Breastfeeding and Risk of Infections at 6 Years

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KEY WORDS

breastfeeding, infection, Infant Feeding Practice Study II, Year 6 Follow-Up Study

ABBREVIATIONS

aOR—adjusted odds ratio
CI—confidence interval

Dr Li conducted the analysis and drafted the manuscript. All authors had technical input for the analytic design and contributed to and approved the final manuscript.

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abstract

BACKGROUND: Previous studies have shown that breastfeeding is associated with reductions in the risk of common infections among infants; however, whether breastfeeding confers longer term protection is inconclusive.

METHODS: We linked data from the 2005–2007 IFPS II (Infant Feeding Practices Study II) and follow-up data collected when the children were 6 years old. Multivariable logistic regression was used, controlling for sociodemographic variables, to examine associations of initiation, duration, exclusivity of breastfeeding, timing of supplementing breastfeeding with formula, and breast milk intensity (proportion of milk feedings that were breast milk from age 0–6 months) with maternal reports of infection (cold/upper respiratory tract, ear, throat, sinus, pneumonia/lung, and urinary) and sick visits in the past year among 6-year-olds (N = 1281).

RESULTS: The most common past-year infections were colds/upper respiratory tract (66%), ear (25%), and throat (24%) infections. No associations were found between breastfeeding and colds/upper respiratory tract, lung, or urinary tract infections. Prevalence of ear, throat, and sinus infections and number of sick visits differed according to breastfeeding duration, exclusivity, and timing of supplementing breastfeeding with formula ($P < .05$). Among children ever breastfed, children breastfed for ≥9 months had lower odds of past-year ear (adjusted odds ratio [aOR]: 0.69 [95% confidence interval (95% CI): 0.48–0.98]), throat (aOR: 0.68 [95% CI: 0.47–0.98]), and sinus (aOR: 0.47 [95% CI: 0.30–0.72]) infections compared with those breastfed >0 to <3 months. High breast milk intensity (>66.6%) during the first 6 months was associated with lower odds of sinus infection compared with low breast milk intensity (<33.3%) (aOR: 0.53 [95% CI: 0.35–0.79]).

CONCLUSIONS: This prospective longitudinal study suggests that breastfeeding may protect against ear, throat, and sinus infections well beyond infancy. *Pediatrics* 2014;134:S13–S20

Human milk is the best source of nutrition for most newborns and infants.[1] In addition, human milk provides immunologic protection against many infections during infancy.[2] Given the importance of breastfeeding for the health and well-being of mothers and children, the American Academy of Pediatrics recommends breastfeeding for at least 12 months, continued afterward as long as mutually desired by the mother and child.[3] It is well known that human milk contains an array of antimicrobial, antiinflammatory, immunomodulatory, and bioactive molecules and compounds that contribute to its protections against infections.[1] The mechanisms through which breastfeeding could have an impact on infectious disease are multiple, including promoting mucosal maturation, balancing the gut microflora, interfering with the attachment of antigens to epithelial cells, stimulating neonatal immune systems, and limiting exposure to the germs from foreign dietary antigens.[4,5]

What is not well understood is whether early consumption of human milk confers long-term benefits against infections years after lactation is terminated. It has been suggested that breastfeeding may protect against *Helicobacter pylori* colonization,[6–8] *Haemophilus influenzae* type b infection,[9] and acute appendicitis and recurrent tonsillitis requiring tonsillectomy later in life.[10,11] Wheezing illness has been shown to be decreased for up to 6 to 7 years after the termination of breastfeeding compared with nonbreastfeeding.[12–14] Wilson et al[14] also demonstrated that children who had been exclusively breastfed for 15 weeks remained better protected against respiratory tract infections for ~7 years compared with those not breastfed. Saarinen[15] found that any amount of breastfeeding for 3 to 4 months decreased the risk of developing otitis media up to the age of 3 years, whereas Howie et al[16] found that any breastfeeding for at least 13 weeks was not associated with ear infection but was associated with a significantly lower prevalence of gastrointestinal disease in the first 2 years of life compared with those who were never breastfed or breastfed <13 weeks.

The purpose of the present study was to examine the associations between breastfeeding practices during infancy and various infections at 6 years of age by using data from a longitudinal study in the United States.

METHODS

Sample

IFPS II (Infant Feeding Practices Study II), a large longitudinal study conducted by the US Food and Drug Administration and the Centers for Disease Control and Prevention in 2005–2007, followed up mothers from late pregnancy until 1 year after birth by using almost monthly mail surveys during infancy. Mothers enrolled in IFPS II were recontacted by mail in 2012 to collect in-depth information on their children's diet, school services, and behavioral and health outcomes at 6 years of age. Linking data from IFPS II to Y6FU (Year 6 Follow-Up Study), we identified 1542 mother–child pairs with data from both studies. Detailed information on survey administration and data collection of Y6FU are available elsewhere in this supplement.[17]

Outcome Measures

The main outcome measures for our study were infections and the number of sick visits reported by mothers when their children were 6 years old. Data on children's infections were obtained by asking: "During the past 12 months, how many times did your 6-year-old have the following infections?" The multiple choices on the list included "ear infection; sinus infection; throat infection, like strep throat; pneumonia or lung infection; urinary tract infection; and cold or upper respiratory infection." Data on sick visits were obtained by asking: "During the past 12 months, how many times did you take your 6-year-old to a doctor or other health professional for any of the following reasons?" Sick visit was one of the reasons listed in addition to routine well-child visit, follow-up visit, and emergency department visit due to illness. For each question on infection and sick visit, response options were either "none" or the "number of times (1, 2, 3, 4, 5, 6 or more times)" occurred in the past 12 months. We dichotomized each infection into "0" or "≥1" time during the past 12 months, with "0" as the referent. Because ~70% of children had at least 1 sick visit during the past 12 months, we dichotomized sick visit as "0–2" or ">2" times, with "0–2" as the referent.

Main Exposures

Breastfeeding practices were categorized according to initiation, duration, exclusivity, intensity of breastfeeding, and timing of supplementing breastfeeding with formula. Breastfeeding initiation was based on the IFPS II neonatal survey question "Did you ever breastfeed or try to breastfeed your baby, either in the hospital or birth center, or after you went home?" Other breastfeeding measures were developed only among mothers who initiated breastfeeding. Breastfeeding duration to any extent was obtained by using 2 questions in each postpartum survey of IPFS II (~1, 2, 3, 4, 5, 6, 7, 9, 10.5, and 12 months of age): "Have you completely stopped breastfeeding and pumping milk for your baby?" and, if yes, "How old was your baby when you completely stopped breastfeeding and pumping milk?" We then categorized breastfeeding duration into >0 to <3, 3 to <6, 6 to <9, and ≥9 months.

Exclusive breastfeeding data were obtained by asking about the frequency of liquids (including breast milk, formula, other milks, juices, sugar sweet beverages, and water) and foods the infant was fed during the past 7 days at each postpartum survey. Exclusive breastfeeding was defined for each survey as breast milk only without any other liquids or solids fed to infants in the past 7 days; we estimated its duration as the midpoint of infant ages between the last questionnaire when the mother indicated exclusive breastfeeding and the first questionnaire when she indicated nonexclusive breastfeeding. Exclusive breastfeeding duration was categorized into >0 to <4, 4 to <6, and ≥6 months, but it was coded as "unknown" if infants left the surveys before 6 months while exclusively breastfeeding ($n = 22$). To test whether the timing of formula introduction while breastfeeding is associated with infections, a composite variable was created among mothers who initiated breastfeeding: breastfeeding <6 months with formula supplemented before 6 months, breastfeeding ≥6 months with formula supplemented before 6 months, and breastfeeding ≥6 months without formula supplemented before 6 months. To test whether infection was associated with breast milk intensity, defined as the percentage of milk feedings that were breast milk ([number of breast milk feedings/(breast milk + formula + cow's milk + other milk feedings) × 100%]), we calculated the mean percentage of milk feedings being breast milk during the first 6 months and further categorized it as low (>0% to <33.3%), medium (33.3% to 66.6%), or high (>66.6%) breast milk intensity.

Other Measures

To control for potential confounding effects, we adjusted for a series of maternal and child characteristics from IFPS II and Y6FU as shown in Table 1. All maternal sociodemographic variables were from IFPS II, including maternal age (18–24, 25–29, 30–34, or ≥35 years); maternal race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, or other); maternal education (≤high school, some college, or college graduate); household income as poverty income ratio according to 2008 census definitions (<185%, 185%–349%, or ≥350%); marital status (yes or no); parity (primiparous or multiparous); postpartum participation in the Special Supplemental Nutrition Program for Women, Infants, and Children program; and prepregnancy BMI (<18.5, 18.5–24.9, 25.0–29.9, or ≥30.0). Infant covariates were from IFPS II, including gender, birth weight (≤4000 or >4000 g), and infant care assessed by whether the infant was cared for by someone other than the parent on a regular schedule during the past 4 weeks at the month 3 survey (yes, no, or unknown). Both child covariates were from Y6FU, including whether the child attended after-school child care that was outside the home and the type of school the child attended at 6 years of age (public, private, or home based).

Statistical Analysis

A χ^2 test was used to examine the crude relationships between infections and breastfeeding practices, with $P < .05$ as the cutoff for statistical significance. Multivariable logistic regression analyses were used to estimate adjusted odds ratios (aORs) and 95% confidence intervals (CIs) of past-year infection in 6-year-olds according to various breastfeeding practices after adjusting for the aforementioned confounding variables. Similarly, χ^2 tests and multivariable logistic regression analyses were applied to examine the relationships between various breastfeeding practices during infancy and the likelihood of seeing a physician for a sick visit during the past 12 months at 6 years of age. All statistical analyses were performed by using SAS version 9.3 (SAS Institute, Inc, Cary, NC).

RESULTS

Among 1542 mother–child pairs who participated in both IFPS II and Y6FU, 5% ($n = 73$) did not report on infections at 6 years of age, and 2% ($n = 34$) had missing data on breastfeeding practices during infancy. After excluding an additional 10% ($n = 154$) who were missing data on the covariates, the final analytical sample included 1281 mother–child pairs with complete data. Women excluded because of missing data were more likely to have only a high school education or less (19.5% vs 16.2%; $P = .03$) and be a participant in the Special Supplemental Nutrition Program for Women, Infants, and Children (39.9% vs 30.2%; $P < .01$) but less likely to have their child attend child care at 3 months of age (22% vs 34%; $P < .01$). There were no significant differences for all other comparisons (data not shown).

Among 6-year-old children, 66% had at least 1 cold or upper respiratory tract infection, 25% had at least 1 ear infection, 24% had at least 1 throat infection, and 16% reported at least 1 sinus infection in the previous 12 months. Both pneumonia or lung infection and urinary tract infection were relatively uncommon (5% and 4%, respectively) (Table 1). Maternal characteristics that were significantly associated with children's past-year infections reported at age 6 years were maternal race/ethnicity and marital status (for throat infection), poverty–income ratio (for cold or upper respiratory tract infection), and prepregnancy BMI (for cold or upper respiratory tract and sinus infection). Child characteristics that were significantly associated with past-year infections were infant gender (for pneumonia or lung and urinary tract infection) and type of school the child attended at age 6 years (for

TABLE 1 Prevalence of at Least 1 Occurrence of Infection in the Past Year Among 6-Year-Old US Children According to Maternal, Infant, and Child Characteristics, IFPS II (2005–2007) and Y6FU (2012)

Variable	*N*	Past-Year Infections at Age 6 Years (%)					
		Cold or Upper Respiratory Tract	Ear	Throat	Sinus	Pneumonia or Lung	Urinary Tract
Total	1281	65.7	25.1	23.7	15.6	4.6	3.8
Maternal age, y							
18–24	178	60.7	27.5	23.6	15.2	3.9	3.4
25–29	416	66.6	25.7	24.3	13.7	5.5	4.3
30–34	426	69.7	21.6	25.1	18.1	5.2	4.2
≥35	261	61.3	28.0	20.7	14.9	2.7	2.7
Race/ethnicity							
White	1119	66.7	25.7	24.7	16.1	4.5	4.0
Black	42	57.1	21.4	16.7	9.5	7.1	0.0
Hispanic	68	57.4	23.5	19.1	14.7	2.9	4.4
Other	52	63.5	15.4	15.4[a]	11.5	7.7	1.9
Maternal education							
≤High school	207	61.8	30.4	21.7	19.3	1.9	3.9
Some college	467	64.7	25.1	23.8	16.1	6.2	4.3
College graduate	607	67.9	23.2	24.4	14.0	4.3	3.5
Poverty–income ratio, %							
<185	438	61.0	26.9	21.7	17.8	3.7	4.3
185–350	490	65.9	24.7	26.9	13.7	5.3	3.7
>350	353	71.4[a]	23.2	21.8	15.6	4.8	3.4
Married							
No	205	61.0	22.9	18.1	15.6	4.4	5.9
Yes	1076	66.6	25.5	24.8[a]	15.6	4.7	3.4
Parity							
Primiparous	352	69.6	23.3	26.1	15.6	5.1	5.1
Multiparous	929	64.3	25.7	22.8	15.6	4.4	3.3
Postpartum WIC participation							
Yes	388	61.9	28.6	23.7	17.8	4.1	4.4
No	893	67.4	23.5	23.7	14.7	4.8	3.6
Prepregnancy BMI							
Underweight (<18.5)	48	72.9	22.9	31.3	18.8	8.3	6.3
Normal (18.5–24.9)	577	66.9	22.5	23.1	13.5	3.6	3.6
Overweight (>25.0–29.9)	329	67.5	28.3	21.0	14.6	6.7	3.3
Obese (≥30.0)	327	60.9[a]	26.6	26.6	19.9[a]	3.7	4.3
Infant's gender							
Male	630	66.5	25.1	23.5	15.4	3.3	0.8
Female	651	65.0	25.0	24.0	15.8	5.8[a]	6.8[a]
Birth weight, g							
≤4000	1117	65.7	25.1	23.6	15.5	4.7	3.9
>4000	164	65.9	25.0	24.4	16.5	3.7	3.7
Infant cared for by someone other than parent at 3 mo							
Yes	388	67.0	25.3	27.1	21.4	3.4	2.8
No	738	66.4	25.3	22.8	13.4	5.8	4.7
Unknown	155	59.4	23.2	20.0[a]	11.6[a]	1.9	1.9
Attend after-school child care at 6 y							
Yes	347	67.7	24.5	25.7	16.4	6.1	4.0
No	934	65.0	25.3	23.0	15.3	4.1	3.8
School type at 6 y							
Public	1049	65.7	26.2	25.7	15.6	4.7	3.8
Private	156	67.3	25.6	21.3	18.0	5.1	3.9
Home-based	76	63.2	7.9[a]	1.3[a]	10.5	2.6	4.0

WIC, Special Supplemental Nutrition Program for Women, Infants, and Children.

[a] Significant findings based on $P < .05$ by using the χ^2 test for the association between infection and each characteristic.

ear and throat infection) ($P < .05$ based on χ^2 tests). Specifically, boys had a lower prevalence of pneumonia or lung infection (3.3% vs 5.8%) and urinary tract infection (0.8% vs 6.8%) than girls. The proportions of ear and throat infections reported by mothers were lowest among children who were being home-schooled.

In this study, 86% of mothers initiated breastfeeding. Among them, 28% stopped breastfeeding before 3 months, and 79% stopped exclusive breastfeeding before 4 months (Table 2). Cold or upper respiratory tract infection, pneumonia or lung infection, and urinary tract infection was not significantly associated with any infant feeding measures. However, the proportion of 6-year-old children reported to have past-year throat and sinus infections was lower among ever-breastfed children. When the relationships between breastfeeding and infections were examined only among children who initiated breastfeeding, significant associations were observed for ear, throat, and sinus infection by any and exclusive breastfeeding duration and formula supplementation. The proportions of ear, throat, and sinus infections were lowest among those breastfed for ≥9 months, exclusively breastfed for ≥6 months, or breastfed for ≥6 months without formula supplementation before 6 months. Although sinus infection was the only past-year infection significantly related to breast milk intensity during the first 6 months, *P* values for both ear ($P = .05$) and throat ($P = .06$) infection approached the significant level.

Consistent with the crude analysis, multivariable analysis also showed that ear, throat, and sinus infections at 6 years of age were significantly associated with breastfeeding duration and intensity after controlling for the confounding factors included in the present study (Table 3). Specifically, among children who were ever breastfed, the adjusted odds of ear, throat, and sinus infection at 6 years of age were lowest among children who were breastfed for ≥9 months (versus breastfed >0 to <3 months), exclusively breastfed for ≥6 months (versus exclusively

TABLE 2 Prevalence of Past-Year Infections Among 6-Year-Old US Children According to Breastfeeding Practices, IFPS II (2005–2007) and Y6FU (2012)

Variable	*N* (%)	Past-Year Infections at Age 6 Years (%)					
		Cold or Upper Respiratory Tract	Ear	Throat	Sinus	Pneumonia or Lung	Urinary Tract
Total	1281 (100)	65.7	25.1	23.7	15.6	4.6	3.8
Ever breastfed							
No	175 (13.6)	65.7	28.0	29.7	22.3	4.6	4.6
Yes	1106 (86.4)	65.7	24.6	22.8	14.6	4.6	3.7
		$P = .99$[a]	$P = .33$	$P = .04$[b]	$P < .01$[b]	$P = .98$	$P = .58$
Duration of any breastfeeding	1106 (100)						
>0 to <3 mo	311 (28.1)	65.6	28.1	26.1	20.9	4.8	4.5
3 to <6 mo	143 (12.9)	58.0	28.0	25.2	15.4	4.9	2.8
6 to <9 mo	134 (12.1)	67.9	24.6	23.1	13.4	2.2	3.7
≥9 mo	518 (46.9)	67.4	21.4	20.1	10.8	5.0	3.5
		$P = .32$	$P = .02$[b]	$P = .04$[b]	$P < .01$[b]	$P = .97$	$P = .55$
Duration of exclusive breastfeeding	1106 (100)						
>0 to <4 mo	868 (78.5)	65.4	26.4	24.2	15.9	4.8	3.5
4 to <6 mo	195 (17.6)	65.1	19.5	20.0	11.3	4.1	5.1
≥6 mo	43 (3.9)	74.4	11.6	7.0	2.3	2.3	2.3
		$P = .44$	$P < .01$[b]	$P < .01$[b]	$P < .01$[b]	$P = .41$	$P = .63$
Formula supplementation	1106 (100)						
Breastfed <6 mo with formula before 6 mo	445 (40.2)	63.8	28.1	25.8	19.1	4.9	4.0
Breastfed ≥6 mo with formula before 6 mo	285 (25.8)	66.0	24.6	23.5	13.0	5.3	3.9
Breastfed ≥6 mo without formula before 6 mo	376 (34.0)	67.8	20.5	18.6	10.4	3.7	3.2
		$P = .23$	$P = .01$[b]	$P = .01$[b]	$P < .01$[b]	$P = .42$	$P = .52$
Breast milk intensity (% milk feedings being breast milk) during the first 6 mo	1106 (100)						
Low (>0 to <33.3%)	309 (27.9)	64.4	28.2	25.9	20.7	5.2	4.5
Medium (33.3% to 66.6%)	120 (10.8)	61.7	26.7	25.8	15.0	5.0	4.2
High (>66.6%)	677 (61.3)	67.1	22.6	20.8	11.7	4.3	3.3
		$P = .35$	$P = .05$	$P = .06$	$P < .01$[b]	$P = .52$	$P = .31$

[a] *P* value from the χ^2 test for the association between infant feeding and infection.

[b] $P < .05$ is considered statistically significant

breastfed >0 to <4 months), and breastfed for ≥6 months without formula supplementation before 6 months (versus breastfed <6 months with formula supplementation before 6 months). The adjusted odds of sinus infection at 6 years of age were also significantly lower for children fed with high breast milk intensity during the first 6 months (aOR: 0.53 [95% CI: 0.35–0.79] versus low breast milk intensity).

Table 4 presents the proportions and adjusted odds of children having sick visits ≥2 times during the past 12 months at 6 years of age according to various breastfeeding practices during infancy. There was no relationship between sick visits and ever breastfeeding. However, among children who were ever breastfed, the proportions of 6-year-olds who had ≥2 sick visits during the past 12 months were highest among those who were breastfed to any extent for <3 months, exclusively breastfed for <4 months, breastfed for <6 months with formula supplementation before 6 months, and those breastfed with low breast milk intensity during the first 6 months. Similar patterns were observed in the multivariable analysis.

DISCUSSION

Our study found that, among 6-year-old children, ~1 in 4 had an ear or throat infection, and almost 1 in 6 had a sinus infection at least once in the past year. Although ear, throat, and sinus infections were not significantly associated with breastfeeding initiation, the odds of 6-year-old children experiencing these infections in the past 12 months seemed to be reduced by 31% to 53% if they were breastfed for ≥9 months (versus >0 to <3 months), by 63% to 87% if mothers exclusively breastfed for ≥6 months (versus >0 to <4 months), and by 34% to 50% if mothers breastfed for ≥6 months without formula supplementation before 6 months (versus breastfed for >0 to <6 months with formula supplementation before 6 months). Similarly, the odds of 6-year-old children having ≥2 sick visits in the past 12 months were significantly associated with duration and exclusivity of breastfeeding, the timing of supplementing breastfeeding with formula, and breast milk intensity. No association was found between breastfeeding and colds or upper respiratory tract, pneumonia or lung, or urinary tract infections.

The ear, throat, and paranasal sinus are all common sites of infection among

TABLE 3 Adjusted Odds of Past-Year Infections Among 6-Year-Old US Children According to Breastfeeding Practices, IFPS II (2005–2007) and Y6FU (2012); $N = 1281$

Variable	Cold or Upper Respiratory Tract Infection		Ear Infection		Throat Infection		Sinus Infection		Pneumonia or Lung Infection		Urinary Tract Infection	
	aOR[a]	95% CI	aOR	95% CI	aOR	95% CI	aOR	95% CI	aOR	95% CI	aOR	95% CI
Ever breastfed ($n = 1281$)												
No	Ref		Ref		Ref		Ref		Ref		Ref	
Yes	0.93	0.65–1.32	0.94	0.65–1.36	0.74	0.51–1.07	0.70	0.47–1.06	0.89	0.40–1.99	0.78	0.34–1.78
Duration of any breastfeeding ($n = 1106$)												
>0 to <3 mo	Ref		Ref		Ref		Ref		Ref		Ref	
3 to <6 mo	0.68	0.45–1.04	1.04	0.66–1.64	1.00	0.62–1.61	0.71	0.41–1.23	0.81	0.31–2.15	0.55	0.17–1.81
6 to <9 mo	1.02	0.65–1.61	0.84	0.51–1.37	0.87	0.52–1.44	0.61	0.33–1.10	0.37	0.10–1.39	0.73	0.23–2.37
≥9 mo	0.98	0.70–1.36	0.69[b]	0.48–0.98[b]	0.68[b]	0.47–0.98[b]	0.47[b]	0.30–0.72[b]	0.77	0.37–1.60	0.54	0.23–1.25
Duration of exclusive breastfeeding ($n = 1106$)												
>0 to <4 mo	Ref		Ref		Ref		Ref		Ref		Ref	
4 to <6 mo	0.88	0.62–1.25	0.69	0.46–1.03	0.77	0.51–1.16	0.71	0.43–1.18	0.67	0.30–1.52	1.29	0.57–2.92
≥6 mo	1.32	0.64–2.73	0.37[b]	0.14–0.98[b]	0.23[b]	0.07–0.76[b]	0.13[b]	0.02–0.97[b]	0.34	0.04–2.61	0.46	0.06–3.65
Formula supplementation ($n = 1106$)												
Breastfed <6 mo with formula before 6 mo	Ref		Ref		Ref		Ref		Ref		Ref	
Breastfed ≥6 mo with formula before 6 mo	1.08	0.77–1.50	0.81	0.56–1.16	0.86	0.59–1.24	0.65	0.42–1.01	0.92	0.44–1.90	0.83	0.35–1.94
Breastfed ≥6 mo without formula before 6 mo	1.07	0.78–1.48	0.66[b]	0.46–0.94[b]	0.63[b]	0.44–0.92[b]	0.50[b]	0.32–0.78[b]	0.61	0.29–1.29	0.57	0.25–1.32
Breast milk intensity (% milk feedings being breast milk) during the first 6 mo ($n = 1106$)												
Low (>0 to < 33.3%)	Ref		Ref		Ref		Ref		Ref		Ref	
Medium (33.3% to 66.6%)	0.84	0.54–1.32	0.98	0.60–1.61	1.06	0.64–1.74	0.73	0.41–1.31	0.83	0.30–2.29	0.92	0.31–2.76
High (>66.6%)	1.03	0.75–1.41	0.77	0.54–1.08	0.73	0.51–1.03	0.53[b]	0.35–0.79[b]	0.62	0.31–1.26	0.51	0.23–1.14

[a] aOR obtained after controlling for maternal age; race/ethnicity; education; household income; marital status; parity; Special Supplemental Nutrition Program for Women, Infants, and Children participation; prepregnancy BMI; infant gender and birth weight; infant cared for by someone other than parent at 3 months old; infant attending after-school child care at 6 years of age; and the type of school child attended. Reference group comprised children who had no maternal report of past-year infection.

[b] If 95% CI does not include 1, the findings are considered statistically significant.

children. Otitis media accounts for at least 24 million clinic visits each year in the United States and is the most common condition for which antibiotics are prescribed.[18,19] A previous meta-analysis of 266 studies found that among children of all ages who present with sore throat, the pooled prevalence of group A streptococcus was 37% and the prevalence of group A streptococcus carriage among well children with no signs or symptoms of pharyngitis was 12%.[20] Although the exact prevalence and incidence of sinus infection are unknown, it is estimated that up to 1 billion cases of acute sinusitis occur in the United States each year, with $2.2 billion spent on nonprescription and prescription medications for viral and bacterial sinusitis.[21]

Human milk contains a wealth of immunologic factors that fight against infections during infancy. However, the mechanisms by which human milk confers protective effects that last beyond infancy and after breastfeeding ends are unclear. It has been speculated that immunologic factors in breast milk influence the development of the infant's immune system such that they influence the pathogenesis of illness later in life. For example, the thymus is a central organ in the immune system, responsible for the proper development of T lymphocytes. Using an ultrasound technique to measure thymic index size, Hasselbalch et al[22] found that, at 4 months of age, infants who were exclusively breastfed had significantly larger thymus glands than those who were partially breastfed or formula-fed only. Jeppesen et al[23] later published a report that not only substantiated their previous findings regarding increased thymus size with breastfeeding, but it also found a correlation between breastfeeding and CD8+ T cells. Alho et al[24] found that one of the major risk factors for otitis media was the existence of a previous episode of otitis media, and the odds were even stronger (odds ratio: 3.74 [CI: 3.40–4.10]) if the previous episode had occurred within the preceding 3 months. This finding suggests that breastfeeding's protective effects on

TABLE 4 Prevalence and Adjusted Odds of 6-Year-Old US Children Having at Least 2 Sick Visits to the Physician Within the Past 12 Months According to Breastfeeding Practices, IFPS II (2005–2007) and Y6FU (2012)

Variable	Prevalence of ≥2 Sick Visits		Odds of ≥2 Sick Visits	
	N	Percent	aOR[a]	95% CI
Total	1259	40.67		
Ever breastfed				
No	171	42.69	Ref	
Yes	1088	40.35	0.97	0.69–1.36
		$P = .56$[b]		
Duration of any breastfeeding				
>0 to <3 mo	308	48.70	Ref	
3 to <6 mo	141	35.46	0.60[c]	0.39–0.92[c]
6 to <9 mo	130	36.15	0.63[c]	0.40–0.99[c]
≥9 mo	509	37.72	0.69[c]	0.50–0.94[c]
		$P < .01$[c]		
Duration of exclusive breastfeeding				
>0 to < 4 mo	854	43.09	Ref	
4 to <6 mo	192	32.81	0.68[c]	0.48–0.97[c]
≥6 mo	42	19.05	0.33[c]	0.15–0.75[c]
		$P < .01$[c]		
Formula supplementation				
Breastfed <6 mo with formula before 6 mo	440	44.55	Ref	
Breastfed ≥6 mo with formula before 6 mo	279	41.94	0.96	0.69–1.32
Breastfed ≥6 mo without formula before 6 mo	369	34.15	0.70[c]	0.51–0.95[c]
		$P < .01$[c]		
Breast milk intensity (% milk feedings comprising breast milk) during the first 6 mo				
Low (>0 to < 33.3%)	307	48.53	Ref	
Medium (33.3% to 66.6%)	117	37.61	0.67	0.43–1.05
High (>66.6%)	664	37.05	0.67[c]	0.50–0.91[c]
		$P < .01$[c]		

[a] aOR obtained after controlling for maternal age; race/ethnicity; education; household income; marital status; parity; Special Supplemental Nutrition Program for Women, Infants, and Children participation; prepregnancy BMI; infant gender and birth weight; infant cared for by someone other than parent at 3 months of age; infant attending after-school child care at 6 years of age; and type of school child attended. Reference group comprised children who had <2 sick visits during the past 12 months.

[b] *P* value from the χ^2 test for the association between infant feeding practices and sick visit.

[c] If 95% CI does not include 1, the findings are considered statistically significant.

ear infections later in life could be also mediated through lower prevalence of otitis media during infancy.

There are several strengths of the present study. First, data were gathered from a detailed longitudinal study on infant feeding practices in the United States, and potential reporting bias for the feeding variables was minimized by a short 7-day retrospective recall at near-monthly intervals throughout the first year. Furthermore, the potentially confounding effects of other variables were limited by controlling for a wide range of variables in the multivariable analysis. In addition, various indicators of breastfeeding practices during infancy were explored, and we captured multiple aspects of infant feeding exposures, including initiation, duration, intensity, and exclusivity of breastfeeding, as well as the timing of supplementing breastfeeding with formula.

However, our results are subject to some limitations. First, because black and Hispanic mothers were underrepresented in this study, our results may not be applicable to the entire US population. Second, infections were self-reported by mothers who were not specifically instructed to report infectious illnesses that must be established by physician diagnoses during an office or clinic visit. Even if the diagnoses were established in this manner, there is great variability with regard to "certainty" of diagnoses, depending on the knowledge and training of the examining physician. For instance, the diagnosis of sinus infections (sinusitis or inflammation of the paranasal sinuses) is extremely difficult clinically to distinguish from common rhinitis (inflammation of the nasal passages) without resorting to a sinus radiograph. Because it is unlikely that the misclassification of infections depended on early breastfeeding practices given the longitudinal design of this study (nondifferential misclassification), the reporting errors most likely bias the results toward the null.[25]

CONCLUSIONS

This national prospective study of long-term associations of breastfeeding and infections among 6-year-olds in the United States suggests that breastfeeding may protect against ear, throat, and sinus infections well beyond infancy. Given the potentially harmful and costly effects of these infections, improving breastfeeding practices among US mothers could prove beneficial. Breastfeeding mothers need to be encouraged and supported in making their decisions to initiate breastfeeding and to maintain exclusive breastfeeding for the first 6 months as recommended by the American Academy of Pediatrics,[3] and to continue breastfeeding for at least 1 year and as long thereafter as they desire. With optimal breastfeeding practices, the incidence of ear, throat, and sinus infections in later childhood has the potential to be reduced, thereby improving the health and well-being of many US children.

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