

Perceived Stress and Smartphone Addiction in Medical College Students: The Mediating Role of Negative Emotions and the Moderating Role of Psychological Capital

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Abstract

Background: Many studies have confirmed the existence of an extremely close relationship between smartphone addiction and perceived stress. However, the mediating and moderating mechanisms underlying the association between perceived stress and smartphone addiction in medical college students remain largely unexplored.

Methods: A questionnaire was distributed among a total of 769 medical college students in Heilongjiang Province, China. Participants completed measures of perceived stress, smartphone addiction, negative emotions and psychological capital. Pearson correlation analysis was used to test correlations between variables. The analysis of moderated mediation model was performed using Hayes's PROCESS macro.

Results: Pearson correlation analysis indicated perceived stress ($r = 0.18, p < 0.01$) and negative emotions ($r = 0.31, p < 0.01$) were positively correlated with smartphone addiction, and psychological capital was negatively correlated with smartphone addiction ($r = -0.29, p < 0.01$). The moderated mediation analysis indicated that negative emotions partially mediated the association between perceived stress and smartphone addiction (mediation effect accounted for 33.3%, $SE = 0.10, 95\% CI = [0.10, 0.24]$), and the first stage of the mediation process was significantly moderated by psychological capital (moderated mediation = $-0.01, SE = 0.01, 95\% CI = [-0.01, -0.00]$).

Conclusions: Negative emotions plays a mediating role between perceived stress and smartphone addiction, and psychological capital plays an important moderating role in the first stage of the mediation process.

Introduction

The smartphone has become an important tool for accessing information, interaction, and entertainment in modern society. However, excessive use of smartphone has more and more adverse influences on individuals, which has aroused great concern of the society. Smartphone addiction, also known as problematic smartphone use or mobile phone dependence[1], is essentially behavioral addiction. It refers to the individual behavior being out of control because of the use of mobile phones, resulting in a state of obsession[1]. The individual's physiological, psychological and social functions are significantly impaired[2]. Specifically, a large number of studies have shown that smartphone addiction can cause a variety of maladaptive outcomes, including physical health difficulties[3], sleep disturbances[4], academic failures[5], and emotional and behavioral problems[6].

The general strain theory is originally used for explaining criminal behaviors[7], and now has been well used for analyzing addictive behaviors[8, 9]. According to the general strain theory, strains or stressors increase the likelihood of negative emotions like anger and frustration[10]. These emotions cause corrective behavior[10], and addictive behavior may be a method for reducing strain or alleviating negative emotions. Medical college students, as a special group of college students, they have high levels of stress that could be due to academic burden, frequency of examinations, lengthy academic curriculum

and worrying about the future[11]. When faced with these stress, they are more likely to use smartphone as a way to relieve stress. Perceived stress refers to the degree to which an individual perceives an external event as stress[12]. Whether the objective stress affects the individual depends on the individual interpretation and perception of the stress event[12]. Perceived stress could make individual in a stress situation, which is considered to be a risk factor in the occurrence and recurrence of many addictions, such as problematic online gaming[13], substance abuse[14, 15], internet addiction[8] and so on. Particularly, some studies have confirmed that stress could effectively predict smartphone addiction[16, 17]. Individuals who perceive more stress are more inclined to engage in smartphone addiction[18].

Unfortunately, previous studies have made valuable contributions to the relationship between stress and smartphone addiction, however, the mediating (i.e., how perceived stress relates to medical college students smartphone addiction) and moderating mechanisms (i.e., when the relation is most potent) underlying the association between perceived stress and smartphone addiction in medical college students remain largely unexplored. Confirming its mediating and moderating mechanisms could be critical to advance our understanding of smartphone addiction in medical college students, and to develop effective intervention as well.

The mediating role of negative emotions

Abundant studies have shown that perceived stress is positively correlated with negative emotions[19, 20]. Stress is one of the most important risks leading to mental health problems. To some extent, the existence of stress can break the balance between the individual and the environment. The imbalance makes the individual difficult to adapt to the impact of objective events on themselves, which leads to some negative emotions such as anxiety and depression. Negative emotions have an important impact on individual cognition and behavior. Previous studies have found a positive correlation between negative emotions and problematic behavior. On the one hand, negative emotions can cause substance problematic use, such as drug abuse[21]. Apart from substance problematic use, a large number of studies have shown that negative emotions are related to non-material problematic use, such as internet addiction[22, 23] and smartphone addiction[24, 25]. For example, one study pointed out that anxiety and depression scores emerged as independent positive predictors of smartphone addiction[24]. Individuals with high depression scores are more likely to become addicted to smartphone. Relevant studies have shown that mood regulation (defined as reducing negative feelings-loneliness, anxiety, depression, stress) could reduced the occurrence of smartphone addiction among a convenient sample of 394 Chinese university students[26]. Furthermore, some studies have indicated that individuals are prone to eliminate negative emotions accumulated in daily life through negative means including substance abuse, dependence, and addiction[21]. Considering that smartphone addiction behavior is problematic behavior, we could speculate that negative emotions are significantly positively correlated with smartphone addiction based on the mentioned studies.

Therefore, we assume that negative emotions will play a mediating role in the relationship between perceived stress and smartphone addiction. This hypothesis could be corroborated by similar studies. For

example, many researchers have found that negative emotions mediated the relationship between stress and problematic behaviors including eating disorders[27], problematic use of marijuana[21]. To our knowledge, the mediate effect in the relations of perceived stress and smartphone addiction in medical college students remains largely unexplored.

The moderating role of psychological capital

Psychological capital is an important personal resource, defined by Luthans et al. as “a positive psychological state that an individual performs in the process of growth and development” [28]. It is composed of four psychological resource capacities, namely self-efficacy, hope, optimism and resilience[28]. According to Bandura’s Social Cognitive Theory[29, 30], efficacy is defined as “having confidence to undertake and make the necessary effort to succeed at challenging tasks”[31]. Hope means persevering toward goals and when necessary, redirecting paths to goals in order to succeed[31]. Optimism refers to “a mood or attitude”[31]. Resilience is defined as “sustaining and bouncing back and even beyond to attain success when beset by problems and adversity”[31]. Resilience could help individual cope with stress effectively, and achieve good adaptation and development[32, 33]. The general strain theory incorporating conditioning factors into the theory to explain individual differences in adaptations to strain[34]. Agnew proposed that an individual’s internal and external factors condition the effects of strain on negative emotions, which in turn affects deviant coping[7]. That is, the conditioning factors influence an individual’s selection of deviant or nondeviant coping by decreasing or increasing the likelihood that the individual will experience negative emotions in response to strain. For example, an angry adolescent high in self-efficacy is less likely to turn to delinquency than an equally angry adolescent low in self-efficacy[34]. Particulatly, some studies have revealed the moderating effect of resilience[35]. A.P. Wingo et al. found that resilience moderated depressive symptom severity in a cross-sectional study of 792 adults[35], that is, individual high in resilience had lower levels of depression. In a survey of Chinese physicians, psychological capital moderates the association between occupational stress and depressive symptoms in female physicians. Psychological capital could be a positive resource for combating depressive symptoms[36]. To our knowledge, no studies have examined psychological capital as a moderator of the direct and/or indirect associations between perceived stress and smartphone addiction.

Based on the literature reviewed above, we put forward the following hypotheses: Hypothesis 1. Negative emotions will mediate the link between perceived stress and smartphone addiction in medical college students. Hypothesis 2. The direct and/or indirect associations between perceived stress and smartphone addiction via negative emotions will vary as a function of psychological capital. Figure 1 illustrates the proposed model.

Methods

Participants

Participants were 769 medical college students recruited from Harbin Medical University, China. The mean age of the participants was 20.46 years (SD = 1.40, range = 17–29 years). 19% of the participants were males and 81% of the participants were female. 467 of the participants were from cities (61%), and 302 of the participants were from rural areas (39%). Finally, 58% of medical college students came from one-child families, and 42% of them came from non-only child families.

Measures

Mobile Phone Addiction Index Scale

Smartphone addiction was measured by the Mobile Phone Addiction Index Scale[37]. The scale consists of 17 items that measure four dimensions of smartphone addiction: inability to control cravings, anxiety and feeling lost, withdrawal and escape as well as productivity loss. Participants answered these items on a five-point scale (ranging from 1 = never, to 5 = always). Previous studies have shown that the MPAI had good reliability and validity in Chinese adolescents and young adults[38]. For the current study, the measure demonstrated good reliability ($\alpha = 0.88$).

The Perceived Stress Scale

Perceived stress was assessed using the Perceived Stress Scale. This scale consists of 14 items (e.g.,“Feeling nervous and stress?”). The participants rated each item on a 5-point scale ranging from 1 = never, to 5 = very much, with higher scores indicating higher level of perceived stress. For the current study, the measure demonstrated good reliability($\alpha = 0.82$).

The Positive and Negative Affect Scale

Negative emotions was measured by the the Positive and Negative Affect Scale. The scale consists of 20 items that measure two dimensions of emotions: positive emotions and negative emotions. This scale was measured in a 5-point scale (ranging from 1 = almost none, to 5 = very much), with higher negative emotional scores indicating individual puzzled and painful. The survey asked medical students to tick behind each adjective according to the actual situation in the last week. There are five options after each adjective: almost none, less, medium, more, and very much.

Positive Psychological Capital Questionnaire

The Psychological Capital Questionnaire consists of 26 items, and there is four dimensions: self-efficacy, resilience, hope, and optimism. There are 7 items for the self-efficacy dimension, 7 items for the resilience dimension, 6 items for the hope dimension, and 6 items for the optimistic dimension. This questionnaire was measured in a 7-point scale (ranging from 1 = not at all, to 7 = completely suitable), with higher scores indicating that medical college students have higher psychological capital level.

Procedure

The data were collected in university classrooms between April and May 2017. Trained postgraduate students administered the measures using scripts and a manual of procedures to ensure standardization of the data collection process. Informed consent was obtained from college students before data collection. Students were informed that their participation was completely voluntary and they could decline the participation at any time. Participants received a gift as incentives after they completed all questionnaires

Statistical Analysis

All statistical analyses were conducted using SPSS 23.0. First, descriptive statistics (i.e., M, SD) were calculated for all variables, followed by bivariate associations among these variables. Second, we followed MacKinnon's four-step procedure to establish a mediation effect[39]. Third, we further examined whether the mediation process was moderated by psychological capital. Moderated mediation is often used to examine whether the magnitude of a mediation effect is conditional on the value of a moderator[40]. The analysis of moderated mediation model was performed using Hayes's PROCESS macro (Model 59)[41]. All continuous variables were standardized and the interaction terms were computed from these standardized scores. In addition, the bootstrapping method was applied to examine the significance of all the effects to obtain robust standard errors for parameter estimation[41]. The bootstrapping method produces 95% bias-corrected confidence intervals of these effects from 1,000 resamples of the data. Confidence intervals that do not include zero indicate effects that are significant.

Results

Preliminary analyses

Means, standard deviations, and correlations for all variables are presented in Table 1. Correlation analyses showed that perceived stress was positively associated with smartphone addiction, $r = 0.18$, $p < 0.01$, indicating that perceived stress was a risk factor for smartphone addiction in medical college students. Psychological capital was negatively associated with smartphone addiction, $r = -0.29$, $p < 0.01$. In addition, negative emotions was positively related to smartphone addiction, $r = 0.31$, $p < 0.01$, indicating that medical college students with high negative emotions were more likely to get addicted to smartphone. Finally, perceived stress was positive related to negative emotions, $r = 0.20$, $p < 0.01$.

Table 1
Means, standard deviations, and correlations of the main study variables

Variable	1	2	3	4	5	6	7	8
1.Gender	—							
2.Age	-.13**	—						
3.Only child	.11**	.01	—					
4.Home location	.04	.13**	.46**	—				
5.Perceived stress	-.01	-.07	.01	.01	—			
6.Negative emotions	-.03	.06	-.02	.00	.20**	—		
7.Psychological capital	.15**	-.05	-.01	-.04	.03	-.42**	—	
8.Smartphone addiction	-.04	.05	.04	.05	.18**	.31**	-.29**	—
M	1.81	20.5	1.42	1.39	31.96	22.14	123.55	39.08
SD	0.40	1.40	0.50	0.49	3.45	6.31	16.73	9.89
Note. N = 769. SD: standard deviation.								
*p < 0.05. **p < 0.01.								

Testing for Mediation Effect

In Hypothesis 1, we anticipated that negative emotions would mediate the relationship between perceived stress and smartphone addiction in medical college students. To test this hypothesis, we followed MacKinnon's four-step procedure to establish mediation effect[39], which requires (a) a significant relation between perceived stress and smartphone addiction in medical college students; (b) a significant association between perceived stress and negative emotions; (c) a significant relation between negative emotions and smartphone addiction after controlling for perceived stress; and (d) a significant coefficient for the indirect path between perceived stress and smartphone addiction through negative emotions. The bias-corrected percentile bootstrap approach determines whether the last condition is satisfied.

Regression analyses indicated that, in the first step, perceived stress positively predicted smartphone addiction in medical college students, $b = 0.18$, $p < 0.01$ (see Model 1 of Table 2). In the second step, perceived stress positively predicted negative emotions, $b = 0.20$, $p < 0.01$ (see Model 2 of Table 2). In the third step, when we controlled for perceived stress, negative emotions significantly and positively predicted smartphone addiction, $b = 0.31$, $p < 0.01$ (see Model 3 of Table 2). Finally, the bias-corrected percentile bootstrap method indicated that the indirect effect of perceived stress on smartphone addiction through negative emotions was significant, $ab = 0.06$, $SE = 0.10$, $95\% CI = [0.10, 0.24]$. The

mediation effect accounted for 33.3% of the total effect. Overall, the above four criteria for establishing mediation effect were fully satisfied. Therefore, Hypothesis 1 was supported.

Table 2
Testing the mediation effect of perceived stress on smartphone addiction

Predictors	Model 1 (MCSSA)		Model 2(NE)		Model 3(MCSSA)	
	b	t	b	t	b	t
S	0.18	5.09**	0.20	5.63**	0.12	3.55**
NE					0.31	9.08**
R2	0.03		0.04		0.10	
F	25.88**		31.73**		82.42**	
Note. N = 769. Each column is a regression model that predicts the criterion at the top of the column. PS: perceived stress; NE: negative emotions; MCSSA: medical college students smartphone addiction.						
**p < 0.01.						

Testing for moderated mediation

As noted, Hypothesis 2 predicted that psychological capital would moderate the direct and/or indirect associations between perceived stress and smartphone addiction via negative emotions. To examine this hypothesis, we used the PROCESS macro (Model 59) developed by Hayes to test for moderated mediation[41]. Specially, we estimated the parameters for three regression models. In Model 1, we estimated the moderating effect of psychological capital on the relation between perceived stress and smartphone addiction in medical college students. In Model 2, we estimated the moderating effect of psychological capital on the relation between perceived stress and negative emotions. In Model 3, we estimated the moderating effect of psychological capital on the relation between negative emotions and smartphone addiction. The specifications of the three models are shown in Table 3.

Table 3

Testing the moderated mediation effect of perceived stress on medical college students smartphone addiction

Predictors	Model 1 (MCSSA)		Model 2(NE)		Model 3(MCSSA)	
	b	t	b	t	b	t
PS	0.18	5.43**	0.20	6.39**	0.14	4.18**
PC	-0.29	-8.65**	-0.42	-13.21**	-0.21	-5.77**
PS×PC	-0.04	-1.21	-0.07	-2.04*	-0.03	-0.75
NE	—	—	—	—	0.19	4.88**
NE×PC	—	—	—	—	-0.03	-0.72
R2	0.12	—	0.22	—	0.15	—
F	35.40**	—	73.80**	—	27.01**	—

Note. N = 769. Each column is a regression model that predicts the criterion at the top of the column. PS: perceived stress; NE: negative emotion; PC: psychological capital; MCSSA: medical college students smartphone addiction.

*p < 0.05. **p < 0.01.

Moderated mediation was established if either or both of two patterns existed[40, 41]: (a) the path between perceived stress and negative emotions was moderated by psychological capital (first stage moderation), and/or (b) the path between negative emotions and smartphone addiction was moderated by psychological capital (second stage moderation).

As Table 3 illustrates, in Model 1, there was a significant effect of perceived stress on smartphone addiction, $b = 0.18$, $p < 0.01$, but this effect was not moderated by psychological capital, $b = -0.04$, $p > 0.05$. Model 2 showed that the effect of perceived stress on negative emotions was significant, $b = 0.20$, $p < 0.01$, and more importantly, this effect was moderated by psychological capital, $b = -0.07$, $p < 0.05$. For descriptive purposes, we plotted predicted negative emotions against perceived stress, separately for low and high levels of psychological capital (1 SD below the mean and 1 SD above the mean, respectively) (Fig. 2). Simple slope tests indicated that for medical college students with high levels of psychological capital, perceived stress was not significantly associated with negative emotions, $b_{\text{simple}} = 0.145$, $p = 0.15$. However, for medical college students with low levels of psychological capital, perceived stress was significantly associated with negative emotions, $b_{\text{simple}} = 0.22$, $p < 0.05$. That is, in the low psychological capital group, perceived stress has a significant positive predictive effect on negative emotions. This shows that the influence of perceived stress on negative emotions decreases with the increase of psychological capital. In other words, the indirect influence of perceived stress on smartphone addiction through negative emotions decreases with the increase of psychological capital. Model 3 indicated that

there was a significant effect of negative emotions on smartphone addiction, $b = 0.19$, $p < 0.01$, but this effect was not moderated by psychological capital, $b = -0.03$, $p > 0.05$.

The bias-corrected percentile bootstrap method further indicated that the indirect effect of perceived stress on smartphone addiction through negative emotions was moderated by psychological capital, with the index of moderated mediation = -0.01 , $SE = 0.01$, $95\%CI = [-0.01, -0.00]$. For medical college students low in psychological capital, perceived stress had an adverse impact on smartphone addiction through increased negative emotions, $b = 0.16$, $SE = 0.05$, $95\%CI = [0.08, 0.27]$. In contrast, the indirect effect was much weaker for medical college students high in psychological capital, $b = 0.06$, $SE = 0.03$, $95\%CI = [0.02, 0.13]$. Thus, Hypothesis 2 was partially supported.

Discussion

The influence of perceived stress on smartphone addiction has begun to gain empirical support[16]. However, questions concerning the underlying mediating and moderating mechanisms stay largely unknown. Our study adds to the literature by examining the mediating role of negative emotions and the moderating role of psychological capital in the relationship between perceived stress and smartphone addiction. The results indicated that the impact of perceived stress on smartphone addiction can be partially explained by negative emotions. That is, perceived stress would positively predict negative emotions, and negative emotions could positively predict smartphone addiction. Furthermore, this indirect relation was moderated by psychological capital in the first stage of the mediation process. The following sections will discuss each of the hypotheses according to the research results.

The mediating role of negative emotions

In line with previous studies[16-18]. We found that perceived stress was positively correlated with smartphone addiction in medical college students. The more stress medical college students perceive, the more likely they are to become addicted to smartphone. This is consistent with the general strain theory[8] proposing that all kinds of strain or stress experienced by individual would cause negative emotions, which subsequently causes problem behaviors. Many studies have shown that stress is an important risk factor for individual addictive behaviors[42-44]. For example, Mai et al. found that stress is positively associated with adolescent Internet addiction[44]. These findings suggest that stress plays an important role in addictive behavior.

In addition, our study showed that negative emotions partially mediated the link between perceived stress and smartphone addiction. For the first stage of the mediation process (i.e., the links between perceived stress and negative emotions), we revealed that negative emotions increase with the perceived stress. Our result supports the views of Coyne and Downey[45]. They believed that stressors could cause emotional changes, and these stressors mainly come from the various life events experienced in the daily life (i.e. study, peers and family for university students). These multiple stressors could lead to negative emotions in medical college students. Moreover, some studies have shown that perceived stress is strong predictor of negative emotions[8, 19, 46]. For example, Spada et al. found that a positive and significant correlation

between perceived stress, anxiety and depression[19]. For the second stage of the mediation model (i.e., the links between negative emotions and smartphone addiction), this study revealed that negative emotions was positively associated with smartphone addiction in medical college students. This finding is in line with the cognitive-behavioral model of pathological Internet use proposed by Davis[47], which postulates that addiction behavior is the result of a predisposed vulnerability including negative emotions. In addition, many studies have confirmed the relationship between negative emotions and addictive behaviors[48-50]. For example, one study showed that a significant positive relationship between depression and smartphone addiction and also indicated that depression is able to predict and account for the smartphone addiction among students[25]. Furthermore, Sangmin Jun et al. found that negative emotions play a mediating role in the link between academic stress and Internet addiction[8]. Based on the above theories, it clarifies the link between perceived stress and negative emotions[19, 46] as well as the link between negative emotions and smartphone addiction[24]. In this study, We integrated these two relationships with a mediation model approach. Our study goes one step further by uncovering that individual who perceive more stress have more negative emotions, and they are more likely to engage in smartphone addiction.

This findings has important implications for policymakers who develop means to prevent and intervene smartphone addiction among medical college students. The results suggest that it is particularly important for counselors to deal with medical college students' negative emotions in the context of smartphone addiction. The findings also suggest that the early prevention of stress is important in halting the development of negative emotions that subsequently influence smartphone addiction.

The moderating role of psychological capital

Our findings confirmed the moderating role of psychological capital in the indirect association between perceived stress and smartphone addiction. Specifically, we found that psychological capital attenuated the link between perceived stress and negative emotions. No significant correlation between perceived stress and negative emotions was found in medical college students with higher levels of psychological capital. However, perceived stress is more likely to lead to negative emotions in medical college students with lower levels of psychological capital. Our findings are in line with the research of Zhong li-feng et al. [51], which suggests that not all the people who are exposed to stressful conditions feel negative emotions to the same degree. The perceived stress depend not only on the effects of stressors but also on how the individual appraises the situation, one of the students' positive psychological states such as psychological capital may attenuate the negative effects of stress on negative emotions. Moreover, Hobfoll proposed a conservation of resources theory[52], and considered that valuable resources played a positive role in the process of individual stress response[53]. These resources included material, power, interpersonal relationships, and positive psychological factors[52]. This theory provides a reliable perspective to explain that psychological capital could protect individual from the adverse effects of stress, and it is a protective factor for mental health[35, 54, 55]. Our results also support the opinion that individual with higher levels of psychological capital may view stress as controllable factor and are able to recover from stressful experiences quickly and efficiently[56-58]. When faced with stress, medical

college students with higher levels of psychological capital might bounce back from adversity or failure with positive psychological capacity (resilience), preserve the will to accomplish a learning task or goal (hope), have more confidence and exert greater effort in the pursuit of success (self-efficacy), and have positive expectations and attributes regarding outcomes (optimism).

This finding indicates that psychological capital is a positive personal trait and an important protective factor. It prevents individuals from being affected by perceived stress, reducing their negative emotions and the likelihood of developing smartphone addiction. Our findings suggest that we should pay attention to psychological capital when helping medical college students deal with the negative effects of perceived stress in the future. And our findings also suggest that we should enhance students' psychological capital in their daily life to keep them from developing addiction behavior when faced stress.

Limitation

Several limitations must be considered when interpreting the findings of this study. First, this study was cross-sectional and cannot infer causality. For example, smartphone addiction is used as a result variable in this study, but smartphone addiction may also have a reverse effect on risk factors (such as perceived stress, negative emotions) and protective factors (such as psychological capital). Therefore, further studies should apply the longitudinal or experimental designs to confirm the causal assumptions in this study. Second, the representativeness of the sample may restrict the generalizability of our results, because our participants were from one and the same university. Future research may explore the proposed model among diverse populations. Third, medical college students' self-reported data on perceived stress and smartphone addiction could not be independently verified. The understanding of each questionnaire item measuring an abstract concept vary from one participant to another. Future research should use multiple informants (e.g. parents, teachers, and peers) to collect data to ensure its accuracy.

Conclusion

In summary, this study is among the first research to uncover the mediation role of negative emotions and moderation role of psychological capital in the relation between perceived stress and smartphone addiction. It explains how, when, and when of how perceived stress is related to smartphone addiction. These results deepen previous studies by clarifying the mediation and moderation factors in the link between perceived stress and smartphone addiction. In this study, negative emotions serves as one potential mediation mechanism between perceived stress and smartphone addiction in medical college students. Moreover, the mediation mechanism was moderated by psychological capital, and the adverse impact of perceived stress on smartphone addiction through decreased negative emotions appears to be weaker for medical college students with higher levels of psychological capital. Our findings demonstrate the importance of moderated mediation model in understanding mechanism linking perceived stress and smartphone addiction in medical college students.

Declarations

Ethics approval and consent to participate:

This study was approved by the Ethics Committee of Harbin Medical University. All the medical college students participated voluntarily.

Consent for publication:

Not applicable.

Availability of data and material:

The data used and analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests:

The authors declare that they have no competing interest.

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Authors' contributors:

YJY and PL conceived and designed of the study. AM and ZNY collected the data. HYC and WBW participated in statistical analysis and interpretation of data. ZXQ and XHQ interpreted the data and wrote the preliminary manuscript. JWZ and XXY revised the content of the manuscript. PL performed compiled the data, and wrote the preliminary manuscript. All authors have read and approved the final manuscript.

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Figures

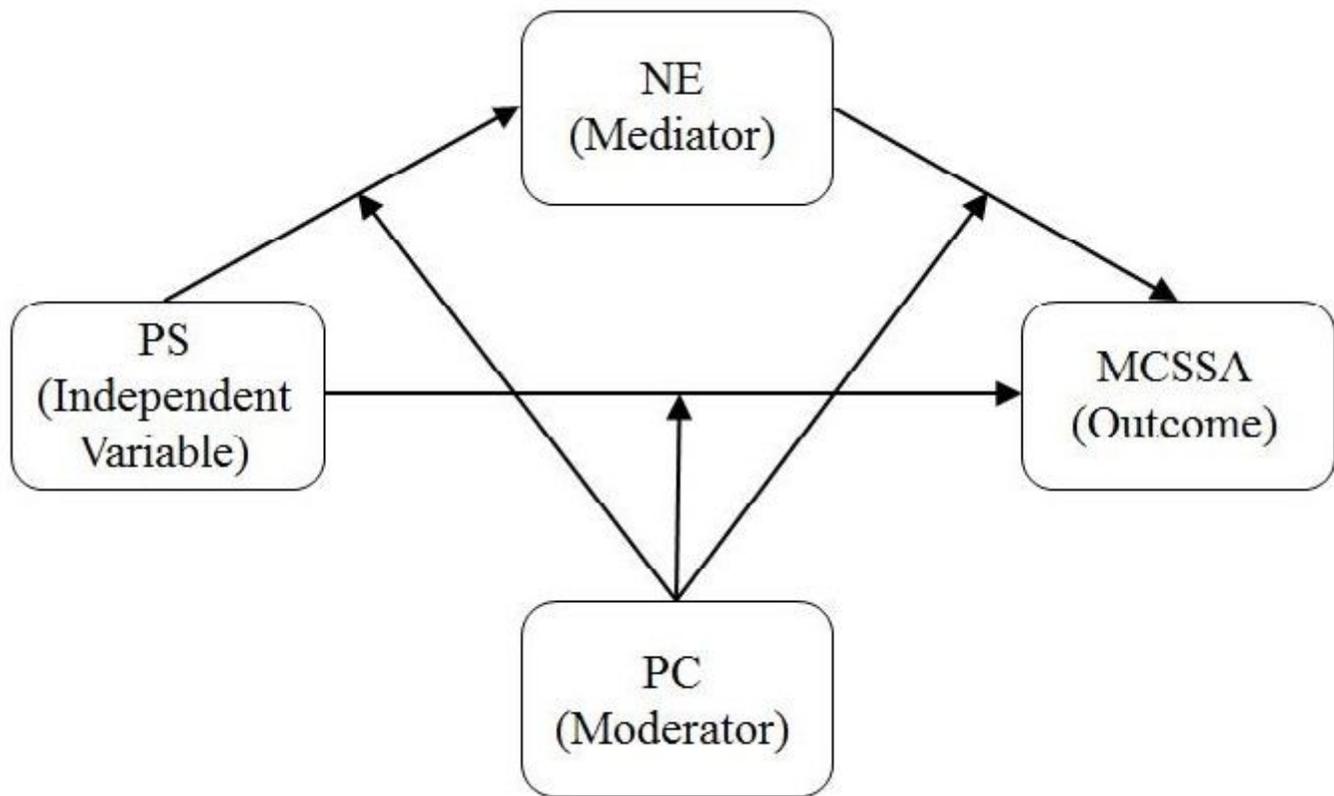


Figure 1

The proposed moderated mediation model. Note. PS: perceived stress; NE: negative emotion; PC: psychological capital; MCSSA: medical college students smartphone addiction.

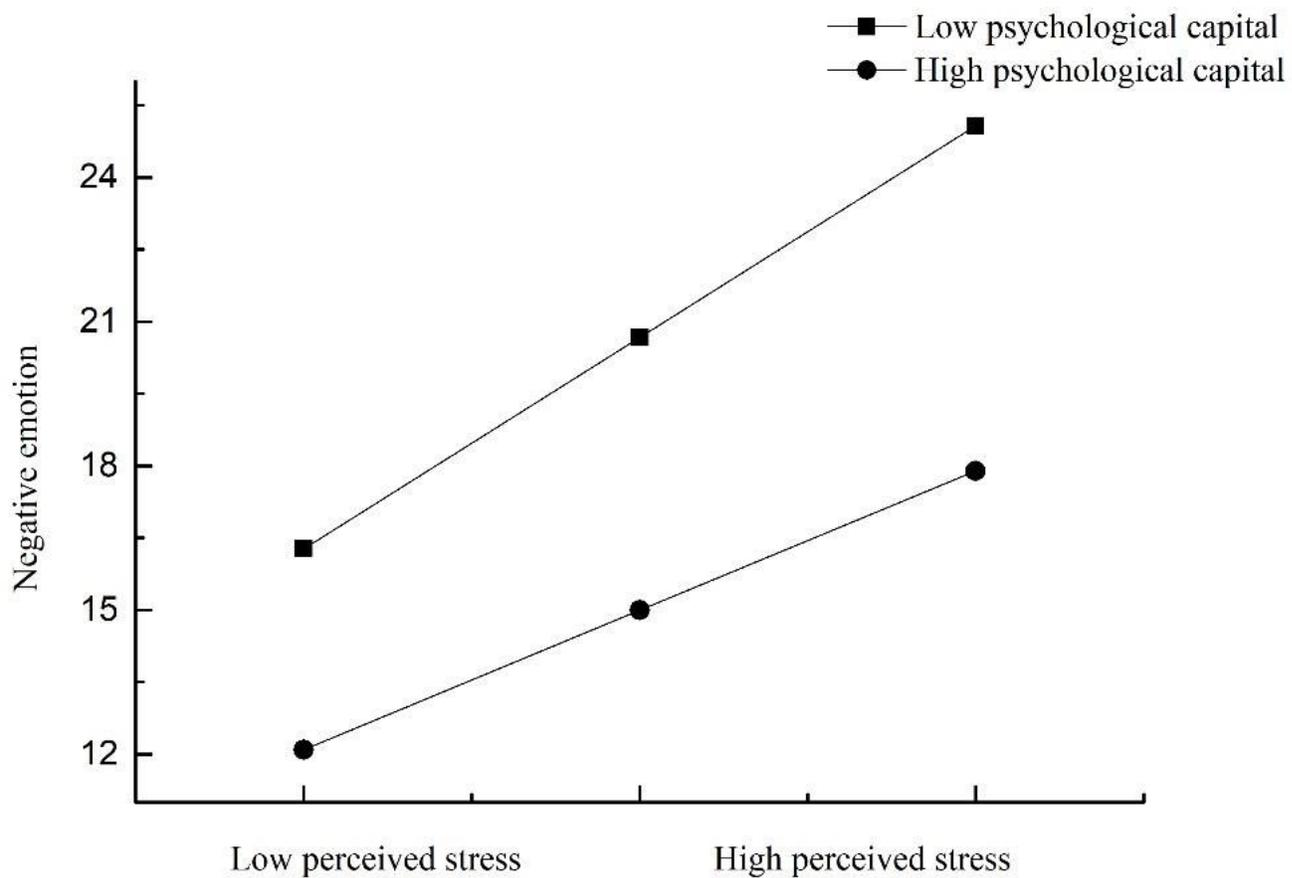


Figure 2

Plot of the relationship between perceived stress and negative emotions at two levels of psychological capital.