Extended Abstract

Exposure to bottled breast milk and childhood obesity*

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Childhood overweight and obesity are common in the United States (Ogden, 2010). Breastfeeding has been found to be protective against childhood obesity (Arenz et al., 2004; Owen et al., 2005; Harder et al., 2005); the American Academy of Pediatrics recommends mothers exclusively breastfeed their infants for the first 6 months (Gartner et al., 2005). Yet work is an obstacle to exclusive breastfeeding. Among working mothers of 1.5-4.5 month-old infants, just under half continued breastfeeding by regularly pumping milk (Labiner-Wolfe et al., 2008). It is unknown if bottle-feeding breast milk is as protective against childhood overweight as breastfeeding.

One potential mechanism behind breastfeeding's protective effect is behavioral: breastfed infants must actively suckle during feeding, and the mother does not know how much milk the infant is consuming (Fomon et al., 1975). The breastfed infant may therefore become more responsive to its own hunger and satiety responses (Li et al., 2010), and be better able to regulate food intake later in life. A second potential mechanism is nutritional: formula often contains more protein, a different profile of fatty acids, and lacks many bioactive factors, compared to breast milk (Bartok & Ventura, 2009). If the relationship between breastfeeding and later overweight is largely mediated by these nutritional factors, then bottle-feeding breast milk should confer the same protection against overweight as breastfeeding.

Recent research investigating the effect of breast versus bottle delivery of breast milk suggests bottle feeding may not protect against later obesity. Infants bottle-fed breast milk or formula during the first six months of life were more likely to empty a bottle or cup at 12 months compared to infants who were directly breastfed (Li et al., 2010). Though this result suggests the primary advantage of breastfeeding is behavioral, it does not track child weight past the first year of life. We use data from the Early Childhood Longitudinal Study-Birth Cohort (ECLS-B), a

nationally representative birth cohort study, to test how exposure to bottle-fed breast milk compares to breastfeeding and formula feeding as a predictor of child overweight and obesity.

We collect data on our predictors at the 9 month parent interview. We combine variables on mothers' return to work and the introduction of formula to proxy for exposure to bottled breast milk. We define four groups of mothers: a “no work, no formula” group, who take maternity leave but neither return to work nor introduce formula in the first three months; a “work, no formula” group, who return to work before introducing formula; a “work, formula” group, who introduce formula before or at the same time as they return to work; and a “no work, formula” group, who introduce formula but remain on maternity leave in the first three months. We expect the second group to have the greatest exposure of infants to bottled breast-milk.

Our outcomes are based on child height and weight at the two year follow-up. We create binary measures of overweight and obesity using gender- and age-specific cutoffs (Cole et al., 2000). We take two steps to limit spurious associations between infant feeding and child weight. First, we restrict our sample to mothers who took any maternity leave and who initiated breastfeeding. This removes some of the most disadvantaged mothers from the sample, who either cannot take maternity leave or cannot initiate breastfeeding (Phillips, 2004; Ryan et al., 2004). Second, we control for socioeconomic factors that might explain differences among the four groups of mothers: minority race/ethnicity, income below the poverty line, and no post-secondary education. We also control for maternal pre-pregnancy BMI, as overweight mothers are less likely to continue breastfeeding (Donath & Amir, 2000) and more likely to have overweight children (Baker et al., 2004).

[Table 1 here]

The ECLS-B includes 2850 birth mothers who took maternity leave and initiated breastfeeding. We restrict the sample to 2150 mothers with complete information on the variables in the study. At age 2, 28% of children are overweight, and 9% exceed the threshold for obesity. The sample is split almost evenly among our four groups. Overweight is most common in the "work, no formula group" (31%) and least common in the "no work, no formula" group (22%). We use logistic regression to model child overweight and obesity as functions of mothers' return to work, introduction of formula, and the control variables described above. We compare the "work, no formula," "no work, formula," and "work, formula" groups to the "no work, no formula" group. Since our interpretation hinges on comparisons *among* these groups, we also present the results from tests of the equivalency of coefficient pairs. Odds ratios from our logistic regressions and results from the coefficient tests are presented in Table 1.

Being in any group other than "no work, no formula" is associated with greater odds of child overweight and child obesity. Yet there are no significant differences among the other three groups. The "work, no formula" group, most likely to expose infants to bottle-fed breastmilk, has the same odds of child overweight as the "work, formula" group, who introduce formula before returning to work. This suggests bottle-feeding breast milk confers no protection over bottle-feeding formula. Interestingly, the risk associated with the "work, formula" group is not significantly different from that associated with the "no work, formula" group, suggesting once formula is introduced, taking a longer maternity leave offers no protection against child overweight. Our results support the behavioral explanation for breastfeeding's advantage: infants bottle-fed breast milk are no less likely to be overweight at age 2 than infants fed formula, and both are more likely to be overweight than infants who are breastfed.

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Table 1. Odds ratios and coefficient tests from logistic regressions of overweight and obesity at age 2.

	Overweight		Obesity	
	OR	95% CI	OR	95% CI
Mother's work x infant feeding				
No work, no formula	-		-	
Work, no formula	1.55**	(1.16-2.06)	1.88*	(1.15-3.07)
Work, formula	1.36*	(1.01-1.82)	1.72*	(1.05-2.84)
No work, formula	1.46**	(1.10-1.94)	1.74*	(1.06-2.85)
Minority race/ethnicity	1.22*	(1.01-1.48)	1.72**	(1.26-2.35)
Income below poverty line	1.13	(0.81-1.57)	1.31	(0.81-2.11)
Mother's education				
High school or less	-		-	
Some college	1.13	(0.88-1.46)	0.97	(0.65-1.45)
Bachelor's or higher	0.98	(0.76-1.27)	0.99	(0.66-1.47)
Pre-pregnancy body mass index				
<25 kg/m^2	-		-	
25-30 kg/m^2 (overweight)	0.91	(0.72-1.40)	0.94	(0.65-1.36)
30+ kg/m^2 (obese)	1.18	(0.90-1.54)	1.20	(0.79-1.82)
N	2150		2150	
Log likelihood	-1253.1		-620.0	
χ^2	20.51*		24.31**	
	p-value of pairwise coefficient tests		p-value of pairwise coefficient tests	
Work, no formula vs. work, formula	0.33		0.67	
Work, no formula vs. no work, formula	0.66		0.70	
Work, formula vs. no work, formula	0.58		0.97	

* $p < .05$; ** $p < .01$; *** $p < .001$ (two-tailed tests).