Coronavirus stress and overeating: the role of anxiety and COVID-19 burnout

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Abstract
Background: This study examined the role of anxiety and coronavirus disease 2019 (COVID-19) burnout in the relationship between coronavirus stress and overeating among Chinese college students during the COVID-19 pandemic.

Methods: Chinese college students (N = 2926; Mage = 19.90, SD = 1.47, range = 18–25 years old; 54.34% female) completed self-reported online questionnaires regarding coronavirus stress, anxiety, COVID-19 burnout, and overeating.

Results: Anxiety showed partially indirect effect on the association between coronavirus stress and overeating. COVID-19 burnout exacerbated the indirect pathway between coronavirus stress and overeating via anxiety.

Discussion and conclusion: This is the first study, to our knowledge, that examines the underlying mechanisms of the coronavirus stress and overeating behavior association among Chinese college students. The results support several existing theories on stress and problematic eating behaviors and provide practical implications for prevention and intervention programs of overeating during the COVID-19 pandemic.

Keywords: Coronavirus stress, Anxiety, Overeating, COVID-burnout, College students, COVID-19

Plain English summary
One’s response is not arbitrary when confronted with the coronavirus disease 2019 (COVID-19). Previous research has found that individuals with coronavirus stress still be more prone to overeat. We also know from other research that anxiety is the most salient aspect of overeating. However, no research has investigated whether the coronavirus stress of college students is significantly associated with overeating and examine the potential indirect pathway and moderating mechanisms in this association. With the aid of 2926 participants, we found that, coronavirus stress was linked to college students’ overeating. We also found that this relationship was partially explained by anxiety. In addition, the association between anxiety and overeating was stronger for those with higher COVID-19 burnout. This study is an important step in unpacking how coronavirus stress relates to overeating of Chinese college students. However, they are limited by the cross-sectional nature of the study, meaning we cannot imply causality. We recommend that further research replicate our findings in people with diagnosed feeding and eating disorders using a longitudinal design.

Introduction
Since the outbreak of the coronavirus disease 2019 (COVID-19), research studies have documented the adverse behavioral, psychological, and physical outcomes associated with the pandemic [1–3]. One particularly concerning change in health behavior is overeating [4, 5], which is defined as the consumption of energy intake that...
is excessively high in comparison to one's energy expend-
iture [6]. While temporary overeating is typical during
occasions such as feasts and celebrations [7], it becomes a
health risk when sustained for an extended period. Over-
eating is associated with weight gain, obesity, as well as
feeding and eating disorders [8]. Additionally, it is related
to a series of maladaptive psychological outcomes,
including internalizing and externalizing problems (e.g.,
depression, anxiety, self-harm, and substance use dis-
orders) [9]. Thus, the development and maintenance of
overeating poses a health concern, ultimately jeopardiz-
ing one's entire health and well-being.

Stress associated with the COVID-19 pandemic may
play a substantial role in overeating. Representing a form
of chronic stress, coronavirus stress could stimulate the
hypothalamic–pituitary–adrenal (HPA) axis to an exces-
sively high degree, resulting in an abnormally high gluco-
corticoid level in the body [10]. Meanwhile, endogenous
opioid release can be induced by chronic stress because it
adaptively dampens the stress response [10]; how-
ever, this process is also related to addiction and exces-
sive food consumption [11]. A substantial amount of
research has established the link between various types
of stressors and overeating behavior, as well as examined
the related biological mechanisms underlying the asso-
ciations [12]. During the COVID-19 pandemic, a small
number of studies have reported a direct positive associ-
ation between coronavirus stress and problematic eat-
ing patterns [13, 14].

While the direct link between coronavirus stress and
problematic eating patterns has been established, the
exact psychological mechanism by which the link occurs
remains unclear. Anxiety could be one of these mecha-
nisms. Anxiety, representing a longer-term psychological
process [15], is defined as an emotional reaction to stress
that involves fear, apprehension, a sense of danger, and
persistent thoughts and worries [15]. When individuals
are unable to manage stressful events, their risk of devel-
op ing anxiety is aggravated [16]. Increased mental health
issues, including anxiety symptoms associated with the
COVID-19 pandemic, have been recorded [17], and stress,
in particular, has been particularly constructed as a
predictor of anxiety [18]. Anxiety, in turn, is associated
with adverse health outcomes [19] and overeating, in par-
ticular [20, 21]. In terms of problematic eating, the evi-
dence consistently demonstrates a link between anxiety
and overeating [22, 23], probably because of the lack of
control, negative arousal, and body-image related factors.
Furthermore, though a range of negative affective states
(e.g., depression and anger) are theoretically associated
with overeating, the link between overeating and anxiety
was remarkably more salient than that and other negative
affective states [24]. Therefore, with the probable links
between coronavirus stress and anxiety, and between
anxiety and overeating, anxiety could be one psychologi-
cal mechanism underlying the direct association between
coronavirus stress and overeating.

Burnout, a distinct psychological construct from anxi-
ety [26], during the COVID-19 pandemic might further
evacrate the link between anxiety and overeating. Burnout
refers to a psychological condition generated
by an extended response to interpersonal pressures [25]
and is manifested by emotional exhaustion, feelings of
cynicism, and diminished personal success [26]. The risk
enhancing model indicates that while the role of a single
risk is relatively limited in predicting health outcomes,
when the risk accumulates, one risk factor may exacer-
bate the role of another, resulting in severe mental health
consequences [27, 28]. The association between general
burnout and overeating has been reported [29]. Dur-
ing the COVID-19 pandemic, studies have documented
increased overeating [30]. Thus, COVID-19 related burn-
out might be a relevant construct in the coronavirus
stress and overeating association, and might function to
enhance the indirect effect of anxiety in the link between
coronavirus stress and overeating.

College students, in general, represent a vulnerable
population to the COVID-19 pandemic [18, 31], and they
suffer from unhealthy eating habits [32, 33]. However,
because problematic eating is studied primarily among
college students in the Western culture and cultural con-
text is critical when examining psychological issues [34],
it is critical to further the understanding of eating behav-
ior in other cultural contexts, such as in the Chinese col-
lege student population. Therefore, the purposes of this
study were to examine: (1) the direct association between
coronavirus stress and overeating among Chinese college
students; (2) the indirect effect of anxiety underlying this
link; and (3) the moderating role of COVID-19 burnout
in the indirect pathway. Coronavirus stress and overeat-
ing were expected to be positively correlated (hypothesis
1) and partially linked via anxiety (hypothesis 2). Further-
more, the positive link between anxiety and overeating
was predicted to be strengthened by COVID-19 burnout.
The indirect effect of anxiety would therefore be more
pronounced with higher COVID-19 burnout (hypothesis
3). Figure 1 depicts the proposed study model.

**Method**

**Participants**

This study surveyed 2,926 Chinese college students
($M_{\text{age}} = 19.90, SD = 1.47, \text{range} = 18–25$ years old; 54.34%
female). The majority of the participants (37.80%) were
first-year students, followed by 28.02% second-year,
17.40% third-year, and 16.78% fourth-year students.
None of the participants lived on campus because of the COVID-19 policy.

**Procedure**
Participants were recruited from more than 30 universities in 26 regions, such as Jiangxi, Jilin, and Shandong provinces of China. Universities participating in the study included those classified as Double First Class and those classified as ordinary. Data was collected from February 9 to February 13, 2020. The sampling error was calculated using the website (https://www.sphanalytics.com/sample-error-calculator/). This sample error of this research was 1.5%, which is considered within the acceptable limit [35].

Convenience sampling strategies were used. To collect data, we first created an online survey using Survey Star (i.e., an online survey distribution website; Changsha Ranxing Science and Technology, Shanghai, China), and then generated a QR code for easy distribution. Subsequently, the QR code was sent to WeChat and QQ groups (i.e., online social media platforms) to which enrolled university students had exclusive access. Students were then able to read the study information sheet and indicate informed consent prior to answering the questionnaires at their preferred location and time.

This study was approved by the Research Ethics Committee of the first author’s institution. No identifiable information was recorded. Students were instructed that participation in this study was fully voluntary and that they could exit the survey at any time. Participants received no compensation for their participation.

**Measures**

**Coronavirus stress**
Coronavirus stress was assessed by the Coronavirus Stress Measure (CSM) [36]. The scale has 5 items (e.g., “how often have you felt that you were unable to control the important things in your life due to the COVID-19 pandemic?”). Participants rated each item on a five-point scale ranging from 0 (never) to 4 (always), with higher scores showing higher levels of coronavirus stress. In this study, the internal consistency coefficient was 0.93. Confirmatory factor analysis (CFA) in this study suggested that the one-factor model fit the data well: RMSEA = 0.05, CFI = 0.99, TLI = 0.99, SRMR = 0.01, indicating good scale validity [37, 38].

**Anxiety**
The Chinese-version of the anxiety subscale of the Depression Anxiety Stress Scale (DASS-21) [39], adapted from Lovibond and Lovibond [40], was used. This scale consists of 7 items (e.g., “I felt I was close to panic.“). Participants rated each item on a four-point scale ranging from 0 (very inconsistent) to 3 (very consistent), with higher scores showing higher levels of anxiety. The scale has good reliability, validity, and applicability to the Chinese population [41, 42]. In this study, the internal consistency coefficient was 0.89. Confirmatory factor analysis (CFA) in this study suggested that the one-factor model fit the data well: RMSEA = 0.06, CFI = 0.99, TLI = 0.98, SRMR = 0.01.

**COVID-19 burnout**
The COVID-19 burnout was assessed by the COVID-19 burnout scale [42]. This scale has 10 items (e.g., “When you think about COVID-19 overall, how often do you feel disappointed with people?”). Participants rated each item on a five-point scale ranging from 1 (never) to 5 (always), with higher scores showing higher levels of COVID-19 burnout. In this study, the internal consistency coefficient was 0.93. Confirmatory factor analysis (CFA) in this study suggested that the one-factor model fit the data well: RMSEA = 0.07, CFI = 0.99, TLI = 0.97, SRMR = 0.01, which indicated that the validity of this scale was good [37, 38].

**Overeating**
The Chinese version of overeating [43] was measured by the loss of control eating subscale of the Three-Factor Eating Scale [44]. This scale comprises 9 items (e.g., “when I smell a delicious food, I find it very difficult to keep from eating, even if I have just finished a meal.”), and all questions were asked specifically to the period after the COVID-19 pandemic outbreak. Participants rated each item on a four-point scale ranging from 1 (very inconsistent) to 4 (very consistent), with higher scores showing higher levels of overeating. The scale has good reliability, validity, and applicability to the Chinese population [45, 46]. In this study, the internal consistency coefficient was 0.94. Confirmatory factor analysis (CFA) in this study suggested that the one-factor model fit the data well: RMSEA = 0.04, CFI = 0.99, TLI = 0.99, SRMR = 0.01, which indicated that the validity of this scale was good [37, 38].
Data analyses strategy
First, the descriptive statistics and bivariate Pearson correlations were calculated among the study variables using SPSS (version 23). Second, the hypothesized indirect effect of anxiety was examined using Model 4 of the PROCESS macro \[47\] in SPSS. Third, the hypothesized moderating effect of COVID-19 burnout on the indirect link between coronavirus stress and overeating via anxiety was tested using Model 14 of the PROCESS macro in SPSS. All study continuous variables were standardized prior to analyses. The indirect pathway and moderation models were estimated with 5000 bootstrap resamples to produce bias-corrected confidence intervals \[47\]. Because only completed surveys were recorded, there is no missing data in the current dataset.

Results
Preliminary analyses
The means and Pearson-correlations among the study variables are presented in Table 1. Coronavirus stress was related to greater anxiety \((r=0.54)\), overeating \((r=0.34)\), and COVID-19 burnout \((r=0.48); \text{all } ps<0.001\), supporting hypothesis 1. Anxiety was associated with greater COVID-19 burnout \((r=0.64, p<0.001)\) and overeating \((r=0.48, p<0.001)\) and. Lastly, COVID-19 burnout was related to higher overeating \((r=0.44, p<0.001)\).

Anxiety as an indirect pathway
Coronavirus stress was related to higher anxiety \((\beta=0.54, p<0.001)\) and anxiety was further related to greater overeating \((\beta=0.42, p<0.001)\). The residual direct effect of coronavirus stress on overeating remained positive \((\beta=0.11, p<0.001)\), but the strength of this association was reduced compared to the total effect \((\beta=0.34, p<0.001)\). These results showed that anxiety showed partially indirect effect on the association between coronavirus stress and overeating (indirect effect=0.23, \(SE=0.015, 95\% \text{ CI} [0.20, 0.26]\), and the indirect effect accounted for 66.84% of the total effect of coronavirus stress on overeating. Therefore, hypothesis 2 was supported (Table 2).

Table 1 Descriptive statistics and correlations among study variables \((N=2926)\)

| Variable                  | \(M\) | \(SD\) | 1    | 2    | 3    |
|---------------------------|-------|--------|------|------|------|
| 1. Coronavirus stress     | 2.27  | 0.81   | –    |      |      |
| 2. Anxiety                | 0.77  | 0.54   | 0.54*** | –   |      |
| 3. COVID-19 burnout       | 2.44  | 0.66   | 0.46*** | 0.64*** | –   |
| 4. Overeating             | 2.32  | 0.54   | 0.34*** | 0.48*** | 0.44*** |

**p < 0.001

Table 2 The indirect effect of anxiety on the association between coronavirus stress (CS) and overeating

| Predictor | Anxiety | Overeating | \(t\)  | \(t\)  |
|-----------|---------|------------|-------|-------|
| CS        | 0.54    | 3.474***   | 0.11  | 5.83*** |
| Anxiety   | 0.42    | 2.175***   | 0.24  |       |
| \(R^2\)   | 0.29    |            |       |       |
| \(F\)     | 1206.84*** | 455.05*** |       |       |

\(N=2926. \text{ Each column is a regression model that forecasts the criterion at the top of the column}\)

The moderation effect of COVID-19 burnout in the indirect association between coronavirus stress and overeating via anxiety
The direct effect of coronavirus stress on overeating was significant \((\beta=0.06, p<0.001)\). With anxiety and the interaction term (anxiety \(\times\) COVID-19 burnout) included in the model, the direct effect of coronavirus stress on overeating remained significant with a smaller effect size. Furthermore, anxiety was, again, significant related to coronavirus stress \((\beta=0.54, p<0.001)\) and overeating \((\beta=0.27, p<0.001)\). The interaction term of anxiety and COVID-19 burnout showed a significant positive association with overeating \((\beta=0.06, p<0.001)\), suggesting the indirect effect of anxiety on overeating was moderated by COVID-19 burnout (Table 3).

We subsequently plotted predicted overeating against anxiety, separately for low and high levels of COVID-19 burnout (one SD below the mean and one SD above the mean, respectively; Fig. 2). The simple slope test demonstrated that for college students with low levels of COVID-19 burnout, anxiety was positively associated with overeating, \(\beta=0.21, p<0.001\). In contrast, for college students with high COVID-19 burnout, anxiety yielded a stronger positive association with overeating.

Table 3 Testing the moderation effect of COVID-19 burnout in the indirect association

| Predictor | Anxiety | Overeating | \(t\)  | \(t\)  |
|-----------|---------|------------|-------|-------|
| CS        | 0.54    | 3.474***   | 0.06  | 3.37*** |
| Anxiety   | 0.27    | 11.65***   | 0.27  |      |
| Anxiety \(\times\) CB | 0.06 | 5.21*** |       |       |
| \(R^2\)   | 0.29    |            |       |       |
| \(F\)     | 1206.84*** | 270.43*** |       |       |

\(N=2926. \text{ Each column is a regression model that forecasts the criterion at the top of the column}\)

\(p < 0.01, **p < 0.001\)
The bias-corrected percentile bootstrap analysis further indicated that the indirect effect of coronavirus stress on overeating through anxiety was moderated by COVID-19 burnout. Particularly, for college students low in COVID-19 burnout, the indirect effect of coronavirus stress on overeating via anxiety was significant, $\beta = 0.21$, $SE = 0.03$, 95% CI$_{boot} [0.16, 0.27]$. Comparatively, for college students with high COVID-19 burnout, the indirect effect was stronger, $\beta = 0.33$, $SE = 0.02$, 95% CI$_{boot} [0.28, 0.37]$. Thus, supporting hypothesis 3, results indicated that the indirect effect of anxiety was exacerbated by COVID-19 burnout.

**Discussion**

The current study suggests that the experience of coronavirus stress is associated with increased overeating among Chinese college students. Anxiety is one of the mechanisms underlying this relationship, while COVID-19 burnout moderates the indirect effect of anxiety. COVID-19 burnout, in particular, strengthens the link between anxiety and overeating. While several empirical studies have reported the association between coronavirus stress and overeating [48, 49], the current study is the first, to our knowledge, to examine the underlying psychological mechanisms of this link among Chinese college students.

**Anxiety as an indirect pathway**

Anxiety represents a partial indirect pathway linking coronavirus stress and overeating. The positive correlation between coronavirus stress and anxiety is consistent with empirical evidence that both perceived stress and anxiety have increased significantly during the pandemic [50, 51], as well as the biological mechanisms underlying this association [52]. It further lends credence to the proposition that stress related to the COVID-19 pandemic might be a strong predictor of diagnosable psychiatric disorders, including anxiety [53]. Due to the lack of social connections and physical activities during the COVID-19 pandemic, individuals who experience stress may have trouble managing their emotions, resulting in increased internationalizing symptoms such as anxiety [54].

Importantly, anxiety from coronavirus stress was connected with overeating in the current study. This is consistent with the escape model [55], which postulates that overeating is a coping mechanism for individuals seeking to escape from negative self-perceptions by narrowing attention to the unpleasant situation and thus disinhibiting food intake. While overeating may provide momentary relief or pleasure [56–58], it can also result in a number of negative mental and physical health consequences, including weight gain, obesity, and eating disorders. Our finding thus suggests that proper stress coping strategies and anxiety management skills might benefit Chinese students who develop overeating issues during the pandemic.

It is also worth noting that the direct positive link between coronavirus stress and overeating persisted, even after anxiety was considered in the model. This remaining link implies that, in addition to the psychological disorder symptoms associated with coronavirus stress, coronavirus stress itself might be a distinct and significant risk factor for overeating. This outcome is likely given the endocrine and other pertinent biological mechanisms underpinning the relationship between chronic stress and binge eating disorder, a condition characterized by excessive eating [59]. Moreover, there might be other factors within this association. For instance, weight concerns, emotional eating tendencies, and appearance overevaluation are all related to overeating and stress [60, 61] and thus could be relevant mechanisms for the current study topic.

**COVID-19 burnout as a moderator**

COVID-19 burnout exacerbated the link between anxiety and overeating, hence intensifying the indirect pathway of anxiety in the coronavirus stress and overeating association. Increased levels of burnout, characterized by greater emotional tiredness and depersonalization, as well as lower personal accomplishment, have been documented during this COVID-19 pandemic [62]. Adding to prior research revealing that burnout and overeating can coexist [63, 64], our finding further alters that the experience of COVID-19 burnout might be associated
with poorer dieting habits when Chinese college students experience high anxiety.

**Strengths**

This study extends prior research on coronavirus stress and overeating by examining the underlying psychological mechanisms during the COVID-19 pandemic in the Chinese college student population. The findings concur with a number of theories and empirical studies on stress, anxiety, and poor eating patterns, particularly in light of the COVID-19 pandemic. More importantly, our findings have practical implications. Overeating prevention and treatment programs may find it effective to focus on decreasing coronavirus stress, anxiety, and COVID-19 burnout. For example, mindfulness-based stress reduction courses could be evaluated because they have been shown to reduce stress and burnout through improved attention management and tolerance for negative emotions [65, 66]. Exercise intervention may be beneficial in lowering college students’ anxiety levels [67, 68], hence reducing overeating. Additionally, while screening Chinese college students’ susceptibility to stress, anxiety, and burnout during the pandemic, health professionals may find it advantageous to analyze their dietary habits concurrently to initiate appropriate early intervention for problematic eating behaviors.

**Limitations and future directions**

The following limitations should be considered when interpreting the findings of this study. First, this study utilized a cross-sectional design, which prevents causal inferences. While the current moderated indirect pathway model is suggestive [69], longitudinal investigations are necessary to compare the current findings [69]. Furthermore, individuals self-reported their emotions, which may not accurately reflect their psychological states [70]. Other research methodologies, such as interviews, direct observation, or big data analysis, may serve to further elucidate the relationships between stress, anxiety, and overeating. Additionally, personality traits, such as neuroticism, which underpin an individual’s susceptibility to unpleasant feelings, may be relevant to the current study topic [71, 72], and should be examined in future research. Lastly, potential confounders, such as eating disorder status [73], food insecurity [74], and living status [75], should be examined in the current study topic.

**Conclusion**

This study is critical in elucidating the relationship between coronavirus stress and overeating among Chinese college students. Because anxiety represents an indirect pathway in this direct association and COVID-19 burnout exacerbates the link between anxiety and overeating, our study emphasizes the critical nature of addressing anxiety and COVID-19 burnout in overeating prevention and intervention programs. Further, coronavirus stress itself represents a direct risk factor for overeating, and, thus, should be considered in these programs. As the COVID-19 pandemic continues, it is critical to monitor college students’ psychological well-being because its link to recurrent overeating may pose long-term health problems.

**Abbreviations**

CS: Coronavirus stress; CB: COVID-19 burnout.

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**Author contributions**

BY and RW conceptualized the study. RW completed the statistical analyses. PW and CT restructured this manuscript and proofread the paper. RW, BY, PW, CT and QY contributed to the drafting and revising of the manuscript. All authors read and approved the final manuscript.

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**Availability of data and materials**

This study data is available to researchers.

**Declarations**

**Ethical approval and consent to participate**

This study was approved by the Research Ethics Committee of the first author’s institution. We obtained consent from all participating college students before data collection. Participants were given the survey questionnaire where they provided demographic information and completed the measurements listed above. The ethics review approval code is IRB-JXNJU-PSY-2020002.

**Consent for publication**

Not applicable.

**Competing interests**

The authors declare that they have no competing interests.

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