

# Feeding at the Breast and Expressed Milk Feeding: Associations with Otitis Media and Diarrhea in Infants

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**Objective** To examine the associations of substance fed and mode of breast milk delivery with occurrence of otitis media and diarrhea in the first year of life.

**Study design** At 12 months postpartum, women (n = 813; 62% response) completed a questionnaire that assessed sociodemographics, infant occurrence of otitis media and diarrhea, and the timing of starting/stopping feeding at the breast, expressed milk, and formula. Women who intended to “bottle feed” exclusively were not recruited. Logistic and negative binomial regressions were conducted in the full sample (n = 491) and no-formula (n = 106) and bottle-only (n = 49) subsamples.

**Results** Longer duration of expressed milk feeding was associated with increased odds of experiencing otitis media (6-month OR [OR<sub>6-month</sub>] 2.15, 95% CI 1.01-4.55) in the no-formula subsample. Longer durations of breast milk feeding (OR<sub>6-month</sub> 0.70, 95% CI 0.54-0.92; 6-month incidence rate ratio [IRR<sub>6-month</sub>] 0.74, 95% CI 0.63-0.91), and feeding at the breast (OR<sub>6-month</sub> 0.70, 95% CI 0.54-0.89; IRR<sub>6-month</sub> 0.74, 95% CI 0.63-0.88) were associated with less diarrhea, and longer formula feeding duration was associated with increased risk of diarrhea (IRR<sub>6-month</sub> 1.34, 95% CI 1.13-1.54) in the full sample.

**Conclusion** Substance fed and mode of breast milk delivery have different contributions to infant health depending on the health outcome of interest. Feeding at the breast may be advantageous compared with expressed milk feeding for reducing the risk of otitis media, and breast milk feeding compared with formula may reduce the risk of diarrhea. (*J Pediatr* 2016; ■: ■-■).

Infant feeding practices have quietly but radically changed in developed countries in the past 2 decades. In the early 1990s, 38% of infants were fed expressed milk, compared with 69%-85% in more recent years.<sup>1-3</sup> Many infants are exposed to multiple feeding practices, resulting in different combinations of substances fed (breast milk vs formula) and modes of breast milk delivery (at the breast vs bottle) over time.<sup>3</sup> In the first 3 postnatal months alone, 54% of infants are fed a combination of substances and/or modes, yet few studies distinguish the role of the substance fed from the mode of breast milk delivery to evaluate their relative associations with child health outcomes.<sup>4,5</sup>

Prolonged and exclusive breastfeeding has been associated with improved infant immunologic status, including reduced otitis media and gastrointestinal illness.<sup>6-8</sup> The bioactive components of breast milk, such as secretory IgA and IgG, play a role in supporting the developing immune system to fight infections.<sup>9,10</sup> The composition of milk, however, can be altered by collection, freezing, storage, and thawing practices. Storing breast milk for later use causes cell death and cytotoxicity, and certain thawing and heating techniques are associated with a significant decrease in these protective immunoglobulins.<sup>11-15</sup> The bioactive components of milk fed at the breast may, therefore, differ from those in expressed milk. Thus, feeding at the breast may provide greater protection against infections.

The goal of this study was to examine the associations of substance and mode of infant feeding with otitis media and diarrhea in the first postnatal year. To be able to compare with the current literature, the associations between breast milk (inclusive of feeding at the breast and expressed milk feedings) and child health were examined. We also sought to compare feeding at the breast vs expressed milk feeding and expressed milk feeding vs formula feeding.

## Methods

A roster was assembled of all English-speaking women  $\geq 18$  years of age who delivered a singleton, liveborn infant at  $>24$  weeks' gestation at The Ohio State University Wexner Medical Center during 5 months in 2011 (n = 1244). The Ohio State University Wexner Medical Center operates a large delivery service for both high- and low-risk obstetric patients in the Columbus, Ohio area.

IRR	Incidence rate ratio
SES	Socioeconomic status
WIC	Special Supplemental Nutrition Program for Women, Infants, and Children

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Women whose medical record indicated their intention to “bottle feed” their infant exclusively ( $n = 303$ ), women lacking valid contact information ( $n = 111$ ), prisoners ( $n = 11$ ), and infant deaths ( $n = 6$ ) were not recruited.

At 12 months postpartum, a questionnaire was mailed to eligible women ( $n = 813$ ) to assess sociodemographics, infant feeding practices, and the outcomes of interest (otitis media and diarrhea). Participants received a \$10 incentive. This study was reviewed and approved by The Ohio State University Biomedical Institutional Research Board.

Maternal age and parity (primiparous vs multiparous) were obtained from the obstetric record; information about receipt of Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) benefits during pregnancy or postpartum (yes/no), maternal postpartum employment or school enrollment ( $>20$  hours/week by 6 months postpartum vs  $<20$  hours/week or  $>20$  hours/week after 6 months postpartum), maternal education (college or postgraduate vs less), relationship status (married or living with partner vs single, not living with partner, separated, or divorced), perceived financial difficulty (just getting by, difficulty, or great difficulty vs easily or very easily able to make ends meet), race and ethnicity (non-Hispanic white vs African American/black, Hispanic, or other and multiple races), child sex, and childcare attendance outside the home (yes/no) was obtained from the questionnaire. The questionnaire asked mothers: “How many times has a doctor said that your child had an ear infection since he/she was born?” and “How many times has your child had diarrhea (increase in the number of bowel movements) since birth?” These questions formed both binary (ever/never) and count (number of episodes) variables for each child for analysis.

The timing of starting and stopping feeding at the breast, expressed milk feeding, and formula feeding was asked on the questionnaire. Separate variables were calculated for breast milk feeding (inclusive of feeding at the breast and expressed milk), feeding at the breast, expressed milk feeding, and formula feeding. Feeding variables represent the duration of each feeding practice regardless of other feeding practices used during that time.

### Statistical Analyses

We first examined associations between infant feeding and child health in the full sample of infants who were fed at the breast, expressed milk, and/or formula in the first postnatal year. Exploratory analyses were carried out in subsamples of infants who were fed no-formula in the first 6 months (ie, infants could have been fed any combination of at the breast and/or expressed milk) and from a bottle-only in first postnatal year (ie, infants could have been fed any combination of expressed milk and/or formula). The subsample analyses were important to reduce confounding by measured and unmeasured factors that influence feeding practice decisions.

Univariate statistics described the sample and  $\chi^2$ ,  $t$ , and Wilcoxon-Mann-Whitney  $U$  tests were used to compare demographics and outcomes between those fed formula and the no-formula subsample and between those fed at the breast

and the bottle-only subsample. Preliminary confounders selected a priori because of their hypothesized relationship with infant feeding practices and the outcomes included parity, WIC, mother attending work or school  $>20$  hours/week by 6 months postpartum, maternal education, relationship status, perceived financial difficulty, maternal race, and childcare attendance outside the home. Negative binomial regression examined associations between otitis media and diarrhea and each confounder. Confounders found to be associated with the outcome were retained in adjusted models to examine associations between feeding practices and each health outcome while we controlled for relevant sociodemographics.

Associations between durations of breast milk feeding, feeding at the breast, expressed milk feeding, and formula feeding and otitis media and diarrhea were examined with the use of logistic and negative binomial regression models. Models predicted outcomes based on 1- (unadjusted and adjusted models), 3-, and 6-month (adjusted models) durations of each feeding variable. Logistic regression tested the association between binary health outcomes (0 episodes vs 1+ episodes) and feeding durations. Negative binomial regression models estimated the incidence rate ratio (IRR) of otitis media and diarrhea in relation to feeding behaviors. Because the otitis media and diarrhea outcomes used in these models represented the number of episodes in the first postnatal year and the dispersion parameter for negative binomial regression models was significantly different from zero, overdispersion of otitis media and diarrhea episodes were confirmed (Figure). Therefore, negative binomial regression methods were appropriate.

Analyses were first conducted in the full sample. Exploratory analyses were then conducted in the no-formula and bottle-only subsamples. Analyses used SAS 9.3 (Cary, North Carolina)<sup>16</sup> and STATA Intercooled 11 (StataCorp LP, College Station, Texas).<sup>17</sup>

## Results

Of the 813 mailed questionnaires, 501 were returned (62% response rate). Unintelligible responses ( $n = 2$ ), those without feeding ( $n = 3$ ) or outcome data ( $n = 1$ ), and infants fed no breast milk or formula in the first 5 postnatal days ( $n = 4$ ) were excluded. The final sample comprised 491 mother-infant dyads; 22% ( $n = 106$ ) of children received no formula (no-formula subsample) in the first 6 months and 10% ( $n = 49$ ) were fed by bottle only (bottle-only subsample) for the first postnatal year. Mothers of infants in the no-formula subsample were older ( $t = 2.5$ ,  $P = .01$ ), more likely to be multiparous ( $\chi^2 = 4.7$ ,  $P = .03$ ), highly educated ( $\chi^2 = 13.8$ ,  $P = .0002$ ), and living with a spouse/partner ( $\chi^2 = 4.7$ ,  $P = .03$ ); they were less likely to receive WIC ( $\chi^2 = 11.2$ ,  $P = .0008$ ), to perceive financial difficulty ( $\chi^2 = 4.4$ ,  $P = .04$ ), and to work  $>20$  hours outside the home by 6 months postpartum ( $\chi^2 = 6.9$ ,  $P = .0009$ ) than mothers of infants who were fed formula at least once in

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