Abstract

Several examples of empirical research link negative emotion symptoms with fatigue. However, few studies have analyzed the influencing factors (i.e., stimulus of bedtime media use) that affect the relationship between negative emotion symptoms and fatigue. In this study, we have examined whether the stimulus of bedtime media use mediates the relationship between negative emotion symptoms and fatigue among college students. 394 participants, all of whom were Chinese college students, came from an occupational university in Sichuan Province, China. The data includes 92 males and 302 females (mean age = 19.98, SD = 1.43). The results demonstrate that both negative emotion symptoms and visual stimulus of bedtime media use play a part in influencing fatigue. This study shows that the visual stimulus of bedtime media use mediates the association between negative emotion symptoms and fatigue. The findings imply that negative emotion symptoms have an indirect effect on fatigue through the visual stimulus of bedtime media use, as opposed to the auditory stimulus of bedtime media use. Thus, future intervention programs can be developed to promote college students’ emotion regulation abilities, and change their habit of excessive bedtime media use.

Keywords: negative emotion symptoms, visual stimulus, auditory stimulus, bedtime media use, fatigue
Visual Stimulus of Bedtime Media Use Mediate the Relationship between Negative Emotion Symptoms and Fatigue

Introduction

Fatigue is a subjective feeling of tiredness, or a sustained sense of exhaustion [1-4]. It includes the experience of fatigue and the influence fatigue on physical, mental and social aspects [1-4]. A study of 6978 college students in the UK and Egypt, El Ansari, Oskrochi, Haghgoo [5] found that the percentage of students complaining of fatigue was 61% and 85.3% respectively. Fatigue was common among students in China too [6]. In a study of 757 Chinese adolescents students in Taiwan, Chen, Chou, Tzeng, Chang, Kuo, Pan, Yeh, Yeh, Mao [7] found the proportions of fatigue was relatively high in grade 9 to 12, primarily owing to the academic pressure the students faced. Fatigue had a negative influence on students in terms of both their academic performance [8] and health [9]. For example, compiling data from 60 college-aged students, Palmer [10] found that fatigue had negative influence on students’ learning and cognitive performance. In their study of 109 medical students aged 21 to 40, Hwang, Park, Kim, Yim, Ko, Bae, Kyung [11] found that students with clinical fatigue had low scores on physical health and psychological health.

Furthermore, fatigue has attracted considerable research interest in recent years. This large proportion of those suffering from fatigue, and its serious consequences, highlight the urgency to explore the causes and psychological mechanisms that underlie fatigue. Most published papers have attempted to estimate the negative consequence of fatigue. However, relatively few studies have analyzed the causes of
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fatigue. Some of the research has focused on the risk factors of fatigue, such as daily activities [12] and daily events [13]. For example, with a data of 378 university students, Dol [14] found that students' fatigue level was influenced by the duration of participants' internet use per day. In their survey of 36 medical students, Blasche, Zilic, Frischenschlager [15] found that fatigue increased before an examination, and decreased afterwards. However, only a few researchers have investigated the influencing factors vis-à-vis fatigue, such as bedtime media use. For example, with 358 university students data, Zarghami, Khalilian, Setareh, Salehpour [16] found that using a cell phone after the main bedroom lights were switched off caused fatigue.

Likewise, relatively few studies have explored the relationship between negative emotion symptoms (an important influencing factor and intervening variable) and fatigue among college students in China. Therefore, the current study has examined college students’ fatigue from several perspectives. First, we tried to confirm previous studies by testing the relationship between negative emotion symptoms and fatigue among Chinese college students. Second, we extended the existing literature by examining the role of bedtime media use in the relationship between negative emotion symptoms and fatigue. The current study not only suggests a new insight in this area, but also provides practical methods to improve college students’ health condition in China.

Negative emotion symptoms means the states of subjective distress, such as anxiety and depression [17]. Negative emotion symptoms were positively related to fatigue [7,18]. Several studies have revealed that the emotional state at bedtime
affects fatigue [19,20]. According to the hyperarousal model of insomnia, negative emotion symptoms are affected by environmental stimuli and cortical hyperarousal, resulting in insomnia and fatigue [21-24]. Therefore, fatigue was induced through negative emotion symptoms. However, relatively few researchers have examined how negative emotion symptoms relate to fatigue.

The research on media use is a hot topic in recent years. Media use was prevalent, especially at bedtime. For example, using data from a survey of 844 adults, Exelmans, Van den Bulck [25] found that the proportion of those using media at bedtime was 39.8% (books), 31.2% (TV), 26% (music), 23.2% (Internet) and 10.3% (videogames) respectively. Stimulus is accompanied when students used media at bedtime. Bedtime media use had two types of stimulus on media users: visual stimulus and auditory stimulus.

Although relatively few studies have explored the effects of negative emotion symptoms on visual or auditory stimulus of bedtime media use, empirical research has tested the relationship between negative emotion symptoms and media use [26-30]. For example, in their examination of 923 college students in Jiangxi Province, China, Ye, Zheng [31] found that negative emotion symptoms resulted in higher media use. Wills, Pokhrel, Morehouse, Fenster [32] found that the failure of adolescents to keep their emotions in check was related to addictive forms of behavior. It showed that the failure to control negative emotions led to an increase in media use [33]. According to the social cognitive theory, self-regulation was a process where people control their behaviors [34]. The failure of affective self-reaction (one of the processes of self-
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1regulation) caused negative outcomes, such as the addiction to media use [35].

Therefore, people who have negative emotion symptoms tend to use media to comfort themselves, especially media use at bedtime. This means that negative emotion symptoms caused visual or auditory stimulus during bedtime media use.

Meanwhile, bedtime media use was associated with fatigue [25,36-40], and one of the main reasons is the external stimulus at bedtime [41,42]. Szychowska, Hafke-Dys, Preis, Kocinski, Kleka [43] found that both visual stimulus and auditory stimulus acted as factors that served to aggravate human emotions. Both visual stimulus and auditory stimulus were related to insomnia [44] and fatigue [21]. The exposure to light influenced the human biological clock [45,46]. The bright lights of the media form used by the respondents served to suppress the melatonin secretion, thus influencing the sleep quality [42] and causing fatigue [24]. For example, with 7 male adults examined in the sample, it was found that the combination of bright video display and exciting tasks suppressed concentration of melatonin, and the video display suppressed the nocturnal decrease in rectal temperature [41]. This shows that the bright lights from the videos affect human biological responses at bedtime [41].

With a 3-day randomized controlled trial, Heo, Kim, Fava, Mischoulon, Papakostas, Kim, Kim, Chang, Oh, Yu, Jeon [47] found that the light emitting diode generates negative effects in sleeping patterns. Apart from visual stimulus and light exposure, auditory stimulus also affects human’s sleeping [48] and causes fatigue [24]. Auditory stimulus was used as a form of sleep disorder stimulus in experiments [49,50].

Moreover, with a sample of 844 adults (18 – 94 years old), Exelmans, Van den Bulck
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[25] found that listening to music before sleeping increased fatigue. Therefore, two
2types of stimulus (i.e., visual stimulus and auditory stimulus) of bedtime media use
3affected fatigue.

4Combined with the hyperarousal model of insomnia, negative emotion caused
5attention to stimulus and hyperarousal, resulting in fatigue. Bedtime media use
6produced additional stimulus before sleeping, causing hyperarousal as well.
7Therefore, we believe that the stimulus of bedtime media use mediated the association
8between negative emotion symptoms and fatigue.

9In our current research, we hypothesized that negative emotion symptoms and
10stimulus of bedtime media use increased fatigue. Moreover, we want to test the
11mediation effect of stimulus (i.e. visual stimulus or auditory stimulus) of bedtime
12media use in its association between negative emotion symptoms and fatigue. In a
13nutshell, we raised the following 3 hypotheses: (1) negative emotion symptoms were
14positively related to fatigue, (2) two types of stimulus of bedtime media use (i.e.
15visual stimulus and auditory stimulus) significantly caused fatigue; (3) two types of
16stimulus of bedtime media use mediated the relationship between negative emotion
17symptoms and fatigue, respectively.

18Method

Participants and Procedure

Participants came from an occupational university in Sichuan Province, China.

The data was collected in 2016, containing 394 college students, which included 92
22males and 302 females ($M = 19.98$ years, $SD = 1.43$, range = 18-26). All the data was
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1collected in the form of paper questionnaires. The necessary ethical approval was
2obtained from the Department of Sociology, Wuhan University, China. The written
3informed consent was obtained from all of the participants.

4Measures

5Negative Emotion Symptoms

6Depression Anxiety Stress Scales (DASS) is widely used to measure negative
7emotion symptoms. It contains three dimensions: depression, anxiety, and stress. In
8the short version of DASS-21, each factor has 7 items. The total score of 21 items was
9used to measure negative emotion symptoms [51]. It is a four-point scale that asks
10participants about their experiences in the past week (e.g., “I felt that life was
11meaningless”): (0) “This item was not applied to me at all” to (3) “This item was
12applied to me very much”. No item was coded reversely. Wang, Shi, Geng, Zou, Tan,
13Wang, Neumann, Shum, Chan [52] proved that the psychometric properties of the
14Chinese version was acceptable. The Cronbach’s alpha of the current sample was .89.
15In the current study, the total score of the DASS-21 was used to measure the negative
16emotion symptoms among college students.

17Bedtime Media Use

18Building on the studies of Van den Bulck [53], Eggermont, Van den Bulck
19[39], Lemola, Perkinson-Gloor, Brand, Dewald-Kaufmann, Grob [54], Exelmans, Van
20den Bulck [25] and Exelmans, Van den Bulck [40], we asked respondents how often
21they used media with two types of stimulus (i.e., auditory stimulus and visual stimulus
22) before bedtime with accompanying night items. The items contained 2 types of
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stimulus of bedtime media use: visual stimulus (i.e., playing computer games on a computer, internet use on a computer, watching video on a computer, playing games on a smartphone, watching video on a smartphone, sending short messages with software on a smartphone, and reading) and auditory stimulus (i.e., listening to music and making phone calls). For example: how often does the respondent play computer games to help them fall asleep? It is a six point scale: 1 = never, 6 = always. For statistical analyses, visual stimulation activities were calculated by the mean score of the 7 items, and auditory stimulation activities were calculated by the mean score of the 2 items, respectively.

Fatigue

The PROMIS Fatigue Short-Form 7a measures self-reported fatigue by a single total score [3]. Seven items ranged from 1 “never” to 5 “always” (e.g. “How often did you experience extreme exhaustion in the past seven days?”). Fatigue Short-Form 7a scale is available for college students (ages 18+), and the Chinese version is available from PROMIS [55]. The PROMIS scale has proven to be effective [56]. The Cronbach’s alpha of fatigue was .78. In the following statistical analysis, the total score of the 7 items was transformed to a standardized T-score (mean = 50, SD = 10) with the coding from PROMIS [55].

Data analysis

The Pairwise method was adopted to handle the missing data. Firstly, the descriptive statistics and correlation matrix were calculated. We expected that negative emotion symptoms, stimulus of bedtime media use and fatigue was
positively related to each other. Secondly, hierarchical regressions were performed using the entry method to explore the roles of negative emotion symptoms, and the stimulus of bedtime media use on fatigue. In the hierarchical regression, fatigue acted as the dependent variable. The demographic variables (i.e., sex and age; coded: 1 = male, 0 = female) were entered in step 1, followed by negative emotion symptoms in step 2 and two types of stimulus of bedtime media use with types of stimulus in step 3. Thirdly, with the results of hierarchical regressions the mediating effect was examined using PROCESS macro version 2.16.2 for SPSS [57]. Bootstrapping was set at 5,000 resamples [58]. We examined if the stimulus of bedtime media use mediated the association between negative emotion symptoms and fatigue. A model was constructed with the predictors of negative emotion symptoms (X), the outcome of fatigue (Y) and visual stimulus of bedtime media use as mediator (M). Covariates included the sex and age of participants.

Results

Bivariate Correlation Analyses

Table 1 listed the mean and SD values of visual stimulus of bedtime media use, auditory stimulus of bedtime media use, negative emotion symptoms and fatigue. As shown in table 1, negative emotion symptoms was positively related to fatigue ($r = 0.43$, $p < 0.001$). Negative emotion symptoms was significantly positively related to visual stimulus of bedtime media use ($r = 0.13$, $p = 0.009$) and the relationship between negative emotion symptoms and auditory stimulus of bedtime media use was insignificant ($p = 0.059$). Visual stimulus of bedtime media use was positively related
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1to fatigue ($r = .16, p = .001$) while the relationship between auditory stimulus of
2bedtime media use and fatigue was insignificant ($p = .077$). This result indicated that
3negative emotion symptoms may have different influences on visual stimulus and
4auditory stimulus of bedtime media use. Besides, the two types of stimulus of bedtime
5media use may have different effects on fatigue.

6Table 1

7Correlational analysis of negative emotion symptoms, stimulus of bedtime media use

8and fatigue

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Visual stimulus of bedtime media use</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Auditory stimulus of bedtime media use</td>
<td>.56***</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Negative emotion symptoms</td>
<td>.13***</td>
<td>0.10</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>4. Fatigue</td>
<td>.16***</td>
<td>0.09</td>
<td>.43***</td>
<td>-</td>
</tr>
</tbody>
</table>

Mean | 3.08       | 3.76       | 15.19      | 52.55      |
SD  | 0.84       | 1.04       | 8.89       | 5.32       |

9* $p < 0.05$, ** $p < .01$.

10Hierarchical regression analyses

11Hierarchical regressions were shown in table 2. All regression equations were
12statistically significant (in step 1 $F = 4.34, p = .014$; in step 2 $F = 30.76, p < .001$; in
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Step 3 \( F = 20.27, p < .001 \). Negative emotion symptoms was positively related to fatigue \( t = 9.04, p < .001 \). Two types of stimulus of bedtime media use were entered in step 3, and the results showed that visual stimulus had small yet significant explained variance to fatigue \( t = 2.59, p = .010 \). These results supported hypothesis 1 and partially supported hypothesis 2, which proved that negative emotion symptoms and visual stimulus of bedtime media use affected fatigue.
Table 2

Hierarchical regressions of demographic variables, negative emotion symptoms and stimulus of bedtime media use on fatigue

<table>
<thead>
<tr>
<th></th>
<th>step 1</th>
<th></th>
<th></th>
<th>Dependent variable: fatigue</th>
<th>step 2</th>
<th></th>
<th></th>
<th>step 3</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>b</td>
<td>t</td>
<td>VIF</td>
<td></td>
<td>b</td>
<td>t</td>
<td>VIF</td>
<td>b</td>
<td>t</td>
<td>VIF</td>
</tr>
<tr>
<td>Constant</td>
<td>47.15</td>
<td>12.68***</td>
<td>1.00</td>
<td></td>
<td>46.70</td>
<td>13.80***</td>
<td>1.01</td>
<td>45.29</td>
<td>13.14***</td>
<td>1.06</td>
</tr>
<tr>
<td>Sex</td>
<td>-1.61</td>
<td>-2.57*</td>
<td>1.00</td>
<td></td>
<td>-1.14</td>
<td>-1.99*</td>
<td>1.01</td>
<td>-1.46</td>
<td>-2.50*</td>
<td>1.02</td>
</tr>
<tr>
<td>Age</td>
<td>0.29</td>
<td>1.56</td>
<td>1.00</td>
<td></td>
<td>0.12</td>
<td>0.69</td>
<td>1.01</td>
<td>0.09</td>
<td>0.54</td>
<td>1.02</td>
</tr>
<tr>
<td>Negative Emotion</td>
<td>0.25</td>
<td>9.04</td>
<td>1.02</td>
<td></td>
<td>0.24</td>
<td>8.65</td>
<td>1.04</td>
<td>0.24</td>
<td>8.65</td>
<td>1.04</td>
</tr>
<tr>
<td>Emotion</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td></td>
<td>**</td>
<td>**</td>
<td>**</td>
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</tr>
<tr>
<td>Visual</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.92</td>
<td>2.59*</td>
<td>1.54</td>
</tr>
<tr>
<td>Auditory</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.18</td>
<td>-0.64</td>
<td>1.48</td>
</tr>
<tr>
<td>R²</td>
<td>.02</td>
<td></td>
<td></td>
<td></td>
<td>.19</td>
<td></td>
<td></td>
<td>.21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>4.34*</td>
<td></td>
<td></td>
<td></td>
<td>30.76***</td>
<td></td>
<td></td>
<td>20.27***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔR²</td>
<td>.02</td>
<td></td>
<td></td>
<td></td>
<td>.02</td>
<td></td>
<td></td>
<td>.02</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔF</td>
<td>4.34*</td>
<td></td>
<td></td>
<td></td>
<td>81.79***</td>
<td></td>
<td></td>
<td>3.86*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. VIF means variance inflation factor
1* p < .05, ** p < .01, *** p < .001.
Mediating Analyses

The results of mediation effects of stimulus of bedtime media use were shown in Table 3. The direct effect between negative emotion symptoms and fatigue was significant ($p < .001$). The indirect effect between negative emotion symptoms and fatigue was significant, reflecting the mediation role of visual stimulus of bedtime media use. The mediation model explained .21 of variances in fatigue. The result partially supported hypothesis 3, which proved that visual stimulus of bedtime media use played a mediation role between negative emotion symptoms and fatigue.
Table 3

Mediation effect of visual stimulus of bedtime media use between negative emotion symptoms and fatigue.

<table>
<thead>
<tr>
<th>Path</th>
<th>$R^2$</th>
<th>$b$</th>
<th>SE</th>
<th>95% C.I.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative emotion symptoms → Visual stimulus</td>
<td>.05</td>
<td>0.01**</td>
<td>0.00</td>
<td>0.0039, 0.0225</td>
</tr>
<tr>
<td>Visual stimulus → Visual stimulus → Fatigue</td>
<td>.21</td>
<td>0.79**</td>
<td>0.29</td>
<td>0.2152, 1.3622</td>
</tr>
<tr>
<td>Negative emotion symptoms → Fatigue (direct effect)</td>
<td></td>
<td>0.24***</td>
<td>0.03</td>
<td>0.1842, 0.2926</td>
</tr>
<tr>
<td>Fatigue (indirect effect)</td>
<td></td>
<td>0.01</td>
<td>0.01</td>
<td>0.0023, 0.0253</td>
</tr>
</tbody>
</table>

Note. 95% C.I. 95% confidence interval; covariates included participant sex and age.

*p < .05, ** p < .01, *** p < .001
Discussion

In the current study, we examined the mediation effect of two types of stimulus of bedtime media use and its relationship between negative emotion symptoms and fatigue. The results showed that negative emotion symptoms and the visual stimulus of bedtime media use influenced fatigue. Moreover, negative emotion symptoms indirectly influenced fatigue through visual stimulus of bedtime media use.

Previous studies have found that negative emotion symptoms increased the risk of insomnia [59] and fatigue [60]. Likewise, this study showed that negative emotion symptoms could directly predict the onset of fatigue. This result can provide us with a better understanding of the research on insomnia [24]. Negative emotion symptoms affected sleep quality and insomnia [24]. Fatigue is a daytime symptoms of insomnia, therefore, fatigue can be considered as a consequence of insomnia during nighttime [24].

Some research found that daytime fatigue was caused by the failure to regulate emotion, and the rising incidence of negative emotions [61]. This may be because negative emotion and fatigue influence each other. According to the neurocognitive model of insomnia, the distress disorder and insomnia was a cyclical process: negative emotion caused neurobiological and cognitive-behavioral change at bedtime, resulting to insomnia and fatigue, while insomnia or fatigue aggravated the negative emotion symptoms in turn [22,24].

In the current study, negative emotion symptoms were positively and significantly related to visual stimulus activities. Nowadays, many people are highly attached to a smartphone [62]. Research has shown that negative emotion increased when people were separated from their smartphone [63,64]. The decision-making behavior of individuals was
related to neural activities and the regulation of emotion [65]. According to the use and gratification theory, an individual used media to escape from negative emotion [66]. Therefore, those people who had negative emotion symptoms increased their media use as an emotional regulation, which made them feel comfortable and gratified [67]. Therefore, the current study implied that visual stimulus activities was a more enjoyable way for college students to cope with negative emotion. Moreover, the current study implied that college students tended to used media to regulate their emotion with social media use, which was consistent with the previous study [28].

In the current study, two types of stimulus of bedtime media use had different effects on fatigue. The research has shown that only visual stimulus had significant negative effects on fatigue. This was consistent with the previous research. The light of the computer or smartphone screen decreased the melatonin secretion [68], resulting in sleeping later than normal, thus contributing to insomnia [69]. However, in the current study, the relationship between auditory stimulus of bedtime media use and fatigue was insignificant, and this finding is inconsistent with previous studies [25]. This may be because in the current study, auditory stimulus of bedtime media uses are not only a contained factor of listening to music, but also included factors such as making phone calls. Moreover, in research by Eggermont, Van den Bulck [39], it is shown that the effects of music on fatigue was smaller than visual stimulus activities (i.e., computer games or television). Thus, the effects of auditory stimulus of media use at bedtime on fatigue needed further investigation.

In this study, the main finding was the effect of negative emotion symptoms on fatigue was through the mediating role of visual stimulus of bedtime media use. The mediated
Effect of media use was consistent with previous research and our hypothesis. It indicated that negative emotion symptoms had both direct and indirect effects on fatigue. According to the hyperarousal model of insomnia, negative emotion drew attention to stimulus and hyperarousal, resulting to insomnia and fatigue. Visual stimulus of bedtime media use produced additional stimulus before bedtime. Moreover, the light emitted from the media specifically suppressed the secretion of melatonin, resulting to the failing of the onset of sleeping state, disturbing human’s biological clock.

Conclusions, limitations, and practical implications.

The current study contributes and expands the current research about the effects of stimulus of bedtime media use, and the negative emotion symptoms on fatigue among Chinese college students. Specifically, the results suggest that visual stimulus at bedtime media use can serve as a mediation factors for understanding the association between negative emotion symptoms and fatigue.

Several limitations of the current study should be noted. Firstly, respondents of the current study came from an occupational college, therefore, the gender proportion and the representation of the current study needed to be considered. Secondly, sleep quality was not measured in the current study. Fatigue was a daytime symptom of insomnia [21]. Therefore, the influence of sleep quality factors should be considered in future research. Thirdly, the items which measured the media use and the content of media use needs improvement and further investigation. Although visual stimulus of bedtime media use contained 7 items, auditory stimulus of bedtime media use contained only 2 items. Besides, the items measured visual stimulus (i.e., playing games and watching video) also included auditory stimulus. As a
result, future study should supervise the sample and improve the measures. 

There are several practical implications to be considered in the future research. In practice, the mediation effect discovered conducted the intervention programs. Specifically, when college students have high levels of bedtime media use because of the mediating effect between negative emotion symptoms and fatigue, this implied that these students are at greater risk of fatigue. Therefore, knowledge about the effects of stimulus of bedtime media use can help college administrators identify the risks faced by students, and those who are most at risk, thus improving the conditions affecting fatigue among students. For example, administrators should consider the negative effect of stimulus of bedtime media use, and provide students with a form of intervention to control bedtime media use. Equally important is that the student should pay attention to how to regulate their emotion. To build on this, educators who work to better students’ emotion regulation abilities could teach them the skills to control their emotion, and improve the habit of excessive bedtime media use, such as mindfulness practice [70], to improve their sleep quality [71] and decrease fatigue.
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