

RESEARCH ARTICLE

Psychological inflexibility, dysfunctional beliefs and attitudes about sleep, and insomnia severity among Chinese college students: A mediation analysis

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(zengyus@kean.edu)**Citation:** Zeng Y, En Gan SK. Psychological inflexibility, dysfunctional beliefs and attitudes about sleep, and insomnia severity among Chinese college students: A mediation analysis. *Health Psychol Res.* 2026;14(2):0348.
doi: 10.36922/hpr.0348**Received:** October 28, 2025**Revised:** February 9, 2026**Accepted:** February 26, 2026**Published online:** April 28, 2026**Copyright:** © 2026 Author(s). This is an Open-Access article distributed under the terms of the Creative Commons AttributionNon-Commercial 4.0 International (CC BY-NC 4.0), which permits all non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.**Publisher's Note:** AccScience Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.**Abstract****Background:** Insomnia is pervasive among college students and may be exacerbated by maladaptive cognitive factors.**Objective:** This study examined whether psychological inflexibility is associated with greater insomnia severity in Chinese college students and tested whether dysfunctional beliefs and attitudes about sleep mediate this relationship.**Methods:** A cross-sectional survey was conducted among university students recruited via convenience sampling from a university in China. A total of 104 students initially participated, and after data cleaning, the final analytic sample comprised 83 students (56% male; mean age = 20.89 ± 1.51 years). Psychological inflexibility, insomnia severity, and dysfunctional sleep beliefs and attitudes (DBAS) were assessed.**Results:** Pearson's correlations showed that psychological inflexibility was positively correlated with insomnia severity ($r = 0.424, p < 0.001$) and negatively correlated with DBAS-16 scores ($r = -0.377, p < 0.001$). Mediation analysis using Hayes's PROCESS (Model 4) with bootstrapping indicated that dysfunctional sleep beliefs partially mediated the association between inflexibility and insomnia. Greater inflexibility predicted more dysfunctional beliefs ($\beta = -0.377, p < 0.001$), and those beliefs, in turn, predicted higher insomnia severity ($\beta = -0.231, p = 0.0328$), accounting for a significant indirect effect ($\beta = 0.087$, 95% confidence interval [0.0002, 0.2050]). The direct effect of inflexibility on insomnia remained significant ($\beta = 0.337, p = 0.002$), while biological sex did not significantly affect the results.**Conclusion:** These findings suggest that cognitively inflexible students tend to hold unhelpful beliefs about sleep, which, in turn, contributes to greater insomnia severity.**Keywords:** Insomnia; Psychological inflexibility; Dysfunctional beliefs and attitudes about sleep; College students; Mediation

1. Introduction

Insomnia is a prevalent issue among college students,¹ posing significant risks to mental and physical health, impacting academic performance and overall well-being. Approximately 30% of students report significant insomnia symptoms, with about 20%–30% matching the criteria for insomnia.^{2–4} In adults, this statistic is 10–30%.⁵ Insomnia may impair cognitive functions, including memory consolidation, attention, and executive functioning, that are essential for academic success.⁶ This translates to negative outcomes for college students, including elevated stress levels and mental health problems, such as depression and anxiety.¹ Chronic insomnia is linked to long-term health risks: a meta-analysis found that insomnia is associated with a 45% increased risk of developing or dying from cardiovascular disease,⁷ and poor sleep is known to contribute to metabolic issues, including weight gain and obesity. Despite growing awareness and a steady increase in research on college student sleep in the past two decades,¹ insomnia in young adults remains widespread and under-addressed. This highlights the need to identify key factors contributing to insomnia in this population and to develop targeted interventions to promote healthy sleep.

One line of inquiry has focused on psychological inflexibility as a factor associated with insomnia. Psychological inflexibility, a core construct in Acceptance and Commitment Therapy (ACT),^{8,9} refers to a rigid pattern of behavior in which actions are dominated by internal experiences (thoughts, feelings, sensations) at the expense of pursuing valued goals.^{9,10} It is characterized by cognitive fusion, wherein individuals become overly entangled with negative self-evaluative thoughts, and experiential avoidance, wherein they avoid or suppress unwanted internal experiences.⁸ Such rigid and avoidant coping can paradoxically exacerbate distress and limit adaptive behavior. A person high in psychological inflexibility may forsake studying for an exam (a valued goal) to avoid anxiety, undermining long-term aspirations. This cycle of avoidance and mental rigidity significantly impairs functioning and well-being, and it can manifest in problems like insomnia. Greater psychological inflexibility is associated with poorer emotion regulation, leading to negative thought cycles (e.g., rumination) that interfere with the ability to initiate and maintain sleep.¹¹ Thus, individuals high in psychological inflexibility tend to get entangled in negative thoughts and avoid unpleasant emotions or sensations, even when doing so interferes with adaptive behavior. This maladaptive coping style has been linked to a variety of psychopathologies, including heightened anxiety and depression¹² and can perpetuate stress and arousal. According to Harvey's¹³ cognitive-

behavioral model of insomnia, maladaptive cognitions and behaviors play a key role in chronic insomnia. Psychological inflexibility may worsen insomnia severity by increasing rumination, cognitive rigidity, and difficulty disengaging from distressing thoughts at night, which prolongs sleep onset latency and increases nighttime awakenings. Consistent with this model, greater psychological inflexibility was found to be associated with more severe insomnia symptoms and sleep disturbances in both college and adult samples.^{11,14} Similarly, a recent study of Brazilian adults reported that psychological inflexibility was an independent predictor of severe insomnia,¹⁵ suggesting that inflexibility can contribute to sleep problems by perpetuating a cycle of distress and avoidance that disrupts healthy sleep.

Dysfunctional beliefs and attitudes about sleep are another key psychological factor implicated in insomnia. A large proportion of young adults endorse maladaptive beliefs about sleep. One study shows that among 200 college students, over 85% suffered from dysfunctional beliefs about sleep.¹⁶ Dysfunctional beliefs and attitudes about sleep involve excessive, negatively charged thoughts regarding sleep quality and the effects of sleep issues on health or daytime functioning, leading to unhelpful behaviors and causing excessive worry about how insomnia affects daytime performance. The belief that sleep is unpredictable can trigger fear of losing control over sleep. Such misappraisals can transform normal fluctuations in sleep patterns into clinical issues or prolong temporary sleeplessness into chronic sleep problems. Therefore, the perception of sleep deficits is considered a significant factor in the recurrence of depression and emotional distress.¹⁷ Dysfunctional beliefs about sleep are positively correlated with insomnia in college students and contribute to the exacerbation of psychological issues, including anxiety, depression, and insomnia severity.^{1,14,18}

Dysfunctional sleep beliefs and attitudes may serve as a critical link between rigid cognitive patterns and poor sleep, as they can mediate the relationship between psychological inflexibility and insomnia. In a study of shift-working nurses, dysfunctional sleep attitudes significantly predicted insomnia severity and helped explain how psychological inflexibility led to more severe insomnia.¹⁹ This mediation finding implies that inflexible individuals may develop insomnia largely because they adopt unhelpful beliefs about sleep (e.g., "I can't function at all if I don't sleep 8 hours"), heightening their sleep-related anxiety and arousal.

Direct investigations into the psychological mechanisms of insomnia in college students remain limited. Few studies have examined the combined role

of psychological inflexibility and dysfunctional sleep beliefs in this population. Understanding how inflexible coping and maladaptive cognitions drive insomnia can enrich cognitive-behavioral models of insomnia (which traditionally emphasize worry and arousal responses to sleeplessness) and integrate concepts from ACT. In practice, such knowledge can inform interventions: if inflexibility and beliefs are key contributors, then treatments that increase psychological flexibility or correct false beliefs about sleep could be particularly effective for students.

The present study examines the associations among psychological inflexibility, dysfunctional beliefs and attitudes about sleep, and insomnia severity in a convenience sample of Chinese university students. Specifically, this cross-sectional study was conducted as a conceptual replication and cultural extension of a prior study in a young-adult, non-clinical population.¹⁹

Our study was guided by two primary research questions: (i) Is psychological inflexibility associated with greater insomnia severity among Chinese university students? (ii) Do dysfunctional beliefs and attitudes about sleep mediate the relationship between psychological inflexibility and insomnia severity in this population?

Therefore, the objectives of this study were to quantify the relationship between psychological inflexibility and insomnia severity to test a mediation model in which dysfunctional sleep-related beliefs act as a psychological mechanism linking inflexibility to insomnia symptoms. By focusing on modifiable cognitive and regulatory processes within an at-risk student population, this study aims to clarify theoretically meaningful pathways underlying insomnia and to inform the development of targeted, high-impact interventions to improve sleep health and well-being among Chinese university students.

2. Methodology

2.1. Research design and sampling

This study employed a cross-sectional, quantitative, observational survey design with a non-probability convenience sampling strategy. Psychological inflexibility was treated as the independent variable (predictor), insomnia severity as the dependent variable (outcome), and dysfunctional beliefs about sleep as the hypothesized mediator (Figure 1). Healthy non-clinical adult university students in China were recruited from a Chinese university using convenience sampling. Invitations to participants were distributed via social media flyers, posts, and quick response codes linking to the online survey. Eligibility criteria required that participants be currently enrolled university students (age 18 or older) and provide informed

consent. Participants were excluded if they did not complete the full survey or declined consent.

A total of 104 university students responded. After excluding incomplete questionnaires and those who did not provide informed consent, the final sample comprised 83 participants (79.8% of the respondents) with valid data for analysis. Among these 83 students, 56.6% identified as male, 43.4% as female, and the mean age was 20.89 ± 1.514 years. The study received ethics exemption from the Wenzhou-Kean University Ethics Committee (exempt institutional review board reference code: WKUIRB2025-038), and all participants provided electronic informed consent. Participation was voluntary and anonymous, and respondents were informed of their right to withdraw without prejudice. No course credit or monetary compensation was offered. All methods were performed in accordance with the World Medical Association Declaration of Helsinki Ethical Principles for Medical Research Involving Human Participants and relevant institutional guidelines and regulations.

2.2. Procedure

Anonymous online survey data were collected through Qualtrics XM (Qualtrics LLC, USA). After providing consent, participants completed three standardized questionnaires assessing psychological inflexibility, insomnia severity, and dysfunctional sleep beliefs and attitudes (described below), as well as basic demographic information (age, biological sex). The survey included an introduction explaining the study's purpose and instructions to answer questions honestly based on their experiences in the past two weeks. To encourage candid responses, no personally identifying information was collected.

2.3. Measures

2.3.1. Chinese-validated version of acceptance and action questionnaire- II

Psychological inflexibility was measured using the Chinese version of the Acceptance and Action Questionnaire-II (AAQ-II),¹⁰ a 7-item questionnaire with higher scores indicating greater psychological inflexibility. Items were rated on a 7-point Likert scale from 1 ("never true") to 7 ("always true"), and responses were summed to a total score (possible range 7–49). The Chinese AAQ-II was developed and validated by Zhang *et al.*²⁰ and showed good psychometric properties among Chinese college students (Cronbach's $\alpha = 0.86$). In our sample, the AAQ-II demonstrated excellent internal consistency (Cronbach's $\alpha = 0.912$).

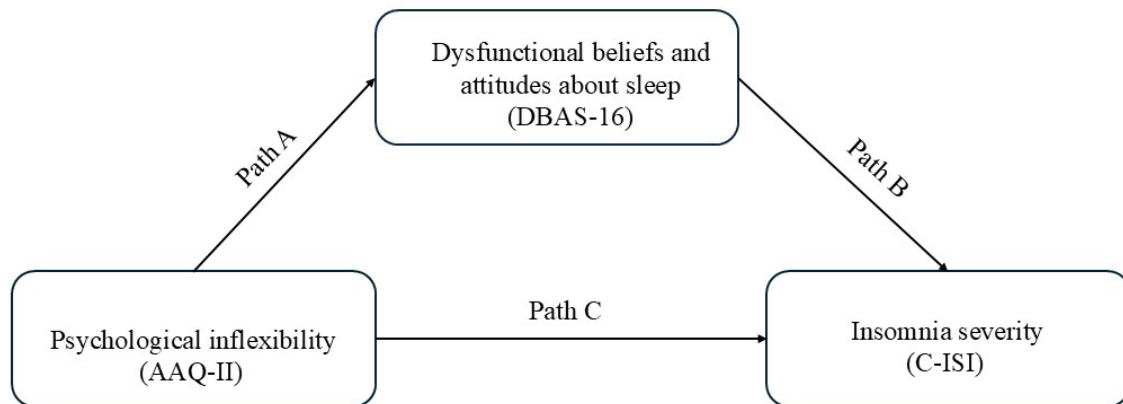


Figure 1. Conceptual mediation model. This diagram illustrates the hypothesized mediation model, in which dysfunctional beliefs and attitudes about sleep mediate the relationship between psychological inflexibility and insomnia severity.

Abbreviations: AAQ-II: Acceptance and Action Questionnaire-II; C-ISI: Chinese version of Insomnia Severity Index; DBAS-16: Dysfunctional Beliefs and Attitudes About Sleep.

2.3.2. Chinese-validated version of the insomnia severity index

Insomnia severity was assessed using the Insomnia Severity Index (ISI), a standard screening tool.^{21,22} It is a 7-item scale questionnaire assessing the nature, frequency, and impact of insomnia symptoms. Each item (e.g., difficulty falling asleep, difficulty staying asleep, problems with daytime functioning due to poor sleep) was rated on a 5-point scale from 1 to 5, yielding a total score from 7 to 35 (higher scores indicated more severe insomnia). We administered the Chinese version of the ISI (C-ISI), which has been validated in multiple studies and shown to have good reliability and validity in the Chinese population (Cronbach's $\alpha = 0.91$).²³ In this study, the C-ISI demonstrated high internal consistency (Cronbach's $\alpha = 0.909$).

2.3.3. Dysfunctional beliefs and attitudes about sleep-16

Dysfunctional beliefs and attitudes about sleep were measured with the 16-item Dysfunctional Beliefs and Attitudes about Sleep Scale (DBAS-16). The DBAS-16 assessed unhelpful beliefs about sleep across areas such as consequences of insomnia, worry/helplessness about sleep, sleep expectations, and medication. We used a Chinese version of the DBAS-16 that was previously validated (Cronbach's $\alpha = 0.786$).²⁴

While the original DBAS-16 utilized a 100-mm visual analogue scale, the validated Chinese version used a 5-point Likert scale.²⁴ To ensure the reliability and

validity of the measurement, this study used a 5-point Likert scale (1 = strongly agree to 5 = strongly disagree). The Chinese-DBAS-16 consisted of 16 items; the total score was calculated as the mean of the 16 item scores. Notably, higher final scores on this version indicate less dysfunctional beliefs (because stronger disagreement with dysfunctional statements yields higher scores). In this study, the questionnaire shows good internal reliability (Cronbach's $\alpha = 0.858$).

2.4. Power analysis

Prior to data collection, we conducted a Monte Carlo simulation-based power analysis to determine the minimum sample size needed to detect the hypothesized mediation effect with adequate power. Using the "Monte Carlo Power Analysis for Indirect Effects" web application (https://schoemanna.shinyapps.io/mc_power_med/), we estimated power for a simple mediation model—psychological inflexibility (X) → dysfunctional beliefs and attitudes about sleep (M) → insomnia severity (Y)—assuming moderate effect sizes based on prior research. Specifically, we input correlation estimates of approximately $r = 0.35$ – 0.50 among the variables and dysfunctional beliefs and insomnia based on previous research ($X-M = 0.36$, $X-Y = 0.34$, $M-Y = 0.51$).¹⁹ The simulation (5,000 replications, 20,000 draws each) indicated that a sample of $n = 68$ would provide 80% power to detect a significant indirect effect at the 95% confidence level. Our final sample size of 83 exceeded this threshold and was thus adequately powered to study the mediation effect.²⁵

2.5. Data analysis

All statistical analyses were conducted using Statistical Package for Social Sciences (SPSS 29.0, IBM, USA). SPSS's Hayes' PROCESS macro (v4.2, IBM, USA) was used for the mediation analysis, and OriginPro (2025, OriginLab Corporation, USA) for generating graphs. We computed descriptive statistics for all variables and examined scale reliabilities. Cronbach's α coefficients for the AAQ-II, C-ISI, and DBAS-16 were all above 0.85, indicating good internal consistency. The assumptions underlying the parametric analyses were then assessed. The normality of distributions was assessed by inspecting skewness and kurtosis values for each scale (Table 1). All values fell within the range of -1 to $+1$ (well within the acceptable ± 2 range), suggesting the data were roughly normally distributed.²⁶ Linearity and homoscedasticity were evaluated using scatterplots of residuals versus predicted values for the outcome, which showed no systematic pattern (Figure A1), indicating constant variance of errors. Independence of errors was confirmed using the Durbin-Watson test, with a statistic of approximately 2.0 (Table 1), indicating minimal autocorrelation in residuals. We also assessed multicollinearity among the predictor variables (psychological inflexibility and dysfunctional beliefs) by calculating variance inflation factors (VIF). VIF values (1.166) were below 1.5, suggesting no multicollinearity concerns.

After verifying assumptions, we proceeded with the primary analyses. Pearson correlation coefficients were computed to examine the bivariate associations between psychological inflexibility, dysfunctional sleep beliefs, and insomnia severity. Next, we tested our mediation hypothesis using Hayes's PROCESS macro (Model 4 for simple mediation). In the mediation model, psychological inflexibility (AAQ-II score) was entered as the independent variable, insomnia severity (C-ISI score) as the dependent

variable, and dysfunctional beliefs (DBAS-16 score) as the mediator. For follow-up analysis, this research included biological sex as covariates in the model to control for their potential influence on sleep statistically (these covariates were not significant and were therefore not pursued further). The mediation analysis was conducted with bias-corrected bootstrapping (5,000 resamples) to generate confidence intervals (CIs) for the indirect effect, a robust approach recommended for mediation tests. The indirect effect was considered statistically significant if the 95% bootstrap CI did not include zero. All significance tests were two-tailed with an alpha level of 0.05.

3. Results

3.1. Descriptive statistics

Descriptive statistics for all study variables are presented in Table 1. On average, 83 participants reported a moderate level of psychological inflexibility (AAQ-II: mean = 22.663 ± 8.441 ; possible range, 7–49) and mild-to-moderate insomnia symptoms (C-ISI: mean = 14.00 ± 5.691 ; range, 0–28). Endorsement of dysfunctional beliefs about sleep was also relatively high in this sample (DBAS-16: mean = 2.641 ± 0.591 on a 1–5 scale; the lower the score, the higher the level of dysfunctional belief and attitude about sleep), suggesting that most students agreed with the dysfunctional beliefs and attitudes about sleep statements on average. All variables exhibited approximately normal distributions: skewness and kurtosis values for AAQ-II, C-ISI, and DBAS-16 were well within the acceptable range (approximately ± 1), indicating no severe deviations from normality (Table 1). Figure 2 presents boxplots of the score distributions for each measure.

3.2. Correlational analyses

Pearson correlation analysis revealed significant associations among psychological inflexibility, insomnia

Table 1. Descriptive statistics for variables

Test	Minimum	Maximum	Mean	SD	Skewness		Kurtosis		Durbin-Watson
					Statistic	SE	Statistic	SE	
AAQ-II	7.000	42.000	22.663	8.441	0.285	0.264	-0.619	0.523	
C-ISI	7.000	33.000	14.000	5.691	0.938	0.264	0.651	0.523	1.881
DBAS-16	1.560	4.060	2.641	0.591	0.358	0.264	-0.238	0.523	

Abbreviations: AAQ-II: Acceptance and Action Questionnaire-II; C-ISI: Chinese version of Insomnia Severity Index; DBAS-16: Dysfunctional Beliefs and Attitudes About Sleep; SD: Standard deviation; SE: Standard errors.

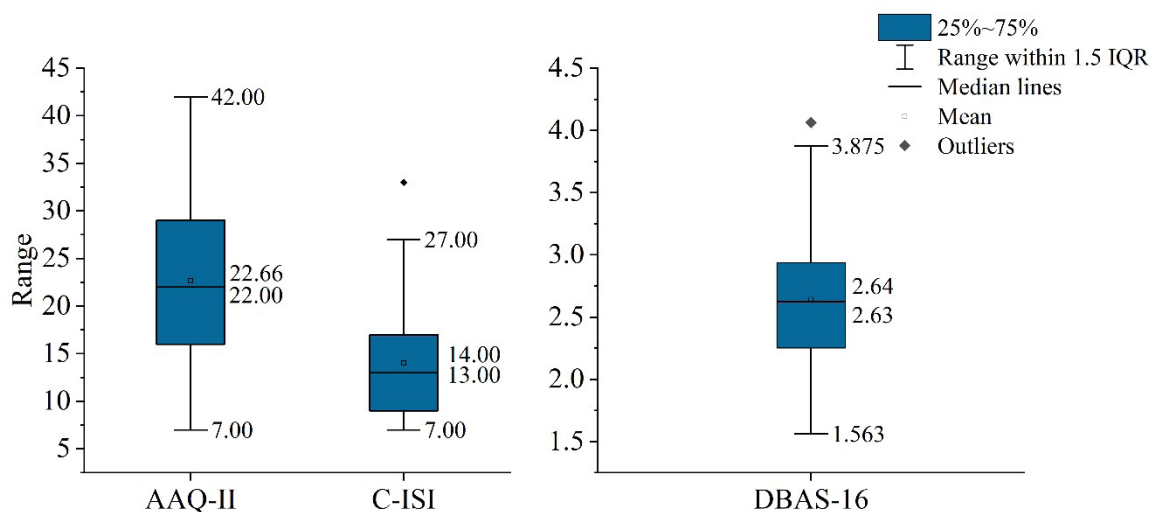


Figure 2. The box plot of the AAQ-II, C-ISI, and DBAS-16 questionnaires' total score

Abbreviations: AAQ-II: Acceptance and Action Questionnaire-II (psychological inflexibility); C-ISI: Chinese version of Insomnia Severity Index; DBAS-16: Dysfunctional Beliefs and Attitudes About Sleep; IQR: Interquartile range.

severity, and dysfunctional beliefs and attitudes about sleep (Table 2). AAQ-II scores were moderately positively correlated with C-ISI ($r = 0.424$, $p < 0.001$), indicating that students with more severe insomnia tend to report greater psychological inflexibility. AAQ-II scores were also significantly negatively and moderately correlated with DBAS-16 ($r = -0.377$, $p < 0.001$), suggesting that higher psychological inflexibility was associated with more dysfunctional beliefs and attitudes about sleep. Insomnia severity (C-ISI) likewise showed a significant, moderate negative correlation with DBAS-16 ($r = -0.358$, $p < 0.001$), indicating that students with more severe insomnia symptoms endorsed more dysfunctional beliefs and attitudes about sleep. These patterns are visualized in the correlation matrix plot in Figure 3.

3.3. Mediation analysis

Mediation analysis was used to test whether dysfunctional beliefs and attitudes about sleep mediate the relationship between psychological inflexibility and insomnia severity. Regression results for the mediation model are summarized in Table 3 and Figure 4, and the overall mediation result is shown in Table 4. In the first regression (path A), psychological inflexibility significantly predicted dysfunctional beliefs: higher AAQ-II scores (greater inflexibility) were associated with lower DBAS-16 scores (more dysfunctional beliefs, $\beta = -0.377$, standard error [SE] = 0.007, $p < 0.001$). This model explained about 14.24% of the variance in sleep belief scores ($R^2 = 0.142$). In the second regression (path B and direct effect), when predicting insomnia severity, the overall model was significant (R^2

Table 2. Correlations between AAQ-II, C-ISI, and DBAS-16

Test	AAQ-II	C-ISI	DBAS-16
Psychological inflexibility (AAQ-II)	–	0.424****	–0.377***
Insomnia severity (C-ISI)	0.424****	–	–0.358****
Dysfunctional beliefs and attitudes about sleep (DBAS-16)	–0.377***	–0.358****	–

Notes: $n = 83$; *** $p < 0.001$ (two-tailed); **** $p < 0.0001$ (two-tailed). Higher AAQ-II and C-ISI scores reflect greater inflexibility and insomnia severity, respectively. Lower DBAS-16 scores reflect more dysfunctional sleep beliefs.

Abbreviations: AAQ-II: Acceptance and Action Questionnaire-II (psychological inflexibility); C-ISI: Chinese version of Insomnia Severity Index; DBAS-16: Dysfunctional Beliefs and Attitudes About Sleep.

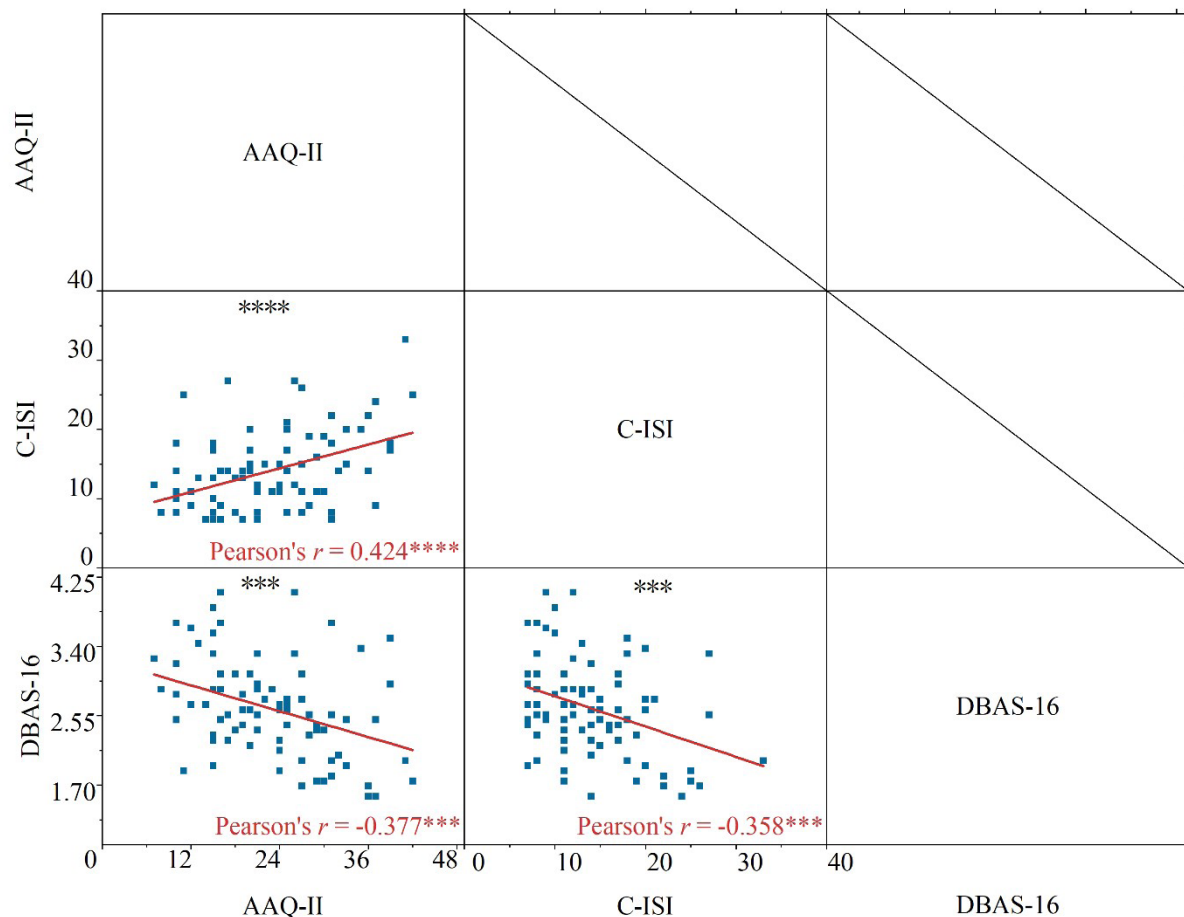


Figure 3. The correlational matrix plot. Note: $n = 83$; $***p < 0.001$ (two-tailed); $****p < 0.0001$ (two-tailed). Higher AAQ-II and C-ISI scores reflect greater inflexibility and insomnia severity, respectively. Lower DBAS-16 scores reflect more dysfunctional sleep beliefs.

Abbreviations: AAQ-II: Acceptance and Action Questionnaire-II (psychological inflexibility); C-ISI: Chinese version of Insomnia Severity Index; DBAS-16: Dysfunctional Beliefs and Attitudes About Sleep.

Table 3. Regression results for the mediation model (psychological inflexibility, dysfunctional beliefs, and insomnia)

Outcome variable	Predict variable	95% CI	SE	Effect (B)	<i>p</i>	β	R^2
Dysfunctional beliefs about sleep (DBAS-16)	Psychological inflexibility (AAQ-II)	[0.0850, 0.3700]	0.007	-0.026	<0.001	-0.377	0.142
	Psychological inflexibility (AAQ-II)	[0.0001, 0.1367]	0.036	0.228	0.002	0.337	
Insomnia severity (C-ISI)	Dysfunctional beliefs and attitudes about sleep (DBAS-16)	[0.0002, 0.2050]	0.052	-0.231	0.033	-0.231	0.226
	Psychological inflexibility (AAQ-II)	[0.0001, 0.1367]	0.036	0.228	0.002	0.337	

Notes: Unstandardized (B) and standardized (β) coefficients are shown. The first model (above) predicted the mediator (dysfunctional sleep beliefs) from psychological inflexibility. The second model predicted insomnia severity from both inflexibility and beliefs ($R^2 = 0.226$ for the full model). Both predictors in the second model were simultaneous; the overall R^2 for insomnia severity was 0.226 (model $p < 0.001$). All tests were two-tailed.

Abbreviations: AAQ-II: Acceptance and Action Questionnaire-II (psychological inflexibility); C-ISI: Chinese version of Insomnia Severity Index; CI: Confidence interval; DBAS-16: Dysfunctional Beliefs and Attitudes About Sleep; SE: Standard error.

Table 4. Mediation analysis result (psychological inflexibility, dysfunctional beliefs and attitudes about sleep, and the insomnia severity)

Type of effect	Mediation pathway	95% CI	SE	Effect	<i>p</i>	β
Direct effect	X $\rightarrow$ Y controlling M	[0.0850, 0.3700]	0.072	0.228	0.002	0.337
Mediation effect	X $\rightarrow$ M $\rightarrow$ Y	[0.0001, 0.1367]	0.036	0.059	–	–
Standard mediation effect	X $\rightarrow$ M $\rightarrow$ Y	[0.0002, 0.2050]	0.052	0.087	–	–
Total effect	X $\rightarrow$ Y without M	[0.1512, 0.4211]	0.068	0.286	<0.001	0.424

Notes: M: Dysfunctional sleep beliefs (DBAS-16); X: Psychological inflexibility (AAQ-II); Y: Insomnia severity (C-ISI). CIs are bias-corrected bootstrap CIs (5,000 resamples). *p*-value for indirect effect is approximate (based on CI excluding 0). The standardized indirect effect is provided for interpretative purposes (no *p*-value computed). The direct effect corresponds to path C, and the indirect effect to the mediation via dysfunctional beliefs. The total effect = direct + indirect.

Abbreviations: AAQ-II: Acceptance and Action Questionnaire-II (psychological inflexibility); C-ISI: Chinese version of Insomnia Severity Index; CI: Confidence interval; DBAS-16: Dysfunctional Beliefs and Attitudes About Sleep; SE: Standard error.

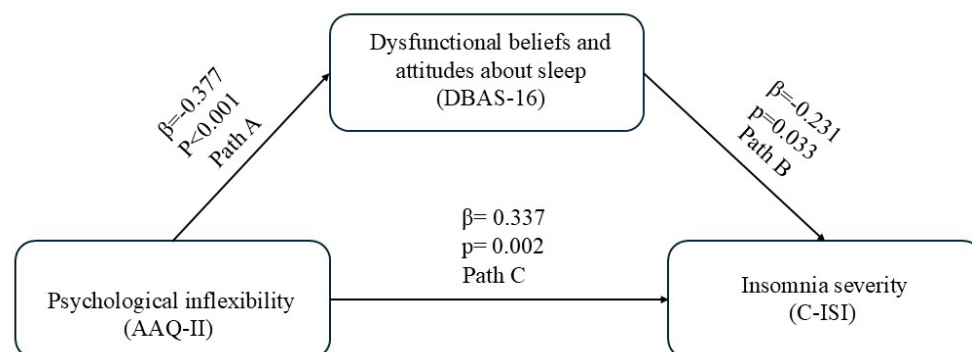


Figure 4. Statistical mediation model with standardized coefficients. This figure presents the tested mediation model with standardized regression coefficients (β) and *p*-values. Dysfunctional beliefs and attitudes about sleep partially mediated the effect of psychological inflexibility on insomnia severity. Abbreviations: AAQ-II: Acceptance and Action Questionnaire-II (psychological inflexibility); C-ISI: Chinese version of Insomnia Severity Index; DBAS-16: Dysfunctional Beliefs and Attitudes About Sleep.

= 0.226, $p < 0.001$), and both predictors contributed. Psychological inflexibility remained a significant positive predictor of C-ISI scores ($\beta = 0.337$, SE = 0.007, $p = 0.002$), and dysfunctional beliefs were a significant negative predictor of C-ISI ($\beta = -0.231$, SE = 0.052, $p = 0.034$). These coefficients indicate that, controlling for psychological inflexibility, students with more dysfunctional beliefs about sleep had higher insomnia scores. The direct effect of psychological inflexibility on insomnia severity (path C) remained significant ($\beta = 0.337$, $p = 0.002$), consistent with partial mediation.

The indirect effect (path A $\times$ B) of inflexibility on insomnia, through dysfunctional beliefs, was statistically significant. The bootstrap estimate of the indirect effect was 0.059, with a 95% CI of [0.0001, 0.1367] (based on 5,000 resamples), indicating a positive mediation effect

(note that inflexibility increases dysfunctional beliefs, which, in turn, increase insomnia). Although the lower bound of this CI was extremely close to zero, it excluded zero, confirming a significant indirect effect at $p < 0.05$. In standardized terms, the indirect effect corresponded to $\beta = 0.087$ (95% CI [0.0002, 0.2050]). The total effect of psychological inflexibility on insomnia severity (without accounting for the mediator) was also significant ($\beta = 0.424$, $p < 0.001$). Figure 4 illustrates the mediation model with standardized coefficients.

Taken together, these findings indicate that dysfunctional beliefs about sleep partially mediate the relationship between psychological inflexibility and insomnia severity. Students who had higher psychological inflexibility tend to report more severe insomnia symptoms, in part because they hold stronger maladaptive beliefs

about sleep. However, since the direct effect of inflexibility on insomnia remained significant (and substantial) even after accounting for sleep beliefs, other mechanisms beyond dysfunctional cognitions likely also contribute to this relationship.

Because biological sex differences in sleep are sometimes reported and important for intervention development, this research conducted a follow-up analysis that included biological sex as a covariate in the mediation model. Including biological sex (coded 1 = male, 2 = female) did not significantly impact the results, making it a non-significant predictor of dysfunctional beliefs or insomnia ($p > 0.05$) while the indirect effect of inflexibility through beliefs remained significant ($B = 0.087$, 95% CI [0.0000, 0.1360]). The direct effect of inflexibility on insomnia also remained unchanged ($\beta = 0.339$, $p = 0.002$). Thus, the mediation effect remained robust after controlling for participants' biological sex (Figures A2 and A3, Tables A1 and A2). Given the results, the primary mediation hypothesis was supported: psychological inflexibility contributes to greater insomnia severity, partly via its influence on dysfunctional sleep-related beliefs.

4. Discussion

This study investigated psychological inflexibility, dysfunctional beliefs and attitudes about sleep and biological sex as factors in insomnia among Chinese college students. Consistent with expectations, greater psychological inflexibility was associated with higher insomnia severity in this student population. Dysfunctional beliefs about sleep partially mediated this relationship, accounting for a significant portion of the association between psychological inflexibility and insomnia severity. In contrast, biological sex did not significantly affect the results in the current sample of Chinese college students. To the best of our understanding, this is the first demonstration of these effects in a sample of Chinese college students, with important implications for understanding the psychological mechanisms of insomnia in young adults and for developing targeted interventions in the Chinese context.

The present findings extend contemporary models of insomnia by integrating constructs from ACT with established cognitive-behavioral theories of sleep. Consistent with prior research, psychological inflexibility was positively associated with insomnia severity, supporting the view that rigid, avoidant coping styles exacerbate sleep disturbances. Recent empirical studies have demonstrated that psychological inflexibility predicts poorer sleep quality and more severe insomnia symptoms across adult and student populations.^{15,27} A recent systematic review

further concluded that psychological flexibility processes, including experiential avoidance and cognitive fusion, are robustly associated with sleep health outcomes across diverse samples.²⁸ By demonstrating this association among Chinese university students, we extended this growing body of work to a young, non-clinical population in a cultural context that received comparatively limited empirical attention.

From a theoretical standpoint, these findings enrich Harvey's cognitive model of insomnia by suggesting that psychological inflexibility may function as a dispositional vulnerability that predisposes individuals to cognitive and physiological arousal processes, such as rumination, worry, and excessive sleep effort, that maintain insomnia. Individuals high in psychological inflexibility may struggle to tolerate internal discomfort related to poor sleep and may respond with increased attempts at cognitive control or avoidance, thereby intensifying pre-sleep arousal. This interpretation aligns with recent ACT-informed sleep research showing that inflexibility-related processes are associated with impaired sleep regulation and poorer insomnia outcomes.²⁹

Importantly, we further identified dysfunctional beliefs and attitudes about sleep as a key psychological mechanism linking inflexibility to insomnia severity. Psychologically inflexible students were more likely to endorse maladaptive sleep beliefs, such as catastrophizing the consequences of insufficient sleep, which, in turn, were associated with worse insomnia symptoms. This mediating pattern aligned with recent evidence from occupational and clinical samples. Dysfunctional sleep beliefs and attitudes, depressive symptoms, and sleep effort fully mediated the association between psychological inflexibility and insomnia in Korean shift-working nurses.¹⁹ However, the observed mediation was partial, suggesting that although dysfunctional beliefs represent a meaningful pathway, additional mechanisms, such as mood disturbance or behavioral hyperarousal, likely contribute to the inflexibility–insomnia link among university students.

Identifying that dysfunctional sleep beliefs and attitudes significantly mediate insomnia has important theoretical implications. Cognitive-behavioral theories posit that maladaptive beliefs about sleep fuel insomnia by increasing performance anxiety and attentional bias toward sleep-related threat cues. The present findings suggest that such beliefs are not randomly distributed but are more likely to emerge and persist among individuals who cope inflexibly with internal experiences. This interpretation is supported by recent studies showing that dysfunctional sleep beliefs are associated not only with poorer sleep quality but also with impaired cognitive and daytime functioning.¹⁷ Together,

these findings indicate that psychological inflexibility may create a cognitive context in which dysfunctional sleep beliefs are more readily adopted and less easily disengaged from, thereby perpetuating insomnia.

Moreover, the observed associations between psychological inflexibility, dysfunctional beliefs and attitudes about sleep, and insomnia severity should be interpreted within the specific sociocultural context of Chinese university students. In China's exam-oriented educational system, academic achievement is strongly linked to perseverance, effort, and self-discipline, often encapsulated by the cultural norm of enduring hardship. Within this framework, sleep is frequently conceptualized instrumentally, as a resource to be controlled, optimized, or even sacrificed to maximize academic productivity, rather than as a flexible biological process subject to natural variability. Empirical evidence from recent Chinese student samples indicates that dysfunctional beliefs about sleep are highly prevalent and strongly associated with poorer sleep quality and greater insomnia severity, even after accounting for emotional distress.^{17,30}

Such culturally shaped sleep beliefs may interact synergistically with psychological inflexibility. Individuals high in psychological inflexibility tend to respond to internal experiences such as fatigue, worry, or sleep disruption with cognitive fusion and experiential avoidance, which intensifies pre-sleep arousal and maladaptive sleep effort. In a cultural context that valorizes endurance and self-control, attempts to suppress discomfort or "push through" sleep deprivation may be socially reinforced rather than questioned. This may partly explain why dysfunctional sleep beliefs emerged as a significant mediator in the present study: psychologically inflexible students may be particularly prone to adopting rigid, performance-oriented sleep beliefs that align with dominant academic norms. Similar cognitive pathways have been documented in recent Chinese and East Asian samples, where dysfunctional sleep beliefs amplify insomnia through heightened worry, stress reactivity, and hyperarousal.^{18,19,30}

Moreover, traditional Chinese norms emphasizing emotional restraint and harmony maintenance may further exacerbate these processes. Sleep difficulties are often normalized, moralized, or interpreted as a failure of self-regulation rather than recognized as legitimate health concerns. Concerns related to self-image may reduce willingness to acknowledge insomnia symptoms or seek professional help, increasing reliance on internal cognitive explanations and self-directed control strategies. Stigma and low help-seeking for sleep problems remain common among Chinese students, contributing to the persistence of maladaptive beliefs and untreated insomnia symptoms.^{1,30}

In this context, dysfunctional sleep beliefs may serve as an internalized, culturally acceptable framework for understanding distress while simultaneously perpetuating sleep disturbance.

Importantly, these cultural influences may also affect symptom reporting. Students who view insomnia as a personal weakness or a sign of insufficient discipline may underreport sleep difficulties or frame them primarily in cognitive terms, such as worry or perceived loss of control, rather than physiological dysregulation. This may contribute to the strong associations observed between dysfunctional beliefs and insomnia severity in Chinese student samples.^{17,30} Thus, the present findings likely reflect the convergence of individual-level regulatory vulnerability (psychological inflexibility), maladaptive cognitive appraisals (dysfunctional sleep beliefs and attitudes), and sociocultural norms emphasizing endurance, academic performance, and self-control.

By situating these results within the Chinese cultural context, the present study extends ACT-based and cognitive-behavioral models of insomnia by demonstrating how sociocultural values shape both the content of sleep-related beliefs and individuals' responses to sleep-related distress. This culturally grounded interpretation underscores the importance of adapting insomnia interventions for Chinese university students by explicitly addressing rigid performance norms, stigma surrounding sleep difficulties, and inflexible coping styles. Such considerations are particularly relevant for prevention and early intervention efforts in high-pressure academic environments.

Cultural norms emphasizing endurance, self-discipline, and emotional restraint may inadvertently reinforce experiential avoidance, a core component of psychological inflexibility. Confucian-influenced norms emphasizing self-restraint and social harmony have been linked to greater endorsement and use of expressive suppression in Chinese/East Asian contexts, which may reduce willingness to engage openly with emotional experience and, in turn, be associated with more avoidance-oriented regulation.³¹⁻³³ Recent qualitative evidence is consistent with this framing: participants describe "emotional silence"/enduring distress privately as a socially endorsed form of strength and role-fulfilment, which can contribute to internalized distress and reduced emotional disclosure or help-seeking. There are patterns that are conceptually consistent with avoidance-oriented emotion regulation.³⁴ Cultural expectations of emotional restraint have been empirically linked to reduced mental health help-seeking behaviors, suggesting broader effects of such norms on psychological functioning.³⁵ In this context, students who find it difficult to accept internal distress, such as fatigue or

transient sleep disruption, may engage in excessive worry or compensatory sleep effort, further disrupting sleep. Thus, the observed associations between psychological inflexibility, dysfunctional sleep beliefs, and insomnia severity likely reflect both individual-level regulatory processes and broader sociocultural influences. By situating these findings within the Chinese college students context, the present study underscores the importance of Chinese college students culturally sensitive models of insomnia that integrate cognitive, regulatory, and contextual factors.

Taken together, the findings support an integrative framework in which psychological inflexibility predisposes individuals to maladaptive sleep-related beliefs, thereby increasing insomnia severity, particularly within high-pressure academic environments. This framework bridges ACT-based and cognitive-behavioral perspectives and is consistent with recent intervention research that shows targeting psychological flexibility can improve sleep outcomes.²⁹ Future longitudinal and cross-cultural studies are needed to clarify causal pathways and to determine the generalizability of these mechanisms across populations.

4.1. Theoretical implications

The results extend existing theories of insomnia by bridging concepts from ACT and cognitive-behavioral models of sleep. The observed correlation between psychological inflexibility and insomnia severity supports the notion that rigid, avoidant coping styles can exacerbate sleep problems. This aligns with prior research in other populations, which shows that inflexibility is associated with worse insomnia outcomes. El Rafihi-Ferreira *et al.*¹⁵ found that psychological inflexibility predicted greater insomnia severity in a large adult sample. This study adds to this literature by focusing on college students, a group for whom this link has not been thoroughly examined in the Chinese context. It appears that even in a young, healthy cohort, those who struggle to adapt to internal stress (high inflexibility) experience more severe insomnia symptoms. This finding enriches Harvey's cognitive model of insomnia¹³ by suggesting that psychological inflexibility may be one predisposition that leads to the cognitive and arousal factors (rumination, worry) that maintain insomnia.

This result, where dysfunctional beliefs and attitudes about sleep play a key mediating role, is in line with recent evidence from other contexts' study on Korean nurses,¹⁹ where once those mediators were accounted for, inflexibility no longer directly affected insomnia, suggesting that inflexibility exerts its influence entirely through those cognitive-emotional mechanisms. Here, the mediation was partial rather than full, indicating that while

dysfunctional beliefs significantly explain some of the link between inflexibility and insomnia, other factors (such as mood, stress reactivity, or sleep effort) likely contribute as well. Notably, Ahn *et al.*¹⁹ included depressive symptoms and sleep effort as additional mediators and found a more complete mediation. While the study did not measure all these variables, their absence could explain why inflexibility retained a direct effect on our model. It suggests that inflexibility may also impact insomnia via pathways like emotional distress (anxiety/depression) or behavioral hyperarousal (excessive effort to force sleep), which were beyond the scope of our single-mediator model. Future research should examine multiple mediators to capture the full process by which inflexibility leads to insomnia.

Nevertheless, the results in our study resonate with cognitive-behavioral theories, which posit that maladaptive beliefs and attitudes about sleep fuel insomnia by increasing performance anxiety. The results show that holding such beliefs is not random; it is more likely among individuals with high psychological inflexibility. This insight suggests that the tendency to handle thoughts and emotions inflexibly can give rise to the specific dysfunctional cognitions that perpetuate insomnia. In other words, an inflexible mindset may set the stage for buying into "sleep myths" and catastrophizing about insomnia, which then worsens sleep. Peltz *et al.*³⁶ provided complementary evidence for this interplay, where college students who strongly believed their sleep was beyond their control had significantly more severe sleep disturbances, particularly when they had low psychological flexibility. These moderation findings and the mediation findings both point to the conclusion that psychological inflexibility and dysfunctional beliefs and attitudes about sleep interact to undermine sleep quality. Inflexibility might predispose students to develop and cling to dysfunctional beliefs and attitudes, which, in turn, heighten insomnia; conversely, students with more flexible coping might be less affected by negative sleep thoughts. Together, these results underscore a nuanced cognitive-behavioral mechanism where it is not only the content of one's sleep-related thoughts that matters, but also the way one relates to and manages those thoughts.

The findings here advocate that incorporating psychological inflexibility and biological sex into models of insomnia could enrich our understanding of the factors contributing to insomnia risk. Traditional models emphasize precipitating factors (like stress) and perpetuating factors (like conditioning and worry) in chronic insomnia. The research findings indicate that a person's general psychological inflexibility may be an underlying vulnerability factor that influences

the perpetuating processes. This relationship between ACT frameworks and insomnia research can spur new hypotheses, e.g., that inflexibility may amplify known risk factors for insomnia, such as perceived stress (by increasing rumination) or negative mood (by avoidance of emotion leading to rebound effects at night). There is emerging support for such ideas, where the relationship between daily stress and adolescent insomnia was mediated by psychological inflexibility.³⁷ This study, focusing on dysfunctional beliefs and attitudes, complements this by identifying a specific cognitive mediator relevant to insomnia. Overall, these findings contribute to a more integrative theory of insomnia that spans personality factors, cognitive appraisals, and sleep behaviors.

4.2. Practical and translational implications

The results have important practical implications for the prevention and treatment of insomnia, particularly among college students. If psychological inflexibility and dysfunctional beliefs and attitudes about sleep are significant contributors to insomnia severity, then these modifiable psychological processes represent promising targets for intervention. This suggests that effective student sleep programs should move beyond sleep hygiene education alone and explicitly address both maladaptive sleep cognitions and rigid coping styles.

On the one hand, cognitive-behavioral therapy for insomnia (CBT-I) directly targets dysfunctional beliefs and attitudes about sleep. CBT-I helps individuals identify, challenge, and reframe inaccurate or catastrophic beliefs (e.g., “I cannot function if I sleep poorly”), thereby reducing sleep-related anxiety and pre-sleep hyperarousal. The present findings reinforce the importance of this cognitive component. In university settings, CBT-I principles could be delivered through counselling centers, group-based workshops, or digital platforms to increase accessibility and scalability.

On the other hand, ACT and related psychological flexibility-based approaches offer a complementary pathway by targeting rigid and avoidant coping patterns. ACT emphasizes mindfulness, acceptance of internal experiences, cognitive defusion, and values-guided action, which can reduce experiential avoidance and excessive effort to control sleep. If psychological inflexibility contributes to insomnia, ACT-based strategies may help students alter how they relate to insomnia-related thoughts and sensations rather than attempting to eliminate them. For example, a student who persistently worries about not sleeping may benefit from learning to accept temporary wakefulness without struggle, thereby reducing arousal and counterproductive sleep effort.

Importantly, CBT-I and ACT approaches are not mutually exclusive and may be most effective when integrated. Interventions that combine cognitive restructuring of maladaptive sleep beliefs with acceptance-based strategies targeting inflexibility may address both the content of sleep-related cognitions and the broader regulatory processes that maintain insomnia. In practice, a university counselling program could teach students to challenge unrealistic sleep expectations while also fostering acceptance of occasional sleep disturbance, reducing the pressure to “fight” sleep. By simultaneously targeting dysfunctional beliefs and inflexible coping, such integrative interventions may more effectively disrupt the mechanisms underlying student insomnia and support both treatment and prevention efforts.

There are also implications for screening and prevention. University health services might consider assessing students for dysfunctional sleep beliefs and attitudes and psychological inflexibility as part of routine wellness checks or sleep education programs. Brief validated questionnaires exist for both constructs (DBAS-16 and AAQ-II, respectively). Identifying students who score high on these scales could help flag those at risk for developing chronic insomnia. Preventive workshops or seminars could then be offered to teach healthy sleep knowledge and flexible coping skills to those at-risk students. Additionally, given prior evidence linking insomnia with psychological distress,³⁸ addressing sleep issues might yield ancillary benefits for mental health. By improving sleep through flexibility and cognitive change, we might also reduce students’ anxiety and depressive symptoms, creating a positive feedback loop for well-being. And with reduced anxiety, it may even translate to better adaptability in academic settings, as suggested for working adults.³⁹

Our study’s findings support a multifaceted intervention strategy for insomnia in young adults: one that increases psychological flexibility (through acceptance-based techniques) and corrects dysfunctional sleep beliefs (through cognitive-behavioral techniques). Such an approach is inherently translational, as it applies the psychological mechanisms we identified in practice. The convergence of evidence from this research and recent clinical trials makes a compelling case that addressing both “headspace” (beliefs and attitudes) and “mindset” (inflexibility) can substantially improve sleep. This is especially relevant for college students, who often face academic stress and irregular schedules that challenge both their sleep and coping abilities. Equipping students with flexibility skills may help them navigate stressors without resorting to maladaptive beliefs or behaviors that harm sleep.

4.3. Limitations and future directions

The cross-sectional design limits the ability to draw causal inferences about the relationships among psychological inflexibility, dysfunctional beliefs and attitudes about sleep, and insomnia severity. Although the mediation model is theoretically consistent with a pathway from inflexibility to insomnia via maladaptive sleep beliefs, the temporal direction of effects cannot be established. It is also possible that chronic insomnia may reduce psychological flexibility over time or reinforce dysfunctional sleep beliefs through repeated negative sleep experiences. In addition, although an *a priori* Monte Carlo simulation-based power analysis indicated that a minimum sample size of 68 would provide 80% power to detect the hypothesized indirect effect, the final sample exceeded this threshold. The modest sample size ($n = 83$), recruited using convenience sampling from a single university, may limit the generalizability of the findings and the precision of effect size estimates. Finally, the mediation model focused solely on dysfunctional sleep beliefs and did not include other relevant psychological factors, such as anxiety, depressive symptoms, perceived stress, or sleep effort, which may also contribute to the association between psychological inflexibility and insomnia. Future longitudinal studies with larger, more diverse samples and multi-mediator models are needed to clarify causal pathways and provide a more comprehensive understanding of the mechanisms underlying student insomnia.

Cultural factors might influence both sleep beliefs and coping styles. Attitudes toward sleep and help-seeking can vary across cultures. Thus, it would be valuable for future research to replicate these findings at other Chinese universities and in different countries. Cross-cultural comparisons could examine whether the relationship among psychological inflexibility, dysfunctional beliefs, and attitudes about sleep and insomnia holds universally or is moderated by cultural attitudes (e.g., collectivist vs. individualist coping differences, Eastern vs. Western beliefs about sleep and health).

We focused on only one mediator (dysfunctional beliefs and attitudes about sleep) and did not measure other relevant variables, such as anxiety, depression, or stress levels. These factors are known to be associated with both inflexibility and insomnia and could either confound or mediate the relationships. Psychological inflexibility might contribute to insomnia partly by increasing general stress or negative mood, which then disrupts sleep. In our study, the significant direct effect in the mediation model hints that omitted variables might account for additional portions of the inflexibility–insomnia link. Future studies should consider a multiple mediation model including

dysfunctional beliefs, mood (depressive or anxiety symptoms), and sleep effort or hyperarousal as parallel mediators. This would provide a more comprehensive understanding of the underlying mechanism. Indeed, as noted in a previous study, a combination of depression, beliefs, and sleep effort fully accounted for the effect of inflexibility on insomnia in nurses.¹⁹ It would be illuminating to test a similar comprehensive model in college students.

Finally, a limitation concerns measurement and response biases inherent to this study's reliance on self-administered, self-report questionnaires. Although validated scales were used, self-report sleep indicators can be influenced by recall error and response tendencies (including social desirability), which may systematically distort reported symptoms and beliefs.⁴⁰ Subjective sleep complaints do not always align with objectively measured sleep (e.g., actigraphy or polysomnography), and subjective–objective sleep discrepancy is well documented in insomnia research, complicating interpretation when only questionnaires are available.⁴¹ Related work also shows that even common self-report measures of habitual sleep duration can exhibit non-trivial estimation bias at the population level.⁴² Accordingly, future studies should incorporate objective sleep assessments, actigraphy, and/or polysomnography alongside questionnaires and, where feasible, multi-night sampling to improve measurement precision and reduce bias.⁴³

Despite these limitations, our study addresses a novel question at the intersection of two theoretical frameworks and uses current (2020s) measures and evidence to inform the hypotheses. Using validated Chinese versions of the instruments ensures the findings are culturally relevant and not mere artifacts of translation. By focusing on a non-clinical student sample, our study highlights risk processes in the early stages, before chronic insomnia fully develops, thereby generating knowledge that is useful for prevention efforts.

5. Conclusion

This study advances our understanding of insomnia in young adults by demonstrating that psychological inflexibility and dysfunctional sleep beliefs are significant, interconnected factors associated with insomnia severity among Chinese college students. Students who have difficulty adapting to internal stressors and who hold rigid, maladaptive beliefs about sleep tend to experience worse insomnia. These insights bridge cognitive-behavioral and ACT perspectives, offering a more integrative view of why certain individuals struggle more with insomnia. Importantly, the results point toward practical

intervention targets: enhancing psychological flexibility and correcting false or catastrophic sleep beliefs may help alleviate insomnia and improve overall mental health in this population. Future research should build on these findings by using longitudinal and experimental designs and exploring integrated intervention approaches. This research could ultimately lead to more effective strategies for promoting healthy sleep and well-being in college students and beyond.

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Conflict of interest

The authors declare no conflict of interest.

Author contributions

Conceptualization: Yusong Zeng
Data curation: Yusong Zeng
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Investigation: Yusong Zeng
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Writing—review & editing: All authors

Ethics approval and consent to participate

The study was approved by the Wenzhou Kean University ethics review board (WKUIRB2025-038) and deemed low risk. Informed consent was obtained from all participants for the survey.

Consent for publication

All participants provided informed consent for the usage of data and gave explicit permission for the publication of any data, images, or information that could potentially reveal their identity. The authors affirm that all relevant consent forms have been obtained and are available upon request.

Availability of data

The raw data are available from the corresponding author upon reasonable request.

Further disclosure

The article was derived from an submitted undergraduate

thesis, after which further biological sex analyses were added.

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Appendix

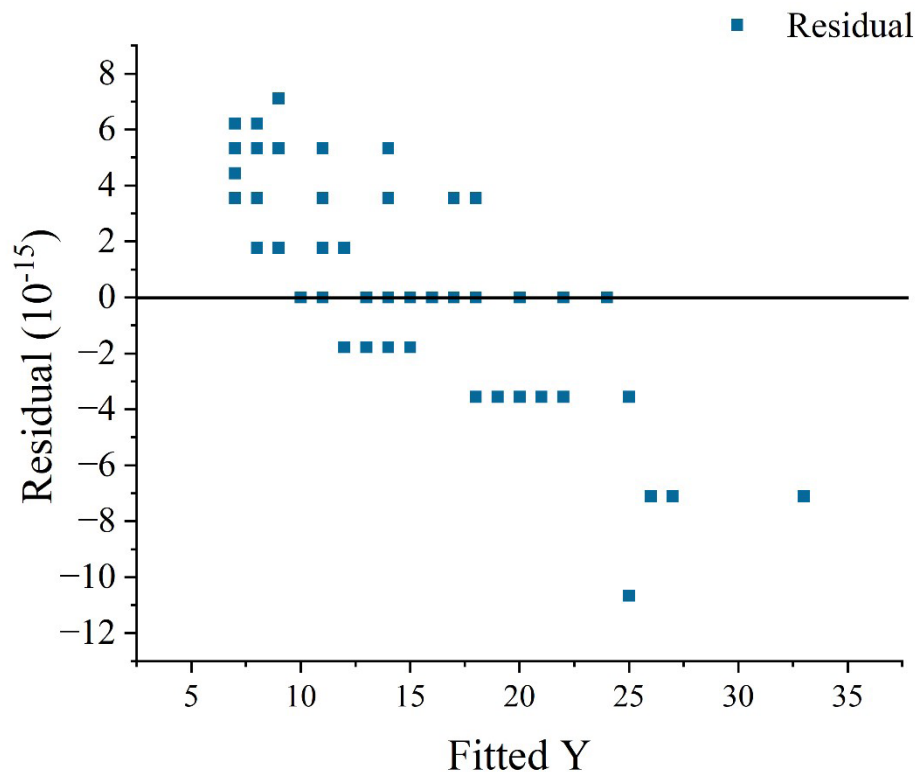


Figure A1. The scatterplots of residuals versus predicted values (fitted Y) for the outcome

Table A1. Regression results (psychological inflexibility, dysfunctional beliefs and attitudes about sleep, insomnia severity, and biological sex)

Outcome variable	Predict variable	95% CI	SE	Effect (B)	<i>p</i>	β	R^2
Dysfunctional beliefs about sleep (DBAS-16)	Psychological inflexibility (AAQ-II)	[-0.0408, -0.0120]	0.0073	-0.0264	0.0005	-0.3773	0.1424
	Biological sex	[-0.2382, 0.2507]	0.1228	0.0062	0.9596	0.0053	
Insomnia severity (C-ISI)	Psychological inflexibility (AAQ-II)	[0.0850, 0.3718]	0.0721	0.2284	0.0022	0.3387	0.2271
	Dysfunctional beliefs about sleep (DBAS-16)	[-4.2705, -0.1762]	1.0285	-2.2234	0.0337	-0.2309	
	Biological sex	[-1.8439, 2.6544]	1.1300	0.4052	0.7208	0.0355	

Note: Results are from a single mediation model including sex as a covariate. Sex did not significantly predict the mediator or outcome. The indirect effect of psychological inflexibility on insomnia severity through dysfunctional sleep beliefs remained significant (Table A2).

Abbreviations: AAQ-II: Acceptance and Action Questionnaire-II; C-ISI: Chinese version of Insomnia Severity Index; CI: Confidence interval; DBAS-16: Dysfunctional Beliefs and Attitudes About Sleep; SE: Standard error.

Table A2. The result of mediation analysis after controlling for biological sex (psychological inflexibility, dysfunctional beliefs and attitudes about sleep, and insomnia severity)

Type of effect	Mediation pathway	95% CI	SE	Effect (B)	<i>p</i>	β
Direct effect	$X \rightarrow Y$ controlling M	[0.0850, 0.3728]	0.0721	0.2284	0.0022	0.3387
Mediation effect	$X \rightarrow M \rightarrow Y$	[0.0000, 0.1360]	0.0351	0.0587	–	–
Standard mediation effect	$X \rightarrow M \rightarrow Y$	[–0.0001, 0.2001]	0.0515	–	–	0.0871
Total effect	$X \rightarrow Y$ without M	[0.1513, 0.4229]	0.0683	0.2871	0.0001	0.4258

Notes: M: Dysfunctional sleep beliefs (DBAS-16); X: Psychological inflexibility (AAQ-II); Y: Insomnia severity (C-ISI). CIs are bias-corrected bootstrap CIs (5,000 resamples). *p*-value for indirect effect is approximate (based on CI excluding 0). The standardized indirect effect is provided for interpretative purposes (no *p*-value computed). The direct effect corresponds to path C, and the indirect effect to the mediation via dysfunctional beliefs. The total effect = direct + indirect. The bootstrap CI for the indirect effect narrowly included zero, indicating that the mediation is marginal at *p* = 0.05 after accounting for sex. The direct and total effects of inflexibility on insomnia were virtually unchanged.

Abbreviations: AAQ-II: Acceptance and Action Questionnaire-II (psychological inflexibility); C-ISI: Chinese version of Insomnia Severity Index; CI: Confidence interval; DBAS-16: Dysfunctional Beliefs and Attitudes About Sleep; SE: Standard error.

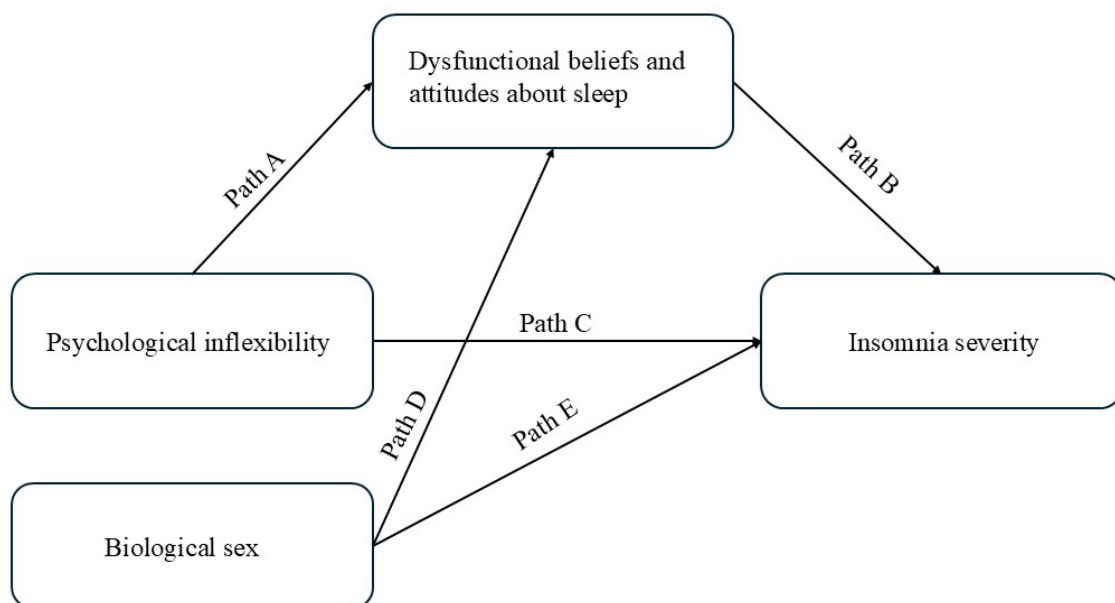


Figure A2. Conceptual mediation model. This diagram illustrates the hypothesized mediation model, in which dysfunctional beliefs and attitudes about sleep mediate the relationship between psychological inflexibility and insomnia severity. Biological sex is included as a covariate influencing both the mediator and the outcome.

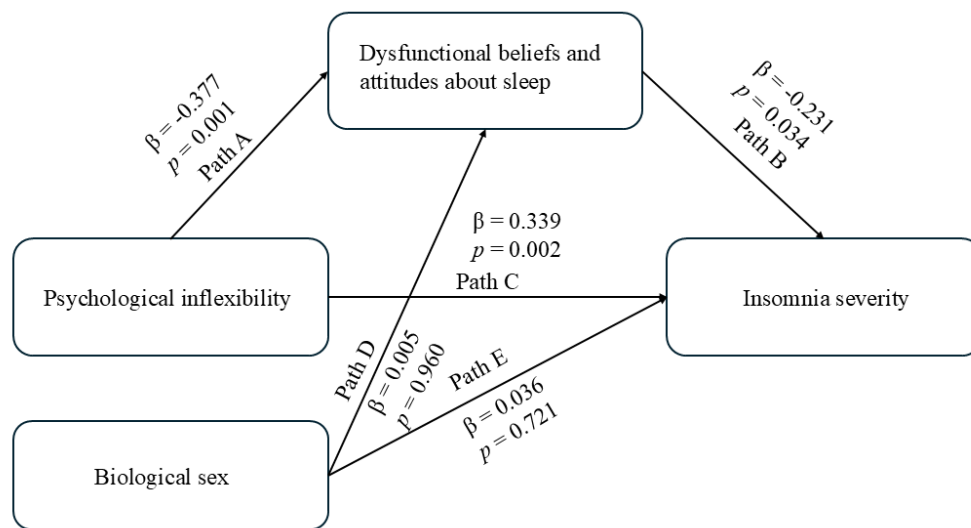


Figure A3. Statistical mediation model with standardized coefficients. This figure presents the tested mediation model with standardized regression coefficients (β) and p -values. Dysfunctional beliefs and attitudes about sleep partially mediate the effect of psychological inflexibility on insomnia severity. Biological sex was included as a covariate in the model.