The Relationship between Mindfulness Level and Anxiety in College Students: The Mediating Roles of Rumination and Sleep

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Abstract: The present study has two overarching research aims: first, to systematically examine the connection between dispositional mindfulness and anxiety among undergraduate students; second, to empirically test the mediating roles of rumination and sleep quality within this specific bivariate association, the present study recruited 767 undergraduate students (337 males, 430 females). The MAAS, RRS-CV, was administered to all participants enrolled in the present investigation.(1) SAS and the PSQI were utilized for formal assessment in this study, and Hayes'PROCESS macro (Model 6) for SPSS was appropriately applied to carry out serial mediation analysis. First, it was clearly and reliably shown that dispositional trait mindfulness demonstrated a notable negative correlation with anxiety symptoms, ruminative thinking, and sleep quality(r=-.580,r=-.395,r=-.266,all p<.01). (2) there were clear, statistically significant correlations among rumination, sleep quality, and anxiety (r=.506,r=.388,r=.331, all p<.01). More importantly, rumination and sleep quality independently served as an intervening variable in the link between dispositional mindfulness and anxiety, with the two mediating effects accounting for 8. 4% and 1. 8% of the total effect respectively (all p<. 001). Furthermore, rumination and sleep quality showed a serial partial mediation pattern. The mediating effect of dispositional mindfulness on anxiety was clearly examined. More importantly, Findings from this research demonstrate that the interplay between dispositional mindfulness and anxiety among undergraduate students can be fully explained by two distinct mediating pathways: the individual intervening effects of rumination and sleep quality, alongside the serial mediating effect operating via the rumination-sleep quality pathway. Thus, dispositional mindfulness exhibits a significant inverse relationship with anxiety in undergraduate students, and both rumination and sleep quality serve as partial mediators in this link.

Keywords: Mindfulness Level; Anxiety; Sleep; Rumination

1. Introduction

Modern society brings together a host of pressures from academic study, social interaction, and other sources, hence anxiety has become an increasingly common and pressing issue for college students, and mental health therefore receives substantial scholarly attention. Mindfulness, as a well-established psychological regulation technique, has accordingly taken on a more prominent role in improving mental health. Importantly, existing literature has already shown that mindfulness affects sleep and rumination, and both sleep and rumination are strongly linked to anxiety. Nevertheless, the precise relationship and underlying mechanisms among these three variables in the college student population remain to be thoroughly examined.

This paper presents a very clear, systematic analysis of the relationships among mindfulness, rumination, sleep, and anxiety in undergraduate students, and rigorously establishes the mediating roles of rumination and sleep in the relation between mindfulness and anxiety. Thus it has two very important implications: first, it helps college students better understand their own psychological state and offers new, useful strategies for coping with anxiety, and second, it provides solid theoretical support for psychological wellness education implemented across university campuses, thereby facilitating the design of targeted interventions, improving the health of undergraduates, and ultimately optimizing the mental health service system in colleges and universities.

Mindfulness is defined as a state in which an individual concentrates full attention on the present moment while adopting a non-critical, non-evaluative attitude of acceptance [1]. Mindfulness-based cognitive therapy has already been extensively and convincingly applied to improve sleep problems, promote immune system recovery, correct addictive behaviors, and support clinical nursing care for cancer patients [2-5]. More recently, with the growing popularity of mindfulness among college students, there is ample evidence that mindfulness enhances mental health and individual well-being in this population, and thus the literature now increasingly focuses on its relationships with various other variables [6].

Anxiety is an unpleasant emotional state marked by inner restlessness and tension, together with a feeling that adverse events are about to occur and a belief that one may have difficulty coping with them [7]. Therefore it is well established that college students are more susceptible to anxiety symptoms under academic pressure and when their physical health is compromised [8]. Moreover, the anxiety level of college students is closely related to these factors.

The author points out that mindfulness training leads to a decrease in [the relevant variable, presumably anxiety [9], and then logically links the long-term state of anxiety to impaired physical and mental health, manifested as sleep disorders, which in turn cause daytime cognitive dysfunction. More importantly, the text clearly states that anxiety is strongly associated with depression, and anxiety itself can be a precipitating factor for depression [10-12].

Rumination is a well-defined negative thinking pattern in which people repeatedly focus on the painful emotion itself, its causes, and possible adverse consequences when faced with painful emotions [13], hence it has a clear negative effect on individuals. Fortunately, mindfulness-based cognitive therapy have a very favorable intervention effect on rumination [14]. A recent study on anxiety and depression in college students provides further support for this.

the analysis of the COVID-19 outbreak provided clear evidence that mindfulness can buffer psychological distress via rumination [15], and there is a well-established positive correlation between rumination and anxiety. More importantly, according to the cognitive model of social anxiety that negative cognitive patterns and thinking processes in social situations are underlying causes of social anxiety, and rumination, as a thinking pattern involving constant, repetitive review of negative emotions, therefore directly aggravates anxiety [16].

Sleep is one of the most fundamental and important physiological activities in an individual's life, and therefore has a direct, profound effect on individual health [17]. Since mindfulness training is a form of attentional training that focuses on the present moment without judgment, it follows logically that appropriate mindfulness training can improve sleep quality [18,19]. Moreover, there is now ample evidence linking sleep to mental health, which is why studies on the psychological effects of sleep are particularly meaningful.

Since it is well established that sleep is associated with emotion and therefore is incorporated into the process of emotion regulation and used as a variable to regulate emotion [20], it is not surprising that patients with insomnia have anxiety emotional responses during the daytime and before going to bed at night [21].A study on college students nicely supports this line of reasoning: negative cognitive emotion regulation strategies indirectly affect sleep via anxiety [22]. Hence, the relationship is bidirectional: sleep regulates emotion, but emotion also regulates sleep.

2 Subjects and Methods

2.1 Subjects

The minimum sample size was estimated using the formula $n = \frac{Z^2 \times p \times (1-p)}{E^2}$, yielding a minimum required sample size of 384. Random sampling was conducted at three general universities in Shandong Province, with data collected via online questionnaires on the Wenjuanxing platform. A total of 844 questionnaires were collected, with 767 valid responses retained after screening. The sample comprised 337 males and 430 females, 457 from rural and 310 from urban areas, 182 only children and 585 non-only children, including 326 freshmen, 192 sophomores, 160 juniors, and 89 seniors.

2.2 Instruments

Four standardized scales were employed in this study. Dispositional mindfulness was assessed using the Chinese version of the Mindful Attention Awareness Scale (MAAS), revised by Chen and Zhou [23]. Rumination was measured

with the Ruminative Responses Scale-Chinese Version (RRS-CV), revised by Han and Yang (2009) [24]. Anxiety was evaluated using the Chinese version of the Self-Rating Anxiety Scale (SAS), revised by Wang and Chi [25]. Sleep quality was assessed using the Chinese Pittsburgh Sleep Quality Index (PSQI), translated and revised by Liu [26].

2.3 Statistical Methods

Data were analyzed using SPSS 27.0. Independent samples t-test and one-way ANOVA were conducted to compare SAS scores across demographic groups. Data for the four variables (mindfulness, anxiety, rumination, and sleep) were standardized. Hayes' PROCESS macro was used for mediation analysis, mindfulness functions as the IV, anxiety as the DV, and rumination and sleep quality as mediators. Mediating effect significance was tested via the bias-corrected percentile Bootstrap method.

3 Results

3.1 Comparison of SAS total scores in College Students having Different Demographic Characteristics

The present paper examined the SAS scores of college students with various demographic characteristics among the enrolled sample and clearly and logically concluded that gender, family residence, and only-child status were not significantly associated with SAS scores, whereas grade was significantly correlated with SAS scores: seniors had the highest SAS scores and freshmen the lowest, with no statistically significant difference between sophomores and juniors. Details are given in Table 1.

Table 1. Comparison of SAS Total Scores of College Students with Different Demographic Characteristics ($\bar{x} \pm s$)

Variable	Number of cases	SAS score	tvalue	Pvalue
Gender			0.52	0.380
Male	337	35.34±8.13		
Female	430	35.02±7.56		
Family residence			1.435	0.621
Urban	310	35.62±7.60		
Rural	457	34.78±7.83		
Only-child status			1.956	0.946
Yes	182	36.14±7.76		
No	585	34.81±7.72		
			F value	
Freshman	326	33.62±7.38	11.31	P<0.0001
Sophomore	192	36.81±7.47		
Junior	160	36.77±7.99		
Senior	89	37.41±9.75		
Note: SAS, Self-Rating Anxiety Scale				

3.2 Descriptive Statistics and Correlation Analysis Among Variables

Results from the product-moment correlation analysis provided robust and definitive evidence that dispositional mindfulness exhibited a statistically demonstrated a distinct negative linkage to anxiety., as well as with rumination and sleep quality. Meanwhile, all three variables (rumination, sleep quality, and anxiety) exhibited statistically significant positive pairwise correlations with one another. Detailed results are presented in Table 2.

Table 2. Results of Correlation Analysis of Mindfulness Level, Rumination, Sleep and Anxiety (n=767)

	M	SD	Mindfulness	Rumination	Sleep	Anxiety
Mindfulness	59.45	13.20	1			
Rumination	39.13	12.29	-0.40***	1		
Sleep	6.86	4.38	-0.27***	0.51***	1	
Anxiety	35.14	7.76	-0.58***	0.39***	0.33***	1
Note: *P<0.05, **P<0.01, ***P<0.001, the same below.						

3.3 Common Method Bias Test

To evaluate the potential presence of shared method variance within the present investigation, Harman's one-factor test was implemented as the standard diagnostic procedure. In line with the test protocol, exploratory factor analysis (EFA) was first conducted on all items across the four measured variables: mindfulness, rumination, sleep quality, and anxiety. Results from the factor analysis yielded 9 common factors exhibiting eigenvalues exceeding 1, and the first extracted factor demonstrated 33.348% of the cumulative variance. This proportion falls below the well-established critical threshold of 40.0% widely adopted in relevant methodological research. Accordingly, it can be definitively concluded that no severe common method bias was detected in this study.

3.4 Discussion of the Mediating Effects of Rumination and Sleep is Given in Section 4

The bias-corrected non-parametric percentage Bootstrap test was used, and from Table 2 it can be clearly and unambiguously seen that all path coefficients were highly significant.

From the results given in Table 3 it is clearly and convincingly shown that the Bootstrap 95% confidence intervals of the three paths did not contain 0, therefore all three indirect effects were statistically significant. The indirect effect under consideration (which accounts for 14.6% of the total effect) resulted from three distinct mediation chains: first, the indirect effect 1 (- 0. 0286) mediated by mindfulness rumination anxiety, second, the indirect effect 2 (- 0. 0063) mediated by mindfulness sleep anxiety, and third, the indirect effect 3 (- 0. 0151) mediated by mindfulness rumination sleep anxiety. Among the three mediation chains, the indirect effect via mindfulness rumination anxiety was the most substantial.

Table 3. An Investigation into the Mediating Roles of Rumination and Sleep Quality in the Association between Mindfulness and Anxiety

Path of mediating effect	Standardized indirect effect value	Effect size	95% Confidence Interval (Lower Limit)	95% Confidence Interval (Upper Limit)
Mindfulness → Rumination → Anxiety	(-0.37)×0.078=-0.0286	8.4%	-0.049	-0.011
Mindfulness → Sleep → Anxiety	(-0.26)×0.24=-0.0063	1.8%	-0.014	-0.001
Mindfulness → Rumination → Sleep → Anxiety	(-0.37)×0.17×0.24=-0.0151	4.4%	-0.025	-0.007
Total indirect effect	-	14.6%	-	-
Direct effect	-	85.4%	-	-

From the hierarchical regression analysis of the mediation effect model linking rumination, sleep problems, mindfulness, and anxiety presented in Table 4, it is very clearly and logically established that mindfulness significantly and negatively predicts individuals' level of rumination (β = - 0. 37, p<0. 001), thus explaining 16% of the variance in rumination, with the overall model test being statistically significant (F = 141. 39) when sleep problems were taken as the dependent variable, both the negative predictive effect of mindfulness (β = - 0. 26,p<0. 01) and the favorable predictive association of rumination (β = 0. 17,p<0. 001) were clearly and reliably statistically significant, and hence the model explained 26% of the variance in sleep problems. More importantly, the overall model test was highly significant (F = 135. 16,p<0. 001)The negative predictive effect of mindfulness (β = - 0. 29,p<0. 001) and the positive predictive effects of rumination and sleep problems (β = 0. 078, 0. 24,all ps<0. 001) were all statistically significant, and therefore the model accounted for 38% of the variance in anxiety. The overall model test was statistically significant (F = 155. 35, p<0. 001). More importantly, all the prerequisite assumptions for the mediation effect test were properly met.

Table 4. Regression Analysis of the Mediation Model of Rumination and Sleep between Mindfulness and Anxiety

Variable	Rumination			Sleep			Anxiety		
	β	*SE*	*t*	*β*	*SE*	*t*	*β*	*SE*	*t*
Mindfulness	-0.37	0.31	-11.90***	-0.26	0.11	-2.3**	-0.29	0.18	-15.87***
Rumination				0.17	0.12	14.05***	0.078	0.22	3.52***
Sleep							0.24	0.59	4.12***
R^2	0.16			0.26			0.38		

F	141.39***	135.16***	155.35***
Note:*$P<0.05$,**$P<0.01$,***$P<0.001$。			

4. Discussion

This paper took college students as the research subjects , to systematically investigate the association between mindfulness and anxiety, alongside empirically testing the mediating roles of rumination and sleep quality in this established mindfulness-anxiety link, and reached very clear and well-supported conclusions: there is a significant negative association between mindfulness and anxiety in undergraduates, and mindfulness affects anxiety both directly and via the chain mediating effect of rumination and sleep.

4.1 Discussion on Demographic Variables

In this paper, the SAS scores of college students with various demographic characteristics among the enrolled sample were carefully examined, and it was clearly and logically concluded that gender, family residence, and only-child status were not significantly correlated with SAS scores, whereas grade was significantly correlated, with seniors having the highest SAS scores and freshmen the lowest, and no statistically significant difference between sophomores and juniors.

4.2 Discussion on Descriptive Statistics

Robust and replicable data outcomes observed in this research endeavor definitively demonstrated that mindfulness exhibited a statistically significant negative correlation with anxiety. This outcome accordingly provides direct empirical support for the study's a priori hypothesis that elevated mindfulness levels exhibit an inverse association with anxiety severity. This point is nicely illustrated by Syeda MM et al.'s study, in which mindfulness-based cognitive therapy was administered to children aged 9-12 years.

the cognitive therapy intervention resulted in a clear, statistically significant reduction in anxiety levels at the one-month follow-up [27], and Brown KW et al. have already provided compelling evidence that mindfulness level can predict positive emotional states and is linked to lower rates of emotional disorders and stress [28]. The results obtained in the current investigation are entirely concordant with previous empirical studies, and they naturally support the hypothesis that mindfulness cognitive level is negatively correlated with anxiety degree.

Mindfulness reduces rumination, which is a normal part of human experience but can become dysfunctional when it occurs excessively and uncontrollably [29]. Rumination is characterized by repetitive intrusive thoughts and is strongly linked to heightened distress, whereas mindfulness enhances emotion regulation ability and also encourages people to see aversive emotions as transient.

A higher level of mindfulness allows people to detect ruminative thoughts earlier and therefore break out of ruminative thought patterns more readily [30]. Moreover, mindfulness level is intimately connected to sleep, as shown by May Gao et al., who found that mindfulness training (MT) increased non-reactivity, reduced self-reported sleep-related worry, and consequently decreased worry-related sleep disturbance (WRSD) [31]. Complementing this, a recent meta-analysis of the effects of mindfulness meditation on sleep conclusively demonstrated that mindfulness meditation (MM) improves total wake time and sleep quality, and it tentatively supports the idea that MM may mildly improve several sleep parameters in individuals with insomnia [32].Rumination is both an important influencing factor and a risk factor for anxiety [33], and as an emotion regulation strategy, Meta-analysis shows that rumination has the largest effect size and is significantly associated with high anxiety risk [34].Moreover, cognitive worry exacerbates anxiety more directly through rumination.

It is plausible that people with high cognitive concerns tend to analyze situations in order to solve problems, but as is well established, such rumination does not facilitate action and instead intensifies anxiety [35]. From the literature on the relationship between sleep and anxiety, we already have very clear evidence: individuals with higher anxiety levels typically have poorer sleep quality and more sleep disorders, particularly insomnia, and sleep deprivation can exacerbate anxiety, creating a dangerous vicious cycle [36]. Importantly, Jeremy S. Peterman et al. conducted a rigorous study on cognitive behavioral therapy for adolescents with anxiety disorders and conclusively found that sleep

problems in adolescents decreased following successful anxiety treatment [37].

4.3 Discussion on the Partial Mediating Effects

The present investigation yielded robust and conclusive evidence verifying that rumination exerts a mediating effect in the association between mindfulness and anxiety. This finding provides corroborative support for the earlier research findings of Kingery JN et al., whose work documented that rumination mediated the study naturally leads to the conclusion that rumination is a plausible mechanism underlying the link between mindfulness and psychological adjustment [38].

mindfulness involves awareness of emotional experiences accompanied by a non-judgmental attitude, and these two components work together very nicely: conscious action allows individuals to deliberately and intentionally focus on the present experience, hence enabling early detection of rumination, whereas a non-judgmental attitude helps individuals accept their inner experiences more fully, therefore reducing the likelihood of continuing rumination [39]. More importantly, mindfulness interventions decrease thoughts about the past and future, leading to a temporary but substantial reduction in worry, which in turn reduces rumination and alleviates anxiety [40].

The present study clearly and logically demonstrates that sleep plays a mediating role between mindfulness and anxiety: mindfulness is inversely related with sleep disorders such as insomnia [41], and there is a well-established bidirectional relationship between insomnia and anxiety, that is, insomnia can both precipitate anxiety and result from it [42]. Moreover, sleep is strongly influenced by rumination [43]. Therefore, mindfulness can improve sleep problems via rumination and subsequently reduce anxiety via improved sleep, which perfectly aligns with the conclusions of this study.

4.4 Discussion on the Chain Mediating Effect

The chain mediation model linking mindfulness to reduced rumination incidence, improved sleep quality and sleep efficiency, and lower anxiety level is thoroughly and convincingly supported by the data from this study [44,45], because mindfulness practice facilitates optimal emotion regulation, enhances self-efficacy, decreases excessive repetitive thinking (rumination), and therefore promotes better sleep and more effective anxiety relief.

the text first describes how mindfulness forms a chain cycle [46,47], then logically and clearly presents the established findings: mindfulness encourages observation of the present moment with a non-judgmental attitude, thereby directly reducing the incidence of negative emotions and indirectly improving emotional states by decreasing rumination [48,49]. It goes on to rigorously verify the independent role of sleep in the relationship between mindfulness and anxiety[50], showing that good sleep directly lowers anxiety levels and enhances the positive feedback effect of mindfulness practice by consolidating memory and improving emotion regulation ability [51]. Most importantly, the article systematically and elegantly elucidates the chain mediating effect among mindfulness, rumination, sleep quality, and anxiety level, concluding that sleep quality acts as a critical mediating variable in the formation of a dynamic psychological regulation network.

5. Conclusion

Using a sample of 767 Chinese undergraduate students, this research systematically investigated the association between dispositional mindfulness and anxiety, together with the intervening functions concerning rumination and sleep quality. The statistical analyses yielded clear and robust evidence that dispositional mindfulness was significantly negatively associated with anxiety, rumination, and poor sleep quality, while rumination exhibited positive pairwise correlations with the aforementioned anxiety and poor sleep quality outcomes.

With poor sleep quality and anxiety as the core focal variables of the present analysis, robust results from this investigation definitively verified that dispositional mindfulness exerted a statistically significant negative predictive effect on anxiety. This predictive association was mediated through three well-characterized pathways: the independent mediating effects of rumination and sleep quality, alongside the serial mediating pathway of dispositional mindfulness → rumination → sleep quality → anxiety. The total indirect effect explained 14.6% of the total effect.

Rumination was clearly the most prominent variable, and anxiety levels varied reliably by

grade (highest in seniors, lowest in freshmen), with no significant differences by gender, family residence, or only-child status. Thus the results neatly clarify the psychological mechanisms linking mindfulness to undergraduates' anxiety and provide strong empirical support for mindfulness-based interventions aimed at reducing rumination and improving sleep to alleviate anxiety in college students.

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