

A cotwin control study of associations between financial hardship and binge eating phenotypes during COVID-19

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Abstract

Background: COVID-19 was associated with significant financial hardship and increased binge eating (BE). However, it is largely unknown whether financial stressors contributed to BE during the pandemic. We used a longitudinal, cotwin control design that controls for genetic/environmental confounds by comparing twins in the same family to examine whether financial hardship during COVID-19 was associated with BE.

Methods: Female twins ($N = 158$; $M_{age} = 22.13$) from the Michigan State University Twin Registry rated financial stressors (e.g., inability to afford necessities) daily for 49 consecutive days during COVID-19. We first examined whether financial hardship was associated with BE phenotypes across the full sample. We then examined whether cotwins who differed on financial hardship also differed in BE.

Results: Participants who experienced greater mean financial hardship across the study had significantly greater dimensional BE symptoms, and participants who experienced greater financial hardship on a given day reported significantly more emotional eating that day. These results were replicated in cotwin control analyses. Twins who experienced more financial hardship than their cotwin across the study reported greater dimensional BE symptoms than their cotwin, and participants who experienced more financial hardship than their cotwin on a given day reported greater emotional eating that day. Results were identical when restricting analyses to monozygotic twins, suggesting associations were not due to genetic confounds.

Conclusions: Results suggest that BE-related symptoms may be elevated in women who experienced financial hardship during COVID-19 independent of potential genetic/environmental confounds. However, additional research in larger samples is needed.

Public Significance: Little is known regarding how financial difficulties during the COVID-19 pandemic may have contributed to increased binge eating (BE). We found preliminary evidence that financial hardship during COVID-19 may be associated with greater rates of BE-related symptoms even when comparing twins from the

same family. While additional research is needed, results suggest that people who experienced financial hardship during COVID-19 may be at increased risk for BE.

KEYWORDS

binge eating, cotwin control, COVID-19, disadvantage, emotional eating, financial, longitudinal, socioeconomic

1 | INTRODUCTION

The COVID-19 pandemic was unprecedented in its financial impact, with almost half (43%) of adults in the United States (US) reporting they or someone in their household lost income or lost their job (Pew Research Center, 2020). The pandemic therefore represents a unique opportunity to understand the impact of financial hardship on mental health. Emerging research suggests financial hardship during the pandemic was associated with significantly increased risk for conditions closely related to eating disorders (EDs), including anxiety (Santabábara et al., 2021) and depression (Witteveen & Velthorst, 2020). However, to date, very little research has examined how financial hardship during COVID-19 may have impacted risk for EDs and their symptoms. The few studies that have examined financial difficulties and disordered eating during COVID-19 have tended to focus narrowly on food insecurity (Christensen et al., 2021; Coulthard et al., 2021) rather than financial hardship more broadly. While food insecurity is an important correlate of disordered eating (Hazzard et al., 2020), other consequences of financial hardship, including increased psychological stress, decreased self-esteem, and limited access to physical/mental healthcare, may increase ED risk even among individuals who are relatively food secure (e.g., Simone et al., 2021). Understanding how COVID-19-related financial hardship defined more broadly may relate to disordered eating is therefore crucial to inform screening for pandemic-onset ED symptoms and meet the needs of those presenting with dysregulated eating (e.g., for low-cost treatment).

Only two studies have examined associations between general financial hardship and disordered eating during COVID-19. Simone et al. (2021) found that participants who reported difficulty living on their household income were more likely to report eating to cope or using unhealthy weight control behaviors even after controlling for food insecurity. Similarly, participants who reported “financial difficulty due to quarantine/confinement” in Haddad et al. (2020) reported greater eating, weight, and shape concerns. While these studies suggest that general financial hardship may have been associated with increased disordered eating during COVID-19, methodological considerations limit the conclusions that can be drawn. Specifically, both studies assessed financial hardship with a single item and examined associations cross-sectionally at a single timepoint. Additional research with more comprehensive measures of financial hardship and study designs that can control for potential confounds are therefore needed.

Cotwin control designs offer a unique opportunity to examine the impact of environmental stressors while controlling for a myriad of environmental and genetic confounds (McGue et al., 2010). Specifically, cotwin control studies examine how differences in a predictor

(e.g., financial hardship) between twins from the same family are associated with an outcome (e.g., dysregulated eating). In other words, if one twin experienced more financial difficulties than their cotwin during COVID-19, were they also at greater risk for dysregulated eating? Because twins are matched on many variables (e.g., age, race/ethnicity, family rearing environment, genes), within-twin pair associations between a predictor and outcome provide strong evidence that the predictor may in fact be driving the relationship, rather than an unmeasured third variable. Both monozygotic and dizygotic twins are informative in cotwin control analyses because they share a common rearing environment and at least some of their genes. However, a significant within-twin pair association between an environmental stressor and outcome among monozygotic twins (who share all their DNA) provides particularly strong evidence that the association is not attributable to genetic confounds.

In the current study, we used a longitudinal, cotwin control design to examine whether financial hardship measured over a 49-day period was associated with dysregulated eating during COVID-19. We focused on binge eating (BE) due to evidence that BE and related phenotypes may have increased more than other ED symptoms (e.g., dietary restraint, body dissatisfaction) in population-based/community samples during the pandemic (De Pasquale et al., 2021; Klump et al., 2022; Ramalho et al., 2022). We examined a range of BE phenotypes, including clinically significant BE episodes as defined in the ICD-11 (i.e., loss of control over eating during which a person perceives they have eaten too much regardless of the actual amount consumed; World Health Organization, 2019), dimensional BE symptoms (i.e., thoughts/urges/behaviors related to BE, such as fear of losing control over eating and eating large amounts in secret), and emotional eating (EE; i.e., eating in response to negative emotions, which is a strong correlate and predictor of clinical BE; Ricca et al., 2009, 2012; Stice et al., 2002). This approach allowed us to capture behaviors that may be more common in population-based samples and examine whether associations with financial difficulties are similar across the spectrum of dysregulated eating.

Initial analyses focused on the full sample of twins. We first examined whether participants who experienced greater mean financial hardship across the study period (i.e., averaged across 49 days) reported greater dysregulated eating in the full sample. We also examined daily associations between financial hardship experienced on a given day and dysregulated eating on that day. We then conducted cotwin control analyses that examined whether twins who experienced more financial hardship than their cotwin across the study or on a given day also experienced more dysregulated eating than their cotwin. We expected individuals who experienced greater financial hardship to report more BE pathology both in the full sample and in cotwin control analyses. While

TABLE 1 Descriptive statistics for participant demographics and symptoms ($N = 158$)

Participant characteristics	Mean (SD) or % of sample (N)	Range	
Age	22.13 (3.71)	15–30	
Zygosity			
Monozygotic	68 (43.0%)	—	
Dizygotic	89 (56.3%)	—	
Unknown	1 (0.6%)	—	
Racial identity			
White	143 (90.5%)	—	
Black/African American	7 (4.4%)	—	
Asian/Asian American	4 (2.5%)	—	
More than one race	3 (1.9%)	—	
Not specified	1 (0.6%)		
Latina ethnicity	6 (3.8%)	—	
Gender identity			
Woman/female	157 (99.4%)	—	
Not specified	1 (0.6%)	—	
Sexual orientation			
Heterosexual/straight	123 (77.8%)	—	
Bisexual	13 (8.2%)	—	
Queer	1 (0.6%)	—	
Pansexual	1 (0.6%)	—	
Gay/lesbian	3 (1.9%)	—	
Asexual	14 (8.9%)	—	
Not specified	3 (1.9%)	—	
Combined parental income			
<\$20,000	0 (0.0%)	—	
\$20,000–\$40,000	9 (5.7%)	—	
\$40,000–\$60,000	10 (6.3%)	—	
\$60,000–\$100,000	59 (37.3%)	—	
>\$100,000	79 (50.0%)	—	
Not specified	1 (0.6%)		
Body mass index (BMI)	24.32 (4.64)	16.48–39.03	
	Mean (SD) or % of sample (N)	Sample range	Possible range
Financial hardship and symptom measures			
MEBS binge eating	1.28 (1.50)	0–7	0–7
Mean DEBQ emotional eating across the study	1.38 (.45)	1–3.44	1–5
Daily financial hardship	.37 (.60)	0–4	0–4
Mean financial hardship across the study	.39 (.53)	0–2.02	0–4
History of a lifetime ED diagnosis			
Lifetime anorexia nervosa	7 (4.4%)	—	—
	4 (2.5%)	—	—

TABLE 1 (Continued)

	Mean (SD) or % of sample (N)	Sample range	Possible range
Lifetime binge-eating disorder			
Lifetime OSFED	18 (11.4%)	—	—
Any lifetime ED	28 (17.7%)	—	—

Note: Interrater agreement for ED diagnoses assessed using the SCID was good ($\kappa > .75$). Gender identity was assessed with the item, “What is your gender identity? Select all that apply.” Options included: female/woman, male/man, transgender, agender, gender nonconforming, genderqueer/fluid, nonbinary, two-spirit, not listed (please specify), and prefer not to answer. Sexual orientation was assessed with the item, “What is your sexual orientation? Select all that apply.” Options included: asexual, bisexual, gay or lesbian, heterosexual, queer, pansexual, and not listed (please specify). Four participants chose “not listed” for sexual orientation and wrote in “straight.” These participants were included in the heterosexual/straight category for reporting purposes. Parental income is presented to provide an indication of the socioeconomic status of the sample; current income for adult participants was not collected. Participants were asked to report the approximate average annual combined income of their parents/caregivers, with response options: under \$20,000, \$20,000–\$40,000, \$40,000–\$60,000, \$60,000–\$100,000, over \$100,000, and prefer not to answer.

Abbreviations: BMI, body mass index; DEBQ, Dutch Eating Behavior Questionnaire; ED, eating disorder as assessed by the Structured Clinical Interview for DSM (SCID); MEBS binge eating, Minnesota Eating Behavior Survey binge eating subscale; OSFED, other specified feeding/eating disorder characterized by purging or other excessive weight control behaviors associated with overvaluation of weight/shape.

we included both monozygotic and dizygotic twins in initial cotwin control analyses to maximize power, we also examined whether associations were similar among monozygotic twins only.

2 | METHODS

2.1 | Participants

The current study involved secondary analysis of data from the ongoing *Twin Study of Exogenous Hormone Exposure and Risk for Binge Eating (EHE-BE)*, a 49-day longitudinal daily diary study of hormones and behavior conducted with women from the Michigan State University Twin Registry (MSUTR; Burt & Klump, 2013, 2019; Klump & Burt, 2006). We included all participants who completed the study between July 2020 when measures regarding financial stressors were added and October 2021. These dates spanned the height of the original COVID-19 outbreak and the 2021 Delta variant wave in the US.

Analyses included 158 female twins (32 monozygotic twin pairs, 41 dizygotic twin pairs, and 12 individuals [4 from monozygotic pairs, 8 from dizygotic pairs] without cotwin data on financial stressors) ages 15–30 (mean = 22.13, $SD = 3.71$). All participants completed the study after the initial paper from our group examining increases in ED symptoms at the beginning of the pandemic (Klump et al., 2022). Because EHE-BE focuses on the impact of combined oral contraceptives (COCs) on BE in women, eligibility criteria included: (1) member

of a female same-sex twin pair (as recorded on birth certificates/driver's licenses); (2) ≥ 1 twin taking COCs (participants not taking COCs required to have regular menstruation); (3) no pregnancy in the past year or lactation in the past 6 months; and (4) no history of genetic/medical conditions or current medications known to influence hormones/appetite/weight. Of note, mean financial hardship did not differ between participants taking and not taking COCs ($p = .513$, $d = .11$). Participant demographic information is reported in Table 1.

Adult participants provided written informed consent and adolescent participants provided written assent with consent provided by their parents. Study procedures were approved by the Michigan State University Institutional Review Board (protocol #04-715). Participants completed daily questionnaires (including measures of financial hardship and dysregulated eating) after 5 p.m. and as close to bedtime as possible (median = 11 p.m. to 12 a.m.) each evening for 49 days. Additional assessments were completed at the beginning (i.e., "intake assessment"), mid-point (~Day 23; "intermediate assessment"), and end (after Day 49; "final assessment") of data collection. Dropout was rare (0.5%).

2.2 | Measures

2.2.1 | Financial hardship during COVID-19

Financial hardship was assessed daily for 49 days using a five-item questionnaire recommended by the NIH PhenX Toolkit to evaluate the psychosocial impact of COVID-19 (Penedo et al., 2020). Items assessed overall financial difficulties ("I have experienced financial difficulties"), lack of basic necessities ("I have not been able to purchase or obtain basic necessities (e.g., food, personal care products)"), anxiety about job/income loss ("I have been anxious about losing or having lost my job, or my primary source of income"), inability to provide for others ("I have not been able to adequately provide for others I financially support"), and loss of health insurance, which is frequently tied to employment in the US ("I feel anxious about being able to maintain or not having adequate health care insurance") on that day. Each item was rated from 0 (*strongly disagree*) to 4 (*strongly agree*). Items were averaged to create an overall score, and this continuous score was used in all analyses. The continuous score had excellent internal consistency (average $\alpha = .91$). Notably, the correlation between mean financial hardship and average negative affect (NA) assessed with the Positive and Negative Affect Schedule (PANAS; Watson et al., 1988) was small and nonsignificant ($r = .12$, $p = .119$), suggesting reports of financial hardship were not merely tapping general NA/worry. Correspondingly, associations between financial hardship and dysregulated eating remained very similar when controlling for NA (see Table S1).

2.2.2 | BE phenotypes

Clinically significant BE episodes

We collected information about clinically significant BE episodes through two methods. First, participants reported whether they had experienced OBEs and/or subjective BE episodes (SBEs) during the

past 28 days at both the intermediate and final assessments on the Eating Disorder Examination Questionnaire (EDE-Q; Fairburn & Beglin, 1994). Second, participants reported whether they binge ate each day on daily questionnaires (assessed with a single item). To ensure participants provided valid reports of BE on daily questionnaires, they were given a detailed definition at intake (i.e., eating a large amount in a short period of time, accompanied by loss of control) and quizzed on their understanding at the intake and intermediate assessments (see Klump et al., 2014). These steps increase accuracy of self-reported BE (Celio et al., 2004) and are consistent with past research (Klump et al., 2014; Mikhail et al., 2021b).

Participants in the current study were defined as having BE episodes if they reported BE on daily questionnaires and OBEs or SBEs on the EDE-Q, or SBEs on the EDE-Q only ($n = 28$; 17.7%). Participants who reported SBEs on the EDE-Q but no BE on daily questionnaires ($n = 9$) were included in the BE group because our daily BE item was designed to assess OBEs, and thus participants with SBEs only would not have endorsed BE on daily questionnaires. Participants were defined as having no BE episodes if they reported no OBEs or SBEs on the EDE-Q and no BE on daily questionnaires ($n = 106$). The proportion of participants with BE during the study was comparable to rates previously observed for young adult women in community samples (Mond et al., 2006).

We combined OBEs and SBEs in primary analyses to ensure sufficient power to detect associations. Our approach of combining OBEs and SBEs is consistent with the ICD-11 and research showing that OBEs and SBEs are similarly associated with distress/impairment (Forney et al., 2014; Keel et al., 2001; Mond et al., 2010). However, we also conducted sensitivity analyses with other definitions of BE. Results were very similar if BE was defined more narrowly to only include participants with OBEs on the EDE-Q and daily questionnaires ($n = 12$), though these findings should be interpreted with caution given the smaller sample size (see Table S7). Results were also broadly similar using a more lenient definition that included anyone who reported OBEs or SBEs on the EDE-Q or any BE on daily questionnaires as having BE, albeit with slightly smaller effect sizes that may reflect inclusion of some participants with less severe BE pathology (see Table S2).

Dimensional BE symptoms

The 7-item Minnesota Eating Behavior Survey¹ BE subscale (MEBS; von Ranson et al., 2005) was used to examine dimensional BE pathology. MEBS BE successfully discriminates between individuals with and without BN (von Ranson et al., 2005). Internal consistency ($\alpha = .66$) was adequate and comparable to past studies.

The MEBS was administered at intake, on average 4 days ($SD = 4.67$, mode = 1 day) before participants began daily questionnaires. MEBS BE shows high test-retest reliability over extended

¹The Minnesota Eating Behavior Survey (MEBS; previously known as the Minnesota Eating Disorder Inventory [M-EDI]) was adapted and reproduced by special permission of Psychological Assessment Resources, 16,204 North Florida Avenue, Lutz, Florida 33549, from the Eating Disorder Inventory (collectively, EDI and EDI-2) by Garner, Olmstead, Polivy, Copyright 1983 by Psychological Assessment Resources. Further reproduction is prohibited without prior permission from Psychological Assessment Resources.

periods (three-year test–retest correlation = .68 in adult women; von Ranson et al., 2005) and financial hardship was also quite stable in our sample ($r = .84$ for financial hardship between the first 24 and last 25 days of questionnaires). Because of the stability of both measures, we believe analyses provide a good indication of the association between financial hardship and dimensional BE symptoms even though these constructs were not measured fully contemporaneously.

Emotional eating

EE was assessed each day using the 13-item Dutch Eating Behavior Questionnaire (DEBQ; van Strien et al., 1986) EE subscale modified with permission to refer to that day. DEBQ EE is strongly correlated with BE in past work (Ricca et al., 2009, 2012) and the current sample ($d = .86$, $p < .001$ for mean EE scores between participants with versus without BE as defined above), loss of control over eating (Goossens, Braet, et al., 2009; Goossens, Soenens, & Braet, 2009), and palatable food consumption (van Strien, 2000), and prospectively predicts development of more severe dysregulated eating (Stice et al., 2002). Internal consistency of the daily DEBQ EE subscale is excellent (average $\alpha = .90$ in the current study).

2.3 | Statistical analyses

2.3.1 | Missing data

Three participants (1.9%) had missing data on MEBS BE and 4 participants (2.5%) on the EDE-Q. Participants showed excellent compliance with the daily diary procedure, completing 89% of daily assessments on average. Missing EE or BE ratings on days when participants completed daily questionnaires were rare (0.2%). Missing values for financial hardship were somewhat more common (6.0%) because these items were added after some participants had already started daily questionnaires. Maximum likelihood estimation was used in all models, which produces relatively unbiased estimates with missing data (Black et al., 2011).

2.3.2 | Associations with mean financial hardship

We first examined how mean financial hardship was associated with BE/EE across the full sample. Mean EE and financial hardship were calculated by averaging daily values over the 49-day study. Mean EE and MEBS BE were log transformed due to positive skew, and all continuous variables were z-scored across participants. Analyses controlled for age given that participants' financial situations may be partially age dependent. We used multilevel models (MLMs) with a family-level random intercept for analyses of MEBS BE and mean EE and multilevel logistic regression with a family-level random intercept for analyses of the odds of any BE episodes.

2.3.3 | Associations with daily financial hardship

We then examined how daily levels of financial hardship were associated with daily dysregulated eating across the study in the full sample.

Daily analyses focused on EE and BE from daily questionnaires because they were assessed each day of the study, while MEBS BE was not. EE and financial hardship were standardized across observations. Analyses of BE used multilevel logistic regression with a random intercept at the participant level (we did not include a random intercept at the family level due to estimation difficulties likely resulting from fewer families in which both twins had BE). Analyses of EE used MLMs with random intercepts at the family and participant levels, a random slope at the participant level, and an AR(1) residual structure to account for autocorrelation. Models also controlled for day of study due to evidence of a small decrease in EE across time ($r = -.11$ between EE and day of participation).

2.3.4 | Cotwin control models

Finally, we examined how differences in financial hardship between cotwins in the same family were related to BE using cotwin control analyses. These analyses (McGue et al., 2010) were conducted for both mean financial hardship and daily financial hardship to examine how differences in financial hardship between twins in the same family (i.e., within-family effects of financial hardship) related to dysregulated eating. Mathematically, the cotwin control model can be described with the equation:

$$y_{ij} = \beta_0 + \beta_w(x_{ij} - \bar{x}_i) + \beta_b\bar{x}_i + \varepsilon_{ij}$$

where y_{ij} is the observed outcome for the j th twin ($j = 1, 2$) in the i th pair, x_{ij} represents financial hardship for an individual twin, $\bar{x}_i$ represents the mean level of financial hardship for that twin pair, β_w represents the within-family effect of financial hardship, and β_b represents the between-family effect of financial hardship. In this model, a significant β_w term suggests that individual-level financial hardship is associated with dysregulated eating *even after* controlling for all family level (environmental and genetic) factors that are shared between twins and may be correlated with individual financial status. A significant β_w term therefore provides strong evidence that financial hardship during COVID-19 is associated with BE even after accounting for many potential confounds.

We first included both monozygotic and dizygotic twins in cotwin control analyses to maximize power, then examined whether the overall pattern of effects was similar in the subsample of monozygotic twins ($n = 68$).

3 | RESULTS

3.1 | Descriptive statistics

Most participants (84.8%) reported some degree of financial hardship on at least one study day. The full possible range of BE pathology was represented on the MEBS (possible and observed range = 0–7), and

TABLE 2 Associations between mean financial hardship during COVID-19 and binge eating phenotypes across the sample

	β	SE	<i>p</i>	95% CI
MEBS binge eating				
Intercept	−.07	.08	.354	−.23, .08
Financial hardship	.27	.08	.001	.11, .43
Age	−.01	.08	.878	−.17, .15
	OR	SE	<i>p</i>	95% CI
Odds of binge eating during the study				
Intercept	.06	.06	.003	.009, .38
Financial hardship	2.11	.98	.110	.84, 5.25
Age	1.18	.59	.738	.45, 3.12
	β	SE	<i>p</i>	95% CI
Mean emotional eating on daily questionnaires				
Intercept	.04	.10	.689	−.15, .23
Financial hardship	.15	.08	.055	−.003, .31
Age	−.009	.10	.930	−.20, .18

Note: Mean emotional eating on daily questionnaires = average emotional eating score on the Dutch Eating Behavior Questionnaire averaged across the 49 days of the study (log transformed); MEBS binge eating = binge eating subscale score on the Minnesota Eating Behavior Survey (log transformed) Effects significant at $p < .05$ are bolded. Abbreviation: OR, odds ratio.

participants also showed good variability in mean EE (possible range = 1–5; observed range = 1–3.44) (see Table 1).

3.2 | Mean financial hardship

3.2.1 | Full sample

Across the sample, greater mean financial hardship was associated with significantly greater MEBS BE ($\beta = .27$; $p = .001$; 95% CI = [.11, .43]) (see Table 2). Effects for mean EE ($\beta = .15$; $p = .055$; 95% CI = [−.003, .31]) and odds of any BE during the study (OR = 2.11; $p = .110$; 95% CI = [.84, 5.25]) were nonsignificant, but in the same direction.

3.2.2 | Cotwin control

In cotwin control analyses, twins who experienced more financial hardship than their cotwin during the study also scored higher on MEBS BE ($\beta = .37$; $p = .003$; 95% CI = [.13, .62]) (see Table 3). Differences in mean financial hardship between monozygotic twins showed a similar association with MEBS BE ($\beta = .30$; $p = .036$; 95% CI = [.02, .58]; see Table 4), suggesting that this association was unlikely to be due to genetic confounds. Twins who experienced greater mean financial hardship than their cotwin also had nearly twice the odds of any BE—however, as in analyses across the full sample, this effect was

not statistically significant (OR = 1.90; $p = .289$; 95% CI = [.58, 6.19]). While twins from families with higher average financial hardship reported significantly greater mean EE ($\beta = .32$; $p = .011$; 95% CI = [.07, .56]), differences in financial hardship between twins from the same family were not significantly associated with EE ($\beta = .05$; $p = .625$; 95% CI = [−.15, .24]).

3.3 | Daily financial hardship

3.4 | Full sample

Participants who reported more financial hardship on a given day reported significantly more EE that day ($\beta = .08$; $p = .004$; 95% CI = [.03, .14]). The association between daily financial hardship and daily BE was nonsignificant, but in the same direction (OR = 1.50; $p = .070$; 95% CI = [.97, 2.32]) (see Table 5).

3.4.1 | Cotwin control

Participants who reported greater financial hardship than their cotwin on a given day also reported significantly more EE than their cotwin that day ($\beta = .07$; $p = .026$; 95% CI = [.008, .13]) (see Table 5). A nearly identical association was observed in the subsample of monozygotic twins ($\beta = .08$; $p = .032$; 95% CI = [.007, .14]). The difference in daily financial hardship between cotwins was not significantly associated with daily odds of BE; however, twins from families that reported higher average financial hardship than other twin pairs on a given day reported greater odds of BE that day (OR = 1.70; $p = .036$; 95% CI = [1.04, 2.80]).

3.4.2 | Post hoc analyses

In post-hoc analyses, we examined whether results were similar in adult twins (18 or older) and twins not living together in the family home, as financial status would likely differ most between cotwins in these subgroups. Results were nearly identical for both mean and daily financial hardship in adults 18 and older ($n = 140$; 88.6% of the sample; see Tables S3 and S4 and S7). Results were also very similar in participants living separately from their cotwin and/or outside of the family home ($n = 93$; 59.2%; see Tables S5–S7), though in some cases p -values were nonsignificant, likely due to smaller sample size.

We also conducted exploratory analyses examining whether associations were stronger in participants with a lifetime ED (assessed with the SCID; First et al., 1996) or from lower SES families (as measured by parental income), who may have been more susceptible to the impact of pandemic-related financial hardship. Associations between financial hardship and dysregulated eating did not significantly differ between participants with and without a lifetime ED (see Table S8). Interactions between financial hardship and parental income were also nonsignificant except in the model for daily BE,

TABLE 3 Cotwin control analyses examining the association between mean financial hardship during COVID-19 and binge eating phenotypes

	β	SE	<i>p</i>	95% CI
MEBS binge eating				
Intercept	−.07	.08	.350	−.23, .08
Financial hardship (between family)	.20	.10	.054	−.004, .41
Financial hardship (within family)	.37	.13	.003	.13, .62
Age	−.01	.08	.905	−.17, .15
	OR	SE	<i>p</i>	95% CI
Odds of binge eating during the study				
Intercept	.06	.06	.003	.009, .39
Financial hardship (between family)	2.41	1.70	.212	.61, 9.59
Financial hardship (within family)	1.90	1.14	.289	.58, 6.19
Age	1.16	.59	.767	.43, 3.14
	β	SE	<i>p</i>	95% CI
Mean emotional eating on daily questionnaires				
Intercept	.04	.10	.689	−.15, .23
Financial hardship (between family)	.32	.12	.011	.07, .56
Financial hardship (within family)	.05	.10	.625	−.15, .24
Age	−.02	.10	.872	−.21, .17

Note: Between family = the effect of family level differences in financial hardship; MEBS binge eating = binge eating subscale score on the Minnesota Eating Behavior Survey (log transformed); mean emotional eating on daily questionnaires = average emotional eating score on the Dutch Eating Behavior Questionnaire averaged across the 49 days of the study (log transformed); within family = the effect of differences in financial hardship between twins in the same family. Effects significant at $p < .05$ are bolded.

Abbreviation: OR, odds ratio.

which suggested the association between daily financial hardship and daily BE was stronger for participants with a *higher* parental income (see Table S9). Though sample sizes were small for interaction analyses and results should be interpreted with caution, findings suggest financial hardship during COVID-19 may have been associated with dysregulated eating even among people without an ED history/early socioeconomic disadvantage.

4 | DISCUSSION

Financial hardship was widespread during the COVID-19 pandemic, with negative implications for mental and physical health (Sampson et al., 2021; Witteveen & Velthorst, 2020). However, very little research has examined the relationship between financial hardship and key ED symptoms during COVID-19. In the current study, we found some preliminary evidence that individuals who experienced greater financial hardship during COVID-19 may have also been more likely to experience dimensional BE symptoms and EE. Associations with clinically significant BE episodes (i.e., OBEs/SBEs) were nonsignificant, but in the same direction. Results were consistent in cotwin control analyses, which showed that twins who experienced greater mean financial hardship than their cotwin across the study reported significantly greater dimensional BE symptoms, and twins who

reported more financial hardship than their cotwin on a given day reported more EE that day. While results cannot establish the directionality of associations between financial hardship and BE and additional research in larger samples is needed, our findings suggest BE may be elevated in individuals who faced financial hardship during the pandemic.

This is the first study to use a cotwin control design to examine associations between financial hardship and dysregulated eating. Results indicate that some associations between financial hardship and dysregulated eating persist even when comparing monozygotic twins who share 100% of their DNA and a common rearing environment. However, we also observed some nuances in cotwin control analyses. When examining financial hardship across the study, participants who experienced greater mean financial hardship than their cotwin reported significantly greater dimensional BE symptoms both in the full sample and the subsample of monozygotic twins, but they did not report greater EE than their cotwin. In daily analyses, this pattern was reversed—participants who reported more financial hardship than their cotwin on a given day reported more EE that day, but not greater odds of BE. Results could suggest financial hardship is most strongly associated with BE when it is persistent and prolonged. Conversely, temporary/day-to-day fluctuations in financial stressors may be more closely related to milder forms of dysregulated eating such as EE.

TABLE 4 Cotwin control analyses examining the association between financial hardship during COVID-19 and binge eating phenotypes in the subsample of monozygotic twins ($n = 68$)

MEBS binge eating				
	β	SE	p	95% CI
Mean financial hardship				
Intercept	−.16	.13	.205	−.42, .09
Financial hardship (between family)	.43	.17	.013	.09, .77
Financial hardship (within family)	.30	.14	.036	.02, .58
Age	.12	.13	.357	−.14, .39
	OR	SE	p	95% CI
Odds of binge eating during the study				
Intercept	.21	.08	<.001	.10, .43
Financial hardship (between family)	2.12	.98	.103	.86, 5.23
Financial hardship (within family)	1.59	.79	.350	.60, 4.21
Age	1.03	.36	.932	.52, 2.06
	β	SE	p	95% CI
Mean emotional eating on daily questionnaires				
Intercept	.02	.14	.858	−.24, .29
Financial hardship (between family)	.71	.18	<.001	.35, 1.07
Financial hardship (within family)	.09	.12	.443	−.14, .33
Age	.02	.14	.873	−.26, .30
Daily financial hardship				
	β	SE	p	95% CI
Daily emotional eating				
Intercept	.31	.14	.027	.04, .59
Financial hardship (between family)	.05	.03	.104	−.01, .12
Financial hardship (within family)	.08	.04	.032	.007, .14
Study day	−.008	.002	<.001	−.01, −.003
	OR	SE	p	95% CI
Daily binge eating				
Intercept	.0008	.001	<.001	.00004, .01
Financial hardship (between family)	1.64	.62	.186	.79, 3.43
Financial hardship (within family)	1.47	.54	.295	.72, 3.00
Study day	.96	.01	.009	.93, .99

Note: MEBS binge eating = binge eating subscale score on the Minnesota Eating Behavior Survey (log transformed); mean emotional eating on daily questionnaires = average emotional eating score on the Dutch Eating Behavior Questionnaire averaged across the 49 days of the study (log transformed); between family = the effect of family level differences in financial hardship; within family = the effect of differences in financial hardship between twins in the same family. Analyses of odds of any binge eating during the study in monozygotic twins excluded the family-level random intercept due to estimation difficulties likely resulting from the smaller sample size. The sample included 32 complete monozygotic twin pairs and 4 individuals from monozygotic twin pairs whose cotwin was missing data on financial hardship. Effects significant at $p < .05$ are bolded.

Abbreviation: OR, odds ratio.

We also observed associations between family-level financial hardship (i.e., averaged across twins) and dysregulated eating even among twins who were not living together in the family home. These effects could suggest that family-level environmental factors correlated with financial hardship are also associated with dysregulated eating. For example, between-family effects of financial hardship could reflect the lasting impact of childhood socioeconomic disadvantage on both twins in a family, particularly as childhood

disadvantage predicts lower income and educational attainment in adulthood (Corak, 2006). It is also possible that financial hardship among close family members is stressful even for individuals who are not experiencing financial difficulties themselves, and this stress could contribute to BE/EE risk. Assessment of individual and family-level financial hardship (including past socioeconomic disadvantage) may therefore be warranted in screening for BE following the pandemic.

TABLE 5 Daily cotwin control analyses examining associations between financial hardship and dysregulated eating on a given day of study participation

Full sample				
	β	SE	<i>p</i>	95% CI
Daily emotional eating				
Intercept	.28	.09	.002	.11, .46
Daily financial hardship	.08	.03	.004	.03, .14
Study day	−.008	.001	<.001	−.01, −.005
	OR	SE	<i>p</i>	95% CI
Daily binge eating				
Intercept	.0004	.0004	<.001	.00005, .003
Daily financial hardship	1.50	.33	.070	.97, 2.32
Study day	.97	.009	.007	.96, .99
Cotwin control analyses				
	β	SE	<i>p</i>	95% CI
Daily emotional eating				
Intercept	.29	.09	.002	.11, .47
Financial hardship (between family)	.07	.03	.003	.02, .12
Financial hardship (within family)	.07	.03	.026	.008, .13
Study day	−.008	.001	<.001	−.01, −.006
	OR	SE	<i>p</i>	95% CI
Daily binge eating				
Intercept	.0004	.0004	<.001	.00006, .003
Financial hardship (between family)	1.70	.43	.036	1.04, 2.80
Financial hardship (within family)	1.20	.37	.552	.65, 2.21
Study day	.97	.009	.009	.96, .99

Note: Study day = day of participation in the study; between family = the effect of family level differences in financial hardship on a given day of participation in the study; within family = the effect of differences in financial hardship between twins in the same family on a given day of participation in the study. Effects significant at $p < .05$ are bolded.

Several potential mechanisms could underlie an association between financial hardship and BE phenotypes during COVID-19. Financial hardship is typically accompanied by considerable psychological stress (Frankham et al., 2020), which is a substantial risk factor for BE (e.g., Fowler et al., 2022; Smith et al., 2021). Interestingly, we found that a measure of general COVID-19 related distress (i.e., “What level of stress and/or distress did you feel TODAY in relation to COVID-19?”) was not significantly correlated with financial hardship in our study ($r = .02$, $p = .810$), indicating the need for measures that tap psychological stress related to financial concerns in particular. For some, increased food insecurity during COVID-19 may have also triggered BE. However, this was an unlikely mechanism in our sample because reports of food insecurity were rare (present on only 2.1% of study days). Additional research is needed on other factors that may mediate associations between financial hardship and dysregulated eating, such as stress, increased social isolation, or decreased self-esteem.

The current study had several strengths, including an extended assessment of financial hardship during COVID-19, multiple measures

of BE, and a twin sample that facilitated cotwin control analyses. However, some limitations should be noted. Our overall sample and the number of participants with BE were relatively small, limiting power to detect associations between mean financial hardship and clinically significant BE. Though results regarding clinically significant BE were in the same direction as those for dimensional BE symptoms, results should be interpreted with caution and replication is needed in samples that include more participants with threshold BE and EDs. Our sample was predominantly White, and findings may not generalize across racial/ethnic groups. Additionally, our sample was relatively small for examining differences in associations across zygosity.

Although cotwin control analyses can examine whether associations persist after accounting for genetic and family environmental factors, they cannot definitively establish causality. This is particularly true in the case of MEBS BE, which was assessed directly before financial hardship rather than after. While our study provides some evidence of an association between financial hardship and BE phenotypes during COVID-19, longitudinal research is needed to determine

the directionality of effects. Associations between dysregulated eating and financial hardship may be reciprocal to some extent (i.e., BE leading to increased financial hardship as well as the reverse), though this is less likely in our population-based sample than in a clinical sample with higher rates of impairing eating pathology.

Nevertheless, our analyses provide preliminary evidence that individuals who faced financial hardship during COVID-19 may be at increased risk for BE pathology. It is therefore vital for screening efforts for BE and related EDs following COVID-19 to include outreach to disadvantaged communities, particularly as EDs are less likely to be recognized in people facing financial hardship (Sonneville & Lipson, 2018). Our findings also highlight the importance of affordable treatment options, as individuals experiencing financial difficulties may lack adequate insurance (particularly in the US) and be unable to pay out of pocket for care.

AUTHOR CONTRIBUTIONS

Megan E. Mikhail: Conceptualization; formal analysis; methodology; writing – original draft. **Lindsay S. Ackerman:** Data curation; methodology; project administration; writing – review and editing. **Kristen M. Culbert:** Methodology; writing – review and editing. **S. Alexandra Burt:** Funding acquisition; methodology; writing – review and editing. **Michael C. Neale:** Funding acquisition; methodology; writing – review and editing. **Pamela K. Keel:** Funding acquisition; methodology; writing – review and editing. **Debra K. Katzman:** Funding acquisition; methodology; writing – review and editing. **Kelly L. Klump:** Conceptualization; funding acquisition; methodology; supervision; writing – review and editing.

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CONFLICT OF INTEREST

The authors have no conflicts to declare.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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