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Mothers' loss of control over eating during pregnancy in relation to their infants' appetitive traits

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Introduction

Infants' appetitive traits, which represent individual variation in appetite and eating behavior,¹ predict obesity risk in later infancy and childhood.^{2–4} Early studies of infant sucking rate found that a vigorous eating style, including sucking more rapidly and with greater pressure, in infancy was associated with higher caloric intake and greater adiposity at age two.⁵ Food approach behaviors, such as responsiveness to food cues, are linked to higher BMIs and greater weight gain during infancy, whereas food avoidance behaviors, such as responsiveness to satiety cues, are linked to lower BMI and less weight gain during infancy.^{3,4} Thus, infancy is a critical period for understanding appetitive traits.

Infant appetitive traits are a complex set of behaviors with a multifactorial etiology. The behavioral susceptibility theory posits that genetic susceptibility to obesity is partly attributable to appetitive traits⁶, highlighting the heritability of infant appetite.^{7,8} Parental characteristics and behaviors also are associated with infant appetite. For example, infant appetite is associated with parental eating behaviors⁹ and parental weight. Compared to infants born to parents with normal weight, infants of parents with overweight/obesity have higher suck rates¹⁰ and a higher number of sucks¹¹ during feeding tasks. A higher number of sucks in infancy also predicts higher weight at age 2 years, suggesting that infant appetite may be a prognostic indicator of obesity¹¹. Given that appetite is a proposed target in the prevention of obesity⁶, it is important to identify early precursors of infant appetitive traits such as maternal characteristics during pregnancy.

Although maternal weight is associated with infants' appetite,^{10,11} little is known about how maternal characteristics during pregnancy prospectively affect infant appetitive traits. Maternal eating behavior is one characteristic that could influence fetal and infant appetite

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development. We recently examined loss of control eating (LOC), an appetitive phenotype characterized by a sense that one is unable to control what or how much one is eating,¹² in a cohort of pregnant women with overweight and obesity. We found that LOC was present in nearly one-quarter of women during the first 20 weeks of pregnancy.¹³ This rate of LOC is similar to published studies among community samples of non-pregnant adults.¹² Recent studies in non-pregnant adults have demonstrated that binge eating, the experience of LOC coupled with the consumption of a large amount of food, relates to food approach behaviors and is associated with obesity.¹⁴ Prior research on LOC indicates that independent of the amount of food consumed, LOC represents a behavioral phenotype associated with psychiatric distress,¹⁵ obesity,¹⁶ and weight gain.¹⁷ Thus, we were interested in prospectively examining mothers' LOC during pregnancy in relation to their infants' appetitive traits. In particular, we were interested in this relationship among women with overweight/obesity, given that their infants are at greater risk for obesity.

Accordingly, in the current study, we interviewed pregnant women with overweight/obesity and examined the role of maternal LOC during pregnancy as a predictor of infant appetitive traits. We hypothesized that LOC in mothers during early pregnancy would be associated with obesity-related appetitive traits in infants: higher food responsiveness, higher enjoyment of food, lower satiety responsiveness, lower slowness in eating, and higher general appetite. We anticipated that LOC would be more strongly related to infant food responsiveness and satiety responsiveness, given that these infant appetitive traits have the most consistent associations with weight and weight gain in infants^{3,4} and children.¹⁸

Materials and Methods

Participants

We recruited eighty-six women who were participating in a longitudinal study of perinatal eating behavior in the context of overweight/obesity to provide information about their infants' appetitive traits. Participant characteristics are presented in Table 1. Women were eligible for the longitudinal study if they were 14 years old, were between 12–20 weeks gestation, had a pre-pregnancy BMI ≥ 25 kg/m², and singleton pregnancy. Exclusion criteria were use of weight-affecting medications, participation in weight-management programming, or psychiatric disorders requiring immediate treatment.

Procedure

The study site's Institutional Review Board approved the research, and participating women provided written informed consent. Women completed interviews, questionnaires, and weight and height measurements during early pregnancy and again at six months postpartum. Compensation was provided for completing assessments.

We administered the BEBQ in two ways. We contacted women who had already completed their final postpartum assessment for the larger study if they had delivered within the last 20 months. These thirty-four women (40% of the present sample) completed the BEBQ by phone. Fifty-two women (60% of the present sample) completed the BEBQ in-person as part of their questionnaire packet at six months postpartum.

Measures

Demographic and weight information—Women self-reported demographic information and pre-pregnancy weight, which has been shown to be valid among pregnant women.¹⁹ Height and weight during early pregnancy (12–20 weeks gestation) were measured via calibrated stadiometer and scale (SECA; Chino, CA), respectively. Weight gain during early pregnancy (early pregnancy [12–20 weeks gestation] weight minus pre-pregnancy weight), pre-pregnancy BMI (kg/m²), and early pregnancy BMI (kg/m²) were calculated.

Maternal LOC during pregnancy—We administered the Eating Disorder Examination-Pregnancy Version (EDE-PV) to assess LOC during women's first study visit (12–20 weeks gestation). The EDE-PV is a structured interview that evaluates eating disorder psychopathology and has been shown to be reliable among pregnant women.^{20,21} Data on LOC was obtained from the Overeating Section in which women's binge eating behaviors are assessed. Women, all of whom were in the first half of pregnancy, were asked about their experience of LOC in the past three months during early pregnancy. We recorded LOC as a dichotomous variable (presence [≥ 1 episode] or absence), given that the experience of LOC at least once is associated with psychological distress¹⁵ and has been found to be prevalent in women.¹² Interrater reliability for LOC episodes was high (intraclass correlation coefficient = .89).

Infant appetitive traits—Women completed the Baby Eating Behaviour Questionnaire (BEBQ), an 18-item parent-report measure of appetitive traits posited to confer risk for obesity, between 6–20 months postpartum. The BEBQ is a psychometrically-sound parent-report²² based on the Children's Eating Behaviour Questionnaire (CEBQ), which has high internal and test-retest reliability²³ and behavioral validity.²⁴ The BEBQ has demonstrated good internal reliability²² and behavioral validity.²⁵ The BEBQ has been used to evaluate infants at 3 months and retrospectively up to 20 months.²² Parents are instructed to focus on the period when infants are exclusively milk-fed, prior to the introduction of solid food.²² The five subscales of the BEBQ include: food responsiveness (6 items), enjoyment of food (4 items), satiety responsiveness (3 items), slowness in eating (4 items), and general appetite (1 item). Each subscale represents the average of the items and ranges from 1–5. Food responsiveness and enjoyment of food are considered to reflect food approach appetitive traits, whereas satiety responsiveness and slowness in eating are considered to reflect food avoidance appetitive traits.

Analyses

First, we ran descriptive statistics to describe the sample in terms of LOC during early pregnancy and mothers' report on their infants' appetitive traits via the BEBQ. We ran correlational analyses with the BEBQ subscales to provide descriptive information on the relationships between subscales in this sample.

We then used independent samples *t*-tests to compare women with and without LOC during early pregnancy on maternal and infant characteristics. Maternal characteristics included education, race, ethnicity, household income, maternal age, gestational age, BMI prior to

pregnancy, BMI during early pregnancy, and weight gain during early pregnancy. Infant characteristics included infant age and age when infant began eating solid foods.

Next, we used independent samples *t*-tests to analyze the primary relation between maternal LOC during early pregnancy and the BEBQ subscales. To provide a more stringent test of the relationship between maternal LOC and each BEBQ subscale, we followed any significant independent samples *t*-test with a regression analysis including relevant maternal and infant covariates. Statistical significance was determined by an alpha of .05, and standardized mean differences (*d*) are provided. Analyses were performed in IBM SPSS Statistics for Windows, Version 24.0 [IBM Corp., Armonk, NY].

Results

LOC during early pregnancy

Nineteen (22%) of the women reported experiencing at least one LOC episode during early pregnancy. Across the sample, the average number of LOC episodes reported was 1.69 ± 6.71 during the past three months of pregnancy, the median number of LOC episodes reported was 0, the interquartile range was 0, and the range of reported episodes was 0–55. Among women who endorsed LOC (22%), the mean number of LOC episodes was 7.63, the median number of LOC episodes was 2, the interquartile range was 8, and the range of reported episodes was 1–55 during the past three months of pregnancy.

Relationship with maternal and infant characteristics—As shown in Table 1, women with LOC did not differ from women without LOC in age, gestational age, weight gain during early pregnancy, education, race, ethnicity, income, their infants' age at the time of BEBQ completion or age when infant began eating solid food (p s > .07). Significant differences between women with and without LOC emerged in BMI prior to pregnancy ($t(43.44) = 2.87, p = .006$) and BMI during pregnancy ($t(84) = 2.36, p = .021$). More specifically, compared to women who did not report LOC, women with LOC had a lower BMI prior to pregnancy ($p = .006, d = -.66$) and during pregnancy ($p = .021, d = -.67$).

BEBQ Descriptive Statistics

Descriptive statistics and correlations for the BEBQ subscales are presented in Table 2. Each BEBQ subscale was correlated with at least one other subscale; however, these correlations were modest, supporting the examination of distinct subscales. Method of assessment (phone or in-person) did not affect the BEBQ subscale scores for food responsiveness, satiety responsiveness, slowness in eating, or general appetite (p s > .160), but was associated with enjoyment of food (mean difference = 0.25, $t(81.22) = 3.06, p = .003, d = .68$).

Associations between LOC and BEBQ Subscales

Table 3 provides the descriptive statistics of the appetitive traits among infants born to women with and without LOC and includes the associated independent samples *t*-tests. Women with LOC during early pregnancy reported higher infant food responsiveness than women who did not report LOC ($t(84) = -2.36, p = .021, d = .58$). LOC was not related to the other BEBQ subscales (p s > .130).

We followed up on the relationship between higher infant food responsiveness and LOC with a hierarchical regression including relevant covariates: (1) demographic variables significantly associated with maternal LOC (BMI prior to pregnancy, BMI during pregnancy; Table 1); (2) demographic variables significantly associated with food responsiveness (maternal age, education, and household income; $ps < .013$); and (3) variables that may affect maternal report of infant appetitive traits (infant age at the time of BEBQ completion, infant age at the time of solid food introduction, and BEBQ assessment method in-person or by phone). Together, the covariates were not significantly associated with infant food responsiveness (Step 1: $R^2 = .182$, $F(8, 60) = 1.67$, $p = .126$), and none of the individual covariates were associated with infant food responsiveness ($ps > .115$). The addition of LOC in Step 2 contributed significantly to the prediction of infant food responsiveness (change in $R^2 = .053$, $F(1, 59) = 4.08$, $p = .048$). Thus, the association between LOC and food responsiveness was evident in the model that included the relevant covariates ($\beta = .26$, $B = .58$, $SE = .29$).

Discussion

In this study, we present the first evaluation of maternal LOC during pregnancy in relation to infant appetitive traits. In line with our hypothesis, mothers who experienced LOC during early pregnancy reported higher food responsiveness in their infants than mothers who did not experience LOC during pregnancy. Moreover, the effect of maternal LOC on ratings of infant's responsivity to food held even after accounting for relevant covariates. These data suggest that a specific behavioral phenotype reflective of maternal eating behavior assessed in the first half of pregnancy may affect infants' responsivity to food cues. There are several reasons that the link between maternal LOC during early pregnancy and infants' food responsivity is notable.

First, given that the data collection process involved maternal report of infant appetitive traits, it is plausible that women who experience LOC may interpret their infants' behavior differently, and subsequently respond with different parent feeding strategies, than women who do not experience LOC. Indeed, maternal infant-feeding style is an environmental factor that has received much attention in relation to childhood obesity risk, and emerging data suggest that intervention focused on parents' feeding styles may benefit infants' eating patterns and weight trajectories.²⁶ Although additional research is needed on mothers' eating behavior during pregnancy as an opportunity for early intervention,²⁶ maternal LOC represents a potentially modifiable factor that can be addressed during pregnancy, may relate to parental feeding style, and may be useful in understanding infant appetitive traits and, ultimately, infant weight gain trajectories.

Second, maternal prenatal LOC was uniquely associated with one of the BEBQ subscales, food responsiveness. Food responsiveness is one aspect of food approach behavior and it may be the strongest indicator of appetitive traits and risk for obesity. Indeed, previous research has documented that food responsiveness is the appetitive trait measure most strongly associated with weight outcomes.² Food responsiveness has been shown to increase over time in children^{23,27} and, consistent with the behavioral susceptibility theory, food responsivity in children has been linked to the obesity-associated (FTO) gene.²⁸ Food

responsiveness also may be a precursor to maladaptive eating behaviors. Food approach behaviors in adults have been linked to binge eating, which includes the experience of LOC and consumption of a large amount of food.¹⁴ Thus, our finding linking maternal, prenatal LOC to infant food responsiveness suggest that maternal LOC during early pregnancy may represent a marker for infants' development of obesity-related eating styles.

Interestingly, apart from food responsivity, no other measure of infant eating behavior assessed on the BEBQ was associated with maternal LOC. Based on previous research indicating that food responsiveness and satiety responsiveness are most consistently related to infant weight,^{3,4} we had hypothesized that infant satiety responsiveness, also would be associated with maternal LOC during pregnancy. However, maternal LOC during pregnancy was not associated with infant satiety responsiveness, enjoyment of food, slowness in eating, or general appetite in infants born to mothers with overweight/obesity.

Strengths of the study include the use of a questionnaire designed to address infant appetitive traits, use of a longitudinal study design and use of a standardized, reliable interview for LOC designed to specifically capture eating behavior among women during pregnancy.²⁰ In addition, the present study examined the link between maternal LOC and infant appetite in the context of carefully considered covariates related to the demographic differences associated with maternal LOC (maternal BMI), infant food responsiveness (maternal age, education, and household income) and other variables that might have affected maternal report of infant appetitive traits (infant age at the time of BEBQ completion, infant age at the time of solid food introduction, and BEBQ assessment method). Finally, these data provide an initial examination into the link between maternal prenatal eating behavior and infant appetite among a sample of infants at high risk for obesity as a result of our focus on mothers with pre-pregnancy overweight/obesity.

Despite these strengths, there are some limitations to these data. Limitations of the study include the small sample size and that the groups of women with LOC and without LOC are unequal, although our rates of LOC are similar to those found in community samples of non-pregnant adults.¹² The unequal group sizes may have reduced our power to detect significant effects. Moreover, the sample is comprised of women with overweight/obesity only. We did not assess women with normal weight. The restricted maternal weight range may have affected our ability to discern a relation between maternal LOC and the other infant appetitive traits, and examining associations between maternal eating behavior and infant appetitive traits in a larger sample with women across the weight spectrum is warranted. Given that most studies of infant appetitive traits have compared children of parents with and without overweight/obesity, associations across the BEBQ subscales may emerge when including a sample of mothers with normal weight prior to pregnancy. In addition, the association we document relies on maternal report of infant appetitive traits, and it is possible that mothers' eating behavior influences their report on their infants' appetitive behavior.

In summary, we documented that among women with overweight or obesity prior to pregnancy, maternal LOC during early pregnancy was linked to infants' food responsiveness. The links between mothers' LOC during pregnancy and infant appetitive

traits will be important to investigate further in larger studies that include maternal prenatal eating patterns and associated biological processes, longitudinal assessment of infant weight trajectories, as well as behavioral assessments of infant appetitive traits. Although the BEBQ has been shown to be behaviorally valid,²⁵ future work that incorporates behavioral assessment along with maternal report of infant appetitive traits will provide stronger evidence for associations between maternal and infant behavior. Repeated assessments of LOC during pregnancy and infants' appetitive traits may also offer additional findings. It may be that rates of LOC vary considerably in later pregnancy, and that persistence of LOC across multiple time points would be even more strongly related to infant appetitive traits.

Conclusions

In conclusion, this is the first study to demonstrate that mothers' eating behavior during early pregnancy predicts their infants' appetitive behavior. Future research is warranted to understand the links between mothers' LOC during pregnancy and the impact on infant appetitive traits and risk for obesity.

Acknowledgments

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Table 1

Participant characteristics and differences among women with and without loss of control eating.

Variable	All Women N = 86 Mean (SD) or n (%)	Women with LOC n = 19 Mean (SD) or n (%)	Women with no LOC n = 67 Mean (SD) or n (%)
Maternal age (years)	29.12 (5.34)	30.37 (7.47)	28.76 (4.58)
Gestational age to date (weeks)	15.85 (2.51)	15.36 (2.41)	15.98 (2.54)
BMI prior to pregnancy (kg/m ²)	32.01 (6.74)	28.94 (4.67) **	32.88 (7.00) **
BMI during early pregnancy (kg/m ²)	33.34 (7.48)	29.87 (5.47) *	34.33 (7.70) *
Weight gain during early pregnancy (kg)	3.67 (7.58)	2.44 (5.17)	4.02 (8.13)
Education			
Grade school or some high school	6 (7%)	3 (16%)	3 (4%)
High school graduate/GED	16 (19%)	4 (21%)	12 (18%)
Some college/technical school	26 (30%)	6 (32%)	20 (30%)
4-year college graduate	16 (19%)	3 (16%)	13 (19%)
Post-graduate degree	22 (26%)	3 (15%)	19 (28%)
Race			
White or Caucasian	45 (52%)	7 (37%)	38 (57%)
Black or African American	34 (40%)	9 (47%)	25 (37%)
Mixed race	4 (5%)	2 (11%)	2 (3%)
Ethnicity (Hispanic/Latina)			
Yes	5 (6%)	3 (16%)	2 (3%)
No	81 (94%)	16 (84%)	65 (97%)
Household income			
\$30,000	46 (53%)	12 (63%)	34 (51%)
>\$30,000	40 (47%)	7 (37%)	33 (49%)
Infant age (months)	8.82 (3.88)	9.83 (4.96)	8.54 (3.51)
Age when infant began eating solid foods (weeks)	23.58 (9.32)	24.06 (9.20)	23.42 (9.45)

Abbreviations: BMI (body mass index); GED (General Educational Development certificate); LOC (loss of control eating [presence = 1, absence = 0]).

*
 $p < .05$,

**
 $p < .01$.

Descriptive statistics and correlations for appetite trait subscales on the Baby Eating Behaviour Questionnaire ($N = 86$).**Table 2**

Descriptive Statistics		Correlations		
Appetite Trait Subscale	Mean (SD)	Enjoyment of food	Satiety responsiveness	Slowness in eating
Food responsiveness	2.37 (0.96)	$r = -.15, p = .179$	$r = .04, p = .702$	$r = .09, p = .430$
Enjoyment of food	4.58 (0.41)		$r = -.35, p = .001$	$r = -.23, p = .032$
Satiety responsiveness	2.06 (0.59)			$r = .18, p = .091$
Slowness in eating	2.13 (0.66)			$r = -.27, p = .011$
General appetite	3.99 (1.11)			$r = -.15, p = .164$

Scores for each subscale range from 1–5.

Descriptive statistics of and independent samples t-tests comparing appetitive traits between infants born to women with and without loss of control ($N=86$).

Table 3

Appetite Trait Subscale	Women with LOC <i>n</i> = 19	Women with no LOC <i>n</i> = 67	Statistic	<i>p</i>	<i>d</i>
	Mean (SD)	Mean (SD)			
Food responsiveness	2.82 (1.11)	2.24 (0.88)	<i>t</i> (84) = −2.36	.021	.58
Enjoyment of food	4.64 (0.27)	4.56 (0.44)	<i>t</i> (48.58) = −1.09	.283	.22
Satiety responsiveness	2.18 (0.66)	2.03 (0.58)	<i>t</i> (84) = −0.94	.350	.21
Slowness in eating	2.33 (0.74)	2.07 (0.62)	<i>t</i> (84) = −1.58	.130	.38
General appetite	4.11 (0.99)	3.96 (1.15)	<i>t</i> (84) = −0.52	.606	.14

Notes: LOC (loss of control eating [presence = 1, absence = 0]). $d = (M_{LOC} - M_{noLOC}) / s_w$. M_{LOC} = mean for women with LOC, M_{noLOC} = mean for women with no LOC, and s_w = pooled within groups standard deviation. Positive d values indicate that women with LOC reported more symptoms than women with no LOC.