

Association between stressful life events and sleep quality in Chinese university students: Mediating and moderating roles of emotion regulation

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Abstract

This study investigated whether emotion regulation mediates or modulates the relationship of SLEs with sleep quality and potential sex differences. A total of 1447 Chinese university students completed the Adolescent Self-Rating Life Events Checklist, the Pittsburgh Sleep Quality Index, and the Emotion Regulation Questionnaire. The results indicated that both cognitive reappraisal and expressive suppression significantly mediated and moderated the negative association between SLEs and sleep quality. Additionally, sex differences were found for the mediating role of cognitive reappraisal and for the modulating roles of cognitive reappraisal and expressive suppression in the relationship between SLEs and sleep quality. Although the present cross-sectional data does not allow us to test any causal relationships, these results help clarify the underlying emotion-regulation process between SLEs and sleep in university students and highlight the importance of considering sex differences in emotion regulation.

Keywords

cognitive reappraisal, emotion regulation, expressive suppression, gender differences, sleep quality, stressful life events, university students

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Introduction

Sleep disturbance is one of the major health challenges worldwide, with university students being particularly susceptible. For instance, a meta-analysis study on 76 studies reported that the overall pooled prevalence of sleep disturbances among 112,939 Chinese university students was 25.7% (Li et al., 2018). As is well known, poor sleep can trigger negative outcomes, such as impaired cognitive ability (García et al., 2021), negative emotion (Tomaso et al., 2021), academic difficulty (Prichard, 2020), social dysfunction (Takaesu et al., 2022). Therefore, it is important to identify risk and protective factors influencing university students' sleep quality (Pan and Zhang, 2022; Semenchuk et al., 2021).

With the rapid development of modern society, higher requirements have been put forth for university students to adapt. Accordingly, stressful life events (SLEs) increase every year among this population. SLEs refer to the events that compel people to make changes in their ongoing life patterns, such as poor interpersonal relationship, academic stress, and other negative dimensions in daily life. A substantial body of literature has established that SLEs are the main factors resulting in poor sleep quality (Li et al., 2019; Pan and Zhang, 2022). Consequently, a key focus of stress research is to explore relevant mediating and moderating factors for the association between SLEs and sleep quality. Nevertheless, studies on emotion regulation as a mediator or modulator are scarce.

Emotion regulation refers to various strategies that an individual employs to regulate daily emotional states (John and Gross, 2004). Adaptive emotion regulation can reduce the detrimental effects of psychological stress (Sachs-Ericsson et al., 2021), whereas maladaptive emotion regulation can exacerbate emotional reactivity and contribute to health problems (Dryman and Heimberg, 2018). Two widely used strategies are cognitive reappraisal (CR) and expressive suppression (ES) (John and

Gross, 2004). CR involves altering the emotional impact of an event by thinking about it differently. For example, if a student fails in a test, he or she can think that he didn't prepare well and there still are more opportunities to pass it. CR is typically regarded as an adaptive strategy, for it has been consistently shown to be positively associated with psychological well-being (Haga et al., 2009) and social functions (Sachs-Ericsson et al., 2021). ES refers to the attempt to hide, inhibit, or reduce ongoing emotion-expressive behaviors (John and Gross, 2004). Extending the example used above, the student might suppress his or her negative emotions by forcing himself not to cry. ES is often considered as maladaptive, for it has been reported to be negatively associated with psychological well-being (Dryman and Heimberg, 2018) and sleep quality (Latif et al., 2019).

This study aimed to examine the role of emotion regulation in the relationship between SLEs and sleep quality in university students. The stress process model is a widely accepted theory for explaining stress-related mental health issues. It includes three major conceptual domains: the sources, the mediators, and the manifestations (Pearlin et al., 1981). According to this model, SLEs may indirectly affect mental health through influencing some mediators. It has been suggested that SLEs are likely to reduce the use of adaptive emotion regulation and trigger maladaptive emotion regulation, leading to more mental health problems (Aune et al., 2023; Miklósi et al., 2014). As an essential indicator of mental health, sleep quality may be directly affected by SLEs or indirectly affected through reduced adaptive emotion regulation and increased maladaptive emotion regulation. Accordingly, we hypothesized that emotion regulation might serve as a mediator for the relationship between SLEs and sleep quality. Given that CR has been considered as adaptive for improving sleep quality, while ES appears to be maladaptive (Latif et al., 2019), we hypothesized that higher SLEs would

indirectly worsen sleep quality through decreased CR and increased ES.

The stress vulnerability model is another popular theory that emphasizes pre-existing background influences as moderators for stress-related mental health issues. According to this model, mental health problems may develop as a result of the interplay between pre-existing differences and daily stressful events. Interestingly, prior research indeed reported that individual difference in CR buffered the negative impacts of SLEs on depression (Shapiro et al., 2016) and suicidal thinking (Franz et al., 2021). However, little research has explored whether emotion regulation modulates the relationship between SLEs and sleep quality. In this study, we hypothesized that CR would buffer the association between SLEs and sleep quality such that among those who tend to use CR more, SLEs would be less associated with sleep problems. We were less certain about the moderating role of ES, but due to many studies reporting negative consequences of ES on mental health (Dryman and Heimberg, 2018; Latif et al., 2019), we hypothesized that the tendency to use this strategy would be associated with an increased association between SLEs and sleep problems.

Accumulating evidence indicates that emotion regulation may vary across sex. Generally, females reported to use more CR than males (Nolen-Hoeksema, 2012), whereas males reported to use more ES than females (Flynn et al., 2010). Sex differences have also been detected in the psychological and physiological effects of emotional regulation (Mink et al., 2023; Rogier et al., 2019). For example, a previous study reported that greater use of CR decreased depressive symptoms more strongly in females than males (Duarte et al., 2015). Another study reported that ES was related to more depressive symptoms in males but fewer depressive symptoms in females (Flynn et al., 2010). In contrast, a recent study reported that ES was adaptive for males but maladaptive for females (Mink et al., 2023). Therefore, sex

difference should be considered when examining mediating or modulating roles of CR and ES in the relationship between SLEs and sleep quality.

In summary, this study explores the specific mechanism of emotion regulation in the relationship between SLEs and sleep quality in university students. We hypothesized that CR and ES might function as mediators or moderators for the relationship between SLEs and sleep quality. The mediating hypothesis suggests that SLEs can indirectly affect sleep quality by affecting emotion regulation strategies, while the moderating hypothesis suggests that the association between SLEs and sleep quality may differ because of their emotion regulation strategies. Besides, we expected sex differences in the mediating or modulating effects of emotion regulation. Specifically, due to prior research reporting more benefits from CR among females (Duarte et al., 2015), we hypothesized that the mediating or modulating roles of CR might be more pronounced in females than males. However, given the contrasting findings regarding sex differences in the beneficial or harmful effects of ES on mental health (Flynn et al., 2010; Mink et al., 2023), no specific hypotheses could be drawn regarding sex differences in the potential mediating or modulating roles of ES.

Materials and methods

Participants

A total of 1500 students were recruited from the authors' university. The participants who gave verbal consent voluntarily completed three self-report questionnaires online. All participants were informed that the survey was for scientific research only and information would be kept strictly confidential. At any time, they could refuse answering any of the questions. After survey completion, each participant received a small gift worth 5 RMB in gratitude for their participation. Finally, 1447 participants contributed usable data, with an effective

recovery rate of 96.5%. Among these respondents, there were 710 freshmen, 496 sophomores, 87 juniors, and 154 senior and graduate students. There were 551 male students (mean age = 19.89 ± 1.66 years), and 896 female students (mean age = 19.53 ± 1.53 years).

Measures

SLEs. The Adolescent Self-Rating Life Events Checklist created by Liu et al. (1997) was used to characterize SLEs. It has been reported to have good reliability and validity in Chinese university students (Li et al., 2019). There are 27 items that can be grouped into six factors: interpersonal relationship, learning stress, punishment, loss, health adjustment, and other life events. Participants are instructed to answer whether the events in the scale had occurred during the preceding 12 months. If the response is “no,” the item is rated as 0. And if the response is “yes,” the participant is required to assess the impact of this event from 1 (no impact) to 5 (very significant impact). Responses can be combined to create a global score. A higher score represents more SLEs. In this study, the Cronbach’s alpha was 0.92, indicating good internal consistency.

Emotion regulation. The Emotion Regulation Questionnaire (Gross and John, 2003) was used to measure emotion regulation. The good reliability and validity of the scale have also been well approved among Chinese university students (Zhao et al., 2020). The subscale of CR includes six items (e.g. “When I want to feel more positive emotions such as joy or amusement, I change what I’m thinking about”), and the subscale of ES includes four items (e.g. “I keep my emotions to myself”). Each item is rated on a 7-point Likert-type scale ranging from 1 (strongly disagree) to 7 (strongly agree). In this study, the Cronbach’s alpha was 0.80 for CR and 0.84 for ES, indicating good internal consistency.

Sleep quality. The Pittsburgh Sleep Quality Index (Buysse et al., 1989) was used to evaluate sleep quality for the preceding month. This scale has been widely used in Chinese university students with good reliability and validity (Li et al., 2019; Pan and Zhang, 2022). It includes 19 items that can be grouped into seven factors: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, use of sleeping medication, and daytime dysfunction. For example, participants were required to answer “During the last month, how was your sleep quality” with responses on a 4-point Likert-type scale, ranging from 0 (very good) to 3 (very bad). Responses were combined to create a global score, with higher score indicating worse sleep quality. In this study, the Cronbach’s alpha was 0.71, indicating moderate internal consistency.

Data analysis

All statistical analyses were conducted with SPSS 20.0. First, we conducted descriptive statistics, independent-samples *t*-tests, and correlation analysis. Second, we examined the mediating role of emotion regulation in the association between SLEs and sleep quality using Model 4 (solid line in Figure 1a) of the SPSS PROCESS macro as proposed by Hayes (2017). The number of repeated samples was set to 5000 to estimate 95% confidence interval (CI) for mediation effects. The significance was indicated by a bootstrap CI that did not include zero. Moderated mediation models were further conducted using Model 59 (dashed line in Figure 1a) of the PROCESS, with sex as a moderator to test whether the mediation effects differed between males and females. Finally, we investigated the modulating role of emotion regulation in the association between SLEs and sleep quality using Model 3 (Figure 2a) of the PROCESS. Sex was included as a moderator to test whether the moderation effects of emotion regulation differed between males and females.

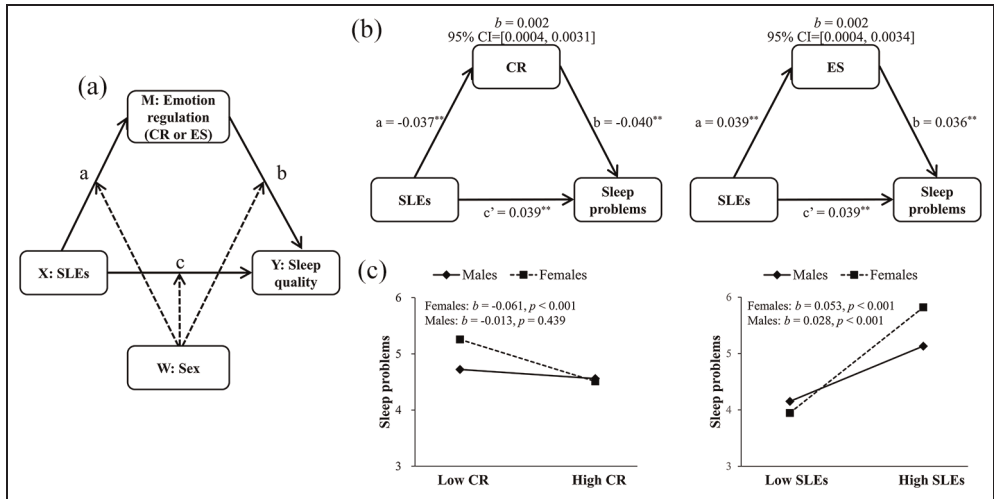


Figure 1. Moderated mediation effects of emotion regulation. (a) The theoretical moderated mediation model in this study. (b) The mediation effect of CR and ES on the association between SLEs and sleep problems across all participants; $**p < 0.01$. (c) The moderating role of sex. A negative correlation between CR and sleep problems was found in females ($b = -0.061, p < 0.001$) but not in males ($b = -0.013, p = 0.439$). A positive correlation between SLEs and sleep problems was found in both females ($b = 0.053, p < 0.001$) and males ($b = 0.028, p < 0.001$) and the correlation was stronger in females.

Age and year in school were included as control variables in all the above regression models.

Results

Descriptive analysis

The normality of each variable was acceptable (skew range = -0.76 – 1.35 ; kurtosis range: -0.57 – 1.94). Harman's one-factor test showed that no single factor could explain the majority of variance (the maximum component accounted for only 35.47%), indicating no common method bias. As expected, females employed more CR ($t_{1445} = 3.65, p < 0.001$) and less ES ($t_{1445} = 7.26, p < 0.001$) than males. Meanwhile, males experienced more SLEs than females ($t_{1445} = 3.77, p < 0.001$). As shown in Table 1, higher SLEs were associated with more sleep problems, less CR, and more ES. More sleep problems were associated with less CR and more ES. Similar correlations were detected separately for females

and males except that CR was not associated with either SLEs or sleep problems in males.

Mediating effect of emotion regulation

Across all participants, the paths from SLEs to both CR and ES as well as the paths from both CR and ES to sleep problems all exhibited significant associations (Figure 1b). Through the bootstrap method, the relationship between SLEs and sleep problems was partially mediated by both CR ($b = 0.002, 95\% \text{ CI } [0.006, 0.023]$) and ES ($b = 0.002, 95\% \text{ CI } [0.002, 0.022]$).

To investigate whether these relationships significantly differed by sex, we conducted moderated mediation analysis using Model 59 of the PROCESS. Interestingly, we observed a significant interaction between sex and CR in explaining sleep problems ($b = -0.048, p = 0.038$). Simple slope test showed that CR was negatively associated with sleep problems in females ($b = -0.061, p < 0.001, \text{ Figure 1c}$) but not in males ($b = -0.013, p = 0.439$).

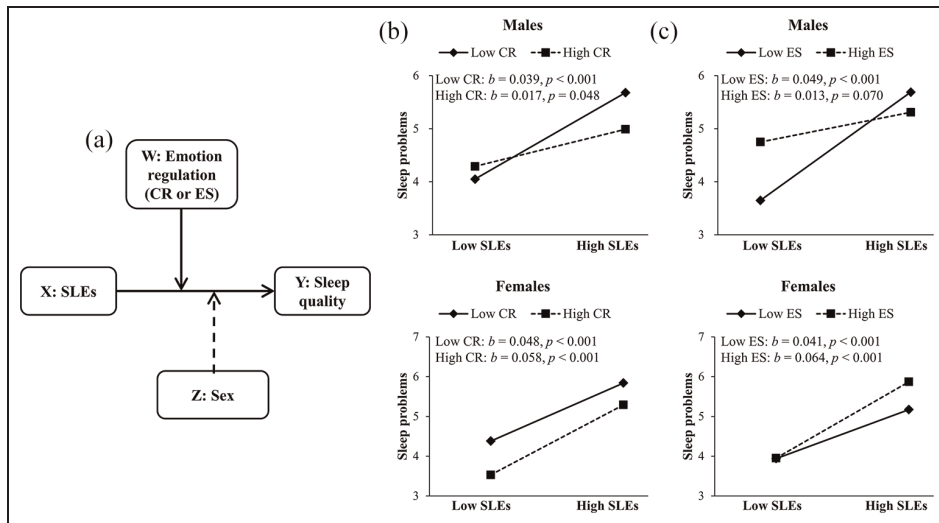


Figure 2. Moderated moderation effects of emotion regulation. (a) The theoretical moderated moderation model in this study; (b) Moderation effects of CR and sex on the relationship between SLEs and sleep problems; (c) Moderation effects of ES and sex on the relationship between SLEs and sleep problems. The criterion on the x-axis was plotted against two levels of the predictor (SLEs): 1 SD below and above the mean. Plotted regression lines represent two levels of the moderator variable (CR or ES): 1 SD below and above the mean.

Table 1. Means and correlations of the main study variables.

	Mean	SD	1	2	3
Total ($n = 1447$)					
1. SLEs	50.53	17.65			
2. CR	30.13	6.09	-0.11**		
3. ES	14.27	5.04	0.17**	0.09	
4. PSQI	4.76	2.77	0.28**	-0.12**	0.11**
Males ($n = 551$)					
1. SLEs	52.75	20.92			
2. CR	29.39	6.51	-0.07		
3. ES	15.48	5.23	0.22**	0.24**	
4. PSQI	4.77	2.87	0.24**	-0.04	0.13**
Females ($n = 896$)					
1. SLEs	49.17	15.15			
2. CR	30.59	5.77	-0.14**		
3. ES	13.53	4.77	0.10**	0.01	
4. PSQI	4.75	2.71	0.33**	-0.18**	0.11**

** $p < 0.01$.

There was also a significant interaction between sex and SLEs in explaining sleep problems ($b = 0.025, p = 0.001$). Simple slope test showed a stronger relationship between SLEs

and sleep problems in females ($b = 0.053, p < 0.001$, Figure 1c) than males ($b = 0.028, p < 0.001$). We further tested whether the indirect effect between SLEs and sleep problems

Table 2. Specific effects for each pathway in the male and female model.

	Female group			Male group		
	<i>b</i>	<i>t</i>	95% CI	<i>b</i>	<i>t</i>	95% CI
Path a: SLEs → CR	-0.048	-3.795	[-0.073, 0.023]	-0.027	-1.952	[-0.054, 0.0002]
Path b: CR → PSQI	-0.058	-3.929	[-0.087, -0.029]	-0.011	-0.626	[-0.047, 0.024]
Path c': SLEs → PSQI	0.052	9.261	[0.041, 0.063]	0.029	5.034	[0.018, 0.041]
Indirect effect	0.003		[0.001, 0.006]	0.0003		[-0.001, 0.002]
	<i>b</i>	<i>t</i>	95% CI	<i>b</i>	<i>t</i>	95% CI
Path a: SLEs → ES	0.031	2.914	[0.010, 0.052]	0.055	5.075	[0.034, 0.076]
Path b: ES → PSQI	0.039	2.181	[0.004, 0.074]	0.045	1.978	[0.0003, 0.091]
Path c': SLEs → PSQI	0.054	9.519	[0.043, 0.065]	0.027	4.584	[0.016, 0.039]
Indirect effect	0.001		[0.0001, 0.003]	0.003		[0.0002, 0.005]

b: unstandardized regression coefficients.

Table 3. Moderated moderation results.

	Model 1				
	<i>b</i>	SE	<i>t</i>	<i>p</i>	95% CI
Age	0.226	0.076	2.995	0.003	[0.078, 0.374]
Year in school	0.044	0.126	0.353	0.7240	[-0.202, 0.291]
SLEs	0.081	0.023	3.602	0.0003	[0.037, 0.126]
CR	0.080	0.042	1.908	0.057	[-0.002, 0.162]
Gender	4.558	1.910	2.390	0.017	[0.818, 8.298]
SLEs × Gender	-0.057	0.034	-1.651	0.099	[-0.124, 0.011]
CR × Gender	-0.190	0.063	-3.043	0.002	[-0.313, -0.068]
SLEs × CR	-0.002	0.001	-2.443	0.015	[-0.003, -0.0004]
SLEs × CR × Gender	0.003	0.001	2.473	0.014	[0.001, 0.005]
	Model 2				
	<i>b</i>	SE	<i>t</i>	<i>p</i>	95% CI
Age	0.222	0.075	2.945	0.003	[0.074, 0.370]
Year in school	0.067	0.125	0.533	0.594	[-0.179, 0.313]
SLEs	0.085	0.018	4.615	0.0001	[0.049, 0.121]
ES	0.221	0.056	3.918	0.0001	[0.110, 0.332]
Gender	3.439	1.288	2.670	0.008	[0.912, 5.966]
SLEs × Gender	-0.065	0.025	-2.578	0.010	[-0.114, -0.016]
ES × Gender	-0.301	0.082	-3.671	0.0003	[-0.462, -0.140]
SLEs × ES	-0.004	0.0010	-3.388	0.001	[-0.006, -0.002]
SLEs × ES × Gender	-0.301	0.002	3.879	0.0001	[-0.003, -0.009]

b: unstandardized regression coefficients.

via CR was conditioned by sex. Interestingly, the indirect effect was significant for females ($b = 0.003$, 95% CI [0.001, 0.006], Table 2) but not for males ($b = 0.0003$, 95% CI [-0.001,

0.002]). When ES was used as a mediator, sex modulated the association between SLEs and sleep problems ($b = 0.029$, $p < 0.001$). As a similar moderating effect has been illustrated in

Figure 1c, we did not display it anymore. The indirect effect from SLEs to sleep problems via ES was significant separately for females ($b = 0.001$, 95% CI [0.0001, 0.003]) and males ($b = 0.003$, 95% CI [0.0002, 0.005]).

Modulating effect of emotion regulation

As shown in Table 3, the SLEs \times CR \times sex interaction reached significant in explaining sleep problems ($b = 0.003$, $p = 0.014$). Among males, those with higher CR showed a weaker correlation between SLEs and sleep problems ($b = 0.017$, $p = 0.048$) than those with lower CR ($b = 0.039$, $p < 0.001$, Figure 2b), indicating that CR alleviated the adverse effects of SLEs on males' sleep quality. Further analysis showed that CR was beneficial to males' sleep quality under high ($b = -0.053$, $p = 0.048$) but not low levels of SLE ($b = 0.019$, $p = 0.411$). In contrast, among females, a similar correlation between SLEs and sleep problems was detected at both low and high levels of CR ($b = 0.048$, $p < 0.001$; $b = 0.058$, $p < 0.001$). Further analysis showed that CR was beneficial to females' sleep quality at both low and high levels of SLEs ($b = -0.074$, $p < 0.001$; $b = -0.047$, $p = 0.009$). There was also a significant SLEs \times ES \times sex interaction in explaining sleep problems ($b = 0.006$, $p < 0.001$). Among males, those with higher ES showed a weaker correlation between SLEs and sleep problems ($b = 0.013$, $p = 0.070$) than those with lower ES ($b = 0.049$, $p < 0.001$). Additionally, ES was harmful to males' sleep quality under low ($b = 0.105$, $p < 0.001$) but not high levels of SLEs ($b = -0.036$, $p = 0.305$). By contrast, among females, those with higher ES showed a stronger correlation between SLEs and sleep problems ($b = 0.064$, $p < 0.001$) than those with lower ES ($b = 0.041$, $p < 0.001$, Figure 2c). Further analysis showed that ES was harmful to females' sleep quality at high ($b = 0.074$, $p = 0.002$) but not low levels of SLEs ($b = 0.002$, $p = 0.951$).

Discussion

In this study, emotion regulation was used as a mediating and moderating variable elucidating the psychological mechanism of the relationship between SLEs and sleep quality in university students. As expected, SLEs indirectly predicted poor sleep quality through reduced CR and increased ES. Besides, the mediation effect of CR was present among females but not males. Moreover, sex differences were found in the modulating roles of CR and ES in the relationship between SLEs and sleep quality.

The mediating role of emotion regulation

In this study, SLEs indirectly predicted poor sleep quality via reduced CR, extending the limited literature regarding the psychological mechanism underlying the association between SLEs and sleep quality (Li et al., 2019; Pan and Zhang, 2022). Previous research has proposed that stress greatly consumes one's prefrontal neural resources and thereby impairs cognitive control (García et al., 2021). Since cognitive control is essential to CR, SLEs may be associated with less CR via reduced cognitive control, and thereby worsen sleep quality. Notably, the mediating role of CR was evident in females but not in males. Such effect was driven by a negative correlation between CR and sleep problems in females but not in males. Previous research has reported that females use more CR than males (Flynn et al., 2010), and this strategy proves to be particularly effective in promoting women's mental health (Zhang et al., 2020). Hence, CR may play a relatively greater mediating role in females' sleep quality.

SLEs also indirectly predicted poor sleep quality via more ES. A previous study reported that adolescents with more SLEs exhibited more maladaptive emotion regulation strategies, which further led to more depressive symptoms (Stikkelbroek et al., 2016). Similarly, Li et al. (2019) observed that rumination, a maladaptive emotion regulation strategy that reflects the inability to deploy attentional resources away

from stressful thoughts, served as a mediator for the relationship between SLEs and sleep quality. The present study extended the extant literature by revealing that inhibiting emotion reactions may be a costly correlate in stress-related sleep problems. According to the stress coping theory, when individuals feel that the stressful situation is uncontrollable, they are more inclined to lose the expectation of positive results and tend to utilize negative coping methods such as ES (Ursin and Eriksen, 2010). As a consequence, they may be reluctant to express their emotions and have difficulty in establishing good social relationships with others (Jazaieri et al., 2017), which are more likely to trigger sleep problems (Gordon et al., 2021).

The modulating role of emotion regulation

Among males, the relationship between SLEs and poor sleep quality was weaker for those who tend to use CR more. It supports the pressure buffer model, providing evidence that psychological factors can buffer the influence of external risk factors on mental health (Wu et al., 2022). It is possible that males who tend to use CR were more adept at active coping (Flouri and Mavroveli, 2013), which might enhance their sense of control over stressful events, create opportunities to develop satisfying social relationships with others, and thereby reduce harmful effects of SLEs on males' sleep quality. Notably, CR did not modulate the relationship between SLEs and sleep quality in females. The relationship between SLEs and females' sleep quality was similar at both lower and higher levels of CR. Given that females use CR more than males in daily life, this strategy may help females develop active coping strategies under both low and high stressful conditions. Accordingly, the use of CR was beneficial to females' sleep quality regardless of whether their SLEs were low or high.

ES also modulated the relationship between SLEs and sleep quality. Among females, the relationship between SLEs and poor sleep

quality was stronger among those who utilized ES more. Previous research has suggested that ES may not dampen the emotional experience but rather exacerbate one's physiological responses (John and Gross, 2004), which may thereby contribute to the onset of sleep problems (Latif et al., 2019). Given that females' sleep quality is likely to be more susceptible to physiological factors, the use of ES may heighten negative physiological responses in females (Mink et al., 2023) and thereby exacerbated the adverse effect of SLEs on their sleep quality. By contrast, the relationship between SLEs and poor sleep quality was weaker among males who tend to use ES more. This is because ES was harmful to males' sleep quality under low levels of SLEs, which disappeared under high SLEs. One proposed explanation is that ES is socially desirable among Eastern males who have experienced adverse life events, which may reduce the harmful effects of ES on males' sleep quality under stressful conditions. A recent review reported a negative impact of ES on mental health in Western cultures but no such relationship in Eastern cultures (Fernandes and Tone, 2021), indicating that culture may be a critical modulator for the impact of ES on mental health. Future research would need to assess the role of culture in the relationship between ES and stress-related sleep problems.

Implications for treatments for sleep disturbance

Our results have implications for treatments for sleep disturbance. For example, cognitive behavioral therapy (CBT) is one of the popular treatments for insomnia. It helps reevaluate maladaptive sleep beliefs and manage sleep-inhibiting cognitive processes such as worry and rumination, which greatly involves the utilization of CR (Clark, 2022). Notably, our study suggests that both CR and ES play mediating and modulating roles in the relationship between SLEs and sleep quality, indicating that reducing

maladaptive ES should be also considered as an important intervention target in the prevention and treatment of sleep problems in individuals who have experienced adverse life events. Moreover, we found sex differences for the roles of emotion regulation, indicating separate emotional processes for males and females. It has been reported that females are more likely than males to have received counseling or therapy (Terlizzi and Norris, 2021). A possible reason is that sex differences in treatment response may be present. For example, as females are more likely than males to use CR, they may benefit more from the cognitive aspect of CBT to reduce rumination and worry that are perpetuating features of insomnia, which is worth further investigation. Understanding sex differences in stress-related sleep problems may help develop more effective treatments by tailoring them to the needs of the individual's gender, rather than applying a "one size fits all" approach.

Limitations

There are several limitations. First, the results were based on a cross-sectional design. Future studies should consider the cause-effect relationships using a longitudinal design. Second, we only addressed two emotion regulation strategies. Future studies should consider multiple measures of emotion-regulation strategies and other risk and protective factors to elucidate the psychological mechanism of SLEs and sleep quality more comprehensively. Third, all the variables were measured using self-report approaches. More objective assessments are needed for future studies. Finally, due to the sample size of this study, the results can only be applied to college students and teenagers.

Conclusion

Despite these limitations, the present study extends the research on the relationship between SLEs and sleep quality. These results provide preliminary evidence supporting that the relationship between SLEs and sleep quality is both mediated

and modulated by CR and ES. Besides, we found sex differences for the mediation effect of CR and the modulation effects of CR and ES, highlighting the importance of considering sex differences in emotion regulation in the prevention and treatment of sleep problems. Our findings may provide some insight to develop strategies for early interventions of sleep problems to reduce the risk of deterioration from subclinical to clinical level of sleep disturbance.

Author contributions

Chunjie Wang and Bao-ming Li conceived the idea and supervised the study. Qingyi Li collected the data, carried out the data analysis, and drafted the initial manuscript. Xuejian Ye and Zheng Li contributed to data collection, data analysis, and interpretation of the data. Shuxuan Yang and Luxiao Yin contributed to data collection and data analysis. All authors approved the final manuscript as submitted.

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Data sharing statement

The current article is accompanied by the relevant raw data generated during and/or analyzed during the study. The file is available in the Figshare repository and accessible as Supplemental Material via the Sage Journals platform. Ethics approval, participant permissions and all other relevant approvals were granted for this data sharing.

Declaration of conflicting interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Ethics approval

The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Research Ethics Review Board of Hangzhou Normal University (#2022111601).

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