Journal of Emotion and Psychopathology
2023, Vol 1, Issue 1, 336-344
https://doi.org/10.55913/joep.v1i1.25

Depressive Symptoms and Binge Eating in Children: Examining Symptom Specificity in a Population-based Sample of Male and Female Children

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Abstract

Introduction: Binge eating and compensatory behaviors have significant adverse health implications and are understudied among children. Studies have shown overlap between depressive symptoms and binge eating and compensatory behaviors, but little research has examined sex differences in depressive symptom specificity and binge eating and compensatory behaviors. The present study examined the associations between depressive symptoms and binge eating and compensatory behaviors among male and female children. **Methods:** Population-based data of 6,975 children ages 9 – 10 years and their caregivers from the multisite Adolescent Brain Cognitive Development (ABCD) study were analyzed. The Kiddie Schedule for Affective Disorders and Schizophrenia (K-SADS) was utilized to measure binge eating, compensatory behavior, and depressive symptoms. **Results:** There was an association between presence of anhedonia with increased likelihood of binge eating among females and males. There were no significant associations between individual depressive symptoms and compensatory symptoms among females or males. Lifetime DSM-5 major depressive disorder was associated with binge eating in males and females and compensatory behaviors in females. **Discussion:** This study provides new knowledge of the specificity of the association between depressive symptoms and binge eating in female compared to male children. Anhedonia may be a key clinical target to reducing binge eating in female and male children.

Keywords. depression; binge eating; children; sex differences; eating disorders.

Binge eating and compensatory behaviors are two prominent behaviors underlying eating disorders (American Psychiatric Association [APA], 2013). Binge eating is the consumption of a considerably large amount of food that is accompanied by loss of control when eating whereas compensatory behaviors refer to behaviors used to prevent weight gain, such as self-induced vomiting, laxatives, or excessive exercise (APA, 2013). The prevalence of binge eating in children and adolescents is high, with almost a quarter of youth with overweight and obesity reporting binge eating (He et al., 2017). Further, a minority of children meet criteria for full- and sub-clinical binge-eating disorder, with rates around 1.32% and 3.0%, respectively (Kjeldbjerg & Clausen, 2021). Compensatory behaviors are less common with population data showing prevalence estimates around 0.4% for male adolescents and 1.67% for female adolescents, with increasing prevalence across adolescence (Stephen et al., 2014). Binge eating and compensatory behaviors are associated with short-term negative psychological consequences, including shame, guilt, and social isolation (Goldschmidt et al., 2018; Hinrichsen et al., 2007). Long-term health consequences are increased risk for weight gain, type 2 diabetes, and heart disease as well as psychosocial problems (e.g., increased depression, stress, and social isolation) and reduced quality of life (Bohon, 2019; Mason & Heron, 2016; Striegel et al., 2012; Stephen et al., 2014; Tith et al., 2020).

Development of binge eating and compensatory behaviors in children may be due to a complex

*Corresponding Author: Tyler B. Mason ✉ tylermas@usc.edu
Received: 22 April 2022 | Revision Received: 24 August 2022 | Accepted: 9 September 2022
Handling Editor: David A. Preece
Published by Black Swan Psychological Assessments Pty Ltd
www.emotionandpsychopathology.org

interplay of psychological, environmental, and social factors (Crowther & Mizes, 2013; Tanofsky-Kraff et al., 2020), but one important factor that has been associated with binge eating and compensatory behaviors in children and adults is depression (Allen et al., 2013: Udo & Grilo, 2019). However, more research is needed to understand the nature of the association between depression and binge eating and compensatory behaviors and how this may differ between male and female children. Despite lower rates of depressive symptoms, binge eating, and compensatory behaviors among male children compared to female children, male children are not immune to engaging in binge eating and compensatory behaviors (Bohon, 2019; Olivardia, 2004; Stephen et al, 2014). Furthermore, depression may have different symptom manifestations in males versus females (Eid et al., 2019). Therefore, this necessitates understanding associations between different depressive symptoms and binge eating and compensatory behaviors among male and female children.

Depression is a common mental health problem among children and adolescents worldwide (Thapar et al., 2012). Individuals with depression can experience a range of symptoms such as sadness, irritability, fatigue, decreased energy, loss of interest, and loss of appetite (Fried & Nesse, 2015; Kanter et al., 2008). Studies have highlighted the significance of exploring these relationships among children and adolescents, as this developmental period is a critical stage for learning healthy and unhealthy habits and behaviors (Klomek et al., 2007; Lewinsohn & Essau, 2002; Cicchetti & Toth, 1998). For example, researchers have found that depressive symptoms are associated with maladaptive behaviors, including disordered eating, alcohol use, and tobacco use (Fluharty et al., 2017; Johannessen et al., 2017; Ortiz et al., 2019).

Among adolescent males and females and young adult women, composite scores of depressive symptoms are strongly associated with binge eating and compensatory behaviors (Sinclair-McBride & Cole, 2017; Skinner et al. 2012; Stephen et al., 2014). Specifically, longitudinal data provides evidence of a reciprocal relationship between total depressive symptoms and binge eating, where over time depressive symptoms predicted binge eating and vice versa (Sinclair-McBride & Cole, 2017). In a prospective study, male and female children with persistent loss of control eating experienced higher depressive symptoms over time (Tanofsky-Kraff et al., 2011). Also, a separate study showed that binge eating was predictive of the onset of elevated depressive symptoms among female and male adolescents and young adults (Sonneville et al., 2013). However, less research has examined how specific depressive symptoms are related to binge eating and compensatory behaviors in children.

Individuals with depression can present with a heterogeneous range of symptoms, which is also impacted by sex (Eid et al., 2019). For example, studies have shown that women are more likely to present with somatic- and cognitive-affective depressive symptoms compared to men (Marcus et al., 2008; Silverstein, 2002) whereas men are more likely to have melancholic features (e.g., anhedonia, psychomotor agitation) and feelings of worthlessness (Hildebrandt et al., 2003; Poutanen et al., 2009). Therefore, it is unclear if depression as a disorder is related to risk of binge eating and compensatory behaviors, or if there are specific symptoms that are associated with binge eating and compensatory behaviors in male and female children.

The purpose of the current study was to conduct a secondary data analysis using data from a population-based study of male and female children to examine associations between various depressive symptoms and likelihood of engaging in binge eating and compensatory behaviors. Analyses were conducted separately for male and female children. Given the strong association between depression and binge eating and compensatory behaviors and evidence of gender differences in depressive symptom presentation (Hildebrandt et al., 2003; Marcus et al., 2008; Poutanen et al., 2009; Silverstein, 2002), we expected there to be several depressive symptoms associated with binge eating and compensatory behaviors for male and female children. However, due to the exploratory study of examining individual depression symptoms separately among male and female children in relation to binge eating and compensatory behaviors, we did not generate any specific hypotheses.

Method

Participants and Procedure

This research utilizes data between 2016 to 2017 from the multisite longitudinal Adolescent Brain Cognitive Development (ABCD) study (Karcher & Barch, 2021). The ABCD study is an ongoing 10-year longitudinal study of children's health and neural development across adolescence and is being conducted at 21 sites across the United States. Children and their caregivers were mostly recruited though school systems near the 21 research sites. Representative sampling was implemented to ensure that the study participants would approximate United States population socio-demographics (Garavan et al., 2018). Participants of the study consist of 11,876 children, who were aged 8 through 10 years old at the time of recruitment, and their caregivers from across the United States. The

subjects' caregivers provided informed consent and children gave verbal assent. Children completed the study in English, but caregivers could complete the study in English or Spanish. The ABCD study protocol was approved by the Institutional Review Board at the University of California, San Diego. Data collection included completion of a battery of assessments completed by children and caregivers. The current study used baseline interview, self-report, and anthropometric data.

Measures

Baseline demographic and anthropometric measures.

Child sex assigned at birth, race/ethnicity, and household income were assessed by a demographics survey administered to caregivers (Barch et al., 2021). Race/ethnicity was categorized as White, Black, Asian, Hispanic, or Mixed/Other. Household income was categorized into <$50,000, $50,000 – $99,999, ≥100,000, or missing. Participants' height and weight were measured twice in the laboratory, and the averages were used to calculate body mass index percentiles (BMI%) using the CDC standards for age-sex-weight-height-specific cut-offs (Kuczmarski et al., 2000).

Kiddie Schedule for Affective Disorders and Schizophrenia (K-SADS; Kaufman et al., 1997).

The K-SADS semi-structured interview was administered to the child's caregiver and assessed for binge eating, compensatory behaviors, and depressive symptoms based on the Diagnostic and Statistical Manual of Mental Disorders, fifth edition (DSM-5) criteria (APA, 2013). Current binge eating and compensatory behaviors were each assessed as presence or absence of the respective behavior in the past two weeks. Binge eating required objective overeating and loss of control over eating to be present. Lifetime depressive symptoms used in the current study included lifetime presence of depressed mood, irritability, anhedonia, worthlessness, guilt, sleep disturbances, and concentration disturbances. Appetite and weight changes were not used in the current study given their high overlap with binge eating. Hopelessness was omitted as this symptom was not present in any children. Mood items (i.e., depressed mood, irritability, and anhedonia) were administered to the full ABCD sample whereas the other depressive symptom items were only administered to children who endorsed presence of the screening items (Barch et al., 2021). Lifetime DSM-5 major depressive disorder, binge-eating disorder, and bulimia nervosa diagnoses was calculated using depressive symptom and eating disorder KSADS module data.

Statistical Analysis

Analyses were conducted using SPSS v25.0 with complex sampling. Complex sampling allows for use of propensity weighting to correct for demographic selection bias and are provided with ABCD data. Chi-squared tests were first conducted to examine differences in endorsement of symptoms between male and female children. Next, bivariate correlations were run among lifetime depressive symptoms to examine multicollinearity. Two complex samples logistic regression were used to examine associations between lifetime depressive symptoms and current binge eating and compensatory behaviors. Each depressive symptom was entered concurrently as predictors of binge eating and compensatory behaviors. Covariates included race/ethnicity, income, and body mass index z-score (BMI-z). Models were run separately for males and females using the subsample function in the complex samples module. Models were also run examining the association of lifetime DSM-5 depressive disorder diagnosis and current binge eating and compensatory behaviors with the aforementioned covariates.

Results

Due to skip logic inherent in the KSADS administration (i.e., mood items were the only items given to the full ABCD sample), the analytic sample was comprised of 6,975 children. The analytic sample was 52.2% male and 47.8% female. The race/ethnicity of the sample was 53.9% White, 13.7% Black, 20.2% Hispanic, 2.0% Asian, and 10.2% Other. The mean BMI percentile score of children was 62.07 (SD = 30.75), and the mean age was 9.52 (SD = 0.51). The percent endorsement for individual symptoms and lifetime DSM-5 major depressive disorder, current binge-eating disorder, and current bulimia nervosa diagnoses for the total sample and comparisons by sex are displayed in Table 1. Irritability, depressed mood, anhedonia, and concentration disturbance were the most common symptoms present in children. Prevalence of several symptoms significantly differed by sex; irritability, decreased self-esteem, anhedonia, concentration disturbance, and binge eating were 21 – 40% less likely to be present in female children compared to male children. Bivariate correlations among depressive symptoms showed little evidence for multicollinearity, with depressive symptoms generally being moderately correlated (rs < .70 for both male and female children; see Table 2).

Table 3 displays the complex samples logistic regression of lifetime depressive symptoms in relation

Table 2. Frequency of Depressive symptoms and Binge Eating and Differences by Gender

	Total (N = 6,975)	Female Children (n = 3,326)	Male Children (n = 3,649)	χ^2 Test of Group Differences
Lifetime DSM-5 MDD, % present	4.4%	3.9%	4.9%	$\chi^2 = 4.84$, $p = .06$, OR = .77
Lifetime Depressive Symptom, % present				
Irritability	14.0%	12.4%	15.5%	$\chi^2 = 13.21$, $p = .002$, OR = .78
Indecision	9.8%	9.6%	10.0%	$\chi^2 = 0.36$, $p = .61$, OR = .95
Psychomotor retardation	3.1%	2.7%	3.4%	$\chi^2 = 2.91$, $p = .14$, OR = .79
Decreased self-esteem	8.6%	7.1%	10.0%	$\chi^2 = 19.26$, $p < .001$, OR = .68
Depressed mood	13.8%	13.3%	14.2%	$\chi^2 = 1.12$, $p = .36$, OR = .93
Anhedonia	12.0%	10.7%	13.1%	$\chi^2 = 9.61$, $p = .007$, OR = .79
Concentration disturbance	13.3%	10.3%	16.1%	$\chi^2 = 50.64$, $p < .001$, OR = .60
Fatigue	8.4%	8.2%	8.6%	$\chi^2 = 0.22$, $p = .68$, OR = .96
Hypersomnia	4.6%	5.0%	4.3%	$\chi^2 = 1.54$, $p = .29$, OR = 1.15
Guilt	5.5%	5.1%	5.9%	$\chi^2 = 1.72$, $p = .26$, OR = .87
Current binge eating, % present	6.1%	5.4%	6.7%	$\chi^2 = 5.86$, $p = .04$, OR = .78
Current compensatory behavior, % present	2.6%	3.0%	2.2%	$\chi^2 = 3.71$, $p = .09$, OR = 1.36
Current binge-eating disorder[1], % present	1.6%	1.5%	1.6%	$\chi^2 = 0.10$, $p = .78$, OR = .94
Current bulimia nervosa, % present	0.2%	0.1%	0.2%	$\chi^2 = 0.33$, $p = .57$, OR = .71

Note. DSM-5 = Diagnostic and Statistical Manual-Fifth edition; MDD = major depressive disorder; [1]Includes full- and sub-threshold binge-eating disorder

Table 1. Phi Correlations among Lifetime Depressive Symptoms

	1	2	3	4	5	6	7	8	9	10
1. Irritability	-	.49	.24	.49	.41	.43	.62	.37	.25	.34
2. Indecision	.45	-	.30	.45	.38	.45	.61	.44	.34	.36
3. Psychomotor retardation	.21	.33	-	.33	.27	.18	.36	.42	.36	.35
4. Decreased self-esteem	.44	.53	.29	-	.56	.33	.59	.44	.22	.58
5. Depressed mood	.37	.41	.27	.48	-	.32	.53	.41	.24	.45
6. Anhedonia	.38	.43	.23	.30	.29	-	.46	.34	.28	.20
7. Concentration disturbance	.50	.57	.38	.49	.49	.40	-	.54	.36	.44
8. Fatigue	.41	.56	.37	.43	.41	.37	.56	-	.49	.37
9. Hypersomnia	.27	.38	.24	.26	.31	.31	.38	.49	-	.22
10. Guilt	.34	.47	.30	.63	.41	.23	.41	.27	.21	-

Note. Correlations for male children are above the diagonal, and correlations for female children are below the diagonal. All correlations reached $p < .001$

to current binge eating stratified by sex. Among females, Black and Other race, compared to White race, were associated with lower likelihood of binge eating, and greater BMI percentile was related to greater likelihood of binge eating. Female children with lifetime anhedonia were almost 3 times more likely to have current binge eating compared to female children without lifetime anhedonia. No other depressive symptoms were associated with binge eating among female children. Among males, Hispanic ethnicity, compared to White race, and greater BMI percentile were associated with greater likelihood of binge eating. Male children with lifetime anhedonia present were about 1.5 times more likely to have current binge eating compared to male children without lifetime anhedonia. No other significant associations between depressive symptoms and binge eating emerged among males; although, of note, indecision

Table 3. Logistic Models of Individual Depressive Symptoms in Relation to Binge Eating, Stratified by Gender

	Odds of Binge Eating					
	Female			Male		
	OR	95% CI	*p*	OR	95% CI	*p*
Covariates						
Race			.006			.009
Black vs. White	0.33	0.18, 0.61		1.32	0.82, 2.11	
Hispanic vs. White	0.70	0.43, 1.15		1.73	1.18, 2.54	
Asian vs. White	1.68	0.44, 6.38		2.35	0.76, 7.25	
Other vs. White	0.50	0.26, 0.98		0.71	0.38, 1.33	
BMI percentile	1.05	1.04, 1.06	<.001	1.04	1.03, 1.06	<.001
Income	1.01	0.92, 1.11	.26			.30
$50,000-99,999 vs. <$50,000	1.40	0.83, 2.35		0.68	0.45, 1.03	
≥$100,000 vs. <$50,000	0.85	0.50, 1.46		0.79	0.51, 1.22	
Missing vs. <$50,000	1.08	0.57, 2.05		0.92	0.57, 1.50	
Depressive symptoms						
Irritability	1.70	0.96, 3.00	.07	0.71	0.44, 1.14	.15
Indecision	1.70	0.93, 3.10	.09	1.68	0.99, 2.86	.05
Psychomotor retardation	0.69	0.32, 1.47	.34	1.46	0.69, 3.07	.33
Decreased self-esteem	1.65	0.82, 3.34	.16	1.49	0.85, 2.60	.17
Depressed mood	0.58	0.33, 1.03	.06	0.81	0.51, 1.29	.38
Anhedonia	2.90	1.78, 4.72	<.001	1.60	1.02, 2.50	.04
Concentration disturbance	1.18	0.61, 2.27	.63	1.51	0.87, 2.63	.14
Fatigue	1.04	0.55, 1.96	.91	0.99	0.55, 1.76	.96
Hypersomnia	1.93	0.97, 3.82	.06	1.27	0.68, 2.39	.46
Guilt	1.05	0.48, 2.31	.90	1.63	0.93, 2.86	.09

Note. Significance is based off of overall Wald *F* test; BMI = body mass index.

was associated with greater likelihood of binge eating at a marginal threshold of significance ($p = .05$). In models of associations of lifetime DSM-5 major depressive disorder and binge eating, lifetime DSM-5 major depressive disorder diagnosis was associated with current binge eating in male (OR = 2.93; 95% CI: 1.75, 4.89) and female (OR = 3.40; 95% CI: 1.89, 6.09) children.

Table 4 displays the complex samples logistic regression of lifetime depressive symptoms in relation to current compensatory behavior stratified by sex. No variables were independently associated with current compensatory behavior among female children. Among males, Black, Hispanic, and Asian race, compared to White race, and higher BMI percentile were associated with greater likelihood of compensatory behavior. $50,000 – <$99,999 and missing income were associated with a lower likelihood of compensatory behavior compared to <$50,000 income. There were no significant independent associations between depressive symptoms and current compensatory behavior among males. In models of associations of lifetime DSM-5 major depressive disorder and compensatory behaviors, lifetime DSM-5 major depressive disorder diagnosis was associated with current compensatory behavior in female children (OR = 2.93; 95% CI: 1.13, 7.61) and approached significance in male children (OR = 2.48; 95% CI: 0.95, 6.44).

Discussion

A wealth of previous research has investigated the overlap of depression and binge eating, but limited studies have been conducted among children. The current analyses showed that male children had higher levels of irritability, decreased self-esteem, anhedonia, concentration disturbance, and binge eating compared to female children. While depressive symptoms and binge eating have been historically higher among female children and adults, these findings may reflect new increases in the occurrence of these symptoms in male children. Findings from our analysis showed evidence for depressive symptom specificity and binge eating among male and female children, but no depressive symptom independently was associated with compensatory behaviors.

Among male and female children, anhedonia was associated with a greater likelihood of binge eating, with a stronger effect size among female children compared to male children. No other depressive symptoms (i.e., irritability, indecision, psychomotor retardation, decreased self-esteem, depressed mood, anhedonia, concentration disturbance, fatigue, hypersomnia, and guilt) were independently associated with binge eating. These results are consistent with previous studies examining relationships between anhedonia with binge eating. Other research among individuals with overweight and obesity has shown that anhedonia was associated with binge eating, as well as

Table 4. Models of Individual Depressive Symptoms in Relation to Compensatory Behavior, Stratified by Gender

	Odds of Compensatory Behavior					
	Female			Male		
	OR	95% CI	*p*	OR	95% CI	*p*
Covariates						
Race			.47			.001
Black vs. White	1.99	0.18, 0.61		2.73	1.22, 6.14	
Hispanic vs. White	1.81	0.43, 1.15		2.52	1.25, 5.04	
Asian vs. White	1.56	0.44, 6.38		4.31	1.01, 18.54	
Other vs. White	1.86	0.26, 0.98		0.44	0.14, 1.39	
BMI percentile	2.22	0.81, 6.11	.56	1.02	1.01, 1.03	.03
Income			.45			.02
$50,000-99,999 vs. <$50,000	0.85	0.43, 1.69		0.41	0.17, 0.97	
≥$100,000 vs. <$50,000	0.63	0.27, 1.43		0.97	0.44, 2.13	
Missing vs. <$50,000	1.31	0.60, 2.83		0.20	0.05, 0.81	
Depressive symptoms						
Irritability	0.76	0.35, 1.67	.50	2.13	0.79, 5.73	.14
Indecision	2.01	0.74, 5.44	.17	2.50	0.90, 6.94	.08
Psychomotor retardation	0.57	0.18, 1.87	.36	2.66	0.99, 7.18	.05
Decreased self-esteem	0.58	0.16, 2.12	.41	1.49	0.85, 2.60	.70
Depressed mood	2.06	0.88, 4.85	.10	1.20	0.46, 3.15	.72
Anhedonia	1.73	0.79, 3.82	.17	0.44	0.19, 1.06	.07
Concentration disturbance	0.79	0.29, 2.19	.65	0.56	0.14, 2.19	.40
Fatigue	1.09	0.42, 2.81	.86	4.51	0.99, 20.39	.05
Hypersomnia	1.93	0.97, 3.82	.12	0.89	0.33, 2.41	.82
Guilt	1.05	0.48, 2.31	.26	1.20	0.45, 3.17	.71

Note. Significance is based off of overall Wald *F* test; BMI = body mass index.

uncontrolled and emotional eating (Keränen et al., 2010). Researchers have also suggested that given the positive associations between anhedonia and maladaptive eating behaviors reported in previous studies, a possible explanation is that individuals who experience anhedonia may use food as an attempt to increase their pleasure levels (Mason et al., 2021). To our knowledge, little research has been conducted on the relationships between anhedonia with binge eating among adolescents, and additional studies are needed to increase understanding of the role that anhedonia may play in facilitating binge-eating behavior among this group, especially as there may be more complex developmental explanations for the nature of these associations.

The results suggest that there were no significant independent associations between specific depressive symptoms and compensatory behaviors among male and female children, yet DSM-5 major depressive disorder diagnosis was associated with greater likelihood of compensatory behaviors. It is possible that severity of depressive symptoms or a combination of symptoms may be important predictors of compensatory behaviors rather than merely presence or absence of individual symptoms.

Strengths of this study include the large population-based sample of children with data obtained through clinical interviews. Further, this study sample was representative of the United States population and thus diverse with respect to sociodemographic characteristics. However, while this study furthers our understanding on the association between binge eating and depressive symptoms in adolescents, there are limitations present that should be noted. While the measures included in the K-SADS assessed for presence or absence of binge eating, compensatory behavior, and symptoms associated with depression, they were only assessed using single dichotomous items. Also, due to the skip logic of the KSADS, the sample of this study consists of only those children whose caregiver endorsed one of three depressive mood items (i.e., depressed mood, irritability, and anhedonia). In addition, we only focused on lifetime depressive symptoms as current depressive symptoms had low prevalence. Another limitation is that there were no data obtained on the severity of the participants' symptoms and lastly, only the parent assessments were examined. Finally, in general, the confidence intervals for the associations between depressive symptoms and binge eating and compensatory behavior were wide, likely due to the overall low prevalence of symptoms. It is important for future research to study such areas to better understand the association between depression and binge eating.

The current study findings have important implications for research and clinical interventions on the comorbidity of depression and binge eating in children and adolescents. Specifically, anhedonia appears to be a key symptom of depression linked to binge eating in male and female children. As such, interventions focused on reducing anhedonia may be important interventions and preventions for childhood

binge eating. For example, Positive Affect Treatment (Craske et al., 2016) is one type of psychological treatment that is efficacious at reducing anhedonia and may be useful as a childhood binge-eating treatment. No independent associations were identified for compensatory behaviors, except for meeting DSM-5 major depression diagnostic criteria. As such, more comprehensive treatments of depression may be needed for prevention of compensatory behaviors.

Additional Information

Funding

This project was supported in part by grant K01DK124435 from the National Institute of Diabetes and Digestive and Kidney Diseases Award Number (NIDDK).

Conflict of Interest

The authors have no conflicts of interest to disclose.

Ethical approval

The ABCD study protocol was approved by the Institutional Review Board at the University of California, San Diego.

Data Availability

Data are available by request through the NIMH Data Archive (NDA): https://nda.nih.gov/

Author CRediT Statement

Tyler Mason: Conceptualization; Methodology; Statistical Analysis; Writing-Original Draft; **Diana Zhang:** Writing-Review & Editing; **Diana Castillo:** Writing-Original Draft; Writing-Review & Editing; **Rachel Dayag:** Writing-Original Draft; Writing-Review & Editing; **Kathy Lam:** Writing-Original Draft; Writing-Review & Editing; **Jeremy Morales:** Writing-Review & Editing; **Kathryn Smith:** Conceptualization; Methodology; Writing-Review & Editing

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