital status	0.336	0.812	0.574	0.513–0.636	0.017
Somatic symptoms score	0.791	0.658	0.774	0.726–0.822	< 0.001
FS score	0.821	0.308	0.572	0.512–0.631	0.021
Combined ^a	0.590	0.863	0.800	0.754–0.846	< 0.001
Female patients					
Academic pressure	0.687	0.551	0.620	0.551–0.689	0.001
Parental marital status	0.354	0.820	0.587	0.515–0.659	0.018
Somatic symptoms score	0.737	0.719	0.780	0.724–0.836	< 0.001
PD score	0.687	0.581	0.664	0.598–0.731	< 0.001
Combined ^b	0.687	0.796	0.808	0.755–0.861	< 0.001
Male patients					
Education level	0.857	0.438	0.648	0.542–0.754	0.013
Suicidal attempts	0.743	0.616	0.680	0.573–0.787	0.003
Somatic symptoms score	0.829	0.616	0.763	0.673–0.853	< 0.001
Combined ^c	0.629	0.863	0.828	0.748–0.907	< 0.001
FS, Fantasy; PD, Personal distress; AUC, Area Under the Curve; CI, Confidence Interval; Bolded <i>P</i> value: < 0.05; ^a , Combination of academic pressure, parental marital status, somatic symptoms score and FS score; ^b , Combination of academic pressures, parental marital status, somatic symptoms score and PD score; ^c , Combination of education level, suicidal attempts and somatic symptoms score.					
Model 2 included significant sociodemographic variables along with subscale scores from the CES-D and IRI that showed significance in univariate analyses.					

4. Discussion

As far as we are aware, this represented the first investigation to explore the link between empathy and insomnia, along with the corresponding sex differences in adolescents with MDD. The prevalence of insomnia in our cohort (35.8%) was substantially higher than the 26.0% rate documented for sleep disturbances in the general Chinese adolescent population[27]. This highlights the substantial severity of insomnia in this specific patient population. This may be attributable to MDD's ability to disrupt sleep-regulatory mechanisms through systemic inflammation and sustained hyperactivity of the hypothalamic-pituitary-adrenal (HPA) axis, which in turn exacerbates insomnia severity[28]. Meanwhile, we found the prevalence of insomnia to be 37.2% among females and 32.4% among males. Although no statistically significant variance was detected, the rate among females was marginally greater than that among males. A prior study has also found that, among adolescents, the prevalence of insomnia was higher in females[29]. The sex difference in insomnia prevalence during puberty appears to be driven by both biological and psychological factors. On the one hand, hormonal changes in adolescence alter sleep architecture. Hormones such as those secreted by the ovaries can suppress sleep[30]. On the other hand, females are more sensitive to emotional and interpersonal stress[31]. Females also tend to exhibit higher levels of neuroticism and engage in more frequent presleep rumination and worry, both of which are known to prolong sleep onset latency.

In terms of general information, individuals with insomnia were significantly more likely to report poorer parental marital status. Previous studies have reported similar findings, indicating that parental marital status was associated with sleep status[32, 33]. Parental marital conflict may induce family stress and emotional insecurity, placing adolescents in a state of heightened vigilance[34]. Such vigilance can activate the HPA axis and increase cortisol levels, consequently leading to difficulty falling asleep and nocturnal awakening[35]. In addition, this study found that patients with lower academic pressure were less likely to experience insomnia. This was consistent with previous findings[36]. A meta-analysis has shown that academic stress can lead to insomnia through multiple dimensions[37]. Specifically, at the cognitive level, academic pressure triggers presleep academic rumination. This rumination prolongs sleep-onset latency and precipitates acute insomnia. At the physiological level, academic pressure activates the HPA axis and the sympathetic nervous system. This activation induces a state of nocturnal hyperarousal that disrupts sleep homeostasis. Poor parental marital quality and academic pressure are two prominent chronic psychosocial stressors. They can precipitate or perpetuate insomnia through multiple emotional, cognitive, and physiological pathways. Therefore, early family intervention is necessary to break the vicious cycle of stress, hypervigilance, and insomnia at the early stages.

Additionally, the study showed that depressed adolescents who had previously attempted suicide reported more insomnia than their non-attempter counterparts. Previous studies have consistently supported this association[38, 39]. The association between suicide attempts and insomnia may be bidirectional. On the one hand, genetic studies have provided foundational support. A large-scale genome-wide association study found a significant genetic correlation between insomnia and suicide attempts[40]. On the other hand, multiple mediating mechanisms have been uncovered. For example, excessive daytime sleepiness has been shown to be a key mediator between insomnia and suicidal behavior in adolescents[41]. Another study indicated that the significant association between insomnia

and suicidal ideation is fully mediated by anxiety and MDD[42]. However, the aforementioned studies have only begun to map the complex interplay between insomnia and suicide attempts, and the current research paradigm remains sharply limited. Most evidence views insomnia as a precursor to suicide, but longitudinal studies on whether suicide attempts later worsen insomnia are still missing. Future research should adopt a bidirectional causal framework to clarify the dynamic association between these two phenomena.

The findings indicated that, in adolescents with MDD, insomnia was strongly associated with MDD symptom severity. The association between MDD and insomnia is not simply unidirectional but rather a complex bidirectional relationship[43, 44]. A prospective cohort study of the United States adolescents showed that baseline insomnia approximately doubled the subsequent risk of incident MDD, while MDD similarly approximately doubled the subsequent risk of incident insomnia[45]. An Iraqi study found a positive correlation between MDD and insomnia, with greater insomnia severity observed as MDD progressed from moderate to severe levels[46]. Insomnia may create a positive-feedback loop through multisystem interactions, further exacerbating neurodegeneration[47]. Therefore, insomnia should be prioritized as a key therapeutic target in the clinical management of adolescents with MDD. Interventions targeting insomnia are likely to confer concurrent benefits on MDD. For example, cognitive behavioral therapy for insomnia (CBT-I) produced significant improvements in sleep and also yielded positive effects on depressive symptoms[48].

Results from our study revealed that insomnia was significantly associated with the empathy of adolescents with MDD. A previous study has observed a comparable association between heightened empathy and sleep disturbances[49]. Empathy is generally seen as a resilience factor. However, sharing in others' distress may increase psychological vulnerability during large-scale trauma exposure, especially in adolescents.[50]. Firstly, when individuals perceived others' pain, the neural signature of empathic distress increased[51]. At the same time, the felt intensity of emotional disturbance and the level of autonomic arousal also rose. Individuals with high emotional empathy were more susceptible to others' suffering. This heightened sensitivity increased their risk of personal distress and internalizing symptoms such as MDD and anxiety, a process mediated by intense emotional resonance[50]. When passively observing others undergoing psychosocial stress, the observer's own HPA axis can be activated[52]. Several studies have confirmed that hyperactivity of the HPA axis, particularly elevated cortisol levels at night or before bedtime, is closely associated with the onset and maintenance of chronic insomnia[53, 54]. Secondly, a study also found that individuals with high empathy exhibited heightened reflective rumination during socioemotional processing[55]. When empathy coexists with worry, it can amplify emotional residue and heighten situational vulnerability to anxiety. Anxiety, for its part, can actively initiate and maintain insomnia through the combined action of neurobiological and psychobehavioral mechanisms[56]. In summary, early attention should be paid to empathy in adolescents with MDD. They merit targeted clinical intervention. For example, research has found that self-compassion can buffer the negative experiences associated with empathy by reducing the personal-distress component of adolescents' affective empathy[57]. Moreover, previous studies have identified self-compassion as an important protective factor against sleep disturbances[58, 59]. A study has also

demonstrated that compassion-focused interventions, by enhancing individuals' tolerance of negative emotions and their ability to regulate emotions, can effectively reduce depressive symptoms[60]. Thus, clinical interventions could prioritize fostering individuals' self-compassion.

Notably, the association between empathy and insomnia was statistically significant only among female patients. The potential mechanisms underlying this sex difference may be explained from multiple perspectives. First, females tend to show heightened responsiveness in emotional empathy. Highly empathic females displayed stronger emotional resonance when confronted with others' distress[61]. In turn, this response mediated excessive cognitive and autonomic activation, and thus served as a key psychological mechanism underlying the onset and maintenance of insomnia[62]. Additionally, adolescent females showed a more pronounced elevation in cortisol levels under stress[63]. This physiological response may further amplify the emotional burden induced by empathy, facilitating the development of insomnia. Meanwhile, a study indicated that hormonal changes, the assignment of social roles, and emotional socialization processes starting in adolescence rendered females more prone to emotional regulation difficulties[64]. They show a reduced ability to identify and differentiate their own emotions from those of others. When confronted with others' distress, this confusion elicits more self-directed discomfort and subsequently intensifies emotional load and sleep disturbances. In contrast, males tended to favor externalizing strategies. These strategies reduced their personal distress when confronted with others' discomfort[65], potentially weakening the link between empathy and insomnia. However, this mechanism awaits further empirical verification.

Our study had several limitations. Firstly, the cross-sectional framework of the study prohibited the establishment of causal relationships. Therefore, large-scale longitudinal studies are needed to examine the temporal sequence and directional relationships between key variables. Secondly, the sample was limited to Anhui Province and relatively small, which may compromise geographical representativeness and increase the risk of selection bias. Thus, caution is warranted when generalizing the findings to broader populations. Finally, both insomnia and empathy were assessed solely with self-report scales, which were susceptible to recall bias. Future studies should incorporate objective indicators such as polysomnography and smart wearable devices to improve the accuracy and ecological validity of sleep assessment.

5. Conclusion

Insomnia was prevalent in adolescents with MDD, and a significant association was observed between insomnia and empathy in this population, particularly among female patients. Future research should further investigate the underlying mechanisms linking empathy and insomnia, and develop targeted interventions to effectively improve sleep quality and overall mental health outcomes in this population.

Declarations

Ethics approval and consent to participate

The study protocol was approved by the Ethics Committee of the Fourth Affiliated Hospital of Anhui Medical University (No. 202009-KYXM-04). Written informed consent was obtained from both participants and their legal guardians after a comprehensive explanation of the study procedures.

Consent for publication

Not applicable.

Competing interests

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Clinical trial number

Not applicable.

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Author Contribution

HL and LX: the study's design. PT, LL, YL, JX, ZL, JW, CC, FG, WL, XL, and XW: collection, analyses and interpretation of the data. PT: drafting of the manuscript. HL and LX: revision of the manuscript. The final version of the publication was approved by all authors.

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Data Availability

The data used for this study are available from the corresponding author on reasonable request.

References

1. Lu B, Lin L, Su X. Global burden of depression or depressive symptoms in children and adolescents: A systematic review and meta-analysis. *J Affect Disord.* 2024;354:553–62. <http://doi.org/10.1016/j.jad.2024.03.074>.
2. Li F, Cui Y, Li Y, Guo L, Ke X, Liu J, Luo X, Zheng Y, Leckman JF. Prevalence of mental disorders in school children and adolescents in China: diagnostic data from detailed clinical assessments of 17,524 individuals. *J Child Psychol Psychiatry.* 2022;63(1):34–46. <http://doi.org/10.1111/jcpp.13445>.
3. Tsuno N, Besset A, Ritchie K. Sleep and depression. *J Clin Psychiatry.* 2005;66(10):1254–69. <http://doi.org/10.4088/jcp.v66n1008>.
4. Geoffroy PA, Hoertel N, Etain B, Bellivier F, Delorme R, Limosin F, Peyre H. Insomnia and hypersomnia in major depressive episode: Prevalence, sociodemographic characteristics and psychiatric comorbidity in a population-based study. *J Affect Disord.* 2018;226:132–41. <http://doi.org/10.1016/j.jad.2017.09.032>.
5. Pei C, Fan C, Luo H, Bai A, Ni S, Luo M, Huang J, Zhou Y, Huo L. Sleep problems in adolescents with depression: Role of childhood trauma, alexithymia, rumination, and self-esteem. *J Affect Disord.* 2023;338:83–91. <http://doi.org/10.1016/j.jad.2023.05.095>.
6. Joshi K, Cambron-Mellott MJ, Costantino H, Pfau A, Jha MK. The real-world burden of adults with major depressive disorder with moderate or severe insomnia symptoms in the United States. *J Affect Disord.* 2023;323:698–706. <http://doi.org/10.1016/j.jad.2022.12.005>.
7. Riise JG, Cambron-Mellott MJ, Zhang Z, Huber V, Pfau A, Yue L, Dwibedi N, Olopoenia A, Geoffroy PA. Examining the burden of major depressive disorder with moderate-to-severe insomnia symptoms in five European countries. *J Affect Disord.* 2025;386:119403. <http://doi.org/10.1016/j.jad.2025.119403>.
8. Fan X, Ma Y, Zhang J, Lin X, Sun B, Rosenheck R, He H. Sleep disturbance and suicidal ideation among youth with depression. *J Affect Disord.* 2024;354:232–8. <http://doi.org/10.1016/j.jad.2024.03.019>.
9. Geoffroy PA, Edán-Sánchez A, Sánchez-Rico M, Mauries S, Palagini L, Peyre H, Lejoyeux M, Maruani J, Hoertel N. Sex differences in insomnia and hypersomnia complaints during major depressive episode: Results from a national sample. *J Affect Disord.* 2025;369:202–10. <http://doi.org/10.1016/j.jad.2024.09.163>.
10. Asarnow LD, Manber R. Cognitive Behavioral Therapy for Insomnia in Depression. *Sleep Med Clin.* 2019;14(2):177–84. <http://doi.org/10.1016/j.jsmc.2019.01.009>.
11. Rong T, Sun X, Zhang Z, Li W, Deng Y, Wang Z, Meng M, Zhu Q, Jiang Y, Zhao J, et al. The association between sleep and empathy in young preschoolers: A population study. *J Sleep Res.* 2022;31(4):e13530. <http://doi.org/10.1111/jsr.13530>.
12. Preston SD, de Waal FB. Empathy: Its ultimate and proximate bases. *Behav Brain Sci.* 2002;25(1):1–20. <http://doi.org/10.1017/s0140525x02000018>. discussion 20–71.

13. Shamay-Tsoory SG. The neural bases for empathy. *Neuroscientist*. 2011;17(1):18–24. <http://doi.org/10.1177/1073858410379268>.
14. McDonald B, Kanske P. Gender differences in empathy, compassion, and prosocial donations, but not theory of mind in a naturalistic social task. *Sci Rep*. 2023;13(1):20748. <http://doi.org/10.1038/s41598-023-47747-9>.
15. Hülsemann MJ, Kaurin A, Kollmann B, Chmitorz A, Ahrens KF, Schenk C, Plichta MM, Lutz B, Basten U, Fiebach CJ, et al. Self-oriented affective empathy is associated with increased negative affect. *Sci Rep*. 2025;15(1):27767. <http://doi.org/10.1038/s41598-025-09860-9>.
16. Bennik EC, Jeronimus BF, Aan Het Rot M. The relation between empathy and depressive symptoms in a Dutch population sample. *J Affect Disord*. 2019;242:48–51. <http://doi.org/10.1016/j.jad.2018.08.008>.
17. Yan Z, Zeng X, Su J, Zhang X. The dark side of empathy: Meta-analysis evidence of the relationship between empathy and depression. *Psych J*. 2021;10(5):794–804. <http://doi.org/10.1002/pchj.482>.
18. Li Y, Wang Y, Guan X, Yue J, Wu HE, Zhen S, He SC, Zhang XY. Genotype-genotype interactions of the OXTR gene polymorphisms are associated with self-reported daytime dysfunction, sleep latency and personal distress. *J Sleep Res*. 2023;32(1):e13668. <http://doi.org/10.1111/jsr.13668>.
19. Brand S, Kirov R, Kalak N, Gerber M, Schmidt NB, Lemola S, Correll CU, Holsboer-Trachsler E. Poor Sleep Is Related to Lower Emotional Competence Among Adolescents. *Behav Sleep Med*. 2016;14(6):602–14. <http://doi.org/10.1080/15402002.2015.1048450>.
20. Radloff LS. The CES-D scale: A self-report depression scale for research in the general population. *Appl Psychol Meas*. 1977;1(3):385–401. <http://doi.org/10.1177/014662167700100306>.
21. Yang W, Xiong G, Garrido LE, Zhang JX, Wang MC, Wang C. Factor structure and criterion validity across the full scale and ten short forms of the CES-D among Chinese adolescents. *Psychol Assess*. 2018;30(9):1186–98. <http://doi.org/10.1037/pas0000559>.
22. Davis MH. Measuring individual differences in empathy: Evidence for a multidimensional approach. *J Personal Soc Psychol*. 1983;44(1):113–26. <http://doi.org/10.1037/0022-3514.44.1.113>.
23. Tan X, Yang Y, Yu M. Longitudinal relationship of empathy and social anxiety among adolescents: The mediation roles of psychological inflexibility and rejection sensitivity. *J Affect Disord*. 2023;339:867–76. <http://doi.org/10.1016/j.jad.2023.07.069>.
24. Fei W, Geng Y, Wang S, Ma Q, Peng X, Zhang M, Zhang T. Association between parental control and subclinical depressive symptoms in a sample of college freshmen: Roles of empathy and gender. *J Affect Disord*. 2021;286:301–8. <http://doi.org/10.1016/j.jad.2021.03.005>.
25. Chung KF, Kan KK, Yeung WF. Assessing insomnia in adolescents: comparison of Insomnia Severity Index, Athens Insomnia Scale and Sleep Quality Index. *Sleep Med*. 2011;12(5):463–70. <http://doi.org/10.1016/j.sleep.2010.09.019>.
26. Gagnon C, Bélanger L, Ivers H, Morin CM. Validation of the Insomnia Severity Index in primary care. *J Am Board Fam Med*. 2013;26(6):701–10. <http://doi.org/10.3122/jabfm.2013.06.130064>.

27. Liang M, Guo L, Huo J, Zhou G. Prevalence of sleep disturbances in Chinese adolescents: A systematic review and meta-analysis. *PLoS ONE*. 2021;16(3):e0247333. <http://doi.org/10.1371/journal.pone.0247333>.
28. Gao T, Xiang H, Wu QN, Zhu LS, Pei WJ, Fu WJ, Chou TS. Advances in the research of comorbid insomnia and depression: mechanisms, impacts, and interventions. *Front Psychiatry*. 2025;16:1468212. <http://doi.org/10.3389/fpsyt.2025.1468212>.
29. Hysing M, Pallesen S, Stormark KM, Lundervold AJ, Sivertsen B. Sleep patterns and insomnia among adolescents: a population-based study. *J Sleep Res*. 2013;22(5):549–56. <http://doi.org/10.1111/jsr.12055>.
30. Dorsey A, de Lecea L, Jennings KJ. Neurobiological and Hormonal Mechanisms Regulating Women's Sleep. *Front Neurosci*. 2020;14:625397. <http://doi.org/10.3389/fnins.2020.625397>.
31. Baldi E, Cerolini S, Meneo D, Baglioni C, Palagini L. Insomnia Disorder: Gender Issues Over the Lifespan. *J Sleep Res*. 2025;34(5):e70110. <http://doi.org/10.1111/jsr.70110>.
32. Gregory AM, Caspi A, Moffitt TE, Poulton R. Family conflict in childhood: a predictor of later insomnia. *Sleep*. 2006;29(8):1063–7. <http://doi.org/10.1093/sleep/29.8.1063>.
33. Rhoades KA, Leve LD, Harold GT, Mannering AM, Neiderhiser JM, Shaw DS, Natsuaki MN, Reiss D. Marital hostility and child sleep problems: direct and indirect associations via hostile parenting. *J Fam Psychol*. 2012;26(4):488–98. <http://doi.org/10.1037/a0029164>.
34. Kelly RJ, El-Sheikh M. Marital conflict and children's sleep: reciprocal relations and socioeconomic effects. *J Fam Psychol*. 2011;25(3):412–22. <http://doi.org/10.1037/a0023789>.
35. Hanson MD, Chen E. Daily stress, cortisol, and sleep: the moderating role of childhood psychosocial environments. *Health Psychol*. 2010;29(4):394–402. <http://doi.org/10.1037/a0019879>.
36. Xu J, Wang H, Liu S, Hale ME, Weng X, Ahemaitijiang N, Hu Y, Suveg C, Han ZR. Relations among family, peer, and academic stress and adjustment in Chinese adolescents: A daily diary analysis. *Dev Psychol*. 2023;59(7):1346–58. <http://doi.org/10.1037/dev0001538>.
37. Gardani M, Bradford DRR, Russell K, Allan S, Beattie L, Ellis JG, Akram U. A systematic review and meta-analysis of poor sleep, insomnia symptoms and stress in undergraduate students. *Sleep Med Rev*. 2022;61:101565. <http://doi.org/10.1016/j.smrv.2021.101565>.
38. Kay DB, Dombrovski AY, Buysse DJ, Reynolds CF, Begley A, Szanto K. Insomnia is associated with suicide attempt in middle-aged and older adults with depression. *Int Psychogeriatr*. 2016;28(4):613–9. <http://doi.org/10.1017/s104161021500174x>.
39. Simmons Z, Burlingame G, Korbanka J, Eastman K, Thomas D, Christensen J, Jenson M, Nadorff MR, Kay DB. Insomnia symptom severity is associated with increased suicidality and death by suicide in a sample of patients with psychiatric disorders. *Sleep*. 2021;44(7). <http://doi.org/10.1093/sleep/zsab032>.
40. Mullins N, Kang J, Campos AI, Coleman JRI, Edwards AC, Galfalvy H, Levey DF, Lori A, Shabalin A, Starnawska A, et al. Dissecting the Shared Genetic Architecture of Suicide Attempt, Psychiatric

- Disorders, and Known Risk Factors. *Biol Psychiatry*. 2022;91(3):313–27.
<http://doi.org/10.1016/j.biopsych.2021.05.029>.
41. Liu ZZ, Jia CX, Liu X. Excessive daytime sleepiness mediates the relationship between insomnia symptoms and suicidal behavior in adolescents. *Sleep*. 2022;45(11).
<http://doi.org/10.1093/sleep/zsac221>.
42. Mao X, Zhang F, Ni C, Zhou Q, Hou T. Anxiety and depression as mediators in insomnia-suicidal ideation link among isolated individuals. *BMC Psychiatry*. 2025;25(1):984.
<http://doi.org/10.1186/s12888-025-07454-3>.
43. Fang H, Tu S, Sheng J, Shao A. Depression in sleep disturbance: A review on a bidirectional relationship, mechanisms and treatment. *J Cell Mol Med*. 2019;23(4):2324–32.
<http://doi.org/10.1111/jcmm.14170>.
44. Franzen PL, Buysse DJ. Sleep disturbances and depression: risk relationships for subsequent depression and therapeutic implications. *Dialogues Clin Neurosci*. 2008;10(4):473–81.
<http://doi.org/10.31887/DCNS.2008.10.4/plfranzen>.
45. Roberts RE, Duong HT. Depression and insomnia among adolescents: a prospective perspective. *J Affect Disord*. 2013;148(1):66–71. <http://doi.org/10.1016/j.jad.2012.11.049>.
46. Mohammed Salih AM, Madallah ZT, Ibrahim RH, Alseadn MSH, Almushhadany OI. Exploring the relationship between insomnia and depression: a cross-sectional prospective study. *Ann Med Surg (Lond)*. 2023;85(6):2573–8. <http://doi.org/10.1097/ms9.0000000000000784>.
47. Palagini L, Geoffroy PA, Miniati M, Perugi G, Biggio G, Marazziti D, Riemann D. Insomnia, sleep loss, and circadian sleep disturbances in mood disorders: a pathway toward neurodegeneration and neuroprogression? A theoretical review. *CNS Spectr*. 2022;27(3):298–308.
<http://doi.org/10.1017/s1092852921000018>.
48. Mirchandaney R, Barete R, Asarnow LD. Moderators of Cognitive Behavioral Treatment for Insomnia on Depression and Anxiety Outcomes. *Curr Psychiatry Rep*. 2022;24(2):121–8.
<http://doi.org/10.1007/s11920-022-01326-3>.
49. Guadagni V, Umilta A, Iaria G. Sleep Quality, Empathy, and Mood During the Isolation Period of the COVID-19 Pandemic in the Canadian Population: Females and Women Suffered the Most. *Front Glob Womens Health*. 2020;1:585938. <http://doi.org/10.3389/fgwh.2020.585938>.
50. Katsoty D, Abramson L, Knafo-Noam A. Empathy as a risk factor for internalizing symptoms during war: A 10-year prospective study from toddlerhood to adolescence. *Dev Psychopathol* 2025:1–9.
<http://doi.org/10.1017/s0954579425100631>
51. Lamm C, Singer T. The role of anterior insular cortex in social emotions. *Brain Struct Funct*. 2010;214(5–6):579–91. <http://doi.org/10.1007/s00429-010-0251-3>.
52. Engert V, Plessow F, Miller R, Kirschbaum C, Singer T. Cortisol increase in empathic stress is modulated by emotional closeness and observation modality. *Psychoneuroendocrinology*. 2014;45:192–201. <http://doi.org/10.1016/j.psyneuen.2014.04.005>.

53. Dressle RJ, Feige B, Spiegelhalder K, Schmucker C, Benz F, Mey NC, Riemann D. HPA axis activity in patients with chronic insomnia: A systematic review and meta-analysis of case-control studies. *Sleep Med Rev.* 2022;62:101588. <http://doi.org/10.1016/j.smr.2022.101588>.
54. Vgontzas AN, Tsigos C, Bixler EO, Stratakis CA, Zachman K, Kales A, Vela-Bueno A, Chrousos GP. Chronic insomnia and activity of the stress system: a preliminary study. *J Psychosom Res.* 1998;45(1):21–31. [http://doi.org/10.1016/s0022-3999\(97\)00302-4](http://doi.org/10.1016/s0022-3999(97)00302-4).
55. Knight LK, Stoica T, Fogleman ND, Depue BE. Convergent Neural Correlates of Empathy and Anxiety During Socioemotional Processing. *Front Hum Neurosci.* 2019;13:94. <http://doi.org/10.3389/fnhum.2019.00094>.
56. Palagini L, Hertenstein E, Riemann D, Nissen C. Sleep, insomnia and mental health. *J Sleep Res.* 2022;31(4):e13628. <http://doi.org/10.1111/jsr.13628>.
57. Marshall SL, Ciarrochi J, Parker PD, Sahdra BK. Is Self-Compassion Selfish? The Development of Self-Compassion, Empathy, and Prosocial Behavior in Adolescence. *J Res Adolesc.* 2020;30(Suppl 2):472–84. <http://doi.org/10.1111/jora.12492>.
58. Rakhimov A, Ong J, Realo A, Tang NKY. Being kind to self is being kind to sleep? A structural equation modelling approach evaluating the direct and indirect associations of self-compassion with sleep quality, emotional distress and mental well-being. *Curr Psychol.* 2023;42(16):14092–105. <http://doi.org/10.1007/s12144-021-02661-z>.
59. Marques DR, Miller-Mendes M, Gomes AA, Pereira AS. The Role of Self-compassion as a Mediator Between Insomnia, Depression, and Anxiety. *Sleep Vigilance.* 2024;8(1):131–8. <http://doi.org/10.1007/s41782-024-00265-8>.
60. Diedrich A, Burger J, Kirchner M, Berking M. Adaptive emotion regulation mediates the relationship between self-compassion and depression in individuals with unipolar depression. *Psychol Psychother.* 2017;90(3):247–63. <http://doi.org/10.1111/papt.12107>.
61. Maffei A, Spironelli C, Angrilli A. Affective and cortical EEG gamma responses to emotional movies in women with high vs low traits of empathy. *Neuropsychologia.* 2019;133:107175. <http://doi.org/10.1016/j.neuropsychologia.2019.107175>.
62. Baglioni C, Spiegelhalder K, Lombardo C, Riemann D. Sleep and emotions: a focus on insomnia. *Sleep Med Rev.* 2010;14(4):227–38. <http://doi.org/10.1016/j.smr.2009.10.007>.
63. Mrug S, Tyson A, Turan B, Granger DA. Sleep problems predict cortisol reactivity to stress in urban adolescents. *Physiol Behav.* 2016;155:95–101. <http://doi.org/10.1016/j.physbeh.2015.12.003>.
64. Levkovich I, Yatzkar U, Shenaar-Golan V. Age and Gender Differences in Emotional and Behavioral Functioning Among Youth Referred to a Psychiatric Outpatient Clinic at a Public Hospital. *Child (Basel).* 2025;12(6). <http://doi.org/10.3390/children12060683>.
65. Trentini C, Tambelli R, Maiorani S, Lauriola M. Gender Differences in Empathy During Adolescence: Does Emotional Self-Awareness Matter? *Psychol Rep.* 2022;125(2):913–36. <http://doi.org/10.1177/0033294120976631>.

Figures

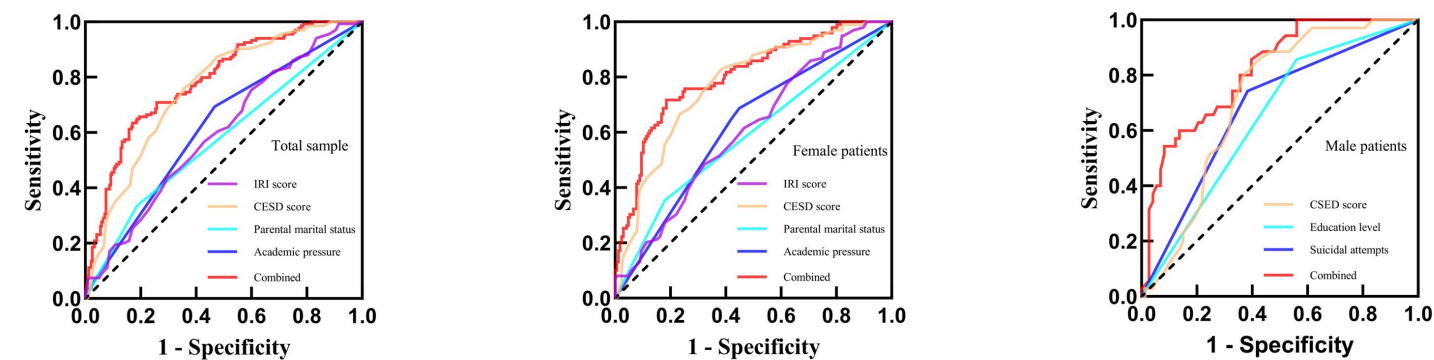


Figure 1
ROC curve analyses of insomnia (Model 1)

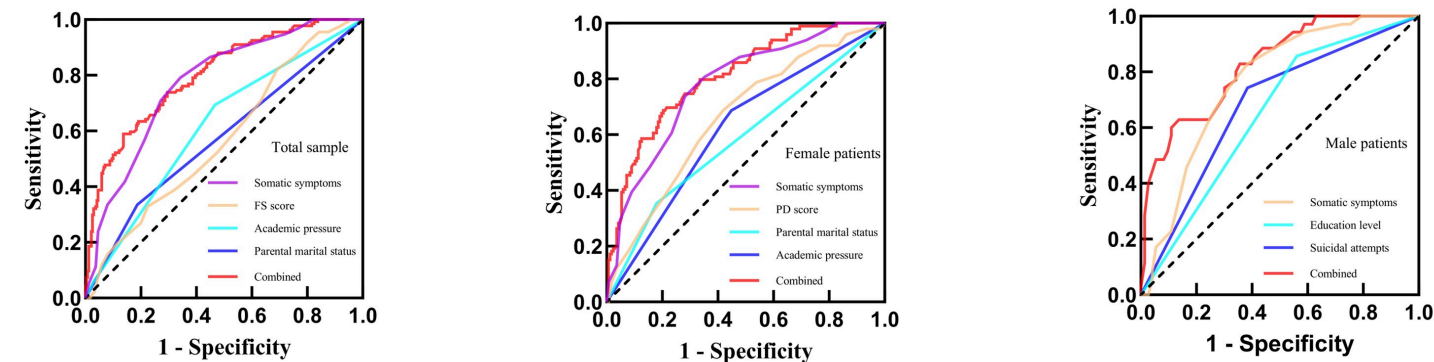


Figure 2
ROC curve analyses of insomnia (Model 2)