

# Associations Between Breastfeeding Practices and Young Children's Language and Motor Skill Development

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## ABSTRACT

**OBJECTIVES.** We examined the associations of breastfeeding initiation and duration with language and motor skill development in a nationally representative sample of US children aged 10 to 71 months.

**METHODS.** Using cross-sectional data on 22 399 children from the 2003 National Survey of Children's Health, we examined relationships between breastfeeding practices and children's language and motor skills development. Outcomes were based on each mother's response to questions regarding her level of concern (a lot, a little, not at all) about her child's development of expressive language, receptive language, fine motor skills, and gross motor skills. Breastfeeding data were based on mothers' recall. Methods of variance estimation were applied and multivariate polynomial regression modeling was done to estimate the effects of breastfeeding initiation and duration on children's development after adjustment for confounders.

**RESULTS.** Mean age of the sample was 2.79 years; 67% were non-Hispanic white, 16% were Hispanic, and 9% were non-Hispanic black. Approximately 17% of mothers reported concerns about their child's expressive language development; ~10% had receptive language concerns; ~6% had concerns about fine motor skills; and 5% reported general motor skills concerns. Multivariate analysis revealed that mothers who initiated breastfeeding were less likely than mothers of never-breastfed children to be concerned a lot about their child's expressive and receptive language development and fine and general motor skills. Mothers of children breastfed 3 to 5.9 months were less likely than mothers of never-breastfed children to be concerned a lot about their child's expressive and receptive language and fine and general motor skills.

**CONCLUSIONS.** As with all cross-sectional data, results should be interpreted with caution. Our findings suggest breastfeeding may protect against delays in young children's language and motor skill development. Fewer concerns about language and motor skill development were evident for children breastfed  $\geq 3$  months, and concerns generally decreased as breastfeeding continued  $\geq 9$  months.

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### Key Words

breastfeeding, initiation, duration, language development, motor skills

### Abbreviations

AAP—American Academy of Pediatrics  
NSCH—National Survey of Children's Health

DHA—docosahexaenoic acid

OR—odds ratio

CI—confidence interval

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**R**ESearch indicates that breastfeeding and otherwise feeding children human milk confer numerous health, immunologic, and nutritional advantages on infants, children, and mothers. Children who are not breastfed are at increased risk of respiratory tract infection, otitis media, diarrhea, necrotizing enterocolitis, undernutrition, and childhood overweight.<sup>1-6</sup> Maternal health risks associated with not breastfeeding include increased risk of postpartum blood loss, premenopausal breast cancer, and ovarian cancer.<sup>7-9</sup> Many medical and professional groups such as the World Health Organization, the United Nations Children's Fund, the American Academy of Obstetricians and Gynecologists, the American Academy of Pediatrics (AAP), and others advocate human milk as the gold standard for infant feeding. The AAP recommends exclusive breastfeeding for the first 6 months of life, followed by the gradual introduction of complementary foods, with continuation of breastfeeding for at least the first year of life and beyond as mutually desired by mother and child.<sup>1</sup> National breastfeeding objectives for the United States call for 75% of women to initiate breastfeeding, 50% to continue breastfeeding for 6 months, and 25% to maintain breastfeeding for 1 year.<sup>10</sup>

Among the benefits attributed to feeding children human milk rather than substitutes such as infant formula are earlier or advanced language and motor skills development.<sup>5,11-14</sup> Research findings, however, have been inconsistent; some studies find no effect from breastfeeding,<sup>14</sup> and others show beneficial effects on children's development attributable to breastfeeding or feeding children human milk.<sup>5,13,15,16</sup> In addition, previous studies suffered from limitations such as failing to control adequately for potential confounding variables, using a small sample size,<sup>5</sup> or focusing only on specific types of children, such as those in a certain age range<sup>5,11,13</sup> or twins,<sup>14</sup> thereby raising questions of generalizability.

The purpose of this study was to increase knowledge and understanding of the relationships between breastfeeding and development of young children's language and motor skill development. Using data from the 2003 National Survey of Children's Health (NSCH), we examined the associations of breastfeeding initiation and breastfeeding duration with expressive and receptive language development and with fine and gross motor skill development in a nationally representative sample of US children aged 10 to 71 months.

## METHODS

### Study Sample

The NSCH contains data on >100 000 children; breastfeeding questions, however, were asked only of families with children <6 years of age, and questions on developmental outcomes were asked only of families with

children aged 4 through 71 months. Additional detail on NSCH survey methodology is described elsewhere.<sup>17</sup>

Our study is based on data from a subsample of NSCH families that includes 25 611 children aged 4 through 71 months for whom the survey respondent was the mother. Children <10 months of age ( $n = 2444$ ) were excluded because we could not determine breastfeeding duration for those in this group who were still breastfeeding, and 7 children were excluded because they had no data for each of the 4 developmental outcomes in our study. We also excluded children with missing data on breastfeeding initiation ( $n = 64$ ) and breastfeeding duration ( $n = 49$ ), as well as 648 children identified as having bone, joint, or muscle problems; hearing or vision impairments; or autism. After these exclusions, the final sample of this study included 22 399 children. Human subjects review was not required for this study.

### Study Variables

Four outcome variables that assess levels of parental concern (a lot, a little, or not at all) about their children's language and motor skill development are based on the following questions:

Are you concerned a lot, a little, or not at all about

1. How [child's name] talks and makes speech sounds? (expressive language development)?
2. How [he/she] understands what you say? (receptive language development)
3. How [he/she] uses [his/her] hands and fingers to do things? (fine motor skill development)
4. How [he/she] uses [his/her] arms and legs? (gross motor skill development)

The independent variables of primary interest are initiation and duration of breastfeeding. The former is assessed by asking whether the child was ever breastfed or fed breast milk. The latter is determined by the mother's response regarding how old the child was when breastfeeding or feeding of breast milk was discontinued. We categorized responses as follows: 0 months (never breastfed), <1, 1 to 2.9, 3 to 5.9, 6 to 8.9, and  $\geq 9$  months. The youngest children in our study were aged 10 months, so if they were still breastfeeding, we categorized them as having breastfed  $\geq 9$  months.

On the basis of previous findings and the availability of data within the NSCH, we used a series of confounding variables in the multivariate analysis, including: child gender, age in years (0-5), and ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, and other); mother's country of birth (United States, non-United States), general health, and mental health (for each health variable: excellent, very good, good, fair, and poor); highest education level in the household (less than high school, high school graduate, more than high school); household poverty level (<100%, 100%-184%,

185%–299%, and  $\geq 300\%$ ); and family structure (single mother without father present, 2-parent family [any combination of biological, step, or adoptive parents]). Few mothers reported fair or poor maternal general health (6.1%) or maternal mental health (4.4%), so we used these as continuous variables in multivariate analyses. Poverty level was calculated as the ratio of self-reported family annual income to the appropriate poverty-threshold values used by the US Census Bureau, with  $<100\%$  indicating the income for the family was below the official definition of poverty.

### Statistical Methods

Distributions of demographics, covariates, and children's developmental outcomes were explored by examining weighted and unweighted data. Methods of variance estimation accounting for the complex sample design (multistage sampling with weighting) were applied. Specifically, SEs were obtained using the Taylor-series approximation method. Weighted data were used in both bivariate and multivariate analyses. Because the developmental outcome variables did not meet the proportional odds assumption that is required for ordinal logistic regression, we conducted multinomial regression modeling to estimate the effect of breastfeeding initiation and duration on the developmental outcomes, and "not at all" concerned was used as the reference group.

Confounding variables included in the multivariate models were as follows: child's gender, age, and ethnicity; mother's country of birth, general health, and mental health; highest education level in the household; household poverty level; and family structure. We tested the modification effects of child age ( $\leq 2$  or  $>2$  years old) on the associations of breastfeeding initiation and breastfeeding duration with each outcome variable (expressive and receptive language development, fine and gross motor skill development). Because no significant interactions were found, the interaction terms for child age were not included in the multivariate analysis. All calculations were performed using Stata 8.0.<sup>18</sup>

### RESULTS

Selected sociodemographic characteristics, breastfeeding practices, and developmental outcomes of the unweighted and weighted study population at the time of the NSCH interview are in Table 1. The mean age of children in the weighted study sample was 2.91 years (SD: 1.50), with fairly proportional distribution of study children of each age (1–5 years). The race or ethnicity of the sample children were non-Hispanic white (58.0%), Hispanic (20.8%), non-Hispanic black (13.3%), and other races (7.8%).

The vast majority (79.9%) of mothers were born in the United States. Approximately 26% of the sample reported that the highest education level in the household was a high school degree, and almost two thirds of

study households reported having more than a high school education (64.5%). Most families (76.8%) had 2 parents living in the home, 33.8% had household incomes at or above 300% of the poverty level, and 18.9% had incomes below 100% of the poverty level.

A small proportion of mothers expressed serious concerns (ie, said they had a lot of concern) about their children's language or motor skill development, ranging from a low of slightly  $>3\%$  (gross motor) to  $\sim 5\%$  (expressive or receptive language). With regard to breastfeeding practices, 72.9% of the mothers in the study reported initiating breastfeeding, which is similar to findings in other national studies,<sup>19,20</sup> and  $\sim 42\%$  breastfed for 6 months or longer.

Initiation of breastfeeding seems to have an inverse association with young children's language and motor skill development (Table 2) and was significantly associated with lower odds of mothers being concerned a lot versus not at all about their child's expressive or receptive language development. In addition, breastfeeding initiation was associated with significantly lower odds of any concerns (ie, a lot or a little) about children's fine motor skill development and with significantly lower odds of serious concerns about gross motor skill development. These relationships persisted even after we adjusted for confounders.

Duration of breastfeeding was not significantly associated with mothers being concerned a little (vs not at all) about either children's language or motor skill development, but was significantly associated with fewer mothers being concerned a lot (vs not at all) about these outcomes (Fig 1). The strongest association between breastfeeding and reduced concerns about delays in language or motor skill development occurred among children breastfed for  $\geq 3$  months. After controlling for confounders, we found significant inverse associations between breastfeeding and concerns about children's expressive language development evident among children breastfed  $\geq 3$  months. Compared with children who were never breastfed, children breastfed 3 to 5.9 months or 6 to 8.9 months had 28% lower odds of their mothers being concerned a lot about their expressive language development; odds were 35% lower for children breastfed  $\geq 9$  months. Among children breastfed for 3 to 5.9 months, 6 to 8.9 months, and  $\geq 9$  months, the respective reductions in the odds of their mothers being concerned a lot about their children's development were: 49%, 23%, and 36% for receptive language; 51%, 33%, and 36% for fine motor skills; and 51%, 32%, and 34% for gross motor skills (Fig 1).

### DISCUSSION

Our findings are consistent with several previous studies that concluded that breastfeeding may be protective against developmental delays,<sup>5,11,13,15,16</sup> with effects generally limited to those children breastfed  $\geq 3$  months.

**TABLE 1 Characteristics of the Study Sample: NSCH, 2003**

Characteristic	Unweighted (N = 22 399), n <sup>a</sup>	Weighted % or Mean
Expressive language concerns		
A lot	947	5.1
A little	2798	13.2
Not at all	18 642	81.7
Receptive language concerns		
A lot	961	5.2
A little	1120	5.4
Not at all	20 310	89.4
Fine motor skill concerns		
A lot	700	4.0
A little	578	2.5
Not at all	21 113	93.6
Gross motor skill concerns		
A lot	643	3.4
A little	460	2.1
Not at all	21 285	94.5
Breastfeeding initiation		
Yes	16 505	72.9
No	5894	27.1
Breastfeeding duration		
Never breastfed, mo	5937	27.3
<1	1498	6.0
1–2.9	2414	10.1
3–5.9	3183	14.5
6–8.9	3066	14.3
≥9	6252	27.8
Child age, y (categorical)		
0	863	3.4
1	5092	20.1
2	3961	17.2
3	4372	20.0
4	4142	20.4
5	3969	18.9
Child age, y (continuous)		
Mean	2.79	2.91
SD	1.51	1.50
Child Gender		
Male	11 479	51.1
Female	10 908	48.9
Child race/ethnicity		
Non-Hispanic white	14 713	58.0
Non-Hispanic black	1934	13.3
Hispanic	3594	20.8
Other	1892	7.8
Maternal nativity		
Not born in the United States	3103	20.1
Born in the United States	19 106	79.9
Highest household education level		
Less than high school	1278	9.3
High school graduate	4588	26.2
More than high school	16 396	64.5
Poverty level, % of federal poverty level		
<100	3141	18.9
100–184	3716	17.9
185–299	4644	18.2
≥300	8746	33.8
Unknown	2152	11.2
Family structure		
Single mother, no father present	4623	23.2
2-parent family	17 637	76.8
Maternal general health (categorical)		
Excellent	8885	37.5
Very good	7366	31.6

**TABLE 1 Continued**

Characteristic	Unweighted (N = 22 399), n <sup>a</sup>	Weighted % or Mean
Good	4645	23.2
Fair	1206	6.7
Poor	167	1.0
Maternal mental health (categorical)		
Excellent	9198	39.4
Very good	7884	33.6
Good	4207	21.5
Fair	889	5.1
Poor	80	0.5
Maternal general health (continuous)		
Mean	1.94	2.02
SD	0.94	0.98
Maternal mental health (continuous)		
Mean	1.87	1.94
SD	0.88	0.92

<sup>a</sup> Numbers may not sum to 22 399 because of missing values

Although the mechanisms explaining the relationship between human milk and child development are not completely understood, some researchers have tried to learn the specific pathways of action. In addition to developing hypotheses about the environmental and psychosocial influences related to breastfeeding (such as mother-child interaction and bonding while nursing), researchers have identified some biological influences of human milk. In a prospective study of 83 infants exclusively breastfed for at least 3 months, Innis and colleagues<sup>11</sup> found that docosahexaenoic acid (DHA), which is present in varying amounts in human milk, might influence the development of visual acuity and neural pathways associated with the progression of language acquisition by term-infants. In an examination of studies involving low birth weight infants, similar positive benefits were found in the relationship between breastfeeding and cognitive development.<sup>15</sup> Lucas and colleagues<sup>21</sup> also found evidence of enhanced motor skill development among preterm infants who were breastfed. Furthermore, beneficial effects of DHA on infants' brain development after birth have been shown,<sup>22,23</sup> with additional evidence of a dose-response relationship between breastfeeding duration and DHA content in infants' brains.<sup>24</sup>

The advantages of breastfeeding on brain and cognitive development seem to be long-lasting. In a meta-analysis of the relationship between breastfeeding and cognitive development, Anderson and colleagues<sup>15</sup> found that, even after adjusting for covariates, breastfed children showed higher levels of cognition as early as 6 months of age through as late as 15 years of age than did children who were fed formula.

In both unadjusted and adjusted analyses, we found evidence of a significant relationship between breastfeeding initiation and reductions in mothers' concerns about their child's language and motor skills develop-

**TABLE 2** Associations Between Breastfeeding Initiation and Mothers' Levels of Concern About Their Children's Language and Motor Skill Development: NSCH, 2003

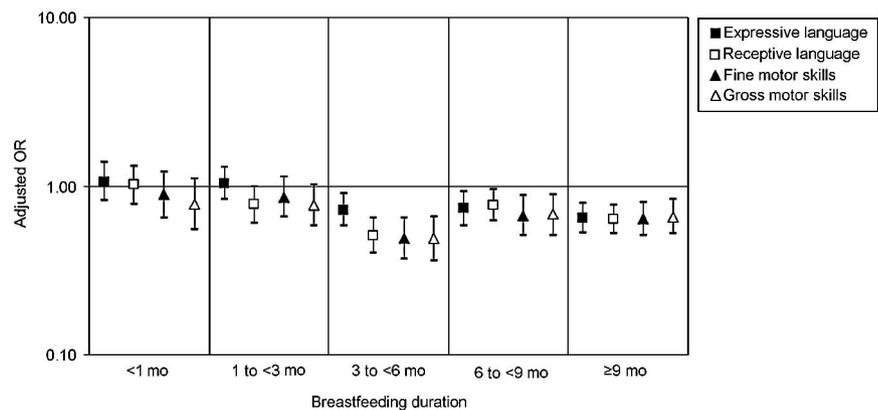
	Concern About Expressive Language				Concern About Receptive Language				Concern About Fine Motor Skills				Concern About Gross Motor Skills			
	A Lot		A Little		A Lot		A Little		A Lot		A Little		A Lot		A Little	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Breastfeeding initiation																
Yes	0.78	0.67–0.91	1.01	0.92–1.11	0.70 <sup>a</sup>	0.60–0.81	0.89 <sup>a</sup>	0.78–1.03	0.67 <sup>a</sup>	0.56–0.79	0.81 <sup>a</sup>	0.67–0.97	0.66 <sup>a</sup>	0.55–0.78	0.96 <sup>a</sup>	0.77–1.19
No (reference)																

The values presented in the table are odds ratios adjusted for child's gender, child's age, child's race/ethnicity, mother's country of birth (United States, non–United States), highest household education level, household poverty level, family structure, mother's general health, and mother's mental health. The referent for both levels of concern (a lot and a little) about language and motor skill development is "not at all" concerned.

<sup>a</sup> Denotes associations significantly different from 1 at  $P < .05$ .

**FIGURE 1**

Adjusted ORs and 95% CIs comparing levels of maternal concern about children's language and motor skill development according to duration that the child was breastfed. The ORs were adjusted for child gender, age, and ethnicity, maternal nativity, highest household education level, poverty level, family structure, maternal general health, and maternal mental health. The comparison is of mothers concerned a lot versus not at all about their children's development. The reference group is children who were never breastfed.



ment. Compared with mothers who never breastfed their children, mothers who initiated breastfeeding were 22% less likely to be concerned a lot about their child's expressive language, and 30% less likely to be concerned a lot about their child's receptive language. Similarly, mothers who initiated breastfeeding had one-third lower odds of being concerned a lot about their children's fine and gross motor skills than did mothers who never breastfed.

We also found an inverse relationship between breastfeeding duration and each child development outcome, with breastfeeding durations of  $\geq 3$  months being associated with lower levels of maternal concerns about development. A threshold effect is also evident, because all the associations between breastfeeding and children's development were observed only among children breastfed  $\geq 3$  months. With the exception of expressive language, in which the inverse relationship strengthened with longer breastfeeding duration, the relationship between breastfeeding duration and lower levels of concerns about child development seemed strongest among children breastfed 3 to 5.9 months. However, we do not conclude that this finding suggests that breastfeeding only within this range of time will result in the best developmental outcomes, in part because we do not have information about intensity or frequency of breastfeeding. Additional research on the association of breast-

feeding intensity and child development may shed more light on this finding.

Our study has some limitations. First, women who breastfed any length of time may differ from those who never breastfed in ways that we were unable to measure. For example, factors known or suspected to be associated with breastfeeding or child development, such as maternal age at childbirth, maternal employment, use of child day care, maternal or household smoking, frequency of reading to a child, infant birth weight, and gestational age, could not be included in our analyses for 1 of 3 reasons: (a) the data were not collected during the NSCH interviews; (b) the data were not collected on children aged 10 to 71 months; or (c) the data had too many missing observations.

A second limitation is that the NSCH collects no data on exclusive breastfeeding (that is, giving an infant no other foods or liquids except human milk) or frequency (how often a child is breastfed or fed breast milk each day), thus we were unable to examine their effects on children's development. Another possible limitation is that breastfeeding data were obtained through mothers' recall, which could be subject to bias. Findings regarding the accuracy of retrospective reports of breastfeeding practices are mixed, however, and Li et al<sup>25</sup> found that maternal recall of breastfeeding practices was valid and reliable, particularly when collected within 3 years. In

addition, as with all cross-sectional studies, additional research is needed to demonstrate a causal relationship between exposure to human milk and enhanced language and motor skill development in children.

The data for our study outcomes were based on mothers' reports of the level of concern they had about different aspects of their children's language and motor skill development. We do not consider this to be a limitation, however. Previous studies found that assessing parents' concerns is an accurate and effective way to learn about children's developmental problems.<sup>26–28</sup> The questions used to obtain these data were drawn from a standardized development surveillance tool, the Parents' Evaluations of Developmental Status,<sup>26</sup> designed for use with parents of children from birth through 8 years of age. The Parents' Evaluations of Developmental Status has a sensitivity of 74% to 79% across age groups, a specificity of 70% to 80%, and is effective with parents with varying levels of income, education, and literacy.

Our study is distinguished by other strengths as well. To our knowledge, this is the largest study to examine the associations of breastfeeding initiation and duration with children's language and motor skill development. Furthermore, our study uses a nationally representative sample of US children, making our findings generalizable to a large population. Although we were unable to include some variables in our analyses, the NSCH data allowed us to take into account several important maternal, child, and household characteristics (child gender, age, and ethnicity; mother's country of birth, general health, and mental health; household education and poverty levels; and family structure).

## CONCLUSIONS

The many risks associated with never breastfeeding or breastfeeding for only a short time are well documented. Although previous studies focused mostly on health risks for children in developing countries, recent studies describe the risks associated with no or little breastfeeding for children in the United States and other industrialized countries. This study of a nationally representative sample of children <6 years provides evidence of an association between breastfeeding and better language and motor skill development in US children. This finding, along with the threshold effect on children's language and motor skill development among those breastfed  $\geq 3$  months, reinforces recommendations of medical and professional organizations,<sup>1</sup> as well as those within *Healthy People 2010*,<sup>10</sup> that women initiate breastfeeding and practice extended breastfeeding beyond the early postpartum period.

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Deborah L. Dee, Ruowei Li, Li-Ching Lee and Laurence M. Grummer-Strawn

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