Stress Response on Behavioral Response of University Students During the Peak Period of COVID-19

ABSTRACT

Background: This study aimed to explore the underlying mechanisms of the relationship between stress response and behavioral response and to develop a moderated mediation model with stress management and risk cognition.

Methods: We developed 4 novel questionnaires, namely, stress response questionnaire, behavioral response questionnaire, stress management questionnaire, and risk cognition questionnaire. A total of 5896 university students in China were investigated during the peak period of the coronavirus disease 2019.

Results: The results showed that stress response had a significant negative predictive effect on behavioral response ($r = -0.489$, $P < .001$). Moreover, stress management had a partial mediating effect between stress response and behavioral response. Risk cognition plays a moderating effect on the mediation model ($\beta = -0.109$, $P = .030$), and the effect of high-risk cognition is more significant.

Conclusion: During the coronavirus disease 2019 period, improving the risk awareness of university students will help to enhance the buffering effect of stress management on behavioral response and indirectly reduce their behavioral response.

Keywords: COVID-19, stress response, behavioral response, stress management, risk cognition, moderated mediating model

Introduction

The outbreak of the coronavirus disease 2019 (COVID-19) in 2020 has brought China’s economy and society into a state of stagnation. In the face of home isolation, city closure, and the rising number of infected people, people’s psychology is facing a huge impact. College and university students, more worthy of attention, are not mature in cognitive experience and emergency response. In addition to the threat of the common virus in the public, colleges and universities are also facing more serious pressure events: the normal life order is disrupted due to the failure to resume classes in colleges and universities, academic pressure, and interpersonal pressure generated by long-term home stay.

With the occurrence of public health emergencies, people often have different degrees of psychological stress response. Stress–response often involves the functions of multiple response systems, including changes in cognitive, emotional, behavioral, and physiological levels, which may have negative effects on individuals. The negative consequences of stress are related to the imbalance between stress perception and stress limiting system. Long-term exposure to stressors is a risk factor for mental illness, such as depression and post-traumatic stress disorder.

Serious social and public health events will also affect the behavior of residents. Behavioral response means that under stress, individuals can have a direct behavioral response and indirect behavioral response. Direct response refers to the behavioral response made by an individual to eliminate or avoid the stimulus when directly facing the stimulus that causes...
Stress response has adaptive protection in the short term. When internal homeostasis is threatened, individuals will produce a series of adaptive compensation responses to maintain internal homeostasis. Moderate stress is conducive to improving the adaptability of the body. Behavioral response and stress response pathways will be integrated within individuals, that is, behavioral response and stress response are highly related. The level of cortisol represents the strength of stress response. The above evidence shows that stress response is significantly correlated with behavioral response. In view of this, we propose hypothesis 1: stress response can positively predict behavioral response.

Individual stress management strategy plays an important role in health. Previous studies found that stress responses are driven by how people manage negative effects of stress. Meanwhile, stress management is also significantly related to behavioral response. The change of stress management strategy needs to change behavior or take a new view on stress. Studies on cancer patients have found that stress management intervention reduces cancer-related negative behavioral reactions. Adolescents' externalized stress-related behaviors are often associated with ineffective cognitive coping strategies (i.e., constructive thinking). These results indicate that stress management is related to behavioral response and stress response. In view of this, we propose hypothesis 2: stress management has a mediating effect between stress response and behavioral response.

The COVID-19 is a rare outbreak of infectious diseases, and it is a high-risk-threatening stress event to the public. Risk cognition is the individual’s understanding and judgment of these risk events, which is affected by the objective risk degree of the event. Different from other risk events, the public’s cognition of epidemic risk has its uniqueness. For example, people in different regions may have different perceptions of the risk of epidemic situations. People in non-epidemic areas even have more negative emotions. Some researchers call it “psychological typhoon eye effect.”

Changes in human behavior may be driven by risk cognition. Studies have found that if the cognition of risk associated with epidemics improved, the impact of epidemics is significantly reduced and the rate of self-reducing contact activity is conducive to the effective control of human epidemics. A study investigated the disaster area of Wenchuan earthquake in 2008 and the results show that residents’ high-risk cognition has a positive impact on their adaptive evacuation behavior. A research has explored farmers’ risk perception and climate change adaptation behavior and found that high-risk cognition and adaptation cognition have a significant positive impact on climate change adaptation behavior. There is a positive correlation between individual risk attitude and task performance in dynamic risk decision-making. Risk cognition is positively correlated with political support behavior and behavior tendency. On the contrary, underestimation of risk is related to exposure enhancement activities, and the positive coping styles of individuals are correspondingly less. It is found that heat exposure leads to the decrease of individuals’ cognition of the same environmental risk, which leads to more behavioral reactions of violating safety measures.

Risk cognition is significantly positively correlated with stress management. The research on workers found that their attention and awareness of occupation-related risks hindered the effectiveness of stress management. Studies have shown that job insecurity affects the perception of psychosocial risks, thus increasing the vulnerability of workers to job-related stress. Some researchers have studied the relationship between stress vulnerability and risk perception and other psychological factors in earthquake disasters and they found that people’s stress vulnerability is significantly related to their perception of earthquake risk. Combined with the above evidence, it is not difficult to find that individuals with high-risk cognition show more behavioral responses than individuals with low-risk cognition and are accompanied by higher stress strategies. In view of this, we propose hypothesis 3: risk perception moderates the relationship between stress management and behavioral response.

To sum up, this study intends to explore the relationship and mechanism among stress response, stress management, behavioral response, and risk cognition of colleges and university students in the epidemic and tries to explore the impact of the COVID-19 on colleges and university students’ coping style and its influence mode and to provide theoretical support for effectively improving the psychological response mechanism of colleges and university students in the face of emergencies. Based on the theory of stress response and the mechanism of psychological processes, this study proposes a moderated mediating model, as shown in Figure 1.

**MAIN POINTS**

- Stress response had a significant negative predictive effect on behavioral response in the epidemic.
- Stress management played a mediating role between stress response and behavioral response.
- For high-risk cognition people, stress management had a significant predictive effect on behavioral response.

![Figure 1. Hypothetical Model: The Mediating Role of Stress Management and the Moderating role of Risk Cognition.](image-url)
Methods

Participants and Procedures
Data were collected through the questionnaire satellite platform. The survey time was February 17-19, 2020. The participants were college and university students. The total number of students in this study was 5896. There are 3 sample groups in this study. The study was reviewed and approved by the Ethical Authority of the School of Educational Science, Huazhong University of Science and Technology (approval date: January 30, 2020; Number: 20200130). The participants were informed about the purpose of the study, both verbally and in writing.

In the first part, the sample size of exploratory factor analysis was 2046, of which 959 (46.87%) were male and 1087 (53.13%) were female, with an average age of 19.74 (1.52).

In the second part, the sample size of confirmatory factor analysis was 2030, of which 970 (47.78%) were male, 1060 (52.22%) were female, with an average age of 19.77 (1.85).

In the third part, the sample size of mediating effect and moderating effect analysis is 1820, of which 823 (45.22%) were male and 997 (54.78%) were female. The average age was 19.72 (1.54) years.

Research Tool
Stress Response Questionnaire: To understand the stress response of colleges and university students in China during COVID-19, based on literature analysis, expert discussion, and on-the-spot interviews with colleges and university students, graduate students, and counselors, we developed a stress response questionnaire composed of 8 items.26,27 The specific forms of stress response investigated were integrated into 1 major category, with 8 factors in total. The questionnaire adopts a 1-4 4-point scoring method. The higher the total score, the more obvious the stress response performance; the lower the total score, the less obvious the stress response performance.

First, we conducted an exploratory factor analysis with a sample size of 2046. The KMO value was 0.50, and Bartlett’s spherical test was significant (P < .001), indicating that the items of the questionnaire were suitable for exploratory factor analysis. The number of effective factors is 1 and the number of questionnaire items is 2. The cumulative total variation of interpretation is 75.85%. The 2 items have a large load, both of which are 0.87.

Second, we conducted confirmatory factor analysis with a sample size of 2030 people. Amos 25.0 software was used to conduct confirmatory factor analysis on the single-factor model of stress response. According to the modification index (MI), the single-factor model was compared with the multi-factor model. Generally, the acceptable standard of structural equation model fitting is NFI (Normed Fit Index), CFI (Comparative Fit Index), IFI (Incremental Fit index), greater than 0.90 (better close to or greater than 0.95), and SRMR (Standardized Root Mean Square Residual) less than 0.08. The results showed that the fitting indexes of single factor were the best; RMSEA (Root Mean Square Error of Approximation) = 0.08, NFI = 0.97, CFI = 0.97, IFI = 0.97, SRMR = 0.03.

Finally, we tested the reliability and validity of the scale. The internal consistency reliability analysis shows that the total internal consistency coefficient of the questionnaire is 0.85, which indicates that the questionnaire has good reliability.

Stress Management Questionnaire: We developed a stress management questionnaire composed of 2 items and integrated the coping styles into 1 category. The questionnaire adopts a 1-5 5-point scoring method. The higher the total score, the more obvious the stress management; the lower the total score, the less obvious the stress management.

First, we conducted an exploratory factor analysis with a sample size of 2046. The KMO value was 0.50, and Bartlett’s spherical test was significant (P < .001), indicating that the items of the questionnaire were suitable for exploratory factor analysis. The number of effective factors is 1 and the number of questionnaire items is 2. The cumulative total variation of interpretation is 75.85%. The 2 items have a large load, both of which are 0.87.

Finally, we tested the reliability and validity of the scale. The results of criterion-related validity showed that there was a significant correlation between the 2 items (r = 0.47, P < .001), which indicated that the stress management questionnaire had good criterion-related validity. Internal consistency reliability analysis found that the total internal consistency coefficient of the questionnaire was 0.64, indicating that it had good reliability.

Risk Cognition Questionnaire: We developed a risk cognition questionnaire composed of 6 items. The risk cognition of the survey was integrated into 2 categories (severity cognition and susceptibility cognition) with a total of 6 factors. Questions 1 and 2 were severity cognition, 3-6 were susceptibility cognition, and 5 and 6 were reverse scoring questions. The questionnaire adopts a scoring method of 1-5 points. The higher the total score, the clearer the risk cognition; the lower the total score, the less clear the risk cognition.

First, we conducted an exploratory factor analysis with a sample size of 2046. The results showed that KMO value was 0.62, and Bartlett’s spherical test was significant (P < .001), indicating that the items of the questionnaire were suitable for exploratory factor analysis. The final number of effective factors is 2, and the number of questionnaire items is 6. The 2 factors are named severity cognition and susceptibility cognition. The total variation of cumulative interpretation is 28.98%. Each item has a large load on the corresponding factors, ranging from 0.33 to 0.75.

Second, we conducted confirmatory factor analysis with a sample size of 2030 people. The results showed that the fitting indexes of 2-factor model were the best; RMSEA = 0.06, NFI = 0.92, CFI = 0.93, IFI = 0.93, SRMR = 0.04, which was significantly better than single-factor model, so the 2-factor model was accepted.
Finally, we tested the reliability and validity of the scale. The results of criterion-related validity showed that there was a significant correlation between the 2 dimensions of risk cognition, severity cognition, and susceptibility cognition ($r = 0.17, P < .001$). This shows that the risk cognition questionnaire has good criterion-related validity. The internal consistency reliability analysis showed that the internal consistency $\alpha$ coefficients of severity cognition and susceptibility cognition were 0.36 and 0.47, respectively, and the total internal consistency coefficient of the questionnaire was 0.47, indicating that it had good reliability.

**Behavioral Response Questionnaire:** We developed a coping style questionnaire composed of 5 items. The coping styles of the survey were integrated into 1 category, with 5 factors in total. The questionnaire was scored from 1 to 5 points. The higher the total score, the more obvious the behavioral response; the lower the total score, the less obvious the behavioral response.

First, we conducted an exploratory factor analysis with a sample size of 2046. The test results showed that KMO value was 0.82 and Bartlett’s spherical test was significant ($P < .001$), indicating that the items of the questionnaire were suitable for exploratory factor analysis. The final number of effective factors was 1, named behavioral response, and the number of questionnaire items formed was 5, the cumulative total variation of interpretation reached 57.34%, each item had a large load on the corresponding factors, ranging from 0.59 to 0.85.

Secondly, we conducted confirmatory factor analysis with a sample size of 2030 people. The results showed that: the single factor fitting index was the best: $\text{RMSEA} = 0.06$, $\text{NFI} = 0.99$, $\text{CFI} = 0.99$, $\text{IFI} = 0.99$, $\text{SRMR} = 0.02$.

Finally, we tested the reliability and validity of the scale. This indicates that the questionnaire has good criterion-related validity. Internal consistency reliability analysis found that the total internal consistency coefficient of the questionnaire was 0.81, indicating that it had good reliability.

**Statistical Analyses:** We used the Bias-corrected percentile Bootstrap method to calculate the moderator effects and mediator effects. Statistical Package for the Social Sciences (SPSS) version 25.0 (IBM SPSS Corp.; Armonk, NY, USA) and Process Syntax by Andrew F. Hayes were used to perform the regression analysis and construct the predicted mediation model. Continuous data are expressed as mean ($\text{SD} = \text{Standard Deviation}$). Pearson correlation was used to analyze the correlation among stress response, stress management, behavioral response, and risk cognition. The type I error rate ($\alpha$) is chosen to be 0.05.

**Results**

**Common Method Bias Analysis**

In this study, Harman’s single-factor test was used to test the common method bias. All items of stress response, risk cognition, social function, and coping style were analyzed without rotation to determine the minimum number of factors necessary for variable variation. If only 1 factor or a certain factor was analyzed and the explanatory power of that factor is too high, it can be judged that there is a serious common method bias. The results of data analysis showed that 7 characteristic roots were larger than 1, and the first common factor could explain 29.06% of the total variation, which was far lower than the recommended critical value of 40.00%. Therefore, there was no common method bias in this study.

**Descriptive Statistics**

We made descriptive statistics on the relevant information of the participants. A total of 1820 participants participated in the moderated mediation model statistics, including 823 (45.22%) male, 997 (54.78%) female; 1099 (60.38%) people in rural areas and 721 (39.62%) people in urban areas; 1488 (81.76%) people had bachelor’s degree, 29 (1.59%) had a master’s degree, 4 (0.22%) had a doctoral degree, and 299 (16.43%) had higher vocational education; 181 (9.95%) people in Wuhan City, 804 (44.18%) people in Hubei Province but outside Wuhan City, 835 (45.88%) people outside Hubei Province. The average age was 19.72 ± 1.54 years (Table 1).

**Correlation Analysis**

We conducted correlation analysis on the variables. Among them, behavioral response was significantly negatively correlated with stress response ($r = −0.489, P < .001$), stress management ($r = −0.133, P < .001$), risk cognition ($r = −0.255, P < .001$), severity cognition ($r = −0.140, P < .001$), and susceptibility cognition ($r = −0.229, P < .001$) (Table 2).

**Mediating Effect Test**

In order to effectively control the measurement error, the structural equation modeling method is used to test the multiple mediating effects. SPSS 25.0 and Model 4 of the PROCESS macro for SPSS were used to perform the mediating effect test. First, the total effect of stress response on behavioral response was tested, and the path coefficient was found to be significant ($β = −0.489, P < .001$). Second, stress management as a mediating variable was added to the model to obtain the mediating model as shown in Figure 2. The results show that stress response predicted stress management significantly positively ($β = 0.093, P < .001$), which would negatively predict behavioral response ($β = −0.088, P < .001$). This indicates that stress management played a partial mediating role in the influence of stress response on behavioral response (Table 3).

**Table 1. Statistical Description of Participants’ Relevant Information (n = 1820)**

| Descriptive Indicators | n (%)     |
|------------------------|-----------|
| Gender                 |           |
| Male                   | 823 (45.22)|
| Female                 | 997 (54.78)|
| Education              |           |
| Bachelor               | 1488 (81.76)|
| Master                 | 29 (1.59)  |
| Doctoral               | 4 (0.22)   |
| Vocational education   | 299 (16.43)|
| Area                   |           |
| Township               | 1099 (60.38)|
| City                   | 721 (39.62)|
| Location               |           |
| Wuhan city             | 181 (9.95) |
| Inside Hubei province   | 804 (44.18)|
| Outside Hubei province  | 835 (45.88)|
Moderated Mediating Effect Test
Statistical Package for the Social Sciences 25.0 and Model 14 of the PROCESS macro for SPSS were used to perform the moderated mediating effect test. First, in order to reduce multicollinearity, all variables were standardized. The results showed that the interaction between stress management and risk cognition had a significant predictive effect on behavioral response (\( \beta = -0.041, P < .001 \)) (Table 4). There was an interaction between stress management and risk cognition in the prediction of behavioral response.

Second, the regulatory effect of risk cognition is shown in Figure 3 and Table 4. After risk cognition was put into model 14, the scores of stress management and risk cognition had a significant predictive effect on behavioral response (\( \beta = -0.109, P = .030 \)), indicating that risk cognition plays a moderating role in stress management on behavioral response prediction (Table 4). The further simple slope analysis is shown in Table 5 and Figure 4. For high-risk cognition participants, stress management had significant predictive effect on behavioral response, 95% CI = -0.189, -0.079 (excluding 0); however, for low-risk cognition participants, stress management had no positive predictive effect on behavioral response, 95% CI = -0.106, 0.001 (including 0), which indicated that compared to the participants with the low-risk cognition participants, the stress management of participants with high-risk cognition has a significant negative predictive effect on behavioral response, and the mediating effect between stress management and behavioral response showed a downward trend.

Discussion
The Influence of Stress Response on Behavioral Response of Colleges and University Students in the Epidemic Period
Our main finding reveals a significant negative correlation between behavioral response and stress response, which was inconsistent with hypothesis 1. This result is consistent with previous findings that uncertainty stress was negatively associated with prevention behaviors. The possible reason for the abovementioned phenomena is that there may be overlapping psychological mechanisms between behavioral response and stress response, which are both conditioned responses to stress events. When faced with stressful events, especially the sudden and threatening large-scale epidemic disease such as the COVID-19, individuals with weaker stress response will take more adaptive behavioral responses, while individuals with stronger stress response will devote more energy to dealing with stress events.

| Table 2. Correlation Analysis of Each Variable |
|-----------------------------------------------|
| Variable | Mean (SD) | 1 | 2 | 3 | 4 | 5 | 6 |
|-----------------|------------|---|---|---|---|---|---|
| Stress response | 1.58 (0.55) | \( r_s \) | - | \( \beta \) | - |
| Stress management | 3.34 (0.92) | 0.093 | - | - | - |
| Behavioral response | 3.56 (0.81) | -0.489 | -0.133 | - | - |
| Risk cognition | 3.13 (0.48) | 0.329 | 0.003 | -0.255 | - |
| Severity recognition | 2.59 (0.60) | 0.153 | 0.118 | -0.140 | 0.562 | - |
| Susceptibility cognition | 4.22 (0.66) | 0.311 | -0.069 | -0.229 | 0.890 | 0.123 | - |

Note: the data have been standardized. SD, standard deviation.

| Table 3. Regression Analysis of the Mediating Role of Stress Management (n = 1820) |
|-----------------------------------------------|
| Model | Outcome variable | Predictive variable | \( R^2 \) | \( F \) | \( \beta \) | \( t \) | \( P \) |
|-----------------|-----------------|-----------------|-----|-----|-----|-----|-----|
| 1 | Behavioral response | Stress response | 0.239 | 571.659\* | -0.489 | -23.909\* | <.001 |
| 2 | Stress management | Stress response | 0.009 | 15.957\* | 0.093 | 3.993\* | <.001 |
| 3 | Behavioral response | Stress response | 0.247 | 297.830\* | -0.481 | -23.518\* | <.001 |
| | Stress management | Stress response | 0.088 | -4.301\* | - | - | <.001 |

Note: the data have been standardized. \*P < .001.
The second major finding is that stress management plays a mediating role in the relationship between stress response and behavioral response. Stress management is positively correlated with stress response and negatively correlated with behavioral response, which was inconsistent with hypothesis 2. Previous researchers have explored the effect of stress management training on endocrine stress response of healthy adolescents under acute psychological stress and the results showed that stress management training can be proved to be helpful to prevent behavioral responses caused by stress-related neuroendocrine activation, which is consistent with the results of this study.40

The possible reason for this result is that when facing stress events, individuals may start-related stress management models and adopt strategies such as pressure regulation and communication with the outside world and information.41 Stress management represents the individual’s regulation and buffering of stress events, which is an adaptive, positive, and constructive psychological and behavioral process. However, overemphasizing the negative effects of stress and stress management may increase the additional strain on the individuals under already stressful situations, resulting in a reduction in behavioral responses.42

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**Moderating Effect of Risk Cognition on Mediating Effect**

Another key finding is that risk cognition played a moderating role in the relationship between stress management and behavioral response, and is negatively correlated with behavioral response. The moderating effect of high-risk cognition on the participants was highly significant. Thus, hypothesis 3 is supported. This result is consistent with the existing research results. Previous studies have found that risk cognition is significantly positively correlated with information-seeking of stress management dimension.31,32

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**Table 4. Moderator Roles of Risk Cognition in the Effect of Stress Management on Behavior Response (n = 1820)**

| Model | Outcome variable | Predictive variable | $R^2$ | $F$ | $\beta$ | $t$ | $P$ |
|-------|------------------|---------------------|-------|-----|--------|-----|-----|
| 1     | Stress management | Stress response     | 0.009 | 15.947* | 0.093 | 0.022* | <.001 |
| 2     | Behavioral response | Stress response     | 0.270 | 336.108* | -0.445 | -0.020* | <.001 |
|       | Stress management | Stress response     | -0.093 | -0.021* | <.001 |
|       | Risk cognition   | Stress response     | -0.109 | -5.110* | .030 |
|       | SM × RC          | Stress response     | -0.041 | -2.173* | <.001 |

Note: the data have been standardized. *$P < .001$, †$P < .05$.

SM, stress management; RC, risk cognition.

**Table 5. Moderating Effect of Risk Cognition on Mediating Variables**

| Effect | $\text{SE}$ | 95% CI         |
|--------|-------------|----------------|
| High risk cognition  (mean + SD) | -0.134 | 0.028 | $[-0.189, -0.079]$ |
| Average risk cognition  (mean − SD) | -0.093 | 0.020 | $[-0.133, -0.053]$ |
| Low risk cognition  (mean − SD) | -0.053 | 0.027 | $[-0.106, 0.001]$ |

SD, standard deviation.

**Mediating Effect of Stress Management on the Relationship Between Stress Response and Behavioral Response**

The second major finding is that stress management plays a mediating role in the relationship between stress response and behavioral response. Stress management is positively correlated with stress response and negatively correlated with behavioral response, which was inconsistent with hypothesis 2. Previous researchers have explored the effect of stress management training on endocrine stress response of healthy adolescents under acute psychological stress and the results showed that stress management training can be proved to be helpful to prevent behavioral responses caused by stress-related neuroendocrine activation, which is consistent with the results of this study.40

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**Figure 3. Moderating Effect of Risk Cognition on the Relationship between Stress Management and Behavioral Response.** *$P < .001$, †$P < .05$.

**Figure 4. Simple Slope analyses of Moderating Effects.**

| Effect | $\text{SE}$ | 95% CI         |
|--------|-------------|----------------|
| High risk cognition  (mean + SD) | -0.134 | 0.028 | $[-0.189, -0.079]$ |
| Average risk cognition  (mean − SD) | -0.093 | 0.020 | $[-0.133, -0.053]$ |
| Low risk cognition  (mean − SD) | -0.053 | 0.027 | $[-0.106, 0.001]$ |

SD, standard deviation.

**Moderating Effect of Risk Cognition on Mediating Effect**

Another key finding is that risk cognition played a moderating role in the relationship between stress management and behavioral response, and is negatively correlated with behavioral response. The moderating effect of high-risk cognition on the participants was highly significant. Thus, hypothesis 3 is supported. This result is consistent with the existing research results. Previous studies have found that risk cognition is significantly positively correlated with information-seeking of stress management dimension.31,32 On the contrary,
underestimation of risk is related to exposure enhancement activities, and the positive coping styles of individuals are correspondingly less.29 The possible reason for this phenomenon is that compared with low-risk cognition, high-risk cognition means that individuals give high-risk weight to the same stress events; in this situation, individuals are more likely to treat it as a more serious stress event, so they will show more stress management strategies in mind and behavior. In the face of more and more serious epidemic situations and almost uncontrollable risk of infection, individuals’ higher behavioral response means that they take higher protective measures to avoid the harm brought by risks, the risk of subjective feelings may also decrease.43

In view of this, in the face of stress events, especially the sudden and infectious pandemic like the COVID-19, improving the stress management of college and university students helps to buffer the effect of stress response on behavioral response, directly buffering their behavioral response. Moreover, improving the risk cognition of colleges and university students helps to increase better the negative predict effect of stress management on behavioral response, thus indirectly buffering their behavioral response, considering that this study is during the early phase of the pandemic. As the COVID-19 pandemic progresses, changes in stress, risk cognition, and behavioral response may emerge.44 Thus, future researchers could use longitudinal studies to track such changes.

**Ethics Committee Approval:** Ethical committee approval was received from the Ethics Committee of Authority of School of Educational Science, Huazhong University of Science and Technology (Approval Date: January 30, 2020; No. 20200130).

**Informed Consent:** Written informed consent was obtained from all participants who participated in this study.

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References

1. Zhan H, Zheng C, Zhang X, et al. Chinese college students’ stress and anxiety levels under COVID-19. Front Psychiatry. 2021;12:615390. [CrossRef]

2. Beasley M, Thompson T, Davidson J. Resilience in response to life stress: the effects of coping style and cognitive hardness. Pers Indiv Differ. 2003;34(1):77-95. [CrossRef]

3. Cao W, Fang Z, Hou G, et al. The psychological impact of the COVID-19 epidemic on college students in China. Psychiatr Res. 2020;287.

4. Markenson D, Dimaggio C, Redlener I. Preparing health professions students for terrorism, disaster, and public health emergencies: core competencies. Acad Med. 2005;80(6):517-526. [CrossRef]

5. Villada C, Hidalgo V, Almela M, et al. Individual differences in the psychological response to psychosocial stress (Trier Social Stress Test): the relevance of trait anxiety and coping styles. Stress Health. 2016;32(2):90-99. [CrossRef]

6. Jarczok MN, Jarczok M, Mauss D, et al. Autonomic nervous system activity and workplace stressors—a systematic review. Neurosci Biobehav Rev. 2013;37(8):1810-1823. [CrossRef]

7. Diaz-Hung ML, Martínez G, Hectz C. Emerging roles of the unfolded protein response (UPR) in the nervous system: a link with adaptive behavior to environmental stress? Int Rev Cell Mol Biol. 2020;350:29-61. [CrossRef]

8. Edelman EJ, Aoun-Barakat L, Villanueva M, et al. Confronting another pandemic: lessons from HIV can inform our COVID-19 response. AIDS Behav. 2020;24(7):1977-1979. [CrossRef]

9. Jos B, Bart V, Julian T. Generalized unsafety theory of stress: unsafe environments and conditions, and the default stress response. Int J Env Res Pub He. 2018;15(3):464. [CrossRef]

10. Shabu SA, Amin K, Mahmood KI, et al. Risk perception and behavioral response to COVID-19: A survey of university students and staff in the Iraqi Kurdistan region. Soc Work Public Hlth. 2021;36(1):1-12. [CrossRef]

11. Antoni MH, Ohabfar HS. The impact of psychosocial stress and stress management on immune responses in patients with cancer. Cancer-Am Cancer Soc. Cancer. 2019;125(9):1417-1431. [CrossRef]

12. Pacák K, Palkovits M. Stressor specificity of central neuroendocrine responses: implications for stress-related disorders. Endocr Rev. 2001;22(4):502-548. [CrossRef]

13. Kuhlman KR, Chiang JJ, Bower JE, et al. Persistent low positive affect and sleep disturbance across adolescence moderate link between stress and depressive symptoms in early adulthood. J Abnorm Child Psychol. 2020;48(1):109-121. [CrossRef]

14. Wong LT, Ngan HFB, Lo PC. Does organizational climate moderate the relationship between job stress and intent to stay?: evidence from Macau SAR, China. J Chin Hum Resour Ma. 2018;9(1):1-20. [CrossRef]

15. Boulton K, Couto E, Grimmer AJ, et al. How integrated are behavioral and endocrine stress response traits? A repeated measures approach to testing the stress-coping style model. Ecol Evol. 2015;5(3):618-633. [CrossRef]

16. Hogh A, Hansen AM, Mikkelsen EG, et al. Exposure to negative acts—an individual randomized stepped care stress intervention. J Clin Nurs. 2017;26(21-22):3408-3419. [CrossRef]

17. de Boer SF, Buwalda B, Koolhaas JM. Untangling the neurobiology of coping styles in rodents: towards neural mechanisms underlying individual differences in disease susceptibility. Neurosci Biobehav Rev. 2017;74(B):401-422. [CrossRef]

18. Favre ML, Matheny J, Kolt GS. Eustress, distress, and interpretation in occupational stress. J Manag Psychol. 2003;18(7):726-744. [CrossRef]

19. Chin WC, Chao KY, Chang HL, et al. Coping strategies of Taiwanese children with autism spectrum disorders. J Clin Nurs. 2017;26(21-22):3408-3421. [CrossRef]

20. Arving C, Assmus J, Thomodsen I, et al. Early rehabilitation of cancer patients—an individual randomized stepped-care stress-management intervention. Psycho-Oncology. 2019;28(2):301-308. [CrossRef]

21. Guillod L, Habersaat S, Suter M, et al. Psychological processes of stress management and neuroendocrine regulation in incarcerated adolescent offenders: a pilot study. Encephale. 2018;44(2):111-117. [CrossRef]

22. Rodríguez C, Ruggiero CJ, Callahan JL, , et al. Does risk for bipolar disorder heighten the disconnect between objective and subjective appraisals of cognition? J Affect Disord. 2013;148(2-3):400-405. [CrossRef]

23. Xie J, Xie X, Gan Y. Psychological typhoon eye effect in the Wenchuan Earthquake. Acta Entiatum Nat Uni Pekinensis. 2011;47(5):944-952. [CrossRef]

24. Poletti P, Ajelli M, Merler S. Risk perception and effectiveness of uncoordinated behavioral responses in an emerging epidemic. Math Biosci. 2012;238(2):80-89. [CrossRef]
25. Ao Y, Huang K, Wang Y, et al. Influence of built environment and risk perception on seismic evacuation behavior: evidence from rural areas affected by Wenchuan earthquake. Int J Disast. Risk Re. 2020;46. [CrossRef]
26. He R, Jin JJ, Kuang FY, et al. Farmers’ risk cognition, risk preferences and climate change adaptive behavior: a structural equation modeling approach. Int J Env Res Pub He. 2019;17(1):85. [CrossRef]
27. Holper L, ten Brincke RHW, Wolf M, et al. fNIRS derived hemodynamic signals and electrodermal responses in a sequential risk-taking task. Brain Res. 2014;1557:141-154. [CrossRef]
28. Chu HR, Yang JZ. Risk or efficacy? How psychological distance influences climate change engagement. Risk Anal. 2020;40(4):758-770. [CrossRef]
29. Wolde B, Lal P, Harclerode M, et al. Comparative optimism: relative risk perception and behavioral response to lead exposure. Environ Manage. 2019;63(5):691-701. [CrossRef]
30. Chang CH, Bernard TE, Logan J. Effects of heat stress on risk perceptions and risk taking. Appl Ergon. 2017;62:150–157. [CrossRef]
31. Feng TJ, Keller LR, Wu P, et al. An empirical study of the toxic capsule crisis in China: risk perceptions and behavioral responses. Risk Anal. 2014;34(4):698-710. [CrossRef]
32. Schneider SS, Bengel J. Psychological stress and risk perception of rescue personnel of the Technisches Hilfswerk. Notfall Rettungsmed. 2014;17(8):690-696. [CrossRef]
33. Nunfam VF, Oosthuizen J, Adusei-Asante K, et al. Perceptions of climate change and occupational heat stress risks and adaptation strategies of mining workers in Ghana. Sci Total Environ. 2019;657:365-378. [CrossRef]
34. De Sio S, Cedrini F, Battagliola ET, et al. The Perception of psychosocial risks and work-related stress in relation to job insecurity and gender differences: a cross-sectional study. BioMed Res Int. 2018;2018:1-6.
35. Armăș I, Cretu RZ, Ionescu R. Self-efficacy, stress, and locus of control: the psychology of earthquake risk perception in Bucharest, Romania. Int J Disast. Risk Re. 2017;22:71-76. [CrossRef]
36. Wang G, Zhang Y, Xie S, et al. Psychological Typhoon Eye effect during the COVID-19 outbreak. Front Public Health. 2020;8:550051. [CrossRef]
37. Zhang Y, Cao X, Aashiq, et al. Psychological stress of university students in the hardest-hit areas at different stages of the COVID-19 epidemic. Child Youth Serv Rev. 2021;125(3):105980. [CrossRef]
38. Peng S, Yang XY, Yang T, et al. Uncertainty stress, and its impact on disease fear and prevention behavior during the COVID-19 epidemic in China: a panel study. Am J Health Behav. 2021;45(2):334-341. [CrossRef]
39. Orgilés M, Morales A, Delvecchio E, et al. Coping behaviors and psychological disturbances in youth affected by the COVID-19 health crisis. Front Psychol. 2021;12:565657. [CrossRef]
40. Gaab J, Blättler N, Menzi T, et al. Randomized controlled evaluation of the effects of cognitive–behavioral stress management on cortisol responses to acute stress in healthy subjects. Psychoneuroendocrinology. 2003;28(6):767-779. [CrossRef]
41. Willert MV, Thulstrup AM, Hertz J. Changes in stress and coping from a randomized controlled trial of a three-month stress management intervention. Scand J Work Environ Health. 2009;35(2):145-152. [CrossRef]
42. Crum AJ, Salovey P, Achor S. Rethinking stress: the role of mindsets in determining the stress response. J Pers Soc Psychol. 2013;104(4):716-733. [CrossRef]
43. Li X, Lv S, Liu L, et al. COVID-19 in Guangdong: immediate perceptions and psychological impact on 304,167 college students. Front Psychol. 2020;11:2024. [CrossRef]
44. Frissen T, Coninck DD, Matthijs K, et al. Longitudinal evidence of how media audiences differ in public health perceptions and behaviors during a global pandemic. Front Pub Health. Front Public Health. 2020;8:583408. [CrossRef]
Appendix

1 Stress Response Questionnaire (1 little time → 4 much time)

1) I feel more nervous and anxious in recent week than usual.
2) I have been afraid for no reason for nearly a week.
3) I am easily upset or frightened in the past week.
4) I feel depressed and depressed in the past week.
5) I feel uneasy and cannot calm down for the past week.
6) I feel tired for no reason for nearly a week.
7) I am very troubled by this epidemic infection.
8) I feel sensitive and suspicious.

2 Stress Management Questionnaire (1 very inconsistent → 5 very consistent)

1) I actively look for ways to relieve pressure.
2) I am happy to tell my troubles to the people close to me.

3 Risk Cognition Questionnaire (1 very inconsistent → 5 very consistent)

1) I think the COVID-19 is very serious now.
2) I think it is necessary to separate villages (between communities).
3) Facing the current epidemic situation, I think I am very dangerous.
4) I think I am very likely to have COVID-19 pneumonia.
5) I think that as long as we take protective measures (wearing masks, washing hands frequently, and disinfecting regularly), we will not be infected.
6) I think the COVID-19 can be cured.

4 Behavioral Response Questionnaire (1 very inconsistent → 5 very consistent)

1) I think strangers have COVID-19 pneumonia.
2) Do not dare to go to crowded places, even if passing by strangers, I will take the initiative to avoid.
3) I dare not talk to strangers.
4) I forced hand washing or cleaning many times, thinking that there were bacteria everywhere, afraid of being infected.
5) I am eager to go to the hospital and ask the doctor to make a thorough examination with reagents.