The Relationship Between College Students' Sense of Social Connection and Insomnia during the COVID-19 Lockdown in China: A Moderated Mediation Model

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Research Article

Keywords: Social connectedness, insomnia, rumination, sports, college students

Posted Date: April 12th, 2023

DOI: https://doi.org/10.21203/rs.3.rs-2737487/v1

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Abstract

The lockdown due to the coronavirus pandemic may have exacerbated mental health problems. This study aimed to explore the mediating and moderating effects of rumination and exercise between social connectedness and insomnia. A cross sectional survey was employed, a total of 10097 Chinese students completed social connectedness (SCS-R), total active time (IPAQ-SF), rumination and insomnia severity (ISI). The results revealed that: (1) social connectedness had a significant direct predictive effect on insomnia in college students ($\beta = -0.19$, $t = -48.31$, $p < 0.01$), can also indirectly predict the level of insomnia through the mediation of rumination ($\beta = -0.13$, $t = -32.41$, $p < 0.01$). (2) The direct effect of social connectedness on insomnia and the mediating effect of rumination were moderated by exercise. This study supports the view that insomnia may be aggravated during lockdown, which was associated with a decreased sense of social connectedness.

1 Introduction

Since the outbreak of COVID-19, educational institutions of colleges and universities in China have implemented campus quarantine when the pandemic at risk. While minimizing the risk of spreading of the disease in the university network, it also brings great challenges to students' physical and mental health. The pandemic will result individuals with increasing unpredictability and uncertainty, loneliness and inactivity (Moreno et al., 2020). Many studies have found that the COVID-19 pandemic has different impacts on people's depression, anxiety, sleep, and etc. [1].

Sleep is not only the representation of the state of physical and mental health during the pandemic, but also has a great influence on people's mood [2]–[4]. Many researchers have explored the prevalence and influencing factors of sleep disturbance before and after the pandemic, and found that sleep disturbance increased in various groups during the pandemic, and found that anxiety, screen time, income decline and social support were possible risk factors of sleep disturbance during the pandemic [2], [5], [6]. Overall, researches on the factors influencing sleep disturbance during the pandemic has been dominated by social and environmental factors, with a lack of exploration of individual physical and psychological factors. Comparing to the environmental factors, individual factors are easier to control and manage. Therefore, the present study explores the influencing mechanism of sleep disturbance among university students during the pandemic period from the perspective of the physical and mental factors of university students during the campus quarantine period.

Social connectedness is an individual's perception of how close they are to others or to the group. Social connectedness theory suggests that good social connections are associated with bonding is associated with higher levels of health and well-being [7]. Conversely, a lack of connection to others can lead to feelings of isolation, anxiety and depression (Lee & Robbins, 1995). It could be harmful to both physical and psychological well-beings of individuals. [9]. During the period pandemic prevention and control, most of universities implemented the campus closure policies, the sense of social connection may be affected by travel restriction, online classes, reduced gathering and less physical contact with others.
In the study of animals, isolating animals from social activities has been found to result in significantly lower sleep quality and efficiency [10]. And human studies also report that high levels of self-reported loneliness and anxiety in human individuals both significantly predict low sleep quality [11], while positive social activity are also associated with better sleep quality [12]. This leads to the hypothesis that a reduced sense of social connectedness negatively affects the sleep quality of individuals during lockdown (H1).

Rumination is a kind of maladaptive cognitive tendency and emotion regulation strategy [13]. Rumination may lead to the increase of anxiety and depression level and the continuous damage of cognitive system. It has been found that the occurrence of ruminative thinking may be related to the active medial temporal lobe subsystem in the brain being dominated by the network core subsystem, compressing the space for activity and resulting in a minimal flow of passing thoughts[14]. At the campus quarantine period, the decrease of social connectedness of college students may decrease the reception of new stimuli by medial temporal lobe subsystem, and lead to more rumination of individuals, which might increases susceptibility to mental and physical health problems, such as depression, anxiety, post-traumatic stress disorder, and poorer sleep quality, etc. [15]. Therefore, it can be hypothesized that during the period of pandemic prevention and control, the decrease of social connectedness of college students may lead to the increase of rumination, which will lead to more insomnia of college students, that is, rumination plays a mediating role in the effect of social connectedness on insomnia (H2).

Exercise is one of the important strategies to improve an individual's physical and mental health as well as a complementary intervention for certain psychosomatic disorders (Callaghan, 2004). Research suggests that voluntary exercise can increase levels of brain-derived neurotrophic factor (BDNF) and other growth factors, stimulate neurogenesis, increase resistance to brain insult and improve learning and mental performance [16]. It has been shown to have a moderating and alleviating effect on depressed mood, cognitive function and feelings of efficacy in individuals.

It is thus hypothesized that exercise plays a regulatory role in the pathway of social connectedness to rumination (H3), and that exercise may reduce the effect of connectedness on rumination. In summary, this study proposes the following hypothetical model of the relationship between social connectedness, ruminative thinking, insomnia, and exercise (Fig. 1).

2 Materials And Methods

2.1 Participants

This study aiming to understand the relationship between social connectedness and insomnia in the college students. The participants who were locked down in Nanjing during the pandemic period (April, 2022) were recruited from a university in eastern China. A total of 10097 copies were included after screening out invalid questionnaires, and the effective rate was 85.4%. In our research sample, 4442(44%) were female, 5655(56%) were male, 7555(74.82%) were undergraduates, 2542(28.18%) were graduate...
students. Participants gave their written informed consent to participate in this study, which was previously approved by the Institutional Review Board of the Yangzhou University, China.

2.2 Measurements

2.2.1 Social connectedness scale (SCS-R)

An revised version of the Social Connectedness Scale [17] was used. It is a 20-item scale, which used to assess the extent to which persons feel connected to others in their surrounding social area. It uses a 6-point Likert scale ranges from ‘strongly disagree’ to ‘strongly agree’*. The higher scores on this scale reflect stronger sense of social connectedness. In this study, Cronbach α was 0.95.

2.2.2 Self-rating questionnaire on rumination

The rumination level was measured by three items, participants were asked to report how often they felt or think each of the questions, rating them on a 4-point Likert scale (0 = never, 1 = sometimes, 2 = often, 3 = always). “I am constantly thinking about the impact of lock down on myself”, “I can't get rid of the negative feelings about lock down”, “I keep thinking that if campus closure doesn't change, I can't continue do what I am doing”. Cronbach α for these three items is 0.87.

2.2.3 Insomnia Severity Index (ISI)

Insomnia Severity Index (ISI) was used to measure the severity of insomnia [18]. The questionnaire tends to measure the quality for participants of last two weeks. ISI composes of seven items, ranges from none to very severe, is a five-point Likert scale. In China, the cutoff of ISI is 10, the score below 10 means no insomnia, score above 10 represents minimal or above insomnia symptoms. Cronbach in this scale was 0.91.

2.2.4 The International Physical Activity Questionnaire-Short (IPAQ-S)

The IPAQ-S was used in this study [19]. The IPAQ-S is a assessment to measure the length of physical activity. Participants were asked to recall the time (hours/days) they had participated physical activities in the past 7 days, the average daily physical activity in the past 7 days was calculated. The criteria could be categorized into three levels, inactive, minimally active and highly active. In this study, we calculate average activity hours per day as independent variables.

2.3 Data analysis

Preliminary analysis of descriptive studies, common method bias, and correlation analysis of all variables were conducted through SPSS v26.0. Mediation and moderation effect were assessed through Process v4.0.

3 Results
3.1 Common method bias

Harman's single factor test was used to examine whether there were serious common methodological biases in the questionnaire tools. The results show that the eigenvalues of the five factors are greater than 1 without rotation, and the interpretation rate of the first common factor is 33.82%, less than 40%. Therefore, there is no common method bias in the data of this study.

3.2 Preliminary analysis

The description of each variable and the results of correlation analysis are shown in Table 1 and Table 2. Table 1 shows that the average score of insomnia which was 6.84. 76.97% of the students scored below 10 during the lockdown, for insomnia below the clinical threshold (minimal or no sleep difficulties), but 23% of the students had an insomnia index score above 10, which means that those students were likely to present with insomnia symptoms[20].

As we can see in Table 2, all variables were significantly correlated with each other, total active time was negatively related to insomnia (r=-0.09, p<0.01) and rumination(r= 0.08, p<0.01). In addition, insomnia was positively correlated with rumination (r= 0.43, p<0.01), while social connectedness was negatively related to insomnia (r=-0.43, p<0.01). Finally, rumination was negatively related to social connectedness (r=-0.42, p<0.01).

Table 1
Number and Proportion of Patients with Insomnia

<table>
<thead>
<tr>
<th>Insomnia index score interval</th>
<th>Number of persons in each section</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–10</td>
<td>7772</td>
<td>76.97%</td>
</tr>
<tr>
<td>10–28</td>
<td>2325</td>
<td>23.03%</td>
</tr>
<tr>
<td>Total</td>
<td>10097</td>
<td></td>
</tr>
</tbody>
</table>

Table 2
Descriptive Data on Means, Standard Deviations and Correlations among Study Variables (N = 10097).

<table>
<thead>
<tr>
<th></th>
<th>M</th>
<th>SD</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.Exercise</td>
<td>2.44</td>
<td>2.08</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.Insomnia</td>
<td>6.84</td>
<td>5.48</td>
<td>-0.09**</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.Rumination</td>
<td>2.11</td>
<td>2.23</td>
<td>-0.08**</td>
<td>0.43**</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>4.SC</td>
<td>37.02</td>
<td>12.39</td>
<td>0.13**</td>
<td>-0.43**</td>
<td>-0.42**</td>
<td>1</td>
</tr>
</tbody>
</table>

Exercise = total active time, SC = social connectedness. **p < 0.01.
3.3 Mediation Model test

Table 3 shows the significance of pathways. The total effect of social connectedness on insomnia was significant (total effect = -0.19, SE = 0.004, t = -48.31, p < 0.01, 95% CI [-0.20, -0.18]). That is, social connectedness was negatively associated with insomnia. Rumination mediated the link between social connectedness and insomnia (indirect = -0.06, 95% CI [-0.06, -0.05]). By controlling the mediators, the direct effect of social connectedness on insomnia was significant (direct effect = -0.13, SE = 0.002, t = -32.41, p < 0.01, 95% CI [-0.14, -0.13]), indicating partial mediation of rumination in the relationship between social connectedness and insomnia. Results verify H1 and H2.

<table>
<thead>
<tr>
<th>Predictors</th>
<th>Model 1 (Insomnia)</th>
<th>Model 2 (Rumination)</th>
<th>Model 3 (Insomnia)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>β</td>
<td>t</td>
<td>β</td>
</tr>
<tr>
<td>SC</td>
<td>-0.19</td>
<td>-48.31**</td>
<td>-0.08</td>
</tr>
<tr>
<td>Rumination</td>
<td></td>
<td></td>
<td>0.75</td>
</tr>
<tr>
<td>R²</td>
<td>0.19</td>
<td></td>
<td>0.18</td>
</tr>
<tr>
<td>F</td>
<td>2333.77**</td>
<td></td>
<td>2159.84**</td>
</tr>
</tbody>
</table>

SC = social connectedness. **p < 0.01.

3.4 Moderated mediation model test

Model 7 of PROCESS 4.0 was used to evaluate the moderated mediation model. Gender and age did not play a significant role in this study. The results showed that the negative predictive effect of total active time on rumination was significant (β = -0.03, t = -3.52, p < 0.01), the interaction between total active time and social connectedness had significant predictive effect on rumination (β = 0.002, t = 3.23, p < 0.01). To be specific, the effect of social connectedness on the degree of insomnia through rumination was regulated by total active time, and it also regulated the first half path of mediating effect (Table 4).

To elaborate upon the moderating effect of exercise, we examined the interaction using a simple slope analyses both low and high levels of exercise. According to Fig. 2, total active time moderated the direct relationship between social connectedness and rumination (see Fig. 2). To be specific, when in longer total active time (M + 1 SD), social connectedness had a significant predictive effect to rumination (direct effect = -0.07, SE = 0.01, p < 0.01, 95% CI [-0.07, -0.06]); when in in shorter total active time (M - 1 SD), the prediction of social connectedness on rumination had reduced (direct effect = -0.08, SE = 0.08, p < 0.01, 95% CI [-0.09, -0.08]).
In conclusion, rumination plays a mediating role between social connectedness and the degree of insomnia, while both the direct effect of social connectedness on insomnia and the mediating effect of ruminant thinking are regulated by total active time. Specifically, with the increase of total active time, the effect of rumination on rumination was weakened, and the effect of social rumination on insomnia was also weakened, which verified hypothesis 3 (H3).

### Table 4
Testing the Moderated Mediation Effect Model (N = 10097)

<table>
<thead>
<tr>
<th>Predictors</th>
<th>Model 1 (Rumination)</th>
<th>Model 2 (Insomnia)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\beta$</td>
<td>$t$</td>
</tr>
<tr>
<td>SC</td>
<td>-0.07</td>
<td>-45.03**</td>
</tr>
<tr>
<td>Exercise</td>
<td>-0.03</td>
<td>-3.52**</td>
</tr>
<tr>
<td>SC×Exercise</td>
<td>0.002</td>
<td>3.23**</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.18</td>
<td>0.27</td>
</tr>
<tr>
<td>$F$</td>
<td>729.97**</td>
<td>1820.32**</td>
</tr>
</tbody>
</table>

SC = social connectedness. Exercise = Total active time. **p < 0.01.

### 4 Discussion

#### 4.1 General discussion

Under the background of the continuous influence of COVID-19 in China, the lockdown management strategy in universities reduces the risk of infection for students while also having an impact on their physical and mental health. This study examines the effect of reduced sense of social connectedness on insomnia in the context of closed campus management and its mechanisms of action, analyzing the mediating role of ruminative thinking and the moderating role of exercise. The results of this study provide insight into the relationship between social connectedness and insomnia and the internal mechanisms of action.

This study found that nearly one fourth of the students had insomnia symptoms. Consistent with previous studies, there was significant problem in sleep disturbances during COVID-19, with poor sleep quality ranging from 5–70% [2]. The prevalence of sleeping disorders was about 14.9% -19.33% [2], [21]. The relatively high prevalence of insomnia among university students in this study may be due to the fact that the questionnaire collection was during a period of extended campus closure. Social connectedness was found to be a significant negative predictor of insomnia, for instance, the lower the sense of social connectedness, the more severe the insomnia. This result lines with previous research on the relationship
between loneliness or social isolation and sleep, the greater the loneliness, the lower the quality of sleep reported by the individual, the longer it took to fall asleep [22]. The higher the possibility of insomnia [23]. The explanation is that the loneliness, anxiety and stress associated with a low sense of connectedness cause a disturbance in reactive cortisol secretion [24]. This disrupts the metabolic and physiological rhythms of the organism, leading to disrupted sleep patterns [25].

This study also found that rumination played a mediating role in the relationship between social connectedness and insomnia, and decreased social connectedness may increase rumination, which in turn aggravates insomnia in college students. According to the theory of embodied cognition [26], action may affect an individual's cognitive process. During the period of campus closed, the scope and content of activities of college students were reduced, and the social connection was weakened. At the same time, the core subsystem of the brain area network had excessive control, which may increase the rumination thinking. According to the cognitive processing theory of insomnia [27], the high activity of thinking in ruminating state makes the students unable to enter the quiet state needed for sleep, which leads to insomnia [28].

This study found that the effects of social connectedness on ruminating thought and insomnia were moderated by duration of exercise; the longer the exercise, the weaker the direct effect of social connectedness on insomnia levels and the mediating effect of ruminative thinking. This means that exercise mitigates the negative effects of a low sense of social connectedness; the longer the duration of exercise, the stronger the effect on counteracting ruminative thinking. Previous studies have pointed out that exercise not only has a positive contribution to an individual's physical and mental development [29], it can also have a complementary therapeutic effect in the psychotherapy of the individual [30]. In terms of the nature of exercise, it is a spontaneous activity, with students actively choosing and completing the exercise resulting in a sense of control and achievement, which can lead to positive emotions. At the same time, exercise may help individuals to redirect their attention from ruminant thoughts arising from a reduced sense of social connectedness to the exercise of the moment, thereby reducing ruminant thoughts and thus contributing to better sleep quality.

This study explored the effects of reduced social connectedness on insomnia in college students through a moderated mediation model, and further revealed the mediating role of rumination thinking and the moderating role of exercise. The results of this study explained the internal mechanism of the influence of social connectedness on the insomnia of college students. This study further built the underlying mechanisms between social connection and insomnia under the impact of COVID-19.

4.2 Implications

The findings on the mechanisms of social connectedness, ruminative thinking and exercise on university students’ sleep problems could provide empirical support and insights for clinical practitioners during the period of pandemic control period. Firstly, reduced sense of social connectedness has a significant direct and indirect influence on university students' insomnia, the intervention of enhancing social connectedness could be applied. For example, by organizing online group counselling or offline activities...
as permitted by the university policy. It can alleviate the feelings of isolation that students experience when they are unable to meet with their families and friends due to university closure. Secondly, the sense of social connectedness affects the quality of sleep through ruminative thinking. University administers can help students reduce ruminant thinking, for example, conducting mindfulness exercises to weaken the role of ruminant thinking. Finally, exercise can mitigate the effects of lowered sense of social connectedness on insomnia in university students. Therefore, students should be encouraged to engage in regular exercise routines with greater frequency and variety into their daily lives.

### 4.3. Limitations and future direction

There are also several limitations in this study. Firstly, the sample group in this study was all from one university, which may not be a representative sample. The future studies could include more samples to test replicability of the results. Secondly, this study used a cross-sectional research method, which could not confirm the casual relationship among variables. Future studies may consider using a longitudinal research design. Finally, exercise intensity, which was not included in this study, is also a factor with a large effect, and could be included in future studies to explore the appropriate duration and intensity of exercise for different groups in different contexts, with a view to providing a richer and more detailed empirical reference for policy orientation.

### 5 Conclusion

Social connectedness not only has a significant direct predictive effect on insomnia of college students, but also has an indirect effect on insomnia through the mediating effect of rumination. The direct effect of social connectedness on ruminant thinking of college students is moderated by exercise. Compared with the students with shorter total active time, the students with longer total active time have weaker direct effect and indirect effect.

### Declarations

**Ethics approval and consent to participate**

This study has been approved by the Institutional Review Board of the Yangzhou University, China.

We confirmed that all methods were performed in accordance with the relevant guidelines and regulations. This study was carried out in compliance with the Declaration of Helsinki guidelines.

**Consent for publication**

Not applicable. We did not use personal information to conduct the survey. There is no risk of personal information disclosure.

**Availability of Data and Material (ADM)**
The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

Funding

This research received no particular grant from any funding agency in the public, private, or not-for-profit sectors.

Authors' contributions

Liu and Jiang wrote the main manuscript text and prepared all of the figures. Zhang completed the translation and polishing of the manuscript. All authors reviewed the manuscript.

Acknowledgment

Not applicable.

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References


Figures
Figure 1

Hypothesis model of mediation of rumination and regulation of total active time

Figure 2

Simple slope analysis of the moderating effect of Supportive Power