

# Effect of Social Media Addiction on Executive Functioning Among Young Adults: The Mediating Roles of Emotional Disturbance and Sleep Quality

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**Introduction:** The increased research examining social media addiction with its negative consequences has raised concerns over the past decade. However, little research has investigated the association between social media addiction and executive functioning as well as the mechanisms underlying this relationship.

**Methods:** Using a survey, the present study examined the association between social media addiction and executive functioning via emotional disturbance and sleep quality among 1051 Chinese young adults, aged 18 to 27 years old ( $M=21.02$  years [ $SD=1.89$ ]; 34.41% male).

**Results:** The results showed that social media addiction had a significant negative association with executive functioning but positive associations with emotional disturbance and poor sleep quality. Structural equation modeling suggested that there was a significant direct effect between social media addiction and executive functioning. Indirect effects via two paths (ie, emotional disturbance alone, and both emotional disturbance and sleep quality) were also statistically significant.

**Discussion:** The findings indicate that both emotional disturbance and poor sleep quality are risk-enhancing mediators in the relationship between social media addiction and executive functioning. Intervention programs (eg, emotional regulation strategies) should be considered to reduce the adverse effects of social media addiction on cognitive impairment among young adults.

**Keywords:** social media addiction, executive functioning, emotional disturbance, sleep quality, young adults

## Introduction

The development of mobile internet technology and the availability of mobile devices such as smartphones/tablets has resulted in a reliance on the use of such technologies. The smartphone has become an indispensable part of people's daily lives as they are used to interacting with others, maintaining relationships, and dealing with work issues. Smartphone use is inextricably linked with social media use<sup>1</sup> and people's use of social networking sites [eg, Facebook, Twitter, WeChat, TikTok].<sup>2,3</sup> The number of social media users has continued to rise worldwide.<sup>4</sup> In China [where the present study was carried out), there are nearly a billion social media users according to the 48th report of China Internet Network Information Center.<sup>5</sup>

In terms of patterns of social media use, active use and passive use are common. Active use refers to direct exchanges with others on social media (eg, texting, posting, and commenting), whereas passive use refers to browsing others' online life without any linking and communications.<sup>6</sup> Previous research found passive use predicted a decline in emotional well-being, while active use did not.<sup>6</sup> However, A review found most research did not support that conclusion.<sup>7</sup> Although social media use may provide many benefits in modern society, excessive or problematic use of social media can have

adverse consequences on physical and mental health among a minority of individuals, especially young adults.<sup>8–11</sup> For some individuals, this may result in problematic social media use and (in extreme cases) social media addiction (SMA).<sup>1</sup>

SMA has been commonly viewed as a type of behavioral addiction<sup>12,13</sup>, although it was not formally recognized in the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5)<sup>14</sup>. SMA has been defined as a problematic pattern of social media use with uncontrollable urges, and the inability to successfully regulate the use of social media resulting in adverse consequences on relationships, occupation, and/or education.<sup>15</sup> In extreme cases, the behavior results in consequences associated with other more traditional addictions such as salience, tolerance, withdrawal symptoms, relapse, mood modification, and conflict.<sup>16</sup>

Research has shown that problematic social media use has a relatively high prevalence and significant harm to health and well-being,<sup>3,17</sup> which has gradually emerged as a problem of global concern. The prevalence of problematic social media use appears to be high in China, especially among young adults. One study reported that 44.9% of Chinese university students aged over 18 years old (N=1090) were at risk of SMA.<sup>17</sup> Moreover, negative consequences have been associated with SMA, such as depression and anxiety,<sup>18</sup> burnout,<sup>19</sup> and poor sleep quality.<sup>20</sup> To date, most research has focused on the negative impacts of SMA in relation to emotional and mental health. Few studies have examined its harmful effects on cognitive abilities or the underlying mechanisms in such relationships. Therefore, the present study examined the effect of SMA on executive functioning as well as the mechanisms of emotional disturbance and sleep quality among Chinese young adults.

Executive functions are higher-order cognitive abilities/processes tied to the frontal lobes of the brain, which encompass abilities such as planning, organization, problem-solving, working memory, and decision-making to facilitate new ways of optimizing behavior in day-to-day environments.<sup>21,22</sup> From the cognitive neuroscience perspective, executive functions involve top-down control in the prefrontal cortex related to reward and emotion, and addictive behaviors may permanently change the neural network and damage prefrontal cortex functioning, such as top-down control.<sup>23,24</sup> Executive dysfunction (impairment of executive functioning) has been increasingly recognized among individuals experiencing addiction.<sup>25</sup>

For internet use (including social media use), a review suggested that information technology can place a burden on cognitive processes, including executive functioning, even for individuals not diagnosed with internet use disorders.<sup>26</sup> A meta-analysis also reported that problematic internet use was associated with executive functioning impairment, such as inhibitory control, decision-making, and working memory.<sup>27</sup> Moreover, previous research has found that executive functioning is negatively associated with problematic social media use.<sup>28</sup> Inhibitory control, one of the processes in executive functioning, was found to be negatively associated with SMA among Chinese female university students.<sup>29</sup> Therefore, the present study aimed to examine the relationship between general executive functioning and SMA. In addition to its direct effect, it also investigated the indirect effects of SMA, via emotional disturbance and sleep quality, on general executive functioning, which has implications for further intervention.

Emotional disturbance attributes negative consequences among young adults, including SMA. For example, in previous studies, SMA has been positively associated with emotional disturbance, such as depression, anxiety, and stress.<sup>30,31</sup> Individuals with higher severity of SMA have reported greater symptoms of emotional disturbance.<sup>32</sup> Moreover, SMA has also been associated with difficulties in emotional regulation,<sup>33</sup> which could contribute to emotional disturbance. Furthermore, the harm of emotional disturbance on the processes and abilities of executive functioning has also been reported in previous research. For example, a longitudinal study found that depression and generalized anxiety symptoms were related to poorer executive functioning capacity 18 years later.<sup>34</sup> An experimental study reported that central executive functioning on a nonverbal task was impaired by trait anxiety.<sup>35</sup> Moreover, anxiety has been found to have adverse effects on the processing efficiency of two central executive functioning related to attentional control: inhibition and shifting.<sup>36</sup> Additionally, depressive rumination has been associated with impairments in inhibition.<sup>37</sup>

Sleep quality is an important predictor of health and well-being. Individuals with SMA have the risk of poor sleep quality, including difficulty in falling asleep and/or maintaining sleep.<sup>32</sup> One study found that only social media use at bedtime was associated with a higher risk of poor sleep quality among freshman college students.<sup>38</sup> Another study with an adult sample aged 18 to 58 years old found that problematic social media use was related to poor sleep quality.<sup>39</sup> In the present study, individuals with a higher level of SMA were expected to have poorer sleep quality. Moreover, in the

relationship between sleep quality and executive functioning, previous research found insufficient sleep leads to poor self-regulatory capacity, and individuals with less sleep are unable to recover from the depletion of self-control resources.<sup>40</sup> For example, individuals with poorer sleep report poorer executive functioning than good sleepers.<sup>41</sup> Another experimental study utilizing event-related potential demonstrated that sleep deprivation led to poorer executive functioning among Chinese males.<sup>42</sup> Sleep quality has also been demonstrated to be a mediator between problematic social media use and cognitive failures (eg, memory and motor functioning).<sup>39</sup>

Previous research has reported that both emotional disturbance and sleep quality are related to behavioral addictions, including SMA.<sup>32,43,44</sup> Moreover, the emotional disturbance was also associated with sleep quality. For example, one study showed that high levels of depression, anxiety, and stress decreased students' sleep quality.<sup>45</sup> Another study found that poor sleep quality was negatively related to psychological well-being among Chinese undergraduates.<sup>46</sup> However, prior to the present study, no research has explored the serial mediation of emotional disturbance and sleep quality between the relationship between SMA and executive functioning.

The present study addresses this research gap and empirically tested the effects of SMA on general executive functioning and the potential underlying mechanisms of emotional disturbance and sleep quality among Chinese young adults. Using structural equation modeling (SEM), the following hypotheses were tested:

H<sub>1</sub>: Executive functioning will have a negative association with SMA.

H<sub>2</sub>: Emotional disturbance will have a negative relationship with executive functioning.

H<sub>3</sub>: Emotional disturbance will mediate the relationship between SMA and executive functioning.

H<sub>4</sub>: Sleep quality will be positively related to executive functioning.

H<sub>5</sub>: Sleep quality will mediate between SMA and executive functioning.

## Methods

### Participants and Procedure

The data were collected from four public universities in Tianjin and Henan provinces (China) via convenience sampling (June-September 2019). Students were invited to participate in class groups using WeChat (a Chinese social media application). Participants were provided with a link to the online survey on a Chinese web survey platform (wjx.cn). Before completing the survey, all the participants gave their consent and knew their rights to participation (eg, withdrawal at any time without penalty). Undergraduate students (N=1051) voluntarily completed the self-report survey without any remuneration. The age ranged from 18 to 27 years old ( $M_{age}=21.02$  years [ $SD=1.89$ ]; 34.41% male). Ethics approval was obtained from the first author's departmental Ethics Committee.

### Measures

#### Social Media Addiction

SMA was assessed using the Bergen Social Media Addiction Scale (BSMAS),<sup>47</sup> which was modified from the Bergen Facebook Addiction Scale.<sup>48</sup> The scale contains six items reflecting the core elements of addiction (ie, salience, conflict, mood modification, withdrawal, tolerance, and relapse).<sup>16</sup> The items concern experiences during the past year (eg, "Felt an urge to use social media more and more") and are answered on a five-point scale, ranging from 1 (very rarely) to 5 (very often). The total score was calculated and higher scores indicate a greater risk of SMA. The internal consistency reliability of BSMAS was good in the present study ( $\alpha =0.84$ ).

#### Emotional Disturbance

The emotional disturbance was assessed using the 21-item Depression Anxiety Stress Scale (DASS-21).<sup>49</sup> The DASS-21 comprises three subscales: depression, anxiety, and stress. Participants respond to how often they experienced such symptoms (eg, "I couldn't seem to experience any positive feeling at all") over the past week on a four-point Likert scale

ranging from 0 (never) to 3 (most of the time) and higher scores mean a higher level of distress. The internal consistency reliability of the DASS in the present study was excellent ( $\alpha=0.94$ ) while the alpha coefficients of the subscales of depression, anxiety, and stress were 0.87, 0.83, and 0.84, respectively.

### Sleep Quality

Five items from the Pittsburgh Sleep Quality Index (PSQI)<sup>50</sup> were used to assess sleep quality. Participants responded these items (eg, “Wake up in the middle of the night or early morning”) on a four-point scale ranging from 0 (never) to 3 (above 3 times per week). Higher scores indicate greater sleep problems and poorer sleep quality. The internal consistency reliability of this scale was very good in the present study ( $\alpha=0.85$ ).

### Executive Functioning

Executive functioning was assessed using Webexec, a six-item scale.<sup>51</sup> Items (eg, “Do you find it difficult to keep your attention on a particular task?”) are rated on a four-point scale ranging from 1 (no problems experienced) to 4 (a great many problems experienced). All the scores of items were reversed and the total score of this scale was calculated with a higher score indicating better executive functioning. The internal consistency reliability of the scale was very good in the present study ( $\alpha=0.88$ ).

In relation to demographic information, participants also provided their gender (male=1; female=2) and age (in years) in the survey.

## Data Analysis

Data analyses were conducted using SPSS 22.0 and Amos 24.0. First, descriptive statistics and Pearson correlations were conducted among the main variables and demographics. Second, structural equation modeling (SEM) analysis was performed with SMA as the independent variable, mental distress, and sleep quality as the mediator variables, and executive functioning as the dependent variable. Item parceling rather than individual items was used in the measurement model to reduce the risk of convergence problems and improve model fits.<sup>52</sup> The SEM utilized maximum likelihood (ML) estimation in the AMOS 24.0 program. According to the suggestion of Kline,<sup>53</sup> the following indicators were used to evaluate the model fit in the present study:  $\chi^2/df$  ratio ( $\leq 3$ ), Comparative Fit Index (CFI;  $\geq 0.95$ ), Tucker–Lewis Index (TLI;  $\geq 0.95$ ), Root Mean Square Error of Approximation (RMSEA;  $\leq 0.05$ ), and Standardized Root Mean Square Residual (SRMR;  $\leq 0.05$ ). Finally, the multi-mediation analyses were conducted using the PROCESS macro in SPSS 22.0.<sup>54,55</sup>

## Results

### Preliminary Analyses

Descriptive statistics (ie, means and standard deviations), and Pearson’s bivariate correlational coefficients for all observed variables are shown in Table 1. For demographic variables, gender was only significantly associated with SMA ( $r=0.10$ ,  $p<0.001$ ), with females reporting higher levels of SMA than males. No gender and age effects were observed in relation to executive functioning, emotional disturbance, or sleep quality ( $p_s > 0.05$ ).

The results of Pearson correlation analyses showed that SMA had a significant negative association with executive functioning ( $r=-0.38$ ,  $p<0.001$ ), supporting  $H_1$ . There were positive associations between SMA and emotional disturbance

**Table 1** Descriptive Statistics and Correlations Among Variables

Variables	M	SD	1	2	3	4	5
1. Social media addiction	15.36	4.89	–				
2. Emotional disturbance	0.70	0.53	0.39***	–			
3. Sleep quality	0.81	0.68	0.31***	0.67***	–		
4. Executive functioning	3.18	0.63	–0.38***	–0.77***	–0.62***	–	
5. Age	21.02	1.89	0.00	0.00	0.03	0.01	–
6. Gender	–	–	0.10***	0.00	0.03	–0.05	–0.04

**Notes:** N=1051; \*\*\* $p<0.001$ ; Sleep quality: Higher scores indicate poorer sleep quality.

( $r=0.39, p<0.001$ ) as well as sleep quality ( $r=0.31, p<0.001$ ). Executive functioning was significantly and negatively correlated with emotional disturbance ( $r=-0.77, p<0.001$ ), and (poor) sleep quality ( $r=-0.62, p<0.001$ ) which supported H<sub>2</sub> and H<sub>4</sub>.

## Structural Equation Model

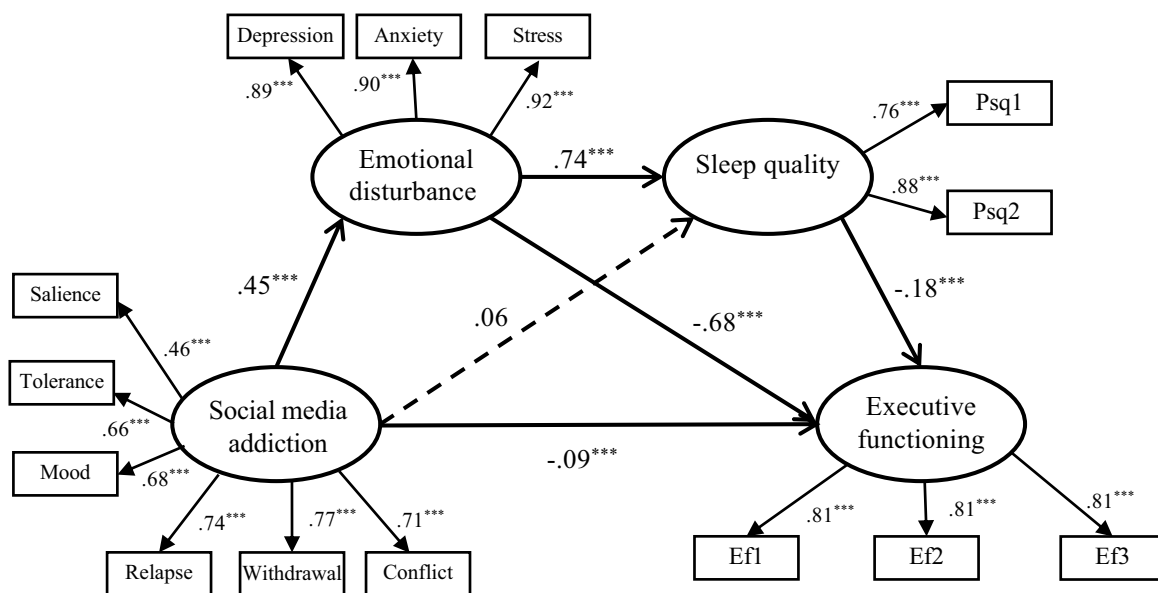
The hypothesized model, in which SMA was expected to exert not only a direct effect on executive functioning but also an indirect effect on emotional disturbance and sleep quality, was tested first. Gender was added as a control variable because of its significant correlation with SMA. The fit indices of this model were good,  $\chi^2(82)=203.967, \chi^2/df=2.49, CFI=0.986, TLI=0.982, RMSEA=0.038, 90\% CI [0.031, 0.044]$ , and SRMR=0.028. All the factor loadings for the indicators of the latent variables were significant ( $p<0.001$ ), demonstrating that the latent constructs were well represented by their indicators. Furthermore, tests of parameter estimates showed that all direct path coefficients were significant in the proposed directions, except for the path from SMA to sleep quality. These results suggested that emotional disturbance and sleep quality may play a partial mediating role in the relationship between SMA and executive functioning.

## Full versus Partial Mediation

To test the assumption that emotional disturbance and sleep quality mediate the relationship between SMA and executive functioning, the following two potential mediation models were compared using a chi-square difference test: (i) a full mediation model with the direct path from SMA to executive functioning constrained to zero; (ii) a partial mediation model with the above direct path not constrained. The chi-square difference test showed that after removing the above direct path, the fit of the model was significantly reduced ( $\Delta\chi^2(1, N=1051)=12.164, p<0.001, \Delta CFI=0.002$ ). Therefore, the partial mediation model was supported. The final model is shown in Figure 1. Except for the path from SMA and sleep quality ( $\beta=0.06, p=0.06$ ), all other path coefficients were significant in the model, among which SMA, emotional disturbance, and sleep quality significantly, negatively predicted executive functioning ( $\beta=-0.09, -0.68, \text{ and } -0.18, p_s<0.001$ ).

## Assessment of Mediation

Direct, indirect, and total effects are shown in Table 2. The direct effect of SMA on executive functioning was statistically significant ( $\beta=-0.09, 95\% CI [-0.13, -0.05]$ ). The indirect effects of SMA on executive functioning via



**Figure 1** The SEM regarding the mediation effects of emotional disturbance and sleep quality.

**Notes:** The path coefficients are standardized. Psq1, Psq2= 1st, 2nd items parcel for poor sleep quality. Ef1, Ef2, Ef3= 1st, 2nd, 3rd items parcel for executive functioning. \*\*\* $p<0.001$ . Sleep quality: Higher scores indicate poorer sleep quality.

**Table 2** Direct Effect, and Indirect Effects, and Total Effect of the Pathways Tested

Pathway	Standardized Effect	95% CI	
		Lower	Upper
Direct effect	-0.09***	-0.13	-0.05
SMA→ED→EF	-0.24***	-0.28	-0.20
SMA→ED→SQ→EF	-0.04***	-0.06	-0.03
Total mediating effect	-0.29***	-0.34	-0.25
Total effect	-0.38***	-0.44	-0.32

**Notes:** \*\*\* $p < 0.001$ . Sleep quality: Higher scores indicate poorer sleep quality.

**Abbreviations:** SMA, Social media addiction; ED, Emotional disturbance; SQ, Sleep quality; EF, Executive functioning.

emotional disturbance alone ( $\beta = -0.24$ , 95% CI [-0.28, -0.20]) and both emotional disturbance and sleep quality ( $\beta = -0.04$ , 95% CI [-0.06, -0.03]), respectively, were also found significant, which supported  $H_3$  and  $H_6$ .

However, there was no significant indirect effect on the relationship of SMA  $\rightarrow$  sleep quality  $\rightarrow$  executive functioning ( $p > 0.05$ ), therefore  $H_5$  was not supported. The mediating effect of SMA on executive functioning accounted for 76% of the total effect. This partial mediation model explained 20%, 60%, and 76% of the variances in emotional disturbance, sleep quality, and executive functioning.

## Discussion

SMA with its negative consequences has become a matter of public concern in recent years. The present study found a higher level of SMA was related to greater severity of emotional disturbance, poorer sleep quality, and poorer executive functioning, which suggests that the adverse effects of SMA not only on mental health but also on cognitive functions.

Supporting  $H_1$ , a negative association was found between SMA and executive functioning, which is consistent with previous findings in investigating the relationships between addictive behaviors (eg, Internet gaming disorder and Internet addiction) and executive functioning.<sup>56,57</sup> The results of SEM suggested a significant direct effect of SMA on executive functioning among this sample, suggesting that young adults with higher levels of SMA tend to have poorer executive functioning, including a series of cognitive processes. Individuals with SMA tend to be unable to control their use of social media successfully, and this symptom is highly related to inhibitory control, which is the process of central executive functioning.<sup>58</sup> As a previous experimental study found smartphone addicts had higher mind-wandering frequency and further influenced executive control functioning,<sup>59</sup> our findings also supported that SMA was associated with poorer executive functioning. The results of SEM also showed that there were indirect effects from SMA on executive functioning. More specifically, there were two pathways underlying the negative association: one pathway involved emotional disturbance alone, and the other involved both emotional disturbance and sleep quality.

The emotional disturbance was positively related to SMA, as results in previous studies have shown.<sup>60,61</sup> This present study further showed individuals with higher SMA reported a higher level of emotional disturbance, which in turn predicted poorer executive functioning. According to previous studies, SMA could contribute to not only more symptoms of emotional disturbance but also emotional regulation deficit,<sup>33,62</sup> both of which are associated with the impairment of brain processes and abilities of executive functioning. For example, anxiety and depression have both been found to impair executive functioning and its related brain systems.<sup>63,64</sup> A longitudinal study also showed the direct effects of depression and generalized anxiety symptoms on executive functioning impairment after 18 years,<sup>34</sup> demonstrating the long-lasting severity of emotional disturbance in the development of executive functioning. Given executive functioning deficits have also been tested as risk factors for anxiety disorder,<sup>65</sup> the bidirectional relationship between emotional disturbance and executive functioning should also be tested in further longitudinal studies.

Furthermore, emotional disturbance could also have a negative impact on executive functioning via sleep quality. As one of the basic activities for individuals, sleep plays a vital role in brain and cognitive functions and sleep

deprivation would impair executive functioning.<sup>42</sup> Poor sleep quality and weak circadian rhythm would make individuals unable to recover from the loss of self-control resources in the long run,<sup>40</sup> and further damage or alter the processes and abilities related to executive functioning.<sup>66,67</sup> The present study is the first to examine the associations among these negative consequences of SMA (ie, emotional disturbance, poor sleep quality, and poor executive functioning). More attention should be paid to the adverse effects of SMA because there were interactions between such negative consequences from behavioral problems to cognitive impairment. The observations of the significant effect of SMA on executive functioning directly also suggested other potential internal mechanisms exist between SMA and executive functioning, which need to be further investigated. Moreover, there was also a significant and positive relationship between SMA and poor sleep quality, which was consistent with previous studies.<sup>68,69</sup> The possible reason may be that a higher level of social media use would reduce melatonin output, and lead to poor sleep quality or sleep problems consequently,<sup>70</sup> except for another reason of emotional disturbance found in the present study.

The limitations of the present study should also be mentioned. First, convenience sampling may limit the generalizability of the findings to Chinese young adult populations, and further study should be undertaken among other samples. Second, the cross-sectional study design limits the interpretation of the results for causal/reciprocal relationships among the variables studied, therefore longitudinal or experimental studies should also be conducted. Third, the current measurement tools (eg, executive functioning and sleep quality) were subject to self-reported bias. More experimental designs for executive functioning and technical tools for sleep should also be used for the replicability of the findings in further research.

Despite the limitations, the study demonstrated the negative association between SMA and executive functioning, as well as positive associations with emotional disturbance and sleep quality among Chinese young adults. Not only a direct effect but the indirect effects of SMA by emotional disturbance alone, or by a serial mediation of emotional disturbance and sleep quality on executive functioning was also found in the present study. The present study expands the understanding of the associations between SMA and its negative consequences on emotional processes and cognitive functions. More practical interventions (eg, emotional regulation strategies) should be conducted to alleviate the negative impact of SMA on executive functioning.

## Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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## Disclosure

The authors report no conflicts of interest in this work.

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