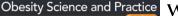ORIGINAL ARTICLE

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Anxiety and stress over COVID-19 pandemic associated with increased eating

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Abstract

Objective: Stressful experiences can dramatically affect eating. The relatively sudden, global emergence of the COVID-19 pandemic served as a massive stressor to virtually all people, regardless of infection status. This study hypothesized that actual and perceived stressors from the onset of the COVID-19 pandemic, in the categories of recurring disruptions, environmental threat, and social isolation would be positively associated with increased self-reported eating in the United States.

Methods: Over 1100 English-fluent adults (52.8% women) living in the United States were recruited for a cross-sectional online survey about eating, COVID-19 consequences, and stress experiences. Linear regressions examined associations between perceived stress on five eating measures, and individual differences in personal/work situations, perceptions, and adverse experiences during the pandemic.

Results: Anxiety, worry, and stress over, rather than direct consequences of, COVID-19 were most consistently associated with self-reported increased eating. Largely, these fell into the stressor categories of environmental threat and social isolation, not recurring disruptions. Body mass index and current self-reported eating pathology symptoms were also consistently associated with these outcomes.

Conclusions: These correlational findings suggest specific stressors have pronounced influences on eating behavior of US adults. Remotely deliverable stress mitigation strategies should be explored to attenuate increased eating.

KEYWORDS
body mass index, linear models, perception, social isolation, surveys and questionnaires

1 | INTRODUCTION

A prominent, relatively rapid indicator of stress is a change in eating behavior.[1,2] Diet and eating behaviors have enduring effects on individuals' mental and physical health,[3–6] and can affect the health of other household members.[7] Whether eating behavior increases or decreases depends upon a number of factors, including the stress source and food availability.[2,8] Internal (i.e., physiological) stress, such as from infection,[9] can decrease food intake, even when food is available. External (i.e., experiential or perceived) stress has a less straightforward effect on the directionality of eating behaviors. *Recurring disruptions,*[10,11] *environmental threat,*[10–12] and *social*

isolation[13] are stressors that can all affect consummatory behaviors. When food is available, whether hyper- or hypophagia occurs is impacted by stressor type, frequency, and number[10,12,14] as well as by individual differences including personality.[10,12,15–17]

The coronavirus disease 2019 (COVID-19) pandemic, resulting from severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), began in late 2019. Less than 3 months after its initial reporting, it was designated a pandemic by the World Health Organization.[18] Worldwide disruption of daily life ensued. A prominent consequence of the pandemic was, and continues to be, significant weight gain,[19–21] brought on by a combination of changes to eating behaviors, food access, emotional experiences, unpredictable stressors, and physical activity levels.

The present study focused on how self-reported eating behaviors of adults across the United States (US) were associated with the stressors they experienced during the first US peak of the COVID-19 pandemic. Experiential and perceived stressors from COVID-19 took numerous forms, grouped here into three primary, partially overlapping categories: recurring disruptions (e.g., caregiver and financial status, enacted state and local policies), environmental threats (e.g., essential employee status, exposure risk of self and loved ones), and social isolation (e.g., loneliness, canceled social events) (Table 1). Beyond these three categories, overall stress was queried with a perceived stress scale and a measure of general anxiety.

Predictions were that self-reported indicators of recurring disruptions, environmental threats, and social isolation, as well as broad indicators of perceived stress and generalized anxiety, would correspond with self-reported changes in eating behaviors. Specifically, the core hypothesis was that increased perceptions and experiences across these three categories of stressors, resulting from the early stages of this once-in-a-lifetime global pandemic, would be associated with self-reported increased eating behaviors.

Previously, a disease has not produced such an aggregate of societal stressors at a time when its behavioral effects can be rapidly examined on a national scale. Given: (1) the assuredness that the pandemic is having dire consequences on mental health[22]; (2) increasing evidence of the importance of diet on mental health,[4–6] and; (3) abundant evidence that repeated overeating and excess weight undermine physical health,[3,8] it follows that identification of those stressors that are best associated with eating behavior changes could facilitate early, targeted interventions to effectively mitigate ensuing physical and mental diseases.

2 | METHODS

2.1 | Participant recruitment

Participants, recruited through Qualtrics paneling from national survey panels, lived within all 50 states of the US plus the District of Columbia. A priori quotas for data collection were set to obtain reasonably equivalent recruitment of women and men, and across the four US census regions (Northeast, Midwest, South, and West).

Surveys were solicited between 17 and 24 April 2020, near the initial zenith of COVID-19 cases in the US, during which most states had implemented policies to reduce the spread of SARS-CoV-2 (e.g., stay-at-home or shelter-in-place orders). Participants were told that the survey included questions about food shopping patterns, attitudes about body weight (both for a separate study), stress, eating behaviors, public policies, and personal circumstances related to the COVID-19 pandemic. For their participation, participants were not paid directly, but rather were given incentives specified in individual contracts they held with their respective paneling company. Examples of incentives included charitable donations, retail gift cards, and rewards programs. Participants were emailed by their paneling company that described the survey, its duration (20–30 min), and their specific compensation rate. If interested, participants used a link in the email to view an online informed consent. Participants who consented filled out a series of questionnaires. All procedures were approved by the Institutional Review Board (Protocol #20-184) at Kent State University and conform to US Federal Policy for the Protection of Human Subjects.

2.2 | Participant eligibility

For study inclusion, all participants had to currently reside in the US, be between the ages of 18 and 65 years, and be fluent in English. One of the purposes of this data collection was to learn about food shopping patterns and procurement during the pandemic (for a separate study), so all participants needed to be the primary food purchaser in their household. Of the 1403 respondents entering the survey with these eligibility criteria, 164 were excluded due to responses that were nonsensical in open-ended questions. A further 41 did not provide anthropometric or demographic details, such as height, race, state of residence, or identified as pregnant and were consequently excluded. The resultant sample was a final $N = 1,198$, averaging 40.10 years (standard deviation = 12.96), with 52.8% identifying as women/transgender women. See Table 2 for all sample details.

2.3 | Measures

2.3.1 | Anthropometric & demographic

Participants reported their state of residence (for regional grouping), racial and ethnic identities, gender identity, age, height, weight, highest education level, and annual household income. Each participant's reported height and weight were used to determine their body mass index (BMI) using the formula recommended by the Centers for Disease Control and Prevention.[23] Because the number of participants with a minoritized gender identity was too small ($N = 7$) to make meaningful inferences, we grouped transgender men ($N = 1$) with the cisgender men reference group in the analyses. Transgender women ($N = 3$) were grouped with cisgender women. Excluding these

TABLE 1 Category of stressor(s) that each question or measure approximates

Question/Measure	Stressor category
Caring for someone else	Recurring disruptions
Agreement with state & local COVID-19 policies	Recurring disruptions
Working from home more or less than before COVID-19	Recurring disruptions, environmental threat, social isolation
Work duties more or less than before COVID-19	Recurring disruptions
Primary source of employment considered essential	Recurring disruptions, environmental threat
Lack of companionship during COVID-19	Social isolation
Feeling left out during COVID-19	Social isolation
Feeling isolated from others during COVID-19	Social isolation
Worry over personal economic consequences	Environmental threat
Worry over self, family member, or friend getting sick or dying from COVID-19	Environmental threat
Worry over canceled business or vacation trips, or social events	Environmental threat, social isolation
Direct personal economic consequences from COVID-19	Recurring disruptions, environmental threat
Direct social consequences from COVID-19	Recurring disruptions, social isolation
Impacted health of social contacts from COVID-19	Environmental threat, social isolation

participants did not meaningfully change the size, significance, or direction of effects. In the interest of inclusion, these minoritized gender identity individuals were retained in analyses.

2.3.2 | Personality

The 10 Item Personality Inventory was used to assess personality.[24] This involved the participant rating, from 1 (disagree strongly) to 7 (agree strongly), the extent to which they believed a pair of traits applied to them.

2.3.3 | Perceived stress scale

Using a four-item perceived stress scale (PSS-4), participants were asked to consider their personal experiences during the preceding month, and to rate from 0 (never) to 4 (very often) how frequently they experienced different stressors.[25]

2.3.4 | Anxiety

With a 7-item measure (GAD-7), the frequency of general anxiety experienced in the past two weeks was measured, from 1 (not at all sure) to 4 (nearly every day).[26]

2.3.5 | COVID-19 experiences

The stressor category or categories that each question or measure approximates are detailed in Table 1.

Two components of recurring disruptions were queried by asking about caregiver responsibility and agreement with state and local policies. Participants were asked to report if they were responsible for caring for someone else (child or adult) with a yes/no question. Participants were asked to indicate whether they agreed or disagreed with state and local policies enacted in their area in response to the COVID-19 pandemic, on a scale from 1 (strongly disagree) to 5 (strongly agree).

Stress from all three categories was assessed through questions regarding the impact of the pandemic on the participant's job with three separate questions. First, participants were asked if they were working from home more or less than before the pandemic. They could respond 1 (I am not working from home), or on a scale from 2 (much less than before) to 6 (much more than before). Next, participants were asked about whether their work duties had increased, decreased, or stayed the same, on a scale from 1 (much less work) to 5 (much more work). Finally, a yes/no question was employed to ask the participant if their primary source of employment was considered essential.

To evaluate how often participants felt socially isolated as a result of the pandemic, they were asked to respond to three questions.[27] These questions asked how often the participant felt they lacked companionship, felt left out, and felt isolated from others, with responses ranging from 1 (hardly ever) to 3 (often) for each question.

To quantify participants' environmental threat and social isolation stressors, they were asked about their worry over potential pandemic consequences through 16 questions, with responses that ranged from 1 (not worried or anxious) to 5 (very worried or anxious). These were organized into three subscales regarding: (1) worry over personal economic consequences of the pandemic (potential loss of income or employment, trouble paying bills, difficulty

TABLE 2 Anthropometrics and demographics of study sample

	Sample demographics & anthropometrics		
	N	% or arithmetic mean	Standard deviation
Census region	1198	-	
Northeast	315	26.3%	-
Midwest	311	26.0%	-
South	316	26.4%	-
West	256	21.4%	-
Race/ethnicity	1198	-	
White	883	73.7%	-
Black	139	11.6%	-
Asian	79	6.6%	-
Hispanic/Latino	70	5.8%	-
Other race	12	1.0%	-
Multiracial	15	1.3%	-
Gender	1198	-	-
Women/Transgender women	632	52.8%	-
Men/Transgender men	563	47.0%	-
Non-binary	3	0.3%	-
Age	1192	40.1	13.0
BMI	1198	27.2	7.86
<18.5	109	9.1%	-
18.5–24.9	451	37.6%	-
25.0–29.9	297	24.8%	-
≥30.0	341	28.5%	-
Education	1197	-	-
Less than high school/GED	39	3.3%	-
High school diploma or GED	248	20.7%	-
Vocational, technical, or associate's degree (2 years)	101	8.4%	-
Some college	314	26.2%	-
College graduate (e.g., bachelor's degree)	324	27.0%	-
Postgraduate degree or higher	171	14.3%	-
Income	1193	-	-
<$25,000	291	24.3%	-
$25,000–$49,999	277	23.1%	-
$50,000–$74,999	213	17.8%	-
$75,000–$99,999	146	12.2%	-
$100,000–$124,999	105	8.8%	-
$125,000–$149,999	63	5.3%	-
≥$150,000	98	8.2%	-
Eating disorder	1198	-	-
History of eating disorder	55	4.3%	-
Current eating disorder	59	4.9%	-

(Continues)

TABLE 2 (Continued)

	Sample demographics & anthropometrics		
	N	% or arithmetic mean	Standard deviation
Carer responsibility	1198	-	-
Yes	915	76.4%	-
No	283	23.6%	-
Personality (ranges: 1–7)			
Extraversion	1198	3.70	1.36
Agreeableness	1198	4.99	1.18
Conscientiousness	1197	5.18	1.32
Emotional stability	1198	4.47	1.46
Openness to experience	1198	4.78	1.21
Agreement with state/local COVID-19 policies	1197	-	-
	53	4.4%	-
	48	4.0%	-
	181	15.1%	-
	406	33.9%	-
	509	42.5%	-
COVID-19 employment status			
Working from home	1196	-	-
I am not working from home	522	43.6%	-
Much less than before	41	3.4%	-
Less than before	50	4.2%	-
About the same	233	19.4%	-
More than before	117	9.8%	-
Much more than before	233	19.4%	-
Work burden	1196	-	-
Much less than before	208	17.4%	-
Less than before	180	15.0%	-
About the same	643	53.7%	-
More than before	104	8.7%	-
Much more than before	61	5.1%	-
Essential employee	1198	-	-
Yes	539	45.0%	-
No	659	55.0%	-
COVID-19 social isolation (range: 1–3)	1198	1.85	0.63
Overall anxiety (range: 4–28)	1198	15.0	6.30

accessing and affording food and essential supplies; seven items; Cronbach's alpha (α) = 0.93); (2) worry over health of self and loved ones during the pandemic (potential of self, household member, or friend/relative contracting COVID-19; potential hospitalization or death of household member or friend/relative due to COVID-19; five

items; α = 0.93); and (3) worry over social consequences (potentially canceled work or vacation trips, major or minor social events potentially canceled; four items; α = 0.85).

Direct consequences of the COVID-19 pandemic experienced by participants, across all three stressor categories, were recorded

with 14 items in a yes/no format. As with worry over potential consequences, these realized consequences were separated into three subscales: (1) experienced personal economic consequences (loss of income or employment, trouble paying bills, difficulty accessing and affording food and essential supplies; seven items); (2) impacted health of social contacts (know someone infected or hospitalized with COVID-19, or whom died from COVID-19; three items); and (3) direct social consequences (canceled work or vacation trips, major or minor social events canceled; four items).

2.3.6 | Eating disorders & binge eating

Two questions assessed whether participants had ever been previously diagnosed with an eating disorder, and whether they currently had an eating disorder. Possible answers were 1 (yes), 2 (no), 3 (not sure).

The four-item binge eating measure from Project EAT[28] was used to determine if participants exhibited binge eating behavior specifically during the COVID-19 pandemic. The first two questions were yes/no responses, asking about eating a large quantity of food, and experiencing a lack of control. Negative responses to either of these questions advanced the participant to the next part of the questionnaire. Affirmative responses to both questions advanced the participant to the third and fourth questions. The third question queried how often the participant experienced binge eating episodes during the pandemic, from 1 (less than one day a week) to 5 (nearly every day). The fourth and final questions asked the participant how upset they were during these binge episodes, on a scale from 1 (not at all) to 4 (a lot). Scores from these four items were aggregated and recoded such that: 1 = probable binge eating disorder; 2 = binge eating with loss of control; 3 = binge eating with no loss of control; 4 = no binge eating.

2.3.7 | Eating behaviors

A revised, 18-item version of the Three-Factor Eating Questionnaire (TFEQ) was applied to evaluate the general eating behaviors of participants. The three factors of the TFEQ are cognitive restraint (six items), uncontrolled eating (nine items), and emotional eating (three items).[29] Of these 18 items, 13 asked about eating habits on a scale from 1 (definitely true) to 4 (definitely false), 4 asked about frequencies of eating-related behaviors from 1 (only at meal times/almost never/unlikely/never) to 4 (almost always/very likely/at least once a week), and 1 question was a scale from 1 (none) to 8 (constant) for the participant's level of restraint in eating.

To specifically assess eating behaviors of participants during the COVID-19 pandemic, participants were asked five questions ($\alpha = 0.93$) regarding how often they ate "during the COVID-19 outbreak": (1) "because you're depressed or sad"; (2) "because

you feel worthless or inadequate"; (3) "as a way to help you cope"; (4) "as a way to comfort yourself"; (5) "as a way to avoid thinking about something unpleasant or to distract yourself". Participants could respond between 1 (almost never or never) to 5 (almost always or always) to each of these five questions. The mean of these five questions was calculated for each participant to determine the degree to which they were eating to cope during the pandemic.

2.4 | Statistical analyses

Increased perceptions and experiences of recurring disruptions, environmental threat, and social isolation stressors experienced during the first month of the COVID-19 pandemic in the United States (see Table 1) were *a priori* hypothesized to be associated with self-reported increased eating behaviors. Likewise, *a priori* use of linear regressions were planned to examine associations between perceived stress or self-reported eating behaviors, and individual differences in personal/work situations, perceptions, and adverse experiences during the pandemic. Covariates included demographic and anthropometric measures for US census regions (Northeast as reference), race/ethnicity (non-Hispanic white as reference), gender (men/transgender men as reference), age, BMI, socioeconomic status (education, income), eating disorder (history or current) and personality. Given the contribution of stress to eating habits, perceived stress was included *a priori* as an independent variable for all subsequent regressions. Thus, variables for all subsequent models were: caregiver status, policy agreement, work situation, loneliness, general anxiety; and worries over, and direct consequences of, COVID-19. Bonferroni corrections were applied to account for the number of variables in each model, resulting in a threshold of $p < 0.0033$ for perceived stress, and $p < 0.0031$ for all subsequent models. Arithmetic means and standard deviations for the focal dependent variables (perceived stress, and five eating measures) are presented in Table 3.

3 | RESULTS

3.1 | Sample characteristics

Participants were equivalently recruited across all four US census regions, with a total sample of $N = 1198$ (Table 2).

3.2 | Perceived stress

Variables in the model (caregiver status, policy agreement, work situation, loneliness, general anxiety; worries over, and direct consequences of, COVID-19 and covariates) ($F_{(35,1173)} = 24.2$, $p < 0.001$) accounted for 42.6% of variance in perceived stress (Table 4). Three personality dimensions were associated with greater perceived

	Focal dependent variables		
	N = 1198		
	Range	Arithmetic mean	Standard deviation
Perceived stress scale	0–16	11.4	3.01
Three factor eating questionnaire			
Cognitive restraint	6–28	13.8	3.61
Uncontrolled eating	9–36	19.4	6.02
Emotional eating	3–12	6.57	2.61
Project EAT binge eating measure	1–4[a]	3.49	0.97
Eating to cope during the COVID-19 outbreak	1–5	2.30	1.08

TABLE 3 Ranges, arithmetic means, and standard deviations of focal dependent variables

[a]Scores from the Project EAT binge eating measure were aggregated and recoded such that: 1 = binge eating disorder; 2 = binge eating with loss of control; 3 = binge eating with no loss of control; 4 = no binge eating.

stress: less extraversion ($\beta = -0.07$, $p = 0.003$), conscientiousness ($\beta = -0.09$, $p < 0.001$), and emotional stability ($\beta = -0.24$, $p < 0.001$). General anxiety ($\beta = 0.28$, $p < 0.001$) was associated with more perceived stress. Direct personal economic consequences of COVID-19 were associated with perceived stress ($\beta = 0.09$, $p = 0.002$), a proxy for measuring both recurring disruptions and environmental threat.

3.3 | Eating behavior

Variables in the model ($F_{(36,1173)} = 3.09$, $p < 0.001$) accounted for 8.9% of cognitive restraint variance (Table 5). Female gender identity was associated with increased cognitive restraint ($\beta = 0.10$, $p = 0.001$). More worry over canceled business or vacation trips, or social events, proxies for environmental threat and social isolation stressors, was associated with more cognitive restraint in eating ($\beta = 0.15$, $p < 0.001$).

Model variables ($F_{(36,1173)} = 11.3$, $p < 0.001$) explained 26.4% of variance in uncontrolled eating (Table 5). A higher BMI was associated with more uncontrolled eating behavior ($\beta = 0.12$, $p < 0.001$). Less conscientiousness ($\beta = -0.09$, $p = 0.003$) and having a current eating disorder ($\beta = 0.11$, $p < 0.001$) were also associated with greater uncontrolled eating. Higher perceived stress ($\beta = 0.11$, $p = 0.002$) and general anxiety ($\beta = 0.15$, $p < 0.001$) were both associated with more uncontrolled eating behavior. Worry over personal economic consequences ($\beta = 0.12$, $p = 0.002$) and worry over canceled business or vacation trips, or social events ($\beta = 0.12$, $p < 0.001$) were each positively associated with uncontrolled eating. These were proxies for environmental threat (both) and social isolation (latter).

Variables in the model ($F_{(36,1173)} = 11.5$, $p < 0.001$) accounted for 26.7% of the variance in emotional eating (Table 5). As with uncontrolled eating, emotional eating was associated with higher BMI ($\beta = 0.16$, $p < 0.001$). Presence of a current eating disorder ($\beta = 0.09$, $p = 0.002$) was associated with more emotional eating. More

perceived stress ($\beta = 0.11$, $p = 0.001$) and general anxiety ($\beta = 0.16$, $p < 0.001$) were positively associated with emotional eating behaviors. A proxy of both social isolation and environmental threat, worries over canceled trips and social events ($\beta = 0.12$, $p < 0.001$) were associated with more emotional eating.

3.4 | Binge eating

Model variables ($F_{(36,1173)} = 7.08$, $p < 0.001$) accounted for 18.3% of the observed variance in binge eating (Table 6; note lower scores indicate *greater* binge eating severity). Having a current eating disorder ($\beta = -0.14$, $p < 0.001$) was associated with more binge eating behavior. Knowing someone who was infected or hospitalized with, or who died from, COVID-19 was associated with increased binge eating ($\beta = -0.10$, $p < 0.001$). This was a proxy for both environmental threat and social isolation.

3.5 | Eating to cope during COVID-19

Variables in the model ($F_{(36,1173)} = 22.3$, $p < 0.001$) accounted for 41.4% of the variance in eating to cope during COVID-19 (Table 6). As with the TFEQ measures of uncontrolled and emotional eating, higher BMI ($\beta = 0.12$, $p < 0.001$) was positively associated with eating to cope during the pandemic. Higher household income ($\beta = 0.10$, $p < 0.001$) and currently having an eating disorder ($\beta = 0.08$, $p = 0.002$) were also associated with more eating to cope during COVID-19. Social isolation stress, as indicated by feeling left out ($\beta = 0.10$, $p = 0.003$), was associated with higher eating to cope, as was greater general anxiety ($\beta = 0.32$, $p < 0.001$). Increased worry over personal economic consequences ($\beta = 0.13$, $p < 0.001$) and worry over canceled trips or social events ($\beta = 0.14$, $p < 0.001$), indicators of environmental threat and social isolation (Table 1) were associated with more eating to cope during COVID-19.

TABLE 4 Results of linear regression on perceived stress

		Perceived stress		
Covariates		B	β	p
Census region[a]				
Midwest		−0.242	−0.035	0.215
South		−0.128	−0.019	0.508
West		−0.089	−0.012	0.667
Race/ethnicity[b]				
Black		−0.234	−0.025	0.294
Asian		0.297	0.025	0.310
Hispanic/Latino		0.123	0.010	0.680
Other race		−0.900	−0.030	0.185
Multiracial		0.195	0.007	0.758
Gender[c]		0.012	0.002	0.933
Age		−0.009	−0.038	0.140
BMI		0.006	0.017	0.499
Education		−0.015	−0.007	0.795
Income		−0.100	−0.062	0.033
Eating disorder				
History of eating disorder		−0.317	−0.025	0.321
Current eating disorder		−0.465	−0.033	0.190
Personality				
Extraversion		**−0.155**	**−0.070**	**0.003[d]**
Agreeableness		−0.031	−0.012	0.667
Conscientiousness		**−0.225**	**−0.099**	**<0.001**
Emotional stability		**−0.485**	**−0.235**	**<0.001**
Openness to experience		−0.105	−0.042	0.110
		Perceived stress		
Dependent variables	Stress	B	β	p
Overall anxiety	N/A	**0.133**	**0.277**	**<0.001**
Carer responsibility	R	−0.076	−0.011	0.646
Agreement with state/local COVID-19 policies	R	−0.186	−0.066	0.007[e]
COVID-19 employment status				
Working from home	R, T, S	0.035	0.024	0.344
Work burden	R	0.034	0.011	0.631
Essential employee	R, T	−0.047	−0.008	0.739
COVID-19 social isolation				
Lack companionship	S	0.286	0.070	0.024
Feel left out	S	0.173	0.042	0.181
Isolated from others	S	0.015	0.004	0.906
COVID-19 worries				
Personal economic impact	T	0.185	0.076	0.031
Self or loved ones getting ill or dying	T	0.078	0.031	0.282
Canceled work, vacation, or social events	T, S	−0.086	−0.034	0.256

(Continues)

TABLE 4 (Continued)

		Perceived stress		
Dependent variables	Stress	B	β	p
COVID-19 consequences				
Personal economic consequences	R, T	**0.147**	**0.090**	**0.002**
Canceled work, vacation, or social events	R, S	0.100	0.041	0.143
Know someone infected or hospitalized, or whom died, from COVID-19	T, S	−0.105	−0.034	0.161

Note: Bonferroni correction means significance threshold of $p < 0.0033$; measures exceeding this threshold are bolded.

Abbreviations: R, recurring disruptions; S, social isolation; Stress, stressor category; T, environmental threat.

[a]Reference region: Northeast.

[b]Reference race/ethnicity: non-Hispanic white.

[c]Reference gender identity: men.

[d]Loss of statistical significance when individuals with current eating disorder ($N = 59$) removed from analyses; $B = -0.156$, $β = -0.071$, $p = 0.004$.

[e]Gain of statistical significance when individuals with current eating disorder ($N = 59$) removed from analyses; $B = -0.233$, $β = -0.081$, $p = 0.001$.

4 | DISCUSSION

These findings agree with other reports indicating that pandemic-related anxiety and stress are increasing eating in adults in the United States[19,21,30] This self-reported increased food consumption can be unhealthy, and may also enhance vulnerability to eating disorders.[31] Though stress has an established impact on eating,[1,2,10–14] the pandemic has produced one of the most ubiquitous, prolonged, and socially disruptive stressors of the last century, opening a new area of research relevant to the majority of the world's population. Indeed, weight gain and increased BMI have become indirect health consequences of the COVID-19 pandemic in non-infected individuals.[19–21] Importantly, the present study quantified both self-reported eating behaviors, emotional perceptions, and stressor experiences in the same individuals, providing insights into associations between specific stressors and the perceptions of resulting eating behavior changes.

In the present study, restricted to the US, most general demographics did not influence the models. Perhaps the most striking absence of any significance was across US region. Compared to the Northeast, which suffered by far the greatest initial spread of SARS-CoV-2, and largest number of fatalities during the first wave of COVID-19 (heavily centered in New York City),[32,33] neither the Midwest, West, nor South were significantly different on any measures, including perceived stress. Race, age, and education were not significant in any model. Gender was significant in only one of the six models (cognitive restraint). However, a few covariates were consistent in their influences—specifically, BMI and having a current eating disorder were significant across three and four of the six models, respectively. Positive associations between BMI and eating behaviors are well-established.[34] The personality dimension of conscientiousness was negatively associated with perceived stress and uncontrolled eating, also in agreement with current literature.[15–17] The relationship between household income and eating in response to stress is less clear in the literature.[3] Here, higher income was associated with increased eating to cope with the pandemic, and trended toward significance for uncontrolled eating ($p < 0.007$). Consequently, self-reported increases in eating during the initial COVID-19 outbreak may be related to being financially able to purchase more food, as previous work has indicated[35,36] but more research should examine this issue.

Relatedly, proxies for environmental threat and social isolation were significant in four of the six models. These were feeling left out (one model), worry about personal economic consequences of COVID-19 (two models), and worry over cancellation of social events or trips for business or vacation (four models). Likewise, across uncontrolled eating, emotional eating, and eating to cope models, general anxiety was consistently significant, and perceived stress was associated with the first two.[37–39] Together, these results indicate that heterogenous, though partially interrelated, environmental threat and social isolation stressors significantly contributed to increased self-reported eating during the COVID-19 pandemic. Though these findings are supported by a wealth of eating and stress literature,[3,14] the pandemic as a whole is a unique and literally global stressor. In light of the ongoing COVID-19 pandemic as 2021 concludes, strategies to mitigate this pandemic stress, and in so doing attenuate problematic increased eating behaviors, will be essential to prevent long-term adverse mental and physical health outcomes.

More unexpectedly, recurring disruption stressors such as policy disagreement, caregiver responsibility, and essential work status, social isolation such as feeling isolated or working from home more, and environmental threats like worrying about a loved one becoming or currently infected with COVID-19, were all seldom associated with changes in self-reported eating behaviors. These outcomes do not align with previous literature on the effects of stressors on eating behavior.[10,14,37–39] Given that neither positive nor negative associations were observed between some of these variables and self-reported eating behavior, it may be that the measures developed for this novel pandemic situation were not sufficiently sensitive, or that self-reports did not accurately reflect actual eating behavior. Another possibility, at least as it relates to social isolation, is that the surge in popularity of video call tools alleviated some social absence stressors.

Given that national surveys have not previously been possible during a global pandemic, hypotheses were driven by tangentially

TABLE 5 Results of linear regressions on eating behavior using Three-Factor Eating Questionnaire

Covariates	Cognitive restraint in eating			Uncontrolled eating			Emotional eating		
	B	β	p	B	β	p	B	β	p
Census region[a]									
Midwest	0.072	0.009	0.808	0.389	0.028	0.382	0.236	0.039	0.218
South	0.235	0.029	0.422	0.218	0.016	0.621	0.037	0.006	0.846
West	0.493	0.056	0.113	0.374	0.026	0.425	0.150	0.024	0.459
Race/ethnicity[b]									
Black	−0.514	−0.046	0.128	−0.068	−0.004	0.894	−0.438	−0.054	0.046
Asian	0.249	0.017	0.573	0.325	0.013	0.626	−0.342	−0.032	0.235
Hispanic/Latino	0.355	0.023	0.430	−0.233	−0.009	0.731	0.048	0.004	0.869
Other race	−1.252	−0.035	0.223	−1.067	−0.018	0.490	−0.868	−0.033	0.194
Multiracial	−0.731	−0.022	0.444	−0.993	−0.018	0.490	−0.544	−0.023	0.381
Gender[c]	**0.750**	**0.104**	**0.001**	−0.147	−0.012	0.661	0.331	0.063	0.023
Age	0.011	0.038	0.243	−0.027	−0.058	0.048	0.002	0.008	0.779
BMI	0.016	0.034	0.272	**0.090**	**0.118**	**<0.001**	**0.053**	**0.162**	**<0.001**
Education	0.216	0.086	0.012	0.117	0.028	0.366	0.054	0.029	0.338
Income	0.058	0.030	0.413	0.287	0.088	0.007[d]	0.117	0.083	0.011
Eating disorder									
History of eating disorder	0.568	0.038	0.239	0.379	0.015	0.603	0.172	0.016	0.583
Current eating disorder	0.445	0.027	0.408	**3.178**	**0.113**	**<0.001**	**1.110**	**0.092**	**0.002**
Personality									
Extraversion	0.074	0.028	0.352	0.145	0.033	0.228	0.047	0.025	0.361
Agreeableness	−0.127	−0.042	0.239	−0.271	−0.053	0.095	−0.126	−0.057	0.072
Conscientiousness	0.032	0.012	0.742	**−0.431**	**−0.094**	**0.003[e]**	−0.097	−0.049	0.123
Emotional stability	0.124	0.050	0.217	−0.021	−0.005	0.891	−0.026	−0.015	0.687
Openness to experience	−0.022	−0.008	0.821	−0.149	−0.030	0.319	−0.166	−0.077	0.010
Perceived Stress	−0.011	−0.009	0.809	**0.212**	**0.105**	**0.002**	**0.093**	**0.107**	**0.001**

Dependent variables	Stress	Cognitive restraint in eating			Uncontrolled eating			Emotional eating		
		B	β	p	B	β	p	B	β	p
Overall anxiety	N/A	0.064	0.112	0.005[f]	**0.143**	**0.148**	**<0.001**	**0.067**	**0.161**	**<0.001**
Carer responsibility	R	0.349	0.041	0.164	0.956	0.067	0.011	0.277	0.045	0.089
Agreement with state/local COVID-19 policies	R	0.120	0.035	0.255	0.106	0.019	0.505	0.060	0.024	0.382
COVID-19 employment status										
Working from home	R, T, S	0.053	0.030	0.345	0.096	0.032	0.258	0.075	0.058	0.041
Work burden	R	0.039	0.011	0.713	0.126	0.021	0.433	0.143	0.056	0.040
Essential employee	R, T	0.010	0.001	0.962	−0.422	−0.035	0.194	0.068	0.013	0.628
COVID-19 social isolation										
Lack companionship	S	0.300	0.061	0.118	−0.018	−0.002	0.951	0.159	0.045	0.203
Feel left out	S	−0.038	−0.008	0.846	0.146	0.018	0.620	0.065	0.018	0.608
Isolated from others	S	0.082	0.017	0.661	0.206	0.026	0.465	0.154	0.045	0.206
COVID-19 worries										
Personal economic impact	T	0.155	0.053	0.231	**0.592**	**0.122**	**0.002[g]**	0.176	0.084	0.037

(Continues)

TABLE 5 (Continued)

Dependent variables	Stress	Cognitive restraint in eating B	β	p	Uncontrolled eating B	β	p	Emotional eating B	β	p
Self or loved ones getting ill or dying	T	−0.227	−0.075	0.039	−0.117	−0.023	0.478	−0.056	−0.025	0.435
Canceled work, vacation, or social events	T, S	**0.444**	**0.145**	**<0.001**	**0.615**	**0.120**	**<0.001**	**0.272**	**0.122**	**<0.001**
COVID-19 consequences										
Personal economic consequences	R, T	−0.087	−0.045	0.229	0.037	0.011	0.733	−0.003	−0.002	0.944
Canceled work, vacation, or social events	R, S	−0.100	−0.034	0.334	−0.036	−0.007	0.816	−0.060	−0.028	0.373
Know someone infected or hospitalized, or whom died, from COVID-19	T, S	0.174	0.047	0.126	−0.138	−0.022	0.422	−0.008	−0.003	0.917

Note: Bonferroni correction means significance threshold of $p < 0.0031$; measures exceeding this threshold are bolded.

Abbreviations: R, recurring disruptions; S, social isolation; Stress, stressor category; T, environmental threat.

[a]Reference region: Northeast.

[b]Reference race/ethnicity: non-Hispanic white.

[c]Reference gender identity: men.

[d]Gain of statistical significance when individuals with current eating disorder ($N = 59$) removed from analyses; $B = 0.320$, $β = 0.100$, $p = 0.003$.

[e]Loss of statistical significance when individuals with current eating disorder ($N = 59$) removed from analyses; $B = −0.362$, $β = −0.080$, $p = 0.016$.

[f]Gain of statistical significance when individuals with current eating disorder ($N = 59$) removed from analyses; $B = 0.069$, $β = 0.120$, $p = 0.003$.

[g]Loss of statistical significance when individuals with current eating disorder ($N = 59$) removed from analyses; $B = 0.552$, $β = 0.116$, $p = 0.005$.

related studies of the effects of discrete stressors. Thus, while virtually all of the information gathered applies to a novel circumstance, it is also probable that meaningful predictors were overlooked due to inherently limited *a priori* knowledge. Likewise, as the world has moved through this pandemic, responses to mandated or self-quarantine have changed. Indeed, as this manuscript is being finalized, many locations throughout the world are experiencing repeated waves of COVID-19 cases, particularly from the delta and omicron variants, and vaccinations have only recently been approved for young children. Furthermore, considerable social debate persists about the need for a vaccine, and scientific evidence indicates that effectiveness of currently available vaccines in adults dramatically drops over 8 months.[40] These protracted global and local stressors have certainly augmented the proportion of people directly affected by the pandemic since the present data were collected. Consequently, such instances may increasingly influence patterns of increased eating, in contrast to the overall absence of such a relationship in the present study. Because this survey was administered online, all measures are self-reported, and thus regressions could over- or underestimate certain effects. This study was designed to be cross-sectional, so while this provides a reasonable nationwide sampling, it inherently lacks the ability to track changes in eating behaviors over time. Related to this, local pandemic responses in the spring of 2020 (when data were collected) varied both in onset and magnitude across the US, and this is a probable source of variability in perceived stress here. Furthermore, the survey was estimated to take participants approximately 30 min to complete, thus sampling

might have excluded marginalized groups, such as those without reliable Internet access, those working overtime in essential positions, or those suddenly furloughed or unemployed and actively seeking new employment. Many of these individuals are therefore more likely to be personally affected by the pandemic, and/or at risk of being infected with SARS-CoV-2. However, the general population is increasingly represented in Internet samples, and this study's demographics reasonably reflect those reported by the US Census Bureau.[41] The findings of this study should be interpreted with these considerations in mind.

Finally, it is tempting to speculate that having a current eating disorder might have falsely driven results. However, when the 59 individuals responding in the affirmative to this question were excluded from all analyses, only 3 of the 24 total significant relationships (excluding having a current eating disorder) were lost, and 3 were gained (see notes in Tables 4 and 5). These include perceived stress being significantly associated with disagreement with state/local policies, and a loss of significant association between perceived stress and the personality dimension of extraversion. Similarly, exclusion of these 59 individuals meant that cognitive restraint in eating and uncontrolled eating became significantly associated with overall anxiety and household income, respectively. Finally, these exclusions resulted in a loss of a significant association between uncontrolled eating and the personality dimension of conscientiousness, as well as worry over personal economic consequences of COVID-19. Because there was no consistency in the types of significant relationships that changed as a

TABLE 6 Results of linear regressions on binge eating and eating to cope during COVID-19

Covariates	Binge eating severity (lower score means higher severity)			Eating to cope during COVID-19		
	B	β	p	B	β	p
Census region[a]						
Midwest	−0.037	−0.017	0.620	−0.015	−0.006	0.830
South	−0.032	−0.015	0.663	−0.064	−0.026	0.360
West	−0.073	−0.031	0.356	0.094	0.036	0.211
Race/ethnicity[b]						
Black	0.014	0.005	0.871	−0.033	−0.010	0.683
Asian	−0.076	−0.019	0.504	0.047	0.011	0.661
Hispanic/Latino	−0.093	−0.023	0.420	−0.066	−0.014	0.545
Other race	0.021	0.002	0.937	−0.160	−0.015	0.517
Multiracial	−0.026	−0.003	0.915	−0.123	−0.012	0.590
Gender[c]	0.024	0.012	0.674	0.068	0.031	0.208
Age	0.004	0.047	0.133	−0.001	−0.016	0.535
BMI	−0.009	−0.075	0.010	**0.017**	**0.123**	**<0.001**
Education	−0.011	−0.017	0.605	−0.009	−0.012	0.664
Income	−0.022	−0.042	0.220	**0.060**	**0.104**	**<0.001**
Eating disorder						
History of eating disorder	−0.303	−0.074	0.014	0.121	0.027	0.296
Current eating disorder	**−0.627**	**−0.139**	**<0.001**	**0.403**	**0.080**	**0.002**
Personality						
Extraversion	0.001	0.002	0.952	0.011	0.014	0.574
Agreeableness	0.009	0.011	0.740	−0.043	−0.047	0.098
Conscientiousness	0.052	0.070	0.036	−0.054	−0.066	0.020
Emotional stability	−0.029	−0.044	0.255	0.006	0.008	0.801
Openness to experience	0.030	0.038	0.235	−0.054	−0.060	0.024
Perceived Stress	−0.020	−0.062	0.081	0.023	0.064	0.032

Dependent variables	Stress	Binge eating severity (lower score means higher severity)			Eating to cope during COVID-19		
		B	β	p	B	β	p
Overall anxiety	N/A	−0.012	−0.076	0.046	**0.057**	**0.328**	**<0.001**
Carer responsibility	R	−0.148	−0.065	0.020	0.164	0.064	0.007
Agreement with state/local COVID-19 policies	R	−0.010	−0.011	0.713	0.016	0.016	0.522
COVID-19 employment status							
Working from home	R, T, S	−0.019	−0.039	0.187	0.005	0.010	0.691
Work burden	R	−0.002	−0.003	0.930	0.000	0.000	0.999
Essential employee	R, T	0.125	0.064	0.023	−0.009	−0.004	0.856
COVID-19 social isolation							
Lack companionship	S	−0.013	−0.010	0.786	0.062	0.042	0.178
Feel left out	S	0.020	0.015	0.682	**0.141**	**0.096**	**0.003**
Isolated from others	S	−0.026	−0.020	0.591	0.000	0.000	0.993

(Continues)

TABLE 6 (Continued)

Dependent variables	Stress	Binge eating severity (lower score means higher severity)			Eating to cope during COVID-19		
		B	β	p	B	β	p
COVID-19 worries							
Personal economic impact	T	−0.088	−0.112	0.008	**0.116**	**0.134**	**<0.001**
Self or loved ones getting ill or dying	T	0.035	0.042	0.215	−0.015	−0.016	0.573
Canceled work, vacation, or social events	T, S	−0.071	−0.086	0.016	**0.127**	**0.139**	**<0.001**
COVID-19 consequences							
Personal economic consequences	R, T	−0.012	−0.023	0.515	−0.023	−0.040	0.178
Canceled work, vacation, or social events	R, S	−0.020	−0.025	0.449	−0.039	−0.044	0.118
Know someone infected or hospitalized, or whom died, from COVID-19	T, S	**−0.102**	**−0.103**	**<0.001**	0.008	0.008	0.762

Note: Bonferroni correction means significance threshold of $p < 0.0031$; measures exceeding this threshold are bolded.

Abbreviations: R, recurring disruptions; S, social isolation; Stress, stressor category; T, environmental threat.

[a]Reference region: Northeast.

[b]Reference race/ethnicity: non-Hispanic white.

[c]Reference gender identity: men.

consequence of excluding these individuals, the increased self-reported eating behavior observed here is not solely, nor even primarily, attributable to having a self-reported current eating disorder. Nonetheless, the stressful conditions of the COVID-19 pandemic certainly are priming vulnerability to eating disorder development and/or relapse.[31]

5 | CONCLUSIONS

The most consistent predictors of self-reported increased eating during the pandemic, based on the present cross-sectional study, are general anxiety, and worries over potential personal economic and social consequences of the pandemic. In other words, stressors in the forms of environmental threat and social isolation appear to have a more pronounced influence on eating behavior of US adults than recurring disruption stressors. Stress has previously been demonstrated to affect not only eating, but also longer-term adverse health outcomes including obesity and other metabolic disruptions, as well as impairing mental health.[3,6,8] Considering the global nature of this pandemic, strategies to alleviate anxiety and diminish experienced stress (actual or perceived) might have a measurable effect upon increased eating behaviors. Remotely deliverable strategies, including mindfulness training,[42] practicing gratitude,[43] and implementing beneficial coping strategies[44] could simultaneously attenuate experiences of stress and diminish engagement in pathological eating. Of course, this postulation would necessitate longitudinal studies to evaluate how implementing such prophylactic and early intervention approaches would causally impact people's mental *and*

physical health. Assessing both short- and long-term influences of the COVID-19 pandemic on eating disorder risk, prevalence, and relapse will be critical in determining the persistence and effective mitigation of this global stressor's consequences.

CONFLICT OF INTEREST

The authors declared no conflict of interest.

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