Eating in the Absence of Hunger and Weight Gain in Low-income Toddlers

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abstract

OBJECTIVE: To identify predictors of eating in the absence of hunger (EAH) in low-income toddlers, describe affect during EAH, test EAH as a predictor of body mass index (BMI), and examine the type of food eaten as a predictor of BMI.

METHODS: EAH, indexed as kilocalories (sweet, salty, and total) of palatable foods consumed after a satiating meal, was measured (n = 209) at ages 21, 27, and 33 months. Child gender, age, race/ethnicity, and previous exposure to the foods; maternal education and depressive symptoms; and family chaos, food insecurity, and structure were obtained via questionnaire. Child and mother BMI were measured. Child affect was coded from videotape. Linear regression was used to examine predictors of EAH and the association of kilocalories consumed and affect with 33 month BMI z-score (BMIz).

RESULTS: Predictors of greater total kilocalories included the child being a boy (P < .01), being older (P < .001), and greater maternal education (P < .01). Being in the the top quartile of sweet kilocalories consumed at 27 months and showing negative affect at food removal had higher BMIz (β = 0.29 [95% confidence interval 0.10 to 0.48] and β = 0.34 [95% confidence interval, 0.12 to 0.56], respectively).There was no association of salty kilocalories consumed or positive affect with BMIz.

CONCLUSIONS: There was little evidence that maternal or family characteristics contribute to EAH. EAH for sweet food predicts higher BMIz in toddlerhood. Studies investigating the etiology of EAH and interventions to reduce EAH in early childhood are needed.

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WHAT'S KNOWN ON THIS SUBJECT: Eating in the absence of hunger (EAH) is a measurable, genetically linked behavior that is associated with overweight in children ages 3 to 13 years. Previous work has shown the potential for behavioral intervention.

WHAT THIS STUDY ADDS: EAH occurs in toddlers. Consumption of sweet, but not salty, foods increases across toddlerhood during EAH, and greater EAH predicts greater adiposity at age 33 months.

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Eating behaviors, including greater food responsiveness, greater food enjoyment, less satiety responsiveness, lesser capacity to voluntarily inhibit eating, greater impulsivity, and lesser self-control have been linked with greater obesity risk and have been the topic of substantial investigation.[1] The continued consumption of foods past satiety, referred to as eating in the absence of hunger (EAH),[2] is correlated with greater food responsiveness and enjoyment, and less satiety responsiveness,[3] as well as greater adiposity.[4–15] Interventions that reduce responsiveness to food cues[16–18] have been shown to reduce EAH, but interventions that increase children's awareness of hunger and satiety cues had no effect.[16] Thus, EAH may primarily reflect food enjoyment and responsiveness as opposed to sensitivity to hunger and satiety cues.

There are a number of gaps in the existing literature. First, we have been unable to identify any studies of EAH that have focused on low-income children, who are at particularly high risk for childhood obesity[19] or children younger than age 3 years. Second, though some studies have examined the stability or change in EAH with age,[5,6,9–11,15] none have done so in children younger than 4 years. Third, studies examining maternal and family characteristics as predictors of child EAH[2,4,5,7–11, 14,20–23] have been in predominantly white cohorts with the exception of 1 study that examined only Hispanic children.[8] Fourth, children exhibit a liking for sweet taste even in the newborn period,[24,25] but whether the association between EAH and adiposity differs based on the type of food eaten in the absence of hunger has not been described. In addition, most studies on early childhood[2,4–15,20–22, 26,27] examine only the amount consumed as an outcome; we have been unable to find any studies that have also examined children's affect during the EAH protocol and how this affect may be associated with child adiposity. We posit that affect during the EAH protocol reflects food enjoyment and responsiveness, each of which have been correlated with kilocalories consumed during EAH[3] and greater adiposity in older children.[28]

Therefore, within a diverse cohort of low-income children followed longitudinally at ages 21, 27, and 33 months, we sought to address 4 objectives: (1) to examine child, maternal, and family characteristics predictive of EAH across toddlerhood; (2) to describe child affect during EAH; (3) to test the prospective association of EAH with BMI z-score (BMIz) at age 33 months; and (4) to examine the type of food eaten and the association with BMIz.

METHODS

Participants and Recruitment

Participants were recruited via flyers posted in community agencies serving low-income families between 2011 and 2014. The study was described as examining whether children with different levels of stress eat differently. Inclusion criteria were that the biological mother was the legal guardian, had an education level less than a 4-year college degree, and was at least 18 years old; the family was eligible for Head Start, the Women Infant and Children Program, or Medicaid and was English-speaking; and the child was between 21 and 27 months old, was born at a gestational age ≥36 weeks, and had no food allergies or significant health problems, perinatal or neonatal complications, or developmental delays. Mothers provided written informed consent. The University of Michigan institutional review board approved the study.

Mother–child dyads were invited to participate in 3 data collections at ages 21, 27, and 33 months; the data collection procedures at each age spanned across 5 days and included measures regarding eating behavior and biobehavioral self-regulation. A total of 244 dyads participated. Most (n = 186) dyads entered the study when the child was age 21 months, but 58 entered the study when the child was age 27 months to maximize recruitment; measures obtained at study entry are henceforth referred to as "baseline" measures. This report is limited to children who participated in at least 1 EAH protocol (scheduled to be obtained on the fifth day of data collection at each age) and one anthropometric measurement (scheduled to be obtained on the first day of data collection at each age). A total of 209 of the 244 participants participated in the EAH protocol at a minimum of 1 age point at which they also provided anthropometry. The 209 participants included in this analysis did not differ from the excluded participants with regard to child gender, child age, maternal BMI, maternal education, maternal depression, family chaos, food security, or family structure. Of the children with complete data included in this report, 47.4% were non-Hispanic white compared with 25.7% of those not included (P = .02). A total of 52 children (24.9%) participated at only 1 age point, 85 (40.7%) participated at only 2 age points, and 72 (34.4%) participated at all 3 age points. Mother–child dyads who participated at 2 or 3 age points did not differ at baseline from those who participated at only 1 age point with regard to child gender, child age, child race/ethnicity, maternal BMI, maternal education, maternal depressive symptoms, food security, or family structure. Those in the sample who participated at 2 or 3 age points, compared with those who participated at only 1, were more likely to report higher family chaos (Confusion, Hubbub, and Order Scale [CHAOS] score, 4.3 [SD, 3.3] vs 3.1 [SD, 3.0] [P = .03]).

TABLE 1 Foods Presented in EAH

Food	Serving	Weight (gm) per Serving, Mean (SD)	Kilocalories per Serving, Mean (SD)	Frequency of Eating in Last 4 wk[a], Mean (SD)		
				21 mo	27 mo	33 mo
Sweet foods						
Nabisco Original Chips Ahoy chocolate chip cookies	2 cookies	22.0 (0.7)	106.4 (3.5)	1.0 (1.1)	1.0 (1.1)	0.7 (0.7)
Nabisco Original Oreo cookies	2 cookies	23.2 (0.8)	109.3 (3.9)	1.0 (1.0)	0.9 (0.9)	0.8 (0.7)
Keebler Animal Cookies, Frosted	5 cookies	19.0 (1.5)	97.9 (7.0.8)	0.2 (0.7)	0.2 (0.5)	0.2 (0.5)
Nabisco Rainbow Candy Blast Chips Ahoy cookies	2 cookies	33.4 (1.2)	176.8 (6.4)	0.1 (0.4)	0.2 (0.5)	0.2 (0.4)
Kellogg's Keebler Fudge Stripe chocolate-coated cookies	2 cookies	23.6 (3.4)	122.1 (17.7)	0.2 (0.5)	0.2 (0.4)	0.2 (0.5)
Salty Foods						
Pringles potato chips	10 chips	18.2 (0.7))	97.6 (3.6)	1.6 (1.2)	1.7 (1.2)	1.6 (1.1)
Frito-Lay Cheetos cheese puffs	10 puffs	20.3 (3.3)	108.8 (17.5)	1.0 (1.3)	1.1 (1.1)	0.8 (1.0)

[a] Response options: 0 = never; 1 = 1to 3 times in the past 4 weeks; 2 = 1 time per week; 3 = 2 to 4 times per week; 4 = 5 to 6 times per week; 5 = 1 time per day; 6 = 2 to 3 times per day; 7 = 4 to 5 times per day; 8 = >6 times per day.

EAH Protocol

Mother–child dyads were invited to participate in a standardized protocol[2] to assess the child's EAH at ages 21, 27, and 33 months in the child's home. The mother was asked to have the child fast for 1 hour and then serve the child a typical lunch that included at least 2 different foods and 1 drink.

After the lunch ended, a research assistant presented a standardized plate of foods (Table 1) and told the child, "Here are some special treats you can eat." Mothers reported how often the child had eaten the food in the past 4 weeks (Table 1). To reduce food neophobia,[29] the experimenter ate 1 Oreo cookie off of the plate and said, "I'm going to have one, too. Mmm, this is really good. You can eat as much as you want." The child was given free access to the food. The mother was asked not to interact with the child during the protocol. After 10 minutes, the plate of food was removed. The remaining food was weighed and the amount consumed was calculated.

Affect was coded from video on a scale from 0 (none) to 2 (high intensity). Positive affect was coded for the 10 seconds during which the research assistant was delivering the plate to the child and the 40 seconds after plate presentation. Negative affect was coded for the 10 seconds during which the research assistant was moving to remove the plate from the child and the 10 seconds after plate removal. Interrater reliability was high (Cohen's $\kappa > 0.80$). A child whose positive affect was >0 after plate presentation was categorized as having "positive affect at food presentation." A child whose negative affect was >0 after plate removal was categorized as having "negative affect at food removal."

Anthropometry

Weight, length, and height of the child were measured by trained research staff. Weight-for-length z-score (WLZ) and BMIz were calculated based on the US Centers for Disease Control and Prevention growth charts.[30] Mothers' weight and height were measured and BMI calculated.

Questionnaires

Mothers reported child gender, birth date, and race and ethnicity; for this analysis, child race/ethnicity was categorized as non-Hispanic white versus not. Mothers reported maternal education (more than a high school diploma versus not), and family structure (single mother versus not). The Center for Epidemiologic Studies-Depression scale is a valid, reliable 20-item questionnaire[31] designed to measure depressive symptoms. Mothers respond to a scale ranging from 0 (rarely or none of the time) to 3 (most or all of the time), and responses are summed so that a higher score indicates more symptoms (range, 0–60). CHAOS[32] consists of 15 statements (true = 1, false = 0) that are designed to assess chaos in the home environment; scores range from 0 to 15, with higher scores reflecting more chaos. The US Department of Agriculture 18-item Household Food Security Survey[33] categorizes households as food secure versus not.

Statistical Analysis

Analyses were conducted by using SAS 9.4 (SAS Institute, Inc, Cary, NC). Univariate statistics were used to describe the sample. Bivariate analyses were conducted by using t tests and χ^2 tests. One-way repeated measure ANOVAs were used to test whether total, sweet, and salty calorie consumption differed across 21, 27, and 33 months. Cochran Q tests were used to test whether positive affect at food presentation and negative affect at food removal differed across 21, 27, and 33 months. If ANOVA or Cochran Q test results were significant ($P < .05$), then post hoc comparisons were conducted using paired t tests or McNemar tests.

Generalized estimating equations, using all available cases, were used to predict calories consumed, positive affect at food presentation, and negative affect at food removal, accounting for repeated measures within subjects. Predictor variables were added in 3 steps: child

TABLE 2 Characteristics of the Sample at Baseline (Study Entry at Either Age 21 or 27 mo; $n = 209$)

Variable	N (%) or Mean (SD)
Child	
Gender	
Girls	102 (48.8%)
Boys	107 (51.2%)
Race/Ethnicity	
White	107 (51.2%)
Black	54 (25.8%)
American Indian or Alaskan Native	0 (0.0%)
Asian or Pacific Islander	0 (0.0%)
Biracial	44 (21.1%)
Other	3 (1.4%)
Unknown	1 (0.5%)
Ethnicity	
Hispanic	23 (11.0%)
Not Hispanic	185 (88.5%)
Unknown	1 (0.5%)
WLZ (CDC norms)	0.51 (1.06)
Maternal	
BMI (kg/m^2)	32.0 (9.5)
Education	
High school or less	80 (38.3%)
More than high school	129 (61.7%)
CES-D score	12.5 (10.0)
Family	
CHAOS score	4.1 (3.3)
Food insecurity	
Food insecure	65 (33.9%)
Food secure	127 (66.1%)
Family Structure	
Single mother	46 (23.2%)
Not single mother	152 (76.8%)

CES-D, Center for Epidemiologic Studies-Depression scale.

characteristics (gender, age, race/ethnicity, and previous exposure to the EAH foods), maternal characteristics (BMI, education, and depressive symptoms); and family characteristics (household chaos, food security, and family structure). Child age, maternal BMI, depressive symptoms, and family structure were time varying covariates. At each step, variables that were statistically significant ($P < .05$) were retained and 95% confidence intervals were calculated. For binary variables, parameter estimates were converted to odds ratios.

Five multivariate linear regression models were used to predict child BMIz at 33 months from kilocalories consumed (total, sweet, and salty), positive affect at food presentation, and negative affect at food removal. To ease interpretation and given preliminary models suggesting that the relationship was nonlinear, we categorized kilocalories consumed into quartiles and compared the top quartile to the bottom 3 quartiles. The top quartiles at age 21 months were ≥114.3 kcal total, ≥84.1 kcal sweet, and ≥40.8 kcal salty. The top quartiles at age 27 months were ≥147.7 kcal total, ≥122.5 kcal sweet, and ≥46.2 kcal salty. These 5 models were fitted for predictors measured at age 21 months and again for predictors measured at age 27 months. Each model was adjusted for child gender, child race/ethnicity, maternal education, maternal BMI, food insecurity, and baseline child WLZ. These models followed the maximum likelihood (ML) approach, which produces valid estimates when missing data are missing at random.

RESULTS

Characteristics of the sample are shown in Table 2. The sample was 51.2% boys, 51.2% white, 25.8% black, and 11.0% Hispanic. The mean WLZ at study entry was 0.51 (SD 1.06). Among the mothers, 38.3% had an education level of a high school diploma or less. The sample size of participants contributing to analyses at each age is shown in Table 3. Amount of food consumed and affect during EAH are shown in Table 4 across ages. Total kilocalories consumed increased with age ($P < .001$). When examined separately by food type (sweet vs salty), there were only significant increases in the amount of sweet food, but not salty food, consumed. Positive affect at food presentation also increased with age ($P = .004$). Negative affect at food removal did not change with age.

Table 5 shows results of the multivariate models testing predictors of EAH. Being a boy, older child age, and more maternal education each predicted more kilocalories consumed. Being a boy and older child age each predicted more kilocalories of sweet food consumed. Older child age and food insecurity predicted display of positive affect at plate presentation. None of the child, maternal, or family characteristics predicted kilocalories of salty food consumed or the display of negative affect at food removal.

Results of the multivariate models predicting BMIz at 33 months are shown in Table 6. Neither kilocalories consumed nor affect at 21 months predicted 33-month BMIz. Both kilocalories of total and sweet food consumed at 27 months predicted greater 33 month BMIz. Kilocalories of salty food consumed at 27 months was not associated with 33 month BMIz. Showing negative affect at food removal at 27 months was associated with higher 33 month BMIz. Positive affect at plate presentation at 27 months was not associated with 33 month BMIz.

DISCUSSION

The main findings of this study were that EAH increased during

TABLE 3 Sample Size Contributing to Analysis at Each Age

	21 mo	27 mo	33 mo	Only 21 mo	Only 27 mo	Only 33 mo	Only 21 and 27 mo	Only 27 and 33 mo	Only 21 and 33 mo	Complete for 21, 27, and 33 mo	Any time point
Entered study at 21 mo and had complete anthropometry and EAH kcal consumed	143	111	94	38	4	3	27	12	11	68	163
Entered study at 27 mo and had complete anthropometry and EAH kcal consumed	N/A	43	38	N/A	8	3	N/A	35	N/A	N/A	46
Total participants (entered study at either 21 or 27 mo) with complete anthropometry and EAH kcal consumed	143	154	132	38	12	6	27	47	11	68	209

TABLE 4 Food Consumed and Affect During EAH Across Age

Variable	Age			*P*
	21 mo (*n* = 143)	27 mo (*n* = 154)	33 mo (*n* = 132)	
Kilocalories consumed, mean (SD)				
Total	87.3 (50.4)[a]	105.4 (65.7)[b]	122.6 (72.0)[c]	<.001
Sweet	57.6 (52.4)[a]	74.4 (60.8)[b]	89.5 (69.8)[b]	<.001
Salty	29.7 (24.6)	30.5 (28.4)	33.1 (32.3)	.30
Affect display, *N* (%)				
Positive at food presentation	96 (67%)[a]	124 (81%)[b]	116 (88%)[b]	.004
Negative at food removal	28 (20%)[a]	31 (20%)[a]	20 (15%)[a]	.62

Superscript letters that differ within a row indicate the means or proportions are significantly different between 2 ages.

toddlerhood, particularly for sweet foods. Greater intake of sweet food and the display of negative affect when the food was taken from the child predicted greater adiposity. To our knowledge, no other published reports have described EAH in children this young. The results of this study align with previous work in older children reporting that EAH increases with age[5,6,9–11,15] and is associated with increased adiposity.[4–15] The results also align with work in infants showing that parent-reported greater food responsiveness predicts greater prospective weight gain from ages 3 to 15 months.[34]

Although older children showed positive affect at food presentation, this positive affect was not associated with greater BMIz at 33 months. Rather, negative affect at food removal predicted greater subsequent BMIz. To our knowledge, no other studies have observed the behavior of children in response to the EAH protocol, and this is the first report describing a link between affect during key points in the EAH protocol and weight gain.

Boys were more likely to display EAH, especially for sweet food, which differs from previous literature that did not detect gender differences in EAH among older children.[2,6–8,12–14,22, 26, 27,35,36] The only maternal characteristic related to EAH was maternal education. Maternal BMI was not associated with EAH, which aligns with findings of some studies,[22] but not others.[8,10,11] It was hypothesized that the characteristics related to household stressors in these low-income families (CHAOS, food insecurity, single mother family structure) would predict EAH. However, no association was found. EAH has previously been shown to be heritable via the fat mass and obesity-associated (FTO) gene.[26,27] This behavior may be related to other biological factors that have yet to be identified.

The association between EAH and future weight status did not emerge until age 27 months. EAH is believed to reflect a biological predisposition to increased food cue reactivity. The food cue reactivity is believed to be a type of Pavlovian conditioning.[16] As such, it exemplifies a likely gene–environment interaction. For EAH and its effects on weight status to manifest, a child with a biological predisposition to increased food cue reactivity may need to have had sufficient exposure to food cues to elicit EAH. The findings suggest that the food cue reactivity is conditioned with repeated exposure to palatable foods before age 2 years, but the conditioned response is not detectable until age 27 months.

Interpretation of these findings should note the study limitations. The home-based protocol reduced experimental control, but increased ecological validity. The presence of

TABLE 5 Child, Maternal, and Family Characteristics Predicting EAH Kilocalories Consumed and Affect Displays (*n* = 209)

Predictor Variables	Food Consumed Variables			Behavior Variables	
	kcal Total β (95% CI)	kcal Sweet β (95% CI)	kcal Salty β (95% CI)	Positive Affect at Food Presentation OR (95% CI)	Negative Affect at Food Removal OR (95% CI)
Child					
Girls vs boys	−21.7 (−35.3 to −8.1)*	−19.2 (−32.9 to −5.5)*	—	—	—
Age (mo)	2.9 (1.8 to 3.9)*	2.7 (1.6 to 3.7)*	—	1.12 (1.06 to 1.17)*	—
Hispanic or not white vs non-Hispanic white	—	—	—	—	—
Frequency of eating in last 4 wk	—	—	—	0.54 (0.34 to 0.88)*	—
Maternal					
BMI	—	—	—	—	—
High school or less versus more than high school	−19.5 (−33.1 to −6.0)*	—	—	—	—
Depressive symptoms	—	—	—	—	—
Family					
CHAOS Score	—	—	—	—	—
Food Insecure versus not	—	—	—	—	—
Single mother versus not	—	—	—	—	—

Predictor variables were added in 3 steps: child characteristics, maternal characteristics; and family characteristics. At each step, only variables that were statistically significant ($P < .05$) were retained in the model. The dashes indicate that the variable was not statistically significant and was therefore not retained in the model. CI, confidence interval; OR, odds ratio.
* $P < .05$

TABLE 6 EAH Food Consumed and Behavior by Age Predicting BMIz at 33 Months

Age	Primary Predictor	Sample Size	33 mo BMIze β (95% CI)
21 mo	Kilocalories consumed (top quartile vs not)		
	Total	89	0.17 (−0.10 to 0.45)
	Sweet	89	0.24 (−0.04 to 0.52)
	Salty	91	0.02 (−0.23 to 0.27)
	Affect Display		
	Positive at food presentation (vs not)	91	−0.16 (−0.40 to 0.08)
	Negative at food removal (vs not)	91	−0.04 (−0.34 to 0.25)
27 mo	Kilocalories consumed (top quartile vs not)		
	Total	104	0.21 (0.01 to 0.40)*
	Sweet	104	0.29 (0.10 to 0.48)**
	Salty	105	−0.09 (−0.30 to 0.12)
	Affect Display		
	Positive at food presentation (vs not)	105	0.09 (−0.13 to 0.31)
	Negative at food removal (vs not)	105	0.34 (0.12 to 0.56)**

Each EAH variable was tested as a main effect in a separate model; all models were adjusted for gender, child race/ethnicity, maternal education, maternal BMI, baseline food insecurity, WLZ at 21 mo for 21-mo models and WLZ at 27 mo for 27-mo models.
* $P < .05$.
** $P < 0.01$.

the researcher during the protocol may have influenced the child's behavior. The fact that the researcher modeled eating a sweet food and not a salty food may have increased the likelihood that the toddlers ate sweet, as opposed to salty, foods. The longitudinal design is a strength, but because of the high-risk nature of the study cohort, attrition was high and there were missing data. Results may not be generalizable to other study populations outside low-income toddlers in the United States. Despite these limitations, the study was able to describe eating behavior in a very young age group longitudinally in a diverse population at a lower socioeconomic level than previous work.

CONCLUSIONS

Hedonic intake of sweet food is visible, starts to increase, and predicts weight gain in children younger than age 3 years. Given that EAH increases with age[5,6,9–11,15] and behavioral intervention has been shown to reduce EAH,[16] this study suggests that the timing of interventions targeting this behavior may need to occur before age 3 years. Developing interventions to reduce EAH that are developmentally appropriate for toddlers may be an important, novel intervention strategy. The lack of association with maternal and family characteristics suggests that further understanding of the etiology of EAH may require more studies about the underlying biology of this behavior.

ABBREVIATIONS

BMIz: BMI z score
CHAOS: Confusion, Hubbub, and Order Scale
EAH: eating in the absence of hunger
WLZ: weight-for-length z score

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