Combination Feeding of Breast Milk and Formula: Evidence for Shorter Breast-Feeding Duration from the National Health and Nutrition Examination Survey

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Objective To examine combination breast milk and formula-feeding (CBFF), defined as daily breast-feeding and formula-feeding begun in the first week of life and to examine associations between CBFF and overall breast-feeding duration.

Study design We used the National Health and Nutrition Examination Survey, 1999-2006, to determine the prevalence of CBFF in both univariable and multivariable analyses. We examined breast-feeding duration using Kaplan-Meier and Cox proportional hazards analyses.

Results Among 6788 children ages 0-71 months, 8% were CBFF and 55% were exclusively breast-fed during the first week of life. Factors independently associated with CBFF were Hispanic ethnicity (adjusted OR, 3.81) and black race (adjusted OR, 2.59). CBFF was associated with decreased overall breast-feeding duration in the full cohort ($P < .001$) but not in the Hispanic or black subgroups. CBFF and formula-feeding, when compared with 4 months of exclusive breast-feeding, were associated with an increased risk for overweight/obesity between ages 2 and 6 years.

Conclusions In a nationally representative sample, CBFF is associated with shorter overall breast-feeding duration in white but not Hispanic or black mother-baby dyads. A significant number of US infants, though breast-fed, do not receive the health benefits of exclusive breast-feeding. *(J Pediatr 2011;159:186-91)*.

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The American Academy of Pediatrics recommends exclusive breast-feeding as the optimal form of infant nutrition for 6 months and continued breast-feeding for 1 year.[1] Healthy People 2020 goals for exclusive breast-feeding are 60% at 3 months and 25% at 6 months, but current rates are only 33% at 3 months and 14% at 6 months.[2-5]

One explanation for higher rates of breast-feeding initiation but poor rates of exclusive breast-feeding is that many breast-fed infants receive supplemental formula. This may be done in the hospital for either medical (hypoglycemia, severe maternal illness) or nonmedical reasons (maternal request). Early formula introduction can interfere with maternal milk supply because breast-feeding is a supply-and-demand system. If milk volume is added in the form of formula, the infant demands less breast milk, and supply decreases.[6-8]

In clinical experience, some breast-fed neonates are fed with supplemental formula from birth and continue to breast-feed successfully. Little is known about such "combination breast milk and formula feeding (CBFF)," including which mothers may feed their infants this way, or which mother-infant dyads may continue successful partial breast-feeding. Exclusive breast-feeding is associated with particularly strong health benefits for mothers and infants. CBFF, is, by definition, partial breast-feeding, which is less effective for disease prevention.[9,12]

In this study, we used nationally representative data to examine CBFF. We identified demographic characteristics associated with CBFF and studied how CBFF affects overall breast-feeding duration.

Methods

The National Health and Nutrition Examination Survey (NHANES) is a cross-sectional survey conducted by the Centers for Disease Control and Prevention, National Center for Health Statistics. In 1999, NHANES became a continuous

BMI	Body mass index
CBFF	Combination breast milk and formula-feeding
EBF	Exclusively breast-fed
NHANES	National Health and Nutrition Examination Survey

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study, with data collection in 2-year blocks that can be combined for purposes of analysis. In the present study, data from 1999-2000, 2001-2002, 2003-2004, and 2005-2006, were combined and analyzed. All subjects gave informed consent, and the data were approved by the Centers for Disease Control and Prevention Institutional Review Board.[13] This study was approved by the Institutional Review Board of the University of Rochester.

NHANES uses a stratified, multistage probability design with oversampling of infants, young children, and racial/ethnic minorities.[13] NHANES 1999-2006 contains data on approximately 40 000 individuals. We limited our analyses to children younger than 6 years of age, for whom there were data on infant feeding. We also excluded infants weighing less than 1800 grams or any who had a neonatal intensive care stay. Our final sample included 6788 children.

Race/ethnicity included five categories: white, black, Mexican-American, other Hispanic, and other. We combined the Mexican-American and other Hispanic categories. Race/ethnicity was based on US Bureau of the Census definitions. Poverty status was categorized as below the federal poverty level, from 100%-200% of the poverty level or above 200% of the poverty level, based on reported family income and the US Poverty Threshold, which is determined annually by the US Census Bureau. Other demographic data obtained by questionnaire administered to the child's parent or other adult household member included receipt of food stamps, receipt of nutrition program for women, infants, and children benefits, mother's age at child's birth, prenatal tobacco exposure, household tobacco exposure, infant sex, maternal educational attainment, marital status and maternal country of birth (United States versus non–United States).

Parents were asked infant feeding questions, which allowed the investigators to construct variables of: (1) exclusively breast-fed in the first week (EBF); (2) CBFF; (3) stopped breast-feeding within the first week; and (4) never breast-fed. The answers to the following allowed construction of the above variables: (1) Was [child's name] ever breast-fed?; (2) At what age did [child's name] first receive infant formula on a daily basis?; (3) At what age did [child's name] first receive cow milk on a daily basis?; and (4) At what age did you stop breast-feeding [child's name]?

If the answer to question (1) was "yes", but that to (4) was "still breast-feeding," the data for that subject were considered as censored in the Cox proportional hazards and Kaplan-Meier analyses. To analyze recall bias, we stratified feeding category by the age of the child at the time of the survey/examination.

We calculated body mass index (BMI) percentiles based on measured weight and length compared with the 2000 CDC growth charts for age and sex for all children in the sample who had passed their second birthday. We divided the population into BMI >85th percentile (overweight and obese) and BMI <85th percentile (normal weight). We performed χ^2 analyses to determine if those fed daily formula plus daily human milk for 4 months had different BMI outcomes compared with those exclusively breast-fed or those solely formula-fed.

Infants were excluded if birth weight was under 1800 g or the infant was admitted to a neonatal intensive care unit.

Analysis

We conducted all analyses using SUDAAN software (Research Triangle Institute, Research Triangle Park, North Carolina) to account for the cluster design of NHANES. Results were weighted to represent national estimates. We calculated CBFF and EBF prevalence and then used χ^2 tests to determine the strengths of association of various demographic characteristics with either CBFF or EBF in univariable analysis. The same methods were used to analyze the BMI data. To determine the factors independently associated with CBFF, we included all individual factors from the univariable analysis that were found to be associated with CBFF with a P value of $< .1$. All such factors were entered into a multivariable logistic regression equation to allow determination of OR and 95% CI.

Breast-feeding duration was illustrated graphically by the method of Kaplan and Meier. To determine which demographic factors were independently associated with overall breast-feeding duration, a Cox proportional hazards model assessed multivariable analyses of overall breast-feeding duration.

Results

Out of the 6788 infants with full feeding data, 55% were EBF for the first week of life. Some of these infants characterized as EBF for the purposes of this study may have received transient

Table I. Factors independently associated with combination feeding

	OR	95% CI
Ethnicity		
Hispanic	3.81	2.51-5.77
White	1.00	
Black	2.59	1.66-4.06
Other	1.91	1.02-3.55
Poverty status		
<100% FPL	1.49	1.17-2.00
100% to 200%	1.37	1.00-1.87
>200%	1.00	
Child received WIC		
Yes	1.28	0.97-1.70
No	1.00	
Family received food stamps		
Yes	0.84	0.57-1-22
No	1.00	
Prenatal tobacco exposure		
Yes	0.89	0.57-1-22
No	1.00	
Maternal country of birth		
US	1.00	1.33-2.71
Non–US	1.90	
Education level		
<High school	1.68	1.25-2.25
High school grad	1.00	
>High school	0.99	0.71-1.37

FPL, federal poverty level; *WIC*, nutrition program for women, infants, and children.
Variables in model include race/ethnicity, poverty status, WIC enrollment, receipt of food stamps, prenatal tobacco exposure, US or foreign born, and maternal education level.

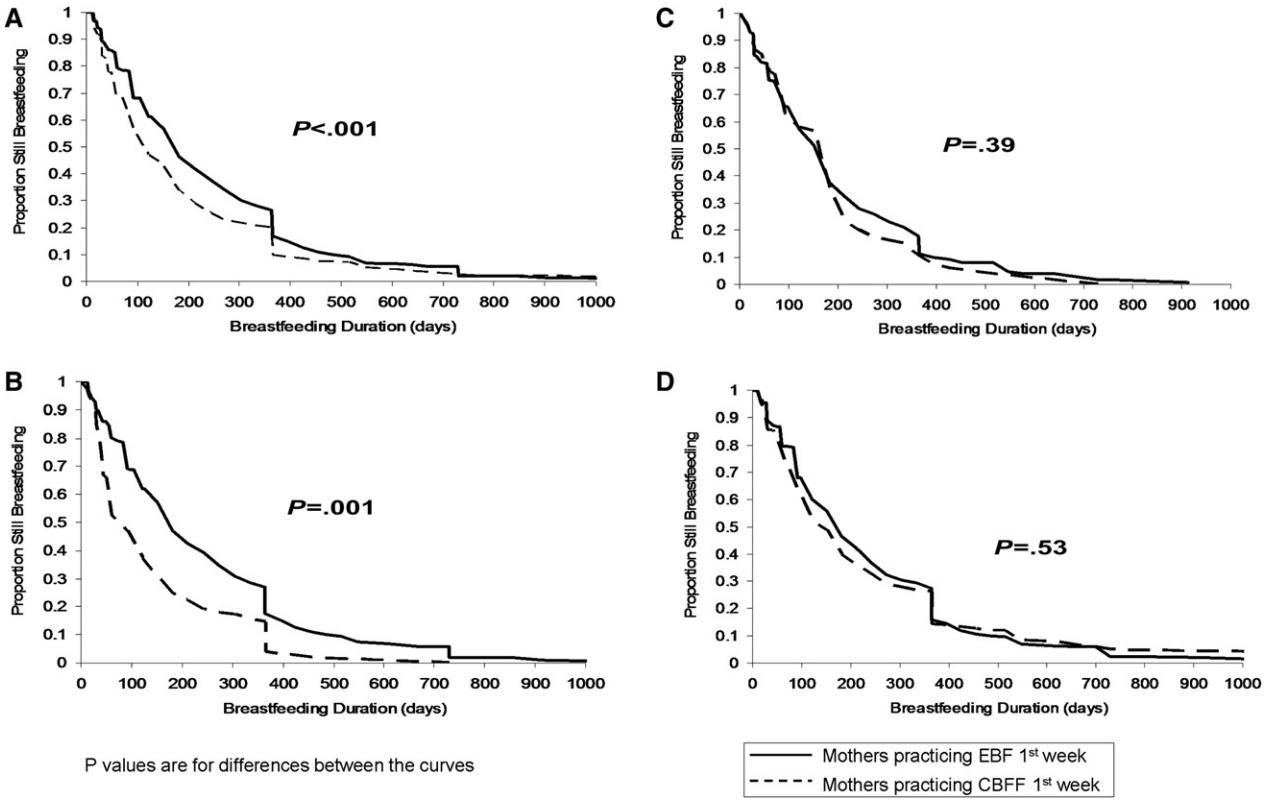

Figure 1. Unadjusted survival analysis of duration of any breast-feeding graphs the EBF infants in a *solid line* and the CBFF infants in a *dotted line*. **A,** All of the 4480 infants who completed the first week of life still breast-feeding are represented. There is a statistically significant difference between the curves for breast-feeding duration.**B,** Breast-feeding duration for the white subset has even more profound differences in breast-feeding duration for EBF versus CBFF, whereas for the nonwhite subsets (**C** and **D**), there are no significant differences in breast-feeding duration.

supplements in the hospital because the questions used to construct the variables only allowed identification of those infants who received formula on a daily basis. Many infants in this dataset were never breast-fed (33%). Three percent initiated breast-feeding but stopped all breast-feeding in the first week. A substantial number, 802 infants (8%), were fed both breast milk and infant formula on a daily basis from the first week of life. These comprise our CBFF subgroup for the remainder of the analyses. Infants in both breast-feeding categories, EBF and CBFF, increased in each of the 2-year periods of the study (data not shown). This is commensurate with other data bases of US breast-feeding rates.[5]

Ethnicity was strongly associated with CBFF, with 24.4% of Hispanic infants and 17.9% of black infants taking both daily breast milk and daily formula from the first week, as compared with only 7.2% of white infants ($P < .0001$). Infants of poorer families were also more likely to be combination breast- and formula-fed, as were infants enrolled in Supplemental Nutrition Program for Women, Infants and Children (both $P < .0001$). Maternal factors associated with CBFF were non-US birth and noncompletion of high school (both $P < .0001$) (data not shown).

In a multivariable model, both Hispanic ethnicity and black race were found to be independent factors associated with CBFF, (adjusted OR, 3.81 and 2.59) (Table I). Living in poverty, non-US birth of mother and noncompletion of high school also remained significant.

CBFF had a detrimental effect on overall breast-feeding duration in the full cohort ($P < .001$) (Figure 1), with 65% of the EBF group still breast-feeding at 4 months, compared with only 40% of the CBFF group. These differences were even more pronounced in the white subset, but no differences in breast-feeding duration were seen in the black and Hispanic subgroups.

To identify possible confounding factors we conducted a multivariable regression adjustment of the breast-feeding duration data (Table II). CBFF, versus EBF, remained an independent predictor of overall breast-feeding duration in the entire sample with a 40% adjusted risk of significantly decreasing breast-feeding duration solely from CBFF. The racial/ethnic differences in the effect of CBFF versus EBF on overall breast-feeding duration persisted in adjusted analyses, in a second adjusted model stratified by race/ethnicity (Table III).

Finally, we asked if daily CBFF for the first 4 months of life had an effect on BMI percentile at ages 2 to 6 years (Figure 2). Data on 2568 children were available for this analysis, as other infants who were either CBFF or EBF had changed to

Table II. Cox proportional hazards models of overall breast-feeding duration: Full cohort

	Hazard ratio	95% CI
EBF	1.00	Referent
CBBF	1.38	1.19-1.66
Hispanic	0.99	0.86-1.14
White	1.00	Referent
Black	1.10	0.95-1.27
Other	1.07	0.83-1.38
<20 years	1.28	1.04-1.58
20–29	1.00	Referent
≥30	0.85	0.75-0.96
Prenatal tobacco exposure	1.21	1.00-1.47
No prenatal tobacco exposure	1.00	Referent
Environmental tobacco exposure	1.24	1.00-1.54
No environmental tobacco exposure	1.00	Referent
US birth	1.00	Referent
Non-US birth	0.93	0.81-1.06
<High school	0.89	0.74-1.06
High school grad	1.00	Referent
>High school	0.88	0.75-1.03
Married/living together	0.81	0.67-0.98
Not married	1.00	Referent

Variables included in the overall model were those demographic characteristics associated with shorter breast-feeding duration in a bivariable model, with $P < .1$. These included race/ethnicity, maternal age, prenatal tobacco exposure, environmental tobacco exposure, maternal education, and country of birth (US versus non–US).

Table III. Cox proportional hazards models of overall breast-feeding duration: Cox proportional hazards model with racial-ethnic subsets

	EBF	CBBF	95% CI
Full cohort*	1.00	1.38	1.19-1.66
White†	1.00	1.77	1.29-2.44
Hispanic†	1.00	1.12	0.95-1.30
Black†	1.00	1.17	0.85-1.63

*Variables included in the overall model were those demographic characteristics associated with shorter breast-feeding duration in a bivariable model, with $P < .1$. These included race/ethnicity, maternal age, prenatal tobacco exposure, environmental tobacco exposure, maternal education, and country of birth (US versus non–US).
†In the subset models, the variables included were the same as above except for race/ethnicity.

either partial breast-feeding or formula-feeding some time during those first 4 months or were younger than 2 years of age at the time of the survey. Those who were CBFF for 4 months and those who were fully formula-fed from birth were at comparable risk of being overweight or obese at age 2 to 6, whereas children who were EBF for 4 full months had a lower risk of overweight or obesity at age 2 to 6. Though this is an interesting and statistically significant finding, we could not perform multivariable analysis due to the small numbers in some categories.

Discussion

CBFF, defined as adding daily supplemental formula from the first week of life, significantly shortens overall breast-feeding duration in white infants but not in Latino or black infants.

Though the data in this study find an association between CBFF and what are likely social and cultural factors related to race and ethnicity, our quantitative approach does not examine reasons behind the observation. An initial qualitative study examined the reasons for CBFF in low-income Mexican-Americans—a phenomenon termed "los dos" (both). One reason mothers fed both breast milk and formula from early on is that they perceived their infants would receive the "best of both"—the health benefits of breast milk and the "vitamins and other things" in formula.[14] Black mothers have historically had lower rates of breast-feeding, but, over the last 15 years, there has been a great increase in overall breast-feeding initiation among African Americans, from 36% in 1993 to 65% in 2007. Improvement in exclusive breast-feeding has not been as robust in multiple national samples, which concurs with the findings of the present study.[3,15]

EBF is recommended for the first 6 months of life.[1] Multiple studies have demonstrated greater protection from numerous childhood illnesses for infants who are EBF.[9-12] The phenomenon of CBFF reduces breast-feeding's role in disease prevention and perhaps adds to racial/ethnic childhood health disparities, as black and Latina mother-infant dyads are both more likely to use CBFF, and the infants have higher burden of disease.[16] EBF is known to significantly reduce postneonatal infant mortality and could reduce or eliminate racial disparities in infant mortality.[17] Studies of parent beliefs about breast-feeding indicate that any amount of breast-feeding is thought to confer all the possible health benefits of breast-feeding.[14,18] This may explain the high rates of CBFF in the present study, as parents may use formula to "add" benefits to breast-feeding or help with any breast-feeding "problems" without knowing that the addition of formula reduces the known positive health benefits of EBF.

CBFF may sometimes begin in the hospital setting, as directed by medical professionals. There are indications for

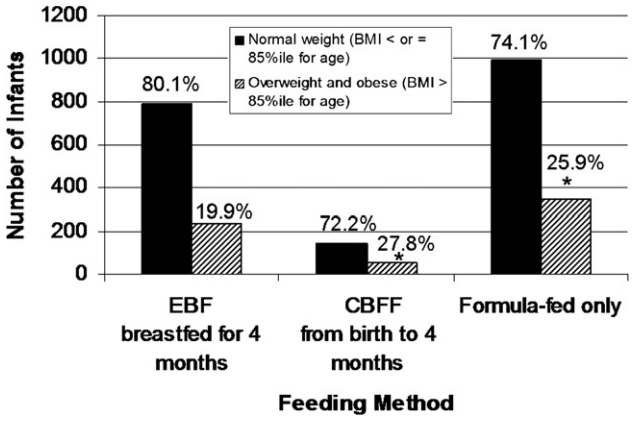

Figure 2. Bar graph showing unadjusted numbers of overweight and obese (BMI >85 percentile) children over 2 years of age, based on whether they were formula-fed, EBF, or CBFF for the first 4 months of life. The CBFF infants behave quite similarly to the formula-fed infants. There is a statistically significant difference between the EBF and CBFF groups but not between the CBFF and formula-fed groups. *$P < .01$.

medical formula supplementation, including mother-infant separation due to maternal illness, infant hypoglycemia, or hyperbilirubinemia and no available human milk, infant weight loss of >8% to 10% in the setting of delayed lactogenesis, and intolerable pain with feedings.[8] Preliminary data indicate that health care providers do not communicate that supplementation should cease once the acute medical issue has resolved.[18] Physician recommendations for infant feeding are very important in infant feeding decisions.[19]

Reasons for parental supplementation of breast-feeding with formula have been well studied. Often-cited reasons for addition of formula to the diets of breast-fed babies include perceived insufficient maternal milk, sore nipples, perception that the baby "prefers" formula, biting, recommendation of a health professional, and mother's thought that her own health problems, medications, or nutritional status preclude her from breast-feeding.[19,20] More recent studies have highlighted fear of sore nipples as a common reason for planning to cease to breast-feed exclusively. These studies did not examine actual breast-feeding outcomes but rather only prenatal intentions.[21,22]

We demonstrated that CBFF leads to shortened overall breast-feeding duration, in both our overall sample and in the white population subset. Others have postulated that early introduction of an artificial nipple for bottle-feeding is part of the reason for breast-feeding failure in such situations. The data in the present study argue against an effect of artificial nipples alone because it would not make sense to see differential effects by race/ethnicity. Most studies of artificial nipples in breast-fed infants have looked at the potentially negative effect of pacifiers on breast-feeding and have found pacifiers alone to not be very detrimental.[23-28] In addition, one randomized trial has shown that early, in-hospital formula supplements given by bottle shortened exclusive but not overall breast-feeding duration, and other studies are equivocal.[7,28] We could not investigate the reasons why mothers introduced formula supplements, and it is possible that maternal intention to CBFF from birth is compatible with successful breast-feeding, and introduction of supplements when breast-feeding is perceived to not be going well is not.

We found that CBFF does not ameliorate the effects of formula on body weight. The protective effect of breast-feeding on overweight and obesity appears to only be present for the EBF infants in this study. Mothers who use CBFF or formula-feed are possibly less attuned to feeding and satiety cues in their offspring.[29] Other studies that have examined early infant feeding patterns have also shown that breast-fed babies, particularly EBF babies, are leaner in early childhood.[30]

There are a number of limitations in this description of CBFF. First, the NHANES data are cross-sectional; thus, causation cannot be inferred from this analysis. Second, the data collection is retrospective, and there may be recall bias. The designers of NHANES try to limit this recall bias by limiting questions on infant feeding to index children who are 6 years and younger at the time of the survey. We analyzed whether there were differences in breast-feeding rates depending on the age of the child at the time of the survey and found that parents of older children reported lower rates of breast-feeding (data not shown). This either represents some recall bias or is a true representation of increasing breast-feeding rates over time. Independent sources of data such as the National Immunization Survey corroborate a similar increase in breast-feeding duration over this time period. Third, there are a number of possible confounding variables we would have liked to be able to control for in the multivariable analyses, but were not available in the NHANES 1999-2002 data set. These include method of delivery and maternal BMI.[13] We were able to exclude from our analysis preterm infants, low birth weight infants, multiple births, and those who had a stay in a neonatal intensive care unit. Fourth, we could not examine the feeding intentions of the mothers.

In conclusion, we found that a significant proportion of US infants are fed both breast milk and formula from the first days of life and continue feeding in this way. Nonwhite infants are fed in this manner more often, which may lessen the protective benefits of breast-feeding in these higher health risk subgroups. Interestingly, early CBFF does not adversely affect overall breast-feeding duration in black and Hispanic subgroups but greatly shortens overall duration in the white subgroup. ■

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