

University of Nebraska - Lincoln
DigitalCommons@University of Nebraska - Lincoln

Public Health Resources

Public Health Resources

2014

Bottle-Feeding Practices During Early Infancy and Eating Behaviors at 6 Years of Age

Ruowei Li

Centers for Disease Control and Prevention, ril6@cdc.gov

Kelley S. Scanlon

Centers for Disease Control and Prevention

Ashleigh May

Centers for Disease Control and Prevention

Chelsea Rose

Pennsylvania State University

Leann L. Birch

Pennsylvania State University - Main Campus, llb15@psu.edu

Follow this and additional works at: <http://digitalcommons.unl.edu/publichealthresources>

Li, Ruowei; Scanlon, Kelley S.; May, Ashleigh; Rose, Chelsea; and Birch, Leann L., "Bottle-Feeding Practices During Early Infancy and Eating Behaviors at 6 Years of Age" (2014). *Public Health Resources*. 504.

<http://digitalcommons.unl.edu/publichealthresources/504>

This Article is brought to you for free and open access by the Public Health Resources at DigitalCommons@University of Nebraska - Lincoln. It has been accepted for inclusion in Public Health Resources by an authorized administrator of DigitalCommons@University of Nebraska - Lincoln.

Bottle-Feeding Practices During Early Infancy and Eating Behaviors at 6 Years of Age

abstract

BACKGROUND: Evidence suggests an association of breastfeeding with a maternal feeding style (MFS) that is less controlling than formula feeding, which, in turn, may improve a child's self-regulation of eating. This study examines associations of bottle-feeding practices during infancy with MFS and children's eating behavior (CEB) at 6 years old.

METHODS: We linked data from the Infant Feeding Practices Study II to the Year 6 Follow-Up, which include 8 MFS and CEB measures adapted from previous validated instruments. Bottle-feeding practices during the first 6 months estimated by using the Infant Feeding Practices Study II were bottle-feeding intensity (BFI), mother's encouragement of infant to finish milk in the bottle, and infant finishing all milk in the bottle. Adjusted odds ratios (aORs) for associations of bottle-feeding practices with MFS and CEB at 6 years old were calculated by using multivariable logistic regressions controlling for sociodemographic characteristics and other feeding practices ($N = 1117$).

RESULTS: Frequent bottle emptying encouraged by mothers during infancy increased odds of mothers encouraging their child to eat all the food on their plate (aOR: 2.37; 95% confidence interval [CI]: 1.65–3.41) and making sure their child eats enough (aOR: 1.62; 95% CI: 1.14–2.31) and of children eating all the food on their plate at 6 years old (aOR: 2.01; 95% CI: 1.05–3.83). High BFI during early infancy also increased the odds of mothers being especially careful to ensure their 6-year-old eats enough.

CONCLUSIONS: Bottle-feeding practices during infancy may have long-term effects on MFS and CEB. Frequent bottle emptying encouraged by mothers and/or high BFI during early infancy increased the likelihood of mothers pressuring their 6-year-old child to eat and children's low satiety responsiveness. *Pediatrics* 2014;134:S70–S77

AUTHORS: Ruowei Li, MD, PhD,^a Kelley S. Scanlon, PhD, RD,^a Ashleigh May, PhD,^a Chelsea Rose, BA,^b and Leann Birch, PhD^b

^aDivision of Nutrition, Physical Activity, and Obesity, Centers for Disease Control and Prevention, Atlanta, Georgia; and

^bDepartment of Human Development and Family Studies, The Pennsylvania State University, State College, Pennsylvania

KEY WORDS

bottle feeding, maternal feeding style, children's eating behaviors, Infant Feeding Practice Study II, Year 6 Follow-Up Study

ABBREVIATIONS

AOR—adjusted odds ratio

BFI—bottle-feeding intensity

CEB—children's eating behavior

CEBQ—Children's Eating Behavior Questionnaire

CFQ—Children's Feeding Questionnaire

CI—confidence interval

EBM%—percentage of total milk feedings of expressed breast milk

IFPS II—Infant Feeding Practices Study II

MFS—maternal feeding style

NHM%—percentage of total milk feedings of nonhuman milk

Y6FU—Year 6 Follow-Up

Dr Li conducted the analysis and drafted the manuscript; and all authors had technical input on the analytic design and contributed to and approved the final manuscript.

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

www.pediatrics.org/cgi/doi/10.1542/peds.2014-0646L

doi:10.1542/peds.2014-0646L

Accepted for publication May 20, 2014

Address correspondence to Ruowei Li, MD, PhD, Division of Nutrition, Physical Activity, and Obesity, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, Mailstop F77, 4770 Buford Hwy NE, Atlanta, GA 30341. E-mail: ril6@cdc.gov

PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275).

Copyright © 2014 by the American Academy of Pediatrics

FINANCIAL DISCLOSURE: The authors have indicated they have no financial relationships relevant to this article to disclose.

FUNDING: This study was funded by the US Food and Drug Administration, Centers for Disease Control and Prevention, Office on Women's Health, National Institutes of Health, and Maternal and Child Health Bureau in the US Department of Health and Human Services.

POTENTIAL CONFLICT OF INTEREST: The authors have indicated they have no potential conflicts of interest to disclose.

This document is a U.S. government work and is not subject to copyright in the United States.

Despite the well-documented health benefits of breastfeeding compared with formula feeding,¹ there is little information on how early feeding choices predict later maternal feeding style (MFS) and children's eating behavior (CEB), with even less research exploring behavioral differences of both mothers and children that are influenced by how milk is delivered to infants.

Mothers who feed their infant at the breast have less obvious control over the quantity of their infant's milk intake, which may allow breastfed infants to grow in autonomy and self-regulate their milk intake. Thus, breastfeeding may promote an MFS that is less controlling and more responsive to infants' internal cues of hunger and satiety than does formula feeding.² In contrast to breastfeeding, which involves active engagement of infants in feeding, formula feeding can be a more passive process driven by caregivers, which may lead to poor infant self-regulation of milk intake. Theoretically, feeding infants human milk in a bottle is also controlled by the caregiver and may affect infants' self-regulation similar to formula feeding, but this theory has been difficult to test given the complex nature of infant feeding.³⁻⁵ In comparison with formula feeding, Taveras et al⁶ observed that mothers who breastfed longer reported less restrictive behavior regarding child feeding at 1 year. Farrow and Blissett⁷ found that breastfeeding, mediated by lower maternal use of controlling strategies, predicted more positive mealtime interactions between mothers and their 1-year-old infants. A less controlling MFS has been shown to promote a healthier eating behavior and weight during childhood.^{2,8,9} Although mothers' pressuring their child to eat is generally associated with reduced food preference for the foods the child is pressured to eat,

food restriction is conversely linked with greater intake of the restricted foods by the child,^{10,11} which was linked to overweight at age 3 years in a previous study.¹²

Most of the previous studies examining MFS and CEB in relation to infant feeding are either retrospective or unable to follow children beyond 3 years old. By using data from a national longitudinal study that followed mothers from the last trimester of pregnancy throughout the first year and then at the child's age of 6 years, this study examined the relationships between bottle-feeding practices during early infancy and MFS and CEB at age 6 years. Our hypotheses were as follows: (1) mothers who feed their children with high bottle-feeding intensity (BFI) and often encourage them to empty their bottles during early infancy have a feeding style that is more controlling when the child is 6 years old and will lead to the child developing an eating behavior that suggests poor self-regulation of intake and (2) children who are fed with high BFI and often finish the milk in the bottle during early infancy develop an eating behavior that may not support self-regulation of food intake at age 6 years.

METHODS

Sample

To test our hypotheses, we linked data from the Infant Feeding Practices Study II (IFPS II) to its Year 6 Follow-Up (Y6FU) study. IFPS II is a US national longitudinal study conducted collaboratively by the US Food and Drug Administration and the Centers for Disease Control and Prevention from May 2005 through June 2007. Approximately 2000 mothers were followed from the last trimester of pregnancy through the first year postpartum with nearly monthly questionnaires mailed at ~1, 2, 3, 4, 5, 6, 7, 9, 10.5, and 12 months after birth. The methods of the IFPS II were detailed in

an article in *Pediatrics* by Fein et al.¹³ Between March and June of 2012, the Food and Drug Administration and Centers for Disease Control and Prevention conducted a follow-up study of IFPS II when children were 6 years old (Y6FU). Y6FU was a cross-sectional mail survey with information collected on children's health, diet, development, and other factors. Detailed information on Y6FU is available in the article by Fein et al¹⁴ in this supplement.

Outcome Measure

The outcome of this study included 4 measures on MFS and 4 measures on CEB that were self-reported by mothers at Y6FU (Appendix). The MFS measures were adapted from the Child Feeding Questionnaire (CFQ) designed and validated by Birch et al.¹⁵ The CFQ evaluates parental beliefs, attitudes, and practices toward the children's diet and was designed to be used with parents whose children are consuming solid foods, with a suggested age range of ~2 to 11 years. The Y6FU includes 4 items adapted from the CFQ that assess maternal control of child food intake, particularly on "pressure to eat" and "food restriction." Each measure of MFS was dichotomized into "yes" (4 and 5 on the Likert scale) versus "no" (1, 2, and 3 on the Likert scale), with "yes" indicating a high maternal control either by pressuring to eat or restricting food intake.

The measures of CEB were selected from the Children's Eating Behavior Questionnaire (CEBQ) developed by Wardle et al.¹⁶ The CEBQ is a parent-rated 35-item instrument to assess 8 dimensions of eating behaviors in preschool-aged and older children, including satiety responsiveness, food responsiveness, enjoyment of food, fussiness, emotional overeating, emotional undereating, desire to drink, and slowness in eating. The Y6FU includes 4 items adapted from the CEBQ that

assess a child's self-regulation of food intake particularly on "satiety responsiveness" and "food responsiveness." Each measure of CEB was dichotomized into "yes" (4 and 5 on the Likert scale) or "no" (1, 2, and 3 on the Likert scale). Because there are no standard definitions and measures for a child's self-regulation, we considered low satiety response or high food responsiveness as an indication of poor self-regulation of food intake at 6 years old. Low satiety was defined as responding "yes" to the question about eating all the food on the plate or responding "no" to the question about the child losing his/her appetite for dinner if she/he had a snack just before. High food responsiveness was defined as a "yes" on either of the food responsiveness questions.

Main Exposure

The main exposures were 3 measures related to bottle-feeding practices during the first 6 months, including percentage of milk feedings given by bottle (BFI), mothers' encouragement of their infant to finish all the milk in the bottle (bottle emptying encouraged by mothers), and infants finishing all of the milk in the bottle (bottle emptying led by infants). Because the purpose of this study was to examine behavioral differences influenced by mode of milk delivery (breast versus bottle) rather than the type of milk (human milk versus nonhuman milk), BFI and bottle-emptying behaviors were estimated regardless of the type of milk in the bottle.

At each IFPS II postpartum survey, mothers were asked how often they breastfed or fed pumped breast milk, formula, or other types of milk (cow milk, soy milk, rice milk, goat milk, etc) in the past 7 days. On the basis of mothers' responses, we first estimated the percentage of total milk feedings that were at the breast (BF%), expressed breast milk (EBM%), or nonhuman milk

(NHM%), including formula, cow, or other milk at each survey ($BF\% + EBM\% + NHM\% = 100\%$) and then calculated BFI as the proportion of milk feedings given by bottle ($EBM\% + NHM\%$). The mean BFI over the first 6 months was calculated among mothers who answered at least 4 of the first 6 surveys and further dichotomized as low (0%–50%) versus high (51%–100%). At the 2-, 3-, 4-, 5-, and 6-month surveys, mothers were also asked to respond to the following questions on a 5-point Likert scale ("never," "rarely," "sometimes," "most of the time," or "always"):

1. "How often does your baby drink all of his or her bottle of formula?"
2. "How often does your baby drink all of his or her cup or bottle of pumped milk?"
3. "How often is your baby encouraged to finish a bottle if he or she stops drinking before the formula is all gone?"
4. "How often is your baby encouraged to finish a cup or bottle if he or she stops drinking before the pumped breast milk is all gone?"

Questions 1 and 3 were asked about infants who had consumed any formula in the past 7 days, whereas questions 2 and 4 were asked about those who had received breast milk. For bottle emptying led by infants, we estimated the average score on questions 1 and 2 during the first 6 months and then dichotomized it into "often," representing infants who "most of the time" or "always" emptied the bottle, and "rarely," representing infants who "never," "rarely," or "sometimes" emptied the bottle. Similarly, mothers' encouragement of their infant to empty the bottle was estimated by responses to questions 3 and 4 and then dichotomized into "often," representing mothers who "most of the time" or "always" encouraged their infant to finish the bottle, versus

"rarely," representing mothers who "never," "rarely," or "sometimes" encouraged their infant to empty the milk bottles.

Other Measures

To control for potentially confounding effects, we adjusted models for characteristics collected during pregnancy and year 1: maternal age (18–24, 25–29, 30–34, and ≥ 35 years), marital status (married versus not married), parity (primiparous versus multiparous), maternal education (high school or less, some college, or college graduate), household income defined as a percentage of the federal poverty index ($<185\%$, 185 to $<350\%$, or $\geq 350\%$),¹⁷ postpartum participation in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) program (yes versus no), race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanics, or others), prepregnancy BMI (BMI: <18.5 , 18.5–24.9, 25.0–29.9, and ≥ 30) on the basis of maternal recall prenatally, infant gender (male versus female), gestational age in weeks, birth weight in kilograms, age (weeks) when solid food intake was first reported, and age (weeks) when bottle of formula or expressed milk was first used.

Statistical Analysis

To test our hypotheses, we examined the association of bottle-feeding practices with each outcome measure separately in this study. We first examined the bivariate associations of BFI and bottle emptying encouraged by mothers or led by infants during early infancy with each MFS and CEB measure. We then constructed separate multiple logistic regression models for each outcome by entering BFI, bottle emptying encouraged by mothers, and bottle emptying led by infants during the first 6 months simultaneously into the model after adjusting for all of the other covariates.

RESULTS

Of the 1542 children who had data from both IFPS II and Y6FU, we excluded 20 children who had missing data on either MFS or CEB, 167 children with missing data on BFI, 125 with missing data on bottle emptying either encouraged by mothers or led by infants, and 113 with missing data on covariates. These exclusions left us with 1117 children who had complete data in the final analytical sample. Women excluded due to missing data were significantly more likely to be <25 years old, have a high school education or less, have a household income <185% of the federal poverty index, be a WIC participant, and have a race/ethnicity other than white. However, there were no significant differences in marital status, parity, prepregnancy BMI, or infant gender (data not shown).

Bivariate analyses revealed that mothers were more likely to encourage their 6-year-old child to eat all the food on his or her plate and to be especially careful to make sure their child ate enough if they had fed their infant with high BFI or often encouraged their infant to finish

the bottle of milk during early infancy and if their infant often drank all of the milk in the bottle during early infancy (Table 1). Similarly, children were more likely to eat all of the food on their plate at 6 years old if they were fed with high BFI or they often emptied the bottle of milk given to them during early infancy and if their mothers often encouraged their infant to finish the milk in the bottle during early infancy (Table 2).

Multivariable analysis on MFS outcomes indicated that the associations of bottle emptying encouraged by mothers during early infancy with both measures of maternal pressure to eat remained significant. However, BFI was only significantly associated with the measure on mothers being especially careful to make sure their child eats enough after controlling for bottle emptying either encouraged by mothers or led by infants during early infancy and other covariates (Table 3). Even though the maternal report for their 6-year-old child on “often/always eat all the food on the plate” was significantly associated with each measure of bottle-feeding practices during early

infancy in the bivariate analysis, it was only significantly associated with bottle emptying encouraged by mothers during early infancy in the multivariable analysis after controlling for BFI and bottle emptying led by infants during early infancy and other covariates (Table 4). Specifically, children who were often encouraged by their mothers to finish the milk bottles during early infancy were about twice as likely to eat all of the food on their plate at 6 years old than those who were rarely encouraged to do so during early infancy (adjusted odds ratio: 2.01; 95% confidence interval: 1.05–3.83) .

DISCUSSION

We found that mothers who fed their infant with high BFI and who often encouraged them to empty the milk bottles during early infancy were more likely to pressure their child to eat at age 6 years. Even though children who were fed with high BFI and often emptied the milk from the bottles during early infancy were more likely to eat all of the food on their plate at 6 years old in the crude analysis, these associations

TABLE 1 Mothers With Each Feeding Style at Child Age of 6 Years by Bottle-Feeding Practices During the First 6 Months

	N	MFS			
		Pressure to Eat		Food Restriction	
		Encourage My Child to Eat All of the Food on the Plate, % yes	Especially Careful to Make Sure My Child Eats Enough, % yes	Make Sure My Child Doesn't Eat Too Many Sweets or Junk Foods, % yes	If I Didn't Guide/Regulate, My Child Would Eat Too Much of His/Her Favorite Foods, % yes
All children	1117	23.7	33.3	53.6	37.5
Bottle-feeding practices during the first 6 mos					
Bottle feeding intensity (BFI)					
Low (0% to 50%)	549	18.6	24.6	55.4	37.7
High (51% to 100%)	568	28.7	41.7	52.0	37.3
<i>P</i>		<.01*	<.01*	.25	.90
Bottle emptying encouraged by mothers					
Rarely	943	21.0	31.6	53.2	36.6
Often	174	38.5	42.5	55.8	42.5
<i>P</i>		<.01*	<.01*	.54	.14
Bottle emptying led by infants					
Rarely	501	19.0	27.94	51.9	38.5
Often	616	27.6	37.66	55.0	36.7
<i>P</i>		<.01*	<.01*	.30	.53

Data from the IFPS II, 2005–2007, and Y6FU, 2012. BFI is defined as the percentage of milk feeds given by bottle. *P* values were obtained by χ^2 test for each association examined. **P* ≤ 0.05.

TABLE 2 Children With Each Eating Behavior at 6 Years Old by Bottle-Feeding Practices During the First 6 Months

	N	CEB at 6 y old			
		Satiety Responsiveness ^a		Food Responsiveness	
		Often/Always Eats All the Food on the Plate, % yes	My Child Will Lose Appetite for Dinner if He or She Has Had a Snack Just Before, % yes	My Child Is Always Asking for Food, % yes	If Allowed to, My Child Would Eat Too Much, % yes
All children	1177	5.6	36.4	11.5	8.4
Bottle-feeding practices during the first 6 mo					
Bottle feeding intensity (BFI)					
Low (0%–50%)	549	3.8	35.7	10.4	7.3
High (51%–100%)	568	7.2	37.0	12.5	9.5
P		.01*	.66	.27	.18
Bottle emptying encouraged by mothers					
Rarely	943	5.0	35.3	11.6	8.6
Often	174	8.6	42.0	10.9	7.5
P		.05*	.09	.81	.63
Bottle emptying led by infants					
Rarely	501	3.8	34.9	10.0	7.4
Often	616	7.0	37.5	12.7	9.3
P		.02*	.37	.16	.26

Data from the IFPS II, 2005–2007, and Y6FU, 2012. P values were obtained by χ^2 test for each association examined. * $P \leq 0.05$.

^a Low satiety was defined as a “yes” response to the question about eating all the food on the plate but a “no” response to the question about the child losing appetite for dinner if he or she had a snack just before.

were no longer significant after adjusting for bottle emptying encouraged by mothers during early infancy. The independent association between bottle emptying encouraged by mothers during early infancy and children often/always eating all the food on the plate at 6 years old suggests that children might be more likely to display low satiety responsiveness to food at 6 years

old if their mothers frequently encouraged them to empty their milk bottles during early infancy.

Previous studies revealed an association between breastfeeding and lower levels of maternal control, particularly pressure to eat and food restriction, during the first 2 years.^{6,7,18,19} The reasons for this relationship, however, remain unclear. Given the difficulties of

distinguishing the effect of milk delivery mode (breast versus bottle) from milk type (human versus nonhuman milk), these relationships were mostly examined in previous studies by comparing breastfeeding with formula feeding without differentiating feeding behaviors that emerge from different modes of milk delivery. Whereas bottle feeding allows mothers to monitor

TABLE 3 Odds of Having Each MFS by Bottle-Feeding Practices During the First 6 Months

Bottle-Feeding Practices During the First 6 mo ^a	MFS at 6 y old			
	Pressure to Eat		Food Restriction	
	Encourage My Child to Eat All of the Food on the Plate	Especially Careful to Make Sure My Child Eats Enough	Make Sure My Child Doesn't Eat Too Many Sweets or Junk Foods	If I Didn't Guide/Regulate, My Child Would Eat Too Much of His/Her Favorite Foods
Bottle feeding intensity (BFI)				
Low (0%–50%)	Ref	Ref	Ref	Ref
High (51%–100%)	1.36 (0.95–1.95)	1.73 (1.26–2.39)*	0.91 (0.68–1.21)	0.96 (0.71–1.30)
Bottle emptying encouraged by mothers				
Rarely	Ref	Ref	Ref	Ref
Often	2.37 (1.65–3.41)*	1.62 (1.14–2.31)*	1.07 (0.76–1.50)	1.41 (1.00–1.97)
Bottle emptying led by infants				
Rarely	Ref	Ref	Ref	Ref
Often	1.31 (0.96–1.79)	1.24 (0.94–1.64)	1.24 (0.96–1.60)	0.88 (0.68–1.14)

Data are adjusted odds ratios (95% confidence intervals) from IFPS II, 2005–2007, and Y6FU, 2012 ($N = 1117$). If the 95% confidence interval does not include 1, the findings are considered significant and shown with an asterisk (*). BFI is defined as percentage of milk feeds given by bottle. Ref, reference.

^a BFI (percentage of milk feedings given by bottle), bottle emptying encouraged by mothers, and bottle emptying led by infants were entered into each model simultaneously after adjusting for maternal age, marital status, parity, maternal education, household income, postpartum WIC participation, race/ethnicity, prepregnancy BMI, infant gender, gestational age, birth weight, and age when solid food or milk bottle was first reported.

TABLE 4 Odds of Having Each CEB by Bottle-Feeding Practices During the First 6 Months

Bottle-Feeding Practices During the First 6 mo ^a	CEBs at 6 y Old			
	Satiety Responsiveness		Food Responsiveness	
	Often/Always Eats All the Food on the Plate	My Child Will Lose Appetite for Dinner if He or She Has Had a Snack Just Before	My Child Is Always Asking for Food	If Allowed to, My Child Would Eat Too Much
Bottle feeding intensity (BFI)				
Low (0%–50%)	Ref	Ref	Ref	Ref
High (51%–100%)	1.63 (0.81–3.28)	1.02 (0.75–1.37)	0.89 (0.56–1.41)	1.04 (0.61–1.80)
Bottle emptying encouraged by mothers				
Rarely	Ref	Ref	Ref	Ref
Often	2.01 (1.05–3.83)*	1.30 (0.92–1.82)	0.96 (0.56–1.64)	0.77 (0.41–1.47)
Bottle emptying led by infants				
Rarely	Ref	Ref	Ref	Ref
Often	1.37 (0.75–2.50)	1.15 (0.88–1.49)	1.22 (0.82–1.83)	1.16 (0.72–1.85)

Data are adjusted odds ratios (95% confidence intervals) from IFPS II, 2005–2007, and Y6FU, 2012 ($N = 1117$). If the 95% confidence interval does not include 1, the findings are considered significant and shown with an asterisk (*). Ref, reference.

^a BFI (percentage of milk feedings given by bottle), bottle emptying encouraged by mothers, and bottle emptying led by infants were entered into each model simultaneously after adjusting for maternal age, marital status, parity, maternal education, household income, postpartum WIC participation, race/ethnicity, prepregnancy BMI, infant gender, gestational age, birth weight, and age when solid food or milk bottle was first reported.

the amount of milk consumed,^{20–22} mothers with infants who feed directly at the breast cannot measure the amount of milk their infant consumes, making it difficult to force the infant to continue feeding when satiated. As a result, mothers with infants feeding at the breast may develop a more responsive feeding style according to their infant's cues of hunger and satiety, which has been shown to be stable once developed.²³ Disentangling the effects of feeding mode from milk type by using a multilevel modeling approach, our previous longitudinal analysis using IFPS II observed a dose-response relationship between BFI and infant weight gain.²⁴ Because this study examined the effects of bottle-feeding practices during early infancy by simultaneously entering 3 measures of bottle feeding in the model after adjusting for confounding factors, the associations observed between bottle-feeding practices and maternal pressure on their child to eat were independent from each other as well as from many infant, maternal, and family characteristics.

Maternal bottle-feeding practices in infancy may also impact CEB later in life. It has been proposed that infants are born with some innate ability to

regulate their energy intake in response to internal appetite cues,^{25–28} but this natural ability could be altered by feeding experiences. Infants who are fed directly at the breast may be given greater opportunities to self-regulate their energy intake compared with infants fed by bottle. Many studies provide evidence on how breastfed infants regulate intake. Dewey and Lönnerdall²¹ found that exclusively breastfed infants maintained the same levels of energy intake when their mother's milk supply was stimulated. Studies also report that infants adapt to the volume of breast milk intake according to variations in fat content of the feeding,^{29,30} the content of morning versus afternoon feedings,²⁰ and the addition of solid foods to the diet.³¹ In contrast, the control of caregivers in bottle feeding may result in fewer opportunities for infants to self-regulate their milk intake. Lack of variation in content and taste of formula feedings may also play a role in poor responses of infants to internal cues of hunger and satiety. For example, the fat content of breast milk is much higher toward the end of each breastfeeding episode, which might serve as a physiologic

signal for infants to stop drinking the milk. Satiety responsiveness examines children's ability to self-regulate intake according to appetite, whereas food responsiveness examines the desire of the child to eat in response to food stimuli regardless of hunger. Testing whether children bottle-fed human milk or formula are at risk of low satiety response or high food responsiveness compared with children fed directly at the breast, Disantis et al⁴ found a significant association between direct breastfeeding and increased children's satiety response only among children aged 3 to 6 years. A more recent study showed that breastfeeding is associated with increased satiety responsiveness in children aged 18 to 24 months.³² Notably, our study found that frequent encouragement of mothers for their infant to empty the bottle during early infancy was significantly associated with children often/always eating all food on the plate at 6 years old after adjusting for BFI and bottle emptying led by infants and all covariates.

Our study has several strengths. First, IFPS II is the largest longitudinal study of infant feeding practices in the United States. Frequent surveys with almost

monthly intervals throughout the first year minimize the potential reporting bias for feeding measures. Second, the residual effects of other variables were limited by controlling for a wide range of potentially confounding variables. Furthermore, multiple outcome measures capture various behavioral dimensions related to MFS and CEB. However, our results are subject to some limitations. IFPS II is not nationally representative and 48% of respondents were unable to be contacted or did not respond to the Y6FU. Thus, our results may not be applicable to all US population groups.

Also, both MFS and CEBs were self-reported by mothers, with the possibility of biased reporting.

CONCLUSIONS

Bottle-feeding practices during infancy may have long-term effects on MFS and CEB. Frequent encouragement of mothers for their infant to empty the bottle during early infancy increased the likelihood of mothers pressuring their 6-year-old child to eat and their child's low satiety responsiveness displayed by eating all the food on the plate. High BFI during early infancy also increased the

odds of mothers being especially careful to ensure that their 6-year-old child eats enough. Because maternal over-control of feeding practices and children's lack of self-regulation of energy intake have been associated with childhood obesity,^{2,33–35} it is possible that 1 of the pathways linking breastfeeding and obesity involves behavioral mechanisms related to bottle feeding. It is important for health professionals to emphasize infant-led feeding and following infant appetite cues when advising new parents, particularly when parents are bottle feeding.

REFERENCES

- Ip S, Chung M, Raman G, et al. Breastfeeding and maternal and infant health outcomes in developed countries. *Evid Rep Technol Assess (Full Rep)*. 2007;153(153):1–186
- Faith MS, Scanlon KS, Birch LL, Francis LA, Sherry B. Parent-child feeding strategies and their relationships to child eating and weight status. *Obes Res*. 2004;12(11):1711–1722
- Bartok CJ. Babies fed breastmilk by breast versus by bottle: a pilot study evaluating early growth patterns. *Breastfeed Med*. 2011;6(3):117–124
- Disantis KI, Collins BN, Fisher JO, Davey A. Do infants fed directly from the breast have improved appetite regulation and slower growth during early childhood compared with infants fed from a bottle? *Int J Behav Nutr Phys Act*. 2011;8:89–100
- Li R, Fein SB, Grummer-Strawn LM. Do infants fed from bottles lack self-regulation of milk intake compared with directly breastfed infants? *Pediatrics*. 2010;125(6). Available at: www.pediatrics.org/cgi/content/full/125/6/e1386
- Taveras EM, Scanlon KS, Birch L, Rifas-Shiman SL, Rich-Edwards JW, Gillman MW. Association of breastfeeding with maternal control of infant feeding at age 1 year. *Pediatrics*. 2004;114(5). Available at: www.pediatrics.org/cgi/content/full/114/5/e577
- Farrow C, Blissett J. Breast-feeding, maternal feeding practices and mealtime negativity at one year. *Appetite*. 2006;46(1):49–56
- Galloway AT, Fiorito LM, Francis LA, Birch LL. 'Finish your soup': counterproductive effects of pressuring children to eat on intake and affect. *Appetite*. 2006;46(3):318–323
- Savage JS, Fisher JO, Birch LL. Parental influence on eating behavior: conception to adolescence. *J Law Med Ethics*. 2007;35(1):22–34
- Fisher JO, Birch LL. Restricting access to palatable foods affects children's behavioral response, food selection, and intake. *Am J Clin Nutr*. 1999;69(6):1264–1272
- Johnson SL, Birch LL. Parents' and children's adiposity and eating style. *Pediatrics*. 1994;94(5):653–661
- Taveras EM, Rifas-Shiman SL, Scanlon KS, Grummer-Strawn LM, Sherry B, Gillman MW. To what extent is the protective effect of breastfeeding on future overweight explained by decreased maternal feeding restriction? *Pediatrics*. 2006;118(6):2341–2348
- Fein SB, Labiner-Wolfe J, Shealy KR, Li R, Chen J, Grummer-Strawn LM. Infant Feeding Practices Study II: study methods. *Pediatrics*. 2008;122(suppl 2):S28–S35
- Fein SB, Li R, Chen J, Scanlon KS, Grummer-Strawn LM. Methods for the year 6 follow-up study of children in the Infant Feeding Practices Study II. *Pediatrics*. 2014;134(suppl 1):S4–S12
- Birch LL, Fisher JO, Grimm-Thomas K, Markey CN, Sawyer R, Johnson SL. Confirmatory factor analysis of the Child Feeding Questionnaire: a measure of parental attitudes, beliefs and practices about child feeding and obesity proneness. *Appetite*. 2001;36(3):201–210
- Wardle J, Guthrie CA, Sanderson S, Rapoport L. Development of the Children's Eating Behaviour Questionnaire. *J Child Psychol Psychiatry*. 2001;42(7):963–970
- US Census Bureau. Poverty thresholds. Available at: www.census.gov/hhes/www/poverty/data/threshld/index.html. Accessed May 30, 2013
- Fisher JO, Birch LL, Smiciklas-Wright H, Picciano MF. Breast-feeding through the first year predicts maternal control in feeding and subsequent toddler energy intakes. *J Am Diet Assoc*. 2000;100(6):641–646
- Farrow CV, Blissett J. Controlling feeding practices: cause or consequence of early child weight? *Pediatrics*. 2008;121(1). Available at: www.pediatrics.org/cgi/content/full/121/1/e164
- Wright P, Fawcett J, Crow R. The development of differences in the feeding behavior of bottle and breast fed human infants from birth to two months. *Behav Processes*. 1980;5(1):1–20
- Dewey KG, Lönnerdal B. Infant self-regulation of breast milk intake. *Acta Paediatr Scand*. 1986;75(6):893–898
- Daly SE, Hartmann PE. Infant demand and milk supply. Part 1: infant demand and milk production in lactating women. *J Hum Lact*. 1995;11(1):21–26
- Blissett J, Farrow C. Predictors of maternal control of feeding at 1 and 2 years of age. *Int J Obes (Lond)*. 2007;31(10):1520–1526
- Li R, Magadia J, Fein SB, Grummer-Strawn LM. Risk of bottle-feeding for rapid weight gain during the first year of life. *Arch Pediatr Adolesc Med*. 2012;166(5):431–436
- Fomon SJ. What are infants fed in the United States? *Pediatrics*. 1975;56(3):350–354
- Poethullil JM. Oral satiation and regulation of intake. *Physiol Behav*. 1995;57(2):349–352

27. Birch LL, Fisher JO. Development of eating behaviors among children and adolescents. *Pediatrics*. 1998;101(3 pt 2):539–549
28. Fox MK, Devaney B, Reidy K, Razafindrakoto C, Ziegler P. Relationship between portion size and energy intake among infants and toddlers: evidence of self-regulation. *J Am Diet Assoc*. 2006;106(1 suppl 1):S77–S83
29. Tyson J, Burchfield J, Sentance F, Mize C, Uauy R, Eastburn J. Adaptation of feeding to a low fat yield in breast milk. *Pediatrics*. 1992;89(2):215–220
30. Pérez-Escamilla R, Cohen RJ, Brown KH, Rivera LL, Canahuati J, Dewey KG. Maternal anthropometric status and lactation performance in a low-income Honduran population: evidence for the role of infants. *Am J Clin Nutr*. 1995;61(3):528–534
31. Heinig MJ, Nommsen LA, Peerson JM, Lonnerdal B, Dewey KG. Intake and growth of breast-fed and formula-fed infants in relation to the timing of introduction of complementary foods: the DARLING study. Davis Area Research on Lactation, Infant Nutrition and Growth. *Acta Paediatr*. 1993; 82(12):999–1006
32. Brown A, Lee M. Breastfeeding during the first year promotes satiety responsiveness in children aged 18-24 months. *Pediatr Obes*. 2012;7(5):382–390
33. Webber L, Hill C, Saxton J, Van Jaarsveld CHM, Wardle J. Eating behaviour and weight in children. *Int J Obes (Lond)*. 2009;33(1):21–28
34. Webber L, Cooke L, Hill C, Wardle J. Child adiposity and maternal feeding practices: a longitudinal analysis. *Am J Clin Nutr*. 2010; 92(6):1423–1428
35. van Jaarsveld CHM, Llewellyn CH, Johnson L, Wardle J. Prospective associations between appetitive traits and weight gain in infancy. *Am J Clin Nutr*. 2011;94(6):1562–1567

APPENDIX Adapted Questions for MFS and CEB

Source of Questionnaire Item	Factor Studied	Original Question	Adapted or Additional Question	Response Options
MFS				
Child-Feeding Questionnaire by Birch et al (2001) ¹⁵	Pressure to eat	My child should always eat all of the food on her plate	How often do you encourage your 6-year-old to eat all of the food on his or her plate?	1. Never 2. Rarely 3. Sometimes 4. Often 5. Always
		I have to be especially careful my child eats enough	I am especially careful to make sure my child eats enough	1. Disagree 2. Slightly disagree 3. Neither disagree nor agree 4. Slightly agree 5. Agree
	Restriction	I have to be sure that my child does not eat too many sweets (candy, ice cream, cake, or pastries)	I make sure that my child does not eat too many sweets or junk foods	1. Disagree 2. Slightly disagree 3. Neither disagree nor agree 4. Slightly agree 5. Agree
		If I did not guide or regulate my child's eating, she would eat too much of her favorite foods	If I did not guide or regulate my child's eating, he or she would eat too much of his or her favorite foods	1. Disagree 2. Slightly disagree 3. Neither disagree nor agree 4. Slightly agree 5. Agree
CEB				
Children's Eating Behavior Questionnaire by Wardle et al (2001) ¹⁶	Satiety responsiveness	My child leaves food on his/her plate at the end of meal	How often does your 6-year-old eat all of the food on his or her plate?	1. Never 2. Rarely 3. Sometimes 4. Often 5. Always
		My child cannot eat a meal if s/he has had a snack just before	My child will lose appetite for dinner if he or she has had a snack just before	1. Disagree 2. Slightly disagree 3. Neither disagree nor agree 4. Slightly agree 5. Agree
	Food responsiveness	My child's always asking for food	My child is always asking for food	1. Disagree 2. Slightly disagree 3. Neither disagree nor agree 4. Slightly agree 5. Agree
		If allowed to, my child would eat too much	If allowed to, my child would eat too much	1. Disagree 2. Slightly disagree 3. Neither disagree nor agree 4. Slightly agree 5. Agree