Stress and Eating Behaviors Pre- and Post COVID-19 Pandemic Declaration in Two Independent Samples of College-Aged Adults

Original Research,

Zachary Zeigler[1], Anthony Acevedo[1], Annika Myers[1], Ruthie Larson[1], Jeb Johnston[2]

[1]*Exercise Science and Sports Nutrition, Grand Canyon University, USA*
[2]*Jeb Johnston, Food on the Mind, USA*

Open Access

Published: January 1, 2026

Journal of Exercise and Nutrition: *2026, Volume 9 (Issue 1): 1*

ISSN: 2640-2572

Abstract

Introduction: This study compared stress and eating behaviors of two independent samples of college students before and after declaration of the COVID-19 pandemic to understand pandemic-related changes in these health-related behaviors.

Methods: This was a non-experimental comparative study using a between-subjects design. Two independent groups were invited to the laboratory for a single visit to measure eating behaviors and stress indicators. Four validated instruments were used in this study: The Weight and Lifestyle Inventory questionnaire, Mindfulness Eating Questionnaire, Three-Factor Eating Questionnaire (TFEQ), and the Perceived Stress Scale (PSS). Independent t-tests and two-way ANOVA were used to compare participants who were tested prior to the COVID-19 pandemic declaration and after.

Results: N=151 (n=81 male, n=70 female) participants completed testing in the pre-COVID group, and a separate group, N=79, completed testing in the post-COVID group (n=40 male and n=26 female). There was a significant difference in TFEQ-uncontrolled eating between groups by sex ($F(1,207)=4.73$, $p=.031$, $\eta 2=.022$). There were differences between the pre-COVID and post-COVID groups ($F(1,204)=5.64$, p 019, $\eta 2=.027$) and between sexes ($F(1,204)=16.84$, $p<0.001$, $\eta 2=.076$) on the TFEQ-emotional eating. The post-COVID group reported higher levels of eating when stressed, depressed/upset, anxious, and when alone compared to the pre-COVID group (all $p<.05$). There were sex differences in eating when stressed, depressed/upset, anxious, and when alone (all $p<.05$). PSS scores were significantly higher in the post-COVID group ($p=.003$). Females (20.4±5.4) reported higher stress than males (17.8±6.3) ($p=.003$).

Conclusions: College students assessed after the pandemic declaration showed higher stress levels and emotional eating scores. Female college students reported higher stress and emotional eating levels than males.

Key Words: Emotional eating, Psychological distress, Gender differences.

Corresponding author: Zachary Zeigler, E-mail: Zachary.zeigler@gcu.edu

Introduction

The World Health Organization (WHO) designated the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), responsible for the COVID-19 pandemic, as a global health emergency on January 30, 2020[1]. Numerous health organizations, including the US Centers for Disease Control and Prevention[2] and the WHO1, issued safety guidelines to minimize exposure to and transmission of the virus. Measures such as social distancing, self-quarantine, and widespread closures were implemented to flatten the epidemic curve. The objective was to alleviate the strain on the healthcare system and reduce the impact on morbidity and mortality rates[3]. However, these safety measures provoked changes in eating behaviors worldwide[4].

Due to the absence of social services such as restaurants and school cafeterias, individuals were forced to eat all their meals at home. Additionally, real or perceived threats of food insecurity started to rise across the globe[5]. Consequently, these and other pandemic factors provoked weight gain in a large percentage of the population[6]. Some of the most often reported causes of COVID-19 pandemic weight gain were increased snacking frequency and emotional eating[7].

Furthermore, psychological factors like anxiety and stress can influence food choices[8]. Specifically, stress can contribute to hyperphagia, binge eating, and a shift in the types of food consumed[9,10]. Reports indicated increased anxiety, stress, and depression during the COVID-19 pandemic[11]. Undesirable changes in eating behaviors may also arise from boredom-induced eating. Boredom, stress, anxiety, and depression can contribute to emotional eating and weight gain[11,12]. Whether or not females experienced more significant changes in eating behaviors during the COVID-19 pandemic is inconclusive[7].

Some data suggest that younger, college-aged adults may have been more likely to eat more junk food[13] and increase overall appetite[14] more than the older population during the COVID-19 pandemic. Altered eating behaviors in college-aged adults are troublesome, as some data suggest that eating behaviors developed and maintained during college are likely to be maintained throughout adulthood[15,16]. Prior data have shown a relationship between stress and weight gain in college students during the pandemic[17,18]. Additionally, past literature has shown elevated stress and emotional eating levels after the pandemic[19,20]. However, to the author's knowledge, no studies have compared college students' stress levels and eating behaviors across independent samples before and after the pandemic. While longitudinal studies tracking the same individuals would be ideal, the unexpected nature of the pandemic made such prospective data collection difficult. Comparing independent samples from the same population and setting provides valuable insights into population-level shifts in eating behaviors and stress responses during this unprecedented disruption. This approach allows us to understand how the pandemic may have altered the baseline characteristics of college students, which may be valuable information for understanding its impact on campus health services. Thus, the purpose of this non-experimental comparative study is to compare stress and eating behaviors between two independent groups of college students, one assessed before the declaration of the COVID-19 pandemic and a separate group assessed following the declaration of the COVID-19 pandemic. A secondary outcome is determining whether sex differences exist in emotional eating among college students.

Methods

The study's methodology was quantitative, and the research design was a non-experimental comparative study using a between-subjects design. The primary analysis was made using a two-way between-subjects design ANOVA, with the main comparisons being eating behaviors between independent groups before and after the pandemic declaration, between sexes, and possible time*sex interactions. The study was conducted at a large private university in the southwestern United States. Pre-COVID data collection ended January 30, 2020 (WHO pandemic declaration date), and post-COVID data collection occurred from August 2020 to May 2021, after the region's peak infection period (June-July 2020) and following establishment of university safety protocols.

All procedures were approved by the Institutional Review Board at the host university and were conducted following the Declaration of Helsinki for human studies of the World Medical Association[21]. Students were recruited through referrals from the university student health clinic and campus advertisements. The American College of Sports Medicine has recognized the host University as an "Exercise is Medicine" campus. The student health clinic asks about physical activity behaviors as part of this initiative. It refers interested students who want advice on an exercise program to participate in health assessments with university student fitness specialists. Data from these laboratory visits were then categorized based on whether testing occurred before or after the COVID-19 pandemic declaration on January 30, 2020[1]. Pre-COVID data were collected between January 2019 and January 30, 2020. Post-COVID data collection took place between August 2020 and May 2021, following the establishment and implementation of university protocols for safe in-person research. All post-COVID laboratory visits adhered to university-approved safety protocols, including the wearing of masks, maintaining physical distancing when possible, implementing enhanced sanitization procedures, and screening participants for COVID-19 symptoms before laboratory entry.

Participants

The data collected for the current study were obtained from testing initially designed to examine cardiovascular markers. Thus, the inclusion and exclusion criteria reflect variables that would impact vascular measurements. Therefore, healthy, nonsmoking young men and women aged 18-30 years were recruited from the campus using the aforementioned method. Biological sex was assessed via self-report on the demographic questionnaire, where

participants indicated either "male" or "female". While it is recognized that sex and gender are distinct constructs, with sex referring to biological characteristics and gender referring to socially constructed roles and identities, the current study collected only biological sex data as it was initially designed for cardiovascular measurements, where biological sex differences are relevant. Subjects were excluded if they had known cardiovascular, pulmonary, renal, or peripheral vascular disease or metabolic disease or had symptoms suggestive of these diseases. Pregnant women and current smokers were excluded from the study.

Protocol

All participants completed a single laboratory visit, during which all data collection occurred. During this visit, participants first provided informed consent. They then completed all questionnaires in the laboratory setting. Four instruments were used in this study: The Weight and Lifestyle Inventory questionnaire, the Mindfulness Eating Questionnaire, the Three Factor Eating Questionnaire, and the Perceived Stress Scale. The measure of college eating behaviors was The Weight and Lifestyle Inventory (WALI) questionnaire[22]. The WALI asks questions about subjects' weight history, family weight history, pregnancy history, tobacco (current smokers were excluded from the study), alcohol use, eating habits/patterns, and medical history. The survey asked participants to report the level to which they believed certain psychological states and behaviors contributed to their weight gain. Participants were asked to report on an ordinal scale, with "1" being assigned to "does not contribute at all" up to "5," "contributes the greatest amount." These items were analyzed individually as designed in the original WALI instrument.

Mindfulness was measured using the Mindfulness Eating Questionnaire (MEQ)[23]. The MEQ evaluates five distinct domains of mindful eating: disinhibition (8 items), awareness (7 items), external cues (6 items), emotional response (4 items), and distraction (3 items). Higher scores indicate greater mindful eating behavior; however, no clinically established cut-off values have been determined for this instrument. Emotional eating was calculated using the emotional eating domain of the Three Factor Eating Questionnaire (TFEQ)[24]. The TFEQ consists of 18 items measuring three distinct domains of eating behavior: emotional eating (3 items), cognitive restraint (6 items), and uncontrolled eating (9 items). While no universal cut-off values have been established, scores exceeding 50 are frequently considered elevated in clinical and research settings. Lastly, stress was measured using the perceived stress scale (PSS)[25]. Normative data indicate mean scores of 12.1 for males and 13.7 for females, though these values may vary across different demographics. These categorizations facilitate the interpretation of stress levels in both clinical and research contexts.

Body mass to the nearest 0.01 kg and stature to the nearest 0.1 cm were measured as described in the Anthropometric Standardization Reference Manual[26]. Height was measured with the subject standing barefoot using a stadiometer (Tree LS-PS 500). The digital scale attached to the stadiometer measured body weight with minimal clothing. Waist and hip circumferences were determined while the subject stood with a Gulick II 150 cm anthropometric tape (model 67020) and reported to the nearest 0.1 cm. Waist circumference was measured with the anthropometric tape parallel to the floor and immediately above the iliac crest, with readings taken at the end of a normal exhalation[27]. Hip circumference was assessed at the level of the most substantial protrusion of the buttocks[26].

Body Composition was determined via whole-body air displacement plethysmography (BOD POD, COSMED). BOD POD is valid when compared to underwater weighing[28]. Participants were asked to wear a bathing suit or tight-fitting shorts and remove their shirts and jewelry to test. They were weighed again using the scale associated with the BOD POD device. They were then asked to place a silicone swim cap (Aegend) on their heads to cover their hair and sit in the BOD POD for two measurements of 50 seconds each. A third measurement was taken if the first two measurements differed by more than 150 mL.

Statistical Analysis

Statistical analyses were performed using SPSS version 28 (IBM, Chicago, IL, USA). Data are expressed as means ± standard deviation unless otherwise specified. A P value < .05 was considered statistically significant. All participants with missing data were removed from the analysis. Nine participants in the sample (n = 5 pre-COVID, n = 4 post-covid) were removed due to incomplete data. Missing data represented less than 4% of the total sample. These participants had substantial missing data (>50% of items) on one or more questionnaires, making imputation inappropriate. The distribution of missing data was similar between the two groups, and analysis of available demographic data showed no significant differences between participants with complete versus incomplete data. Given the small percentage of missing data and its random distribution across groups, complete case analysis was deemed appropriate. However, we acknowledge that deleting cases with missing data could introduce minimal bias in our

results. All ordinal/Likert data were treated as continuous[29,30]. An independent t-test determined demographic group differences between the pre-pandemic and post-pandemic samples. Before testing for differences between the two groups, sex differences were analyzed using an independent t-test with all participants. A univariate two-way between-subjects ANOVA was then used to determine group differences between participants assessed pre-pandemic and post-pandemic declarations and any sex differences in WALI, MEQ, TFEQ, and PSS outcomes. The two-way between-subjects ANOVA was also used to determine if there were group * sex interactions. Prior to conducting statistical analyses, all variables were examined for outliers using boxplot analysis. Extreme outliers, defined as values exceeding three interquartile ranges beyond the first and third quartiles, were identified and removed from the respective analyses. One extreme outlier was identified and removed from the MEQ awareness subscale (pre-pandemic group), and one extreme outlier was identified and removed from the TFEQ emotional eating subscale (pre-pandemic group). The Perceived Stress Scale showed no extreme outliers. This approach maintained the integrity of each individual analysis while preserving the maximum available data for each measure. A Bonferroni correction was applied to adjust for multiple comparisons across the various outcome measures. Significant interactions were interpreted through examination of cell means and graphical representations rather than formal simple effects analyses.

Results

One hundred and fifty-one (n = 81 males, n = 70 females) participants completed pre-covid testing, and 79 (n = 40 males and n = 26 females) completed the post-covid testing. All variables were examined for normality and outliers prior to analysis. All variables met assumptions for parametric testing. Table 1 shows no group differences in age, BMI, height, weight, bodyfat%, waist-to-hip ratio, or VO_2peak (all $p > .05$).

Table 1: Pre and post-COVID participant descriptive.

	Pre-Covid	**Post-Covid**	***P* - Value**
Age (years)	20.9 ± 3.4	20.6 ± 3.4	0.436
BMI (kg/m^2)	25.3 ± 4.4	25.7 ± 4.5	0.435
Weight (kg)	75.1 ± 13.6	76.6 ± 15.7	0.482
Height (cm)	171.7 ± 9.5	172.1 ± 10.5	0.772
Body fat (%)	21.9 ± 10.7	21.5 ± 10.4	0.787
Waist-to-hip ratio	.82 ± .09	.84 ± .07	0.131
VO_2peak (mL.kg.$^{-1}$min^{-1})	35.0 ± 9.1	37.5 ± 10.6	0.074

Data are Means ± SD

Anthropometric Comparison Between Groups

No significant differences were found between pre-COVID and post-COVID groups for any anthropometric or fitness measures (Table 1). Age, BMI, weight, height, body fat percentage, waist-to-hip ratio, and VO_2peak were statistically equivalent between groups (all $p > .05$). These findings indicate that despite differences in reported eating behaviors and stress levels, the two groups were anthropometrically similar, suggesting that any observed differences in eating behavior measures reflect psychological and behavioral responses rather than physiological changes that manifested in measurable body composition differences.

Mindfulness Eating Questionnaire

When combining both groups of participants (pre- and post-COVID), there were sex differences in outcomes of MEQ disinhibition ($F(1,213) = 4.42$, $p = .037$, $\eta^2 = .020$) such that females reported significantly higher disinhibition (2.84 ± .54) than males (2.63 ± .59). There were also sex differences for MEQ-Emotional eating ($F(1,213) = 4.52$, $p = .035$, $\eta^2 = .021$) such that males reported significantly higher (3.27 ± .65) scores than females (3.13 ± .62). Table 2 details the pre-post COVID outcomes overall and by sex. There were no significant differences between pre- and post-COVID groups on MEQ awareness ($p = .283$), MEQ-distraction ($p = .217$), MEQ-disinhibition ($p = .454$), MEQ-emotional eating ($p = .229$), MEQ-external cues ($p = .858$), or MEQ-total score ($p = .274$). Similarly, there were no significant pre- and post-COVID group × sex interactions for any MEQ outcome (all $p > .05$).

TFEQ. No statistical differences were found between pre- and post-COVID groups on TFEQ-cognitive restraint ($p = .234$) and TFEQ-uncontrolled eating ($p = .277$). There were no statistical sex differences in TFEQ-cognitive restraint ($p = .122$) or TFEQ-uncontrolled eating ($p = .465$). There were no pre- and post-COVID group * sex interactions on TFEQ-cognitive restraint ($p = .257$) or TFEQ emotional eating ($p = .873$). There was a statistically significant pre- and post-COVID group * sex interaction on TFEQ-uncontrolled eating ($F(1,207) = 4.73$, $p = .031$, $\eta 2 = .022$). As shown

in Figure 1A, while males showed minimal change in uncontrolled eating scores between pre- and post-COVID periods (approximately 2-point difference), females demonstrated a more pronounced increase (approximately 8-point difference on the 0-100 scale). This small effect size ($\eta 2 = .022$) suggests that while statistically significant, the practical impact may be modest. For emotional eating (Figure 1B), both sexes showed increases post-COVID, with females consistently scoring 10-15 points higher than males across both time periods. The medium effect size for sex differences ($\eta 2 = .076$) indicates this is a meaningful distinction with potential clinical relevance.

Table 2. Mindfulness Eating Questionnaire (MEQ).

MEQ Subscale	Group	Pre - Covid	Post - COVID	Mean Difference	p-value
Awareness	Overall	2.35 ± .045	2.44 ± .070	0.089	$p = .283$
	Males	2.35 ± .061	2.29 ± .087	-0.059	$p = .600$
	Females	2.36 ± .066	2.59 ± .108	0.237	$p = .050$
Distraction	Overall	2.99 ± .580	2.89 ± .590	-0.100	$p = .217$
	Males	2.94 ± .067	2.91 ± .095	-0.027	$p = .819$
	Females	3.03 ± .071	2.79 ± .117	-0.236	$p = .088$
Disinhibition	Overall	2.75 ± .590	2.70 ± .530	-0.050	$p = .454$
	Males	2.63 ± .066	2.64 ± .094	0.004	$p = .970$
	Females	2.88 ± .064	2.75 ± .106	-0.133	$p = .284$
Emotional eating	Overall	3.28 ± .630	3.17 ± .650	-0.110	$p = .229$
	Males	3.27 ± .073	3.27 ± .104	0.009	$p = .944$
	Females	3.21 ± .073	2.94 ± .119	-0.269	$p = .057$
External Cues	Overall	2.37 ± .580	2.35 ± .540	-0.020	$p = .858$
	Males	2.38 ± .063	2.37 ± .090	-0.014	$p = .901$
	Females	2.40 ± .071	2.44 ± .166	0.045	$p = .742$
Total Score	Overall	2.75 ± .300	2.69 ± .290	-0.060	$p = .274$
	Males	2.71 ± .033	2.70 ± .048	-0.013	$p = .826$
	Females	2.79 ± .036	2.70 ± .059	-0.086	$p = .217$

Data are Means ± SD

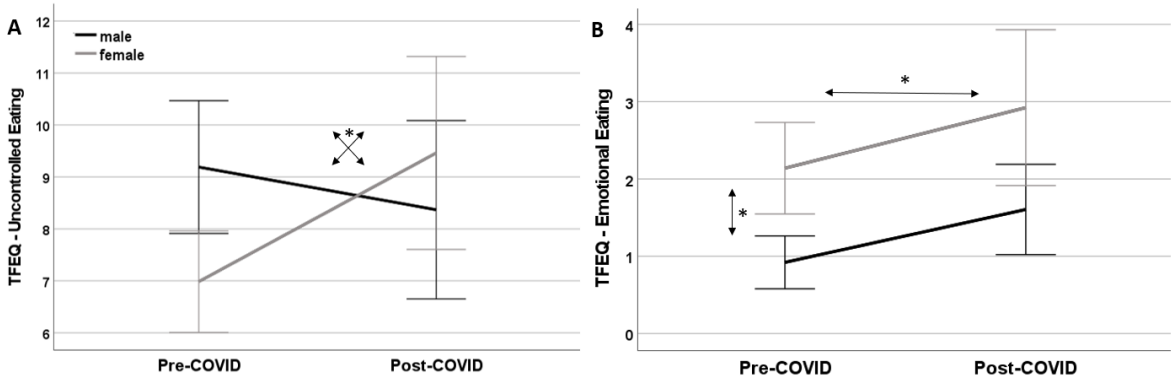

Figure 1: Figure 1A (TFEQ-Uncontrolled Eating) and 1B (Emotional Eating). TFEQ comparison pre and post pandemic declaration by sex. Error bars represent 95% CI. *Represents statistically significant at $p < .05$. Horizontal arrow represents pre-post COVID difference, vertical arrow represents sex differences, and crossing arrow represents interaction effect.

Eating Behaviors that contribute to weight gain

When participants were asked to report the level to which they believed the following behaviors contributed to their weight gain, there were no significant differences between groups, sex differences, or group * sex interactions on "eating when happy," "eating in response to sight or smell," "eating because the good taste of the food," "overeating at dinner," "eating too much food," "continuing to eat be because I do not feel full after a meal," "eating because I feel physically hungry," "eating when angry," "eating when bored," "eating when tired," "overeating at lunch," "snacking after dinner" (all $p > .05$). There were no statistically significant differences between pre- and post-COVID group on "eating because I crave certain foods" ($p = .527$) and "overeating at breakfast" ($p = .643$). There were no statistically significant sex differences in "eating because I cannot stop once I have begun" ($p = .780$). There was also no statistically significant pre- and post-COVID group * sex interaction on "eating because I cannot stop once I have begun" ($p = .915$), "eating because I crave certain foods" ($p = .335$), "eating when stressed" ($p = .472$), "eating when I am depressed/upset" ($p = .831$), "eating when anxious" ($p = .839$), "eating when alone" ($p = .460$), "overeating at breakfast" ($p = .953$).

Figure 2 shows statistically significant differences between pre-COVID and post-COVID groups on multiple eating behaviors: eating because unable to stop once begun ($F(1,202) = 4.06$, $p = .045$, $\eta 2 = .020$), eating when stressed ($F(1,200) = 9.61$, $p = .002$, $\eta 2 = .046$), eating when depressed/upset ($F(1,200) = 12.00$, $p < .001$, $\eta 2 = .057$), eating when anxious ($F(1,198) = 15.06$, $p < .001$, $\eta 2 = .071$), and eating when alone ($F(1,200) = 13.26$, $p < .001$, $\eta 2 = .062$). The most substantial pandemic effects were for eating when anxious and eating when alone, with medium effect sizes indicating post-COVID students rated these behaviors approximately 1 point higher on the 5-point scale—shifting from 'contributes slightly' to 'contributes moderately' to weight gain. Significant sex differences also emerged, with females reporting higher scores than males across multiple behaviors, most notably for eating when stressed ($F(1,200) = 24.71$, $p < .001$, $\eta 2 = .110$), where females consistently rated this behavior 0.8-1.0 points higher. This large effect size for sex differences, combined with the medium effects for pandemic-related changes, suggests that emotional eating patterns have practical significance, warranting targeted interventions, particularly for female students who showed vulnerability to both baseline differences and pandemic-related increases.

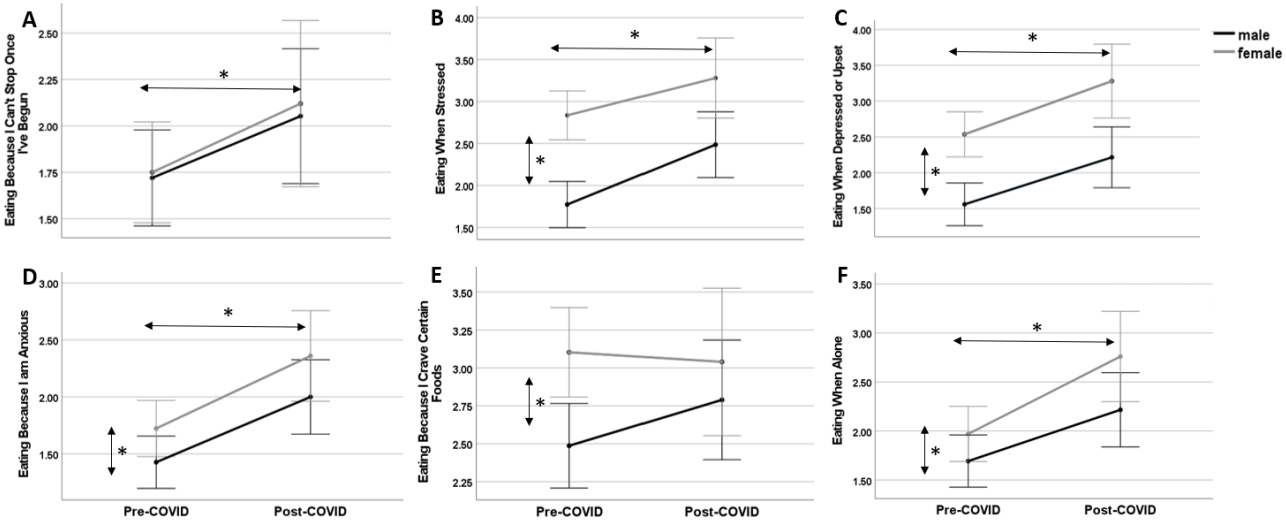

Figure 2: Figure 2A, 2B, 2C, 2D, 2E, DF. Eating behaviors comparison pre and during pandemic and by sex. Error bars represent 95% CI. *Represents statistically significant at $p < .05$. Horizontal arrow represents pre-post COVID difference and vertical arrow represents sex differences.

PSS. Figure 3 demonstrates a statistically significant 2.4-point increase in PSS scores from pre-COVID (18.2 ± 6.2) to post-COVID (20.6 ± 5.2) groups ($F(1,207) = 9.24$, $p = .003$, $\eta 2 = .043$). This change represents a 13% increase in perceived stress, shifting students from the middle of the 'moderate stress' range (14-26) toward its upper boundary, approaching the 'high stress' threshold (≥27). The small-to-medium effect size suggests this elevation has practical significance for student well-being. Additionally, a significant sex difference emerged ($F(1,207) = 8.87$, $p = .003$, $\eta 2 = .041$), with females reporting stress scores 2.6 points higher than males (20.4 ± 5.4 vs. 17.8 ± 6.3). Notably, female

students in the post-COVID period approached the high stress category, while males remained in the mid-moderate range. There was no group × sex interaction (p = .671), indicating that both sexes experienced similar pandemic-related stress increases. These findings suggest that post-pandemic students, particularly females, may require enhanced stress management support, as their stress levels exceed normative values for this age group (typical means: 12.1 for males, 13.7 for females).

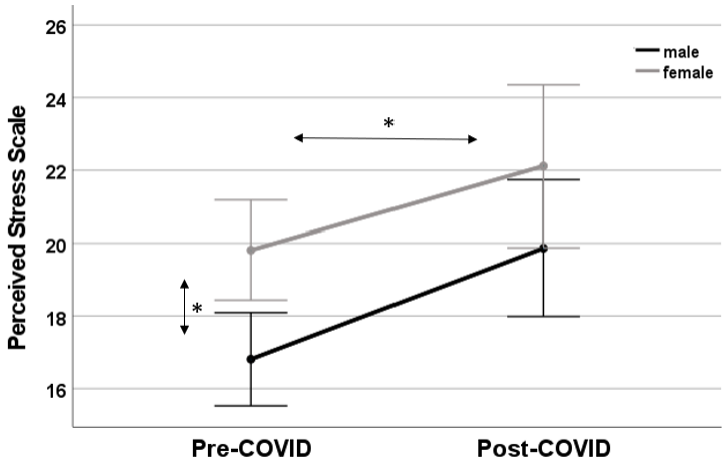

Figure 3: Stress score comparison pre- and during pandemic and by sex. Error bars represent 95% CI. *Represents statistically significant at $p < .05$. Horizontal arrow represents pre-post COVID difference, and vertical arrow represents sex differences.

Discussion

The main finding of this study is that college students assessed after the COVID-19 pandemic showed significantly higher stress levels than those assessed before the pandemic, with PSS scores increasing from moderate (18.2) to approaching high levels (20.6). This difference in perceived stress between groups was accompanied by notable differences in eating behaviors, particularly those driven by emotional responses. The study found that emotional and stress-related eating behaviors were higher in the post-pandemic group than in the pre-pandemic group. In contrast, behaviors in response to physical hunger cues were similar across groups. There were no significant differences between groups in "eating in response to sight or smell," "eating because of good taste," "eating too much food," "continuing to eat because I do not feel full," or "eating because I feel physically hungry."

No statistically significant differences in cognitive restraint were found between the groups. While cognitive restraint, as measured by the TFEQ, captures a broader pattern of controlled eating behaviors, it encompasses both flexible and rigid control strategies[31]. Flexible control involves a more balanced, graduated approach to eating regulation, whereas rigid control involves a more dichotomous, all-or-nothing approach. The lack of difference in cognitive restraint, coupled with higher emotional eating in the post-COVID group, suggests that the observed differences in eating behaviors between the two time periods were primarily driven by emotional responses rather than alterations in dietary control strategies. This pattern aligns with previous research showing that emotional eating can occur independently of an individual's level of cognitive restraint[32].

Biological sex differences emerged as a significant factor in our findings. Our study found statistically significant sex differences in measurements of emotional eating, with females reporting higher levels of stress and emotional eating than males. Prior research has shown that the female sex was a risk factor for COVID-specific anxiety[33,34]. This sex difference in anxiety response aligns with broader pandemic-related mental health findings, where women consistently reported higher levels of anxiety, depression, and stress symptoms[35]. A systematic review found that women were more vulnerable to pandemic-related psychological distress, potentially due to increased domestic responsibilities and economic stressors during lockdown periods[36]. The current sample, however, consisted of college students who likely do not have domestic responsibilities different from those of males. Thus, further research will be needed to determine why female college students experience higher stress levels than males.

These results indicate higher emotional and uncontrolled eating behaviors in the post-pandemic group, though these changes were not accompanied by significant differences in anthropometric measures between groups (Table 1). Several factors may explain this apparent paradox. First, the cross-sectional nature of the current study captured only a snapshot of body composition at different time points with different individuals, rather than tracking changes within the same persons over time. The post-COVID assessments occurred 8-15 months after the pandemic declaration, potentially allowing time for initial weight changes to stabilize or reverse as students adapted to new routines.

Second, compensatory behaviors not measured in the current study may have offset increased emotional eating episodes. The post-COVID group showed higher VO_2peak values (though not statistically significant, $p = .074$), suggesting possible increases in physical activity that could counterbalance additional caloric intake from emotional eating. Additionally, while emotional eating frequency may have increased, portion sizes, total caloric intake, and meal frequency were not directly measured. Students may have experienced more emotional eating episodes without necessarily increasing overall energy intake if regular meals were skipped or reduced due to pandemic-related changes in campus dining access or financial constraints.

It's also important to note that these findings reflect participants' perceptions of eating behaviors that contribute to weight gain, rather than documented weight changes. The WALI questionnaire asks participants to rate contributing factors regardless of whether they have experienced actual weight gain. Therefore, these results may reflect heightened awareness of potentially problematic eating behaviors during the post-pandemic period, rather than necessarily indicating actual weight gain or changes in eating frequency. Future research could explore factor analysis of the WALI weight gain attribution items to develop theoretically-driven subscales (e.g., emotional versus situational eating cues). While the current study maintained the individual item analysis approach consistent with the original WALI design, clustering these items into meaningful subscales could enhance interpretability and reduce multiple comparison issues in future studies.

The effect sizes ($\eta 2$) in the findings merit attention. The strongest effects were observed in sex differences for emotional eating ($\eta 2 = .076$) and eating when stressed ($\eta 2 = .110$), representing medium effect sizes. The differences between the pre-COVID and post-COVID groups showed smaller but significant effects, particularly for eating when anxious ($\eta 2 = .071$) and eating when alone ($\eta 2 = .062$). These effect sizes suggest that while the differences were statistically significant, their practical significance may be moderate. These findings have important implications for university mental health services and student support systems. Universities should consider implementing: Stress management programs specifically targeting emotional eating, sex-specific interventions addressing different stress responses, regular mental health screening during major disruptions, and development of resilience-building programs. These findings align with prior literature that found that the COVID-19 pandemic increased levels of emotional eating[37]. Umano et al. conducted a longitudinal study in children that compared eating behaviors before and during the pandemic[38]. They found that lockdown measures triggered certain eating behaviors that were suggestive of emotional and mindless eating. The current study adds to this by showing differences in eating behaviors between groups of college-aged participants assessed before and after the pandemic declaration.

The activations of the hypothalamic-pituitary-adrenal axis can influence emotional eating development in response to both short-term and long-term stress[39,40]. This activation affects the brain's reward and motivation system and the pathways responsible for controlling impulses. The current study corroborates past research that shows the COVID-19 pandemic was associated with increased stress and levels of emotional eating among adults[37]. The increased stress levels might provoke this increase in undesired emotional response to food, as prior research has shown that higher perceived stress predicts a higher incidence of emotional eating[41].

A key limitation to this study is its between-subjects design. Rather than measuring the same individuals before and after the pandemic (a within-subjects design), two independent groups of college students assessed at different time points were compared. This approach significantly limits the ability to make causal inferences about the pandemic's direct impact on individuals' eating behaviors and stress levels. While obtaining longitudinal data from the same students pre- and post-pandemic was not feasible due to the unexpected nature of the pandemic, this design introduces potential confounding variables that could explain the observed differences beyond the pandemic's impact.

An additional significant limitation is the potential selection bias inherent in the recruitment method. Participants were recruited through voluntary campus fitness programs and health assessments. This recruitment approach may have systematically excluded students experiencing higher stress levels or those less willing to participate in in-person

assessments, particularly during the post-pandemic period when health concerns were heightened. Students struggling with pandemic-related mental health challenges, financial stress, or social isolation may have been less likely to voluntarily engage with campus fitness services. This selection bias could result in an underestimation of the true differences in stress and emotional eating behaviors between the pre- and post-pandemic periods, as the study sample may represent a relatively resilient subset of the college population. Although pre- and post-groups showed similar demographic and anthropometric characteristics (Table 1), other unmeasured variables such as family history, prior mental health status, living situations, and academic stress could have influenced the findings. Future research using within-subjects designs would provide more substantial evidence for pandemic-related changes in eating behaviors and stress. Additionally, the post-COVID sample timing varied, with some participants measured within weeks of the pandemic declaration while others were measured several months after, potentially introducing temporal effects in post-pandemic group responses. COVID-19 exposure or impact on individual participants, and factors such as socioeconomic status, access to healthy food options, social isolation, fear, and sleep were not measured. However, all of these could influence eating behaviors[42].

The exclusion of smokers and individuals with pre-existing health conditions, while necessary for the original cardiovascular measurements, limits the generalizability of our findings. Smoking status and pre-existing conditions may influence both stress responses and eating behaviors, particularly since smoking is often used as a stress management tool and specific health conditions require dietary modifications. Therefore, these results may not fully represent the broader college-aged population, where smoking rates are approximately 8%, and chronic health conditions affect about 15% of students[43]. Another significant limitation is that the only biological sex, not gender identity was measured. While significant differences between males and females in stress and eating behaviors were found, it cannot be determined whether these differences stem from biological factors, gender-related psychosocial influences, or their interaction. The relationship between stress, eating behaviors, and gender identity may be particularly relevant during periods of social disruption like the pandemic. Future studies should include sex and gender measures to better understand their distinct contributions to stress responses and eating behaviors.

Conclusion

In conclusion, this study highlights differences in stress levels and emotional eating behaviors between college students assessed before and after the COVID-19 pandemic declaration. Emotional eating appears to be significantly higher in the post-pandemic group, particularly in response to stress and negative emotions. Sex-specific responses to pandemic-induced stressors were also evident, with females reporting higher levels of stress and emotional eating than males across both periods. These findings have implications for understanding and addressing emotional eating patterns among college students, especially in the context of the COVID-19 pandemic and its potential long-term effects on eating behaviors and mental well-being. Future longitudinal research is needed to establish better causal relationships between pandemic-related stressors and changes in eating behaviors within the same individuals over time.

Conflict of Interest. The authors declare no conflicts on interest.

References

1. Velavan TP, Meyer CG. The COVID-19 epidemic. *Tropical medicine & international health.* 2020;25(3):278. doi: 10.1111/tmi.13383.
2. McIntosh K, Hirsch MS, Bloom A. Coronavirus disease 2019 (COVID-19). *UpToDate Hirsch MS Bloom.* 2020;5:1
3. Saez M, Tobias A, Varga D, Barceló MA. Effectiveness of the measures to flatten the epidemic curve of COVID-19. The case of Spain. *Sci Total Environ.* 2020;727:138761. https://doi.org/10.1016/j.scitotenv.2020.138761.
4. Scarmozzino F, Visioli F. Covid-19 and the subsequent lockdown modified dietary habits of almost half the population in an Italian sample. *Foods.* 2020;9(5):675. https://doi.org/10.3390/foods9050675.
5. Abu Hatab A, Krautscheid L, Boqvist S. COVID-19, livestock systems and food security in developing countries: A systematic review of an emerging literature. *Pathogens.* 2021;10(5):586. https://doi.org/10.3390/pathogens10050586.
6. Zachary Z, Brianna F, Brianna L, et al. Self-quarantine and weight gain related risk factors during the COVID-19 pandemic. *Obesity research & clinical practice.* 2020;14(3):210–216. https://doi.org/10.1016/j.orcp.2020.05.004.
7. Zeigler Z. COVID-19 self-quarantine and weight gain risk factors in adults. *Current obesity reports.* 2021;10:423–433.https://doi.org/10.1007/s13679-021-00449-7.

8. Yannakoulia M, Panagiotakos DB, Pitsavos C, et al. Eating habits in relations to anxiety symptoms among apparently healthy adults. A pattern analysis from the ATTICA Study. *Appetite.* 2008;51(3):519–525. https://doi.org/10.1016/j.appet.2008.04.002.
9. Razzoli M, Bartolomucci A. The dichotomous effect of chronic stress on obesity. *Trends in Endocrinology & Metabolism.* 2016;27(7):504–515
10. Sominsky L, Spencer SJ. Eating behavior and stress: a pathway to obesity. *Frontiers in psychology.* 2014;5:434. https://doi.org/10.3389/fpsyg.2014.00434.
11. Rajkumar RP. COVID-19 and mental health: A review of the existing literature. *Asian journal of psychiatry.* 2020;52:102066. https://doi.org/10.1016/j.ajp.2020.102066.
12. Frayn M, Knäuper B. Emotional eating and weight in adults: a review. *Current Psychology.* 2018;37:924–933. https://doi.org/10.1007/s12144-017-9577-9.
13. Sidor A, Rzymski P. Dietary choices and habits during COVID-19 lockdown: experience from Poland. *Nutrients.* 2020;12(6):1657. https://doi.org/10.3390/nu12061657.
14. Di Renzo L, Gualtieri P, Pivari F, et al. Eating habits and lifestyle changes during COVID-19 lockdown: an Italian survey. *Journal of translational medicine.* 2020;18(1):1–15. https://doi.org/10.1186/s12967-020-02399-5.
15. Sparling PB, Snow TK. Physical activity patterns in recent college alumni. *Res Q Exerc Sport.* 2002;73(2):200–205. https://doi.org/10.1080/02701367.2002.10609009.
16. Fish C. Health promotion needs of students in a college environment. *Public Health Nursing.* 1996;13(2):104–111. https://doi.org/10.1111/j.1525-1446.1996.tb00227.x.
17. Machado BC, Moreira CS, Correia M, Veiga E, Gonçalves S. Coping as a mediator and moderator between psychological distress and disordered eating behaviors and weight changes during the COVID-19 pandemic. *International Journal of Environmental Research and Public Health.* 2023;20(3):2504. https://doi.org/10.3390/ijerph20032504.
18. Güneşer R, Aydın H. Evaluation of Perceived Stress Level and Emotional Eating Behaviors of Sports College Students During COVID-19 Pandemic. *Sakarya Tıp Dergisi.* 2021;11(2):434–441. https://doi.org/10.31832/smj.871642.
19. Al-Musharaf S. Prevalence and predictors of emotional eating among healthy young Saudi women during the COVID-19 pandemic. *Nutrients.* 2020;12(10):2923. https://doi.org/10.3390/nu12102923.
20. Brooks SK, Webster RK, Smith LE, et al. The psychological impact of quarantine and how to reduce it: rapid review of the evidence. *The lancet.* 2020;395(10227):912–920. https://doi.org/10.1016/S0140-6736(20)30460-8.
21. World Medical Association. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. *JAMA.* 2013;310(20):2191–2194. 10.1001/jama.2013.281053.
22. Wadden TA, Foster GD. Weight and lifestyle inventory (WALI). *Obesity.* 2006;14(S3):99S–118S
23. Framson C, Kristal AR, Schenk JM, Littman AJ, Zeliadt S, Benitez D. Development and validation of the mindful eating questionnaire. *J Am Diet Assoc.* 2009;109(8):1439–1444. https://doi.org/10.1016/j.jada.2009.05.006.
24. Shearin EN, Russ MJ, Hull JW, Clarkin JF, Smith GP. Construct validity of the three-factor eating questionnaire: Flexible and rigid control subscales. *Int J Eat Disord.* 1994;16(2):187–198. https://doi.org/10.1002/1098-108X(199409)16:2%3C187::AID-EAT2260160210%3E3.0.CO;2-U.
25. Lee E. Review of the psychometric evidence of the perceived stress scale. *Asian nursing research.* 2012;6(4):121–127. https://doi.org/10.1016/j.anr.2012.08.004.
26. Lohman TG, Roche AF, Martorell R. *Anthropometric standardization reference manual.* Human kinetics books; 1988
27. National Institutes of Health. Clinical guidelines for the identification, evaluation, and treatment of overweight and obesity in adults-the evidence report. *Obes Res.* 1998;6(2):51S–209S
28. Fields DA, Hunter GR, Goran MI. Validation of the BOD POD with hydrostatic weighing: Influence of body clothingin. *Int J Obes.* 2000;24(2):200–205. https://doi.org/10.1038/sj.ijo.0801113.
29. Glass GV, Peckham PD, Sanders JR. Consequences of failure to meet assumptions underlying the fixed effects analyses of variance and covariance. *Review of educational research.* 1972;42(3):237–288. https://doi.org/10.3102/00346543042003237.
30. Lubke GH, Muthén BO. Applying multigroup confirmatory factor models for continuous outcomes to Likert scale data complicates meaningful group comparisons. *Structural equation modeling.* 2004;11(4):514–534. https://doi.org/10.1207/s15328007sem1104_2.
31. Westenhoefer J. Dietary restraint and disinhibition: is restraint a homogeneous construct? *Appetite.* 1991;16(1):45–55. https://doi.org/10.1016/0195-6663(91)90110-E.
32. Macht M. How emotions affect eating: a five-way model. Appetite [Internet]. 2008 Jan [cited 2014 Jan 22]; 50 (1): 1–11.

33. Coulthard H, Sharps M, Cunliffe L, van den Tol A. Eating in the lockdown during the Covid 19 pandemic; self-reported changes in eating behaviour, and associations with BMI, eating style, coping and health anxiety. *Appetite.* 2021;161:105082. https://doi.org/10.1016/j.appet.2020.105082.
34. Wang Y, Yang YY, Li S, Lei X, Yang YF. Investigation on the status of influencing factors for depression symptom of children and adolescents with home quarantine during the prevalence of novel coronavirus pneumonia. *Chin J Child Health Care.* 2020;28(03):277–280. https://doi.org/10.11852/zgetbjzz2020-0178.
35. Wang Y, Di Y, Ye J, Wei W. Study on the public psychological states and its related factors during the outbreak of coronavirus disease 2019 (COVID-19) in some regions of China. *Psychol , Health Med.* 2021;26(1):13–22. https://doi.org/10.1080/13548506.2020.1746817.
36. Xiong J, Lipsitz O, Nasri F, et al. Impact of COVID-19 pandemic on mental health in the general population: A systematic review. *J Affect Disord.* 2020;277:55–64. https://doi.org/10.1016/j.jad.2020.08.001.
37. Burnatowska E, Surma S, Olszanecka-Glinianowicz M. Relationship between mental health and emotional eating during the COVID-19 pandemic: A systematic review. *Nutrients.* 2022;14(19):3989. https://doi.org/10.3390/nu14193989.
38. Umano GR, Rondinelli G, Rivetti G, et al. Effect of COVID-19 lockdown on children's eating behaviours: A longitudinal study. *Children.* 2022;9(7):1078. https://doi.org/10.3390/children9071078.
39. Maier SU, Makwana AB, Hare TA. Acute stress impairs self-control in goal-directed choice by altering multiple functional connections within the brain's decision circuits. *Neuron.* 2015;87(3):621–631. https://doi.org/10.1016/j.neuron.2015.07.005.
40. Tryon MS, Carter CS, DeCant R, Laugero KD. Chronic stress exposure may affect the brain's response to high calorie food cues and predispose to obesogenic eating habits. *Physiol Behav.* 2013;120:233–242. https://doi.org/10.1016/j.physbeh.2013.08.010.
41. Järvelä-Reijonen E, Karhunen L, Sairanen E, et al. High perceived stress is associated with unfavorable eating behavior in overweight and obese Finns of working age. *Appetite.* 2016;103:249–258. https://doi.org/10.1016/j.appet.2016.04.023.
42. Ogden CL, Carroll MD, Kit BK, Flegal KM. Prevalence of obesity in the United States, 2009-2010. *NCHS Data Brief.* 2012;(82)(82):1–8
43. American College Health Association. National college health assessment: Reference group executive summary. *Hanover: American College Health Association.* 2010