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Impact of early formula supplementation on breastfeeding duration, National Immunization Survey, 2019 births

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INTRODUCTION

Breastfeeding reduces risks of many illnesses for children and mothers [1]. Given its numerous benefits, the American Academy of Pediatrics recently changed its recommendation for breastfeeding duration from 1 year to 2 years [2]. One recent study indicated only 7% of U.S. children experiencing prolonged breastfeeding for 2 years [3], but research examining modifiable risk factors that affect breastfeeding duration beyond 1 year is lacking. It is well-known that unindicated formula supplementation during maternity stay could disrupt early breastfeeding by reducing stimulation of maternal milk production and altering infant gut development, however its effects on long-term breastfeeding duration is unknown. This study examines the impact of early formula supplementation on breastfeeding duration using breastfeeding data that extends beyond the first year.

METHODS

The National Immunization Survey-Child (NIS-Child), conducted by U.S. Centers for Disease Control and Prevention (CDC), is a national-representative random-digit-dialed cellular phone survey among a complex, stratified, multistage probability sample of U.S. households with children aged 19–35 months (<https://www.cdc.gov/vaccines/imz-managers/nis/about.html>). Since 2001, breastfeeding data have been collected in the NIS-Child to monitor breastfeeding rates at both national and state levels. They have also been

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AUTHOR CONTRIBUTIONS

RL conceptualized and designed the study, drafted the manuscript, and conducted the analysis. HCH and LDE-E conceptualized and designed the study and reviewed and revised the manuscript and analytic decisions. JC assisted with code for statistical analysis and reviewed and revised the manuscript. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

COMPETING INTERESTS

The authors declare no competing interests.

DISCLAIMER

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used to set up national breastfeeding goals for both Healthy People 2020 and 2030. Based on 2020–2021 NIS-Child, we analyzed breastfeeding data by birth year for estimates among children born in 2019 ($N = 18020$).

The main exposure was formula supplementation (with or without other liquids or solids) within 2 days of birth among breastfed infants, hereafter referred as “early formula supplementation” by asking: “How old was [child’s name] when (he/she) was first fed formula?” Total breastfeeding duration was determined by asking “How old was [child’s name] when [child’s name] completely stopped breastfeeding or being fed breast milk?” Since breastfeeding duration was not normally distributed, medians were estimated. We applied Cox proportional hazards regression models to determine the association of early formula supplementation with breastfeeding cessation after controlling for potential confounders selected a priori, including infant sex, race/ethnicity, maternal education and age, marital status, geographic location, birth order, and introduction of complementary foods other than breastmilk or formula. Both crude (HR) and adjusted hazard ratios (aHR) were analyzed with those still breastfeeding at the survey censored in the analysis.

Because of a significant interaction between formula supplementation and household income, stratified analyses were conducted by federal poverty level (FPL), defined as percentage of self-reported income relative to the federal poverty threshold for family size. To account for cluster sampling, PROC SURVIVAL and PROC KAPMEIER in SUDAAN (RTI International, v11) were used to obtain the Kaplan–Meier survival probability for breastfeeding cessation over time. The NIS was conducted consistent with applicable federal law and CDC determined that this study was not subject to review by Institutional Review Board because deidentified secondary data were used.

RESULTS

Among breastfed infants, 18% received early formula supplementation with higher percentages among families with FPL ≤ 185 than FPL > 185 (21% vs. 17%). Regardless of FPL, breastfed infants with early formula supplementation had shorter breastfeeding duration than those without (FPL ≤ 185 : 22 vs. 35 weeks; FPL > 185 : 26 vs. 52 weeks) (Table 1). After controlling for covariates, early formula supplementation was significantly associated with breastfeeding cessation for both FPL ≤ 185 (aHR = 1.54, 95% CI = 1.32–1.81) and FPL > 185 (aHR = 1.62, 95% CI = 1.41–1.86). Additionally, the risks of earlier breastfeeding cessation were higher among mothers who were high school graduates and unmarried for both FPL $\leq 185\%$ and FPL $> 185\%$ and among mothers with some college, first-born infants, and infants introduced to complementary food < 4 months for FPL $> 185\%$. The Kaplan–Meier curve illustrates that formula supplementation < 2 days had a significantly lower breastfeeding probability than formula supplementation ≥ 2 days regardless of FPL levels (Fig. 1).

DISCUSSION

This is the first national study to show an association between early formula supplementation and breastfeeding duration measured beyond 1 year in the US. Our findings

indicate that breastfed infants supplemented with formula before 2 days is significantly associated with shorter breastfeeding duration, limiting the ability to achieve current U.S. recommendations on breastfeeding duration for 2 years. For maternity care practices to be fully supportive of breastfeeding, United Nations Children's Fund and World Health Organization established Baby Friendly Hospital Initiative (BFHI) and avoiding formula supplementation without a medical indication is a key component of BFHI [4]. The findings from this study reinforce the importance of maternity care practices for long-term breastfeeding recognizing that in-hospital formula feeding might be underreported by maternal recalls. Evidence from a cluster-randomized controlled trial demonstrates that maternity care practices supportive of exclusive breastfeeding during the hospital stay increase probability of any breastfeeding at 12 months [5]. Thus, promoting exclusive breastfeeding during maternity stay would be one of the important strategies for extending breastfeeding duration.

DATA AVAILABILITY

<https://www.cdc.gov/vaccines/imz-managers/nis/datasets.html>.

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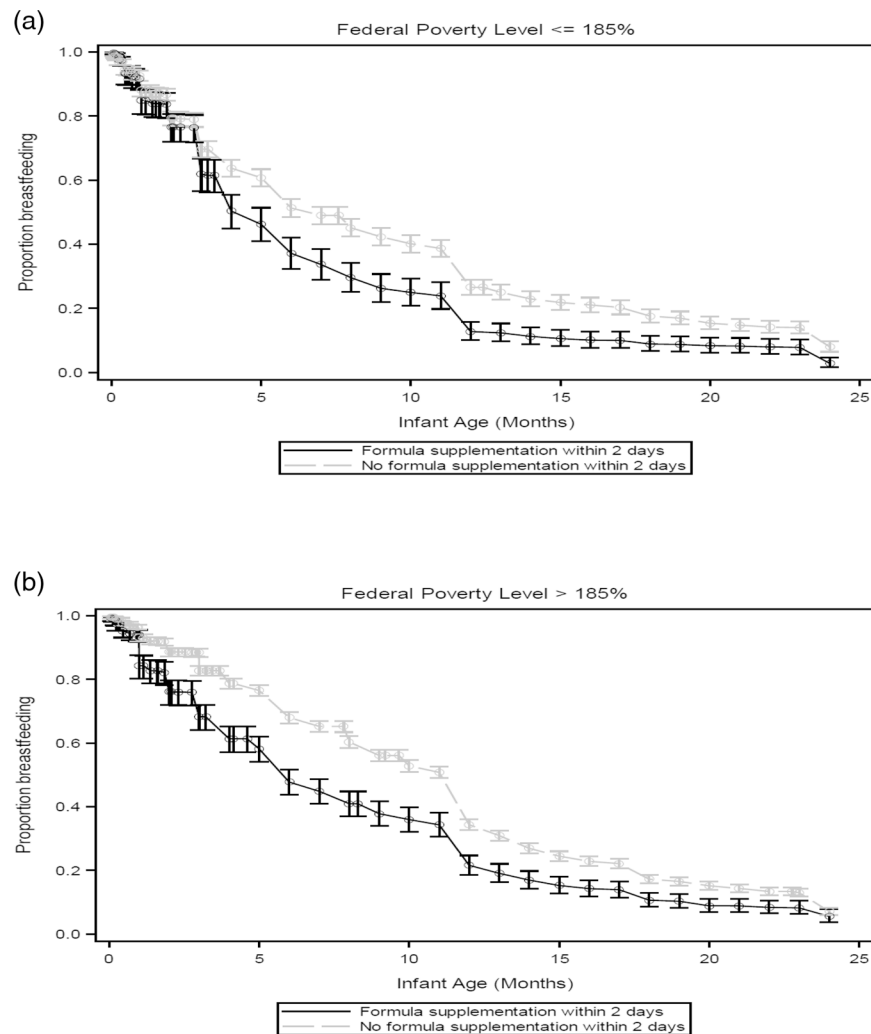


Fig. 1. Kaplan–Meier survival probabilities for breastfeeding cessation and their 95% confidence intervals by infant age according to early formula supplementation among breastfed infants, National Immunization Survey, 2019 birth cohort.

a Federal poverty level \leq 185%. **b** Federal poverty level $>$ 185%.

Table 1.

Association of early formula supplementation among breastfed infants with breastfeeding cessation, National Immunization Survey-Child, 2019 birth cohort.

Characteristic	Federal poverty level 185%		Federal poverty level > 185%		N	Median breastfeeding duration, weeks (IQR)	Crude HR for breastfeeding cessation (95% CI)	Adjusted HR for breastfeeding cessation (95% CI)	Crude HR for breastfeeding cessation (95% CI)	Adjusted HR for breastfeeding cessation (95% CI)
	N	Median breastfeeding duration, weeks (IQR)	Median breastfeeding duration, weeks (IQR)	N						
Total	5366	30.44(13.04–56.53)	47.83(26.09–65.22)	12,654						
Formula supplementation within 2 days of birth										
Yes	1100	21.74(8.70–52.18)	1.53(1.31,1.77)	1.54(1.32,1.81)	2160	26.09(13.04–52.18)	1.69(1.49,1.93)		1.62(1.41,1.86)	
No	4266	34.79(13.04–65.22)	Referent	Referent	10,494	52.18(26.09–69.57)	Referent	Referent		
Infant sex										
Male	2738	30.44(13.04–56.53)	Referent	Referent	6458	47.83(26.09–65.22)	Referent	Referent		
Female	2628	30.44(13.04–60.88)	1.01(0.88,1.16)	1.02(0.89,1.18)	6196	52.18(26.09–65.22)	1.02(0.93,1.13)		0.99(0.89,1.09)	
Race/Ethnicity										
Hispanic	1683	30.44(13.04–60.88)	1.02(0.86,1.22)	0.97(0.79,1.17)	1776	43.48(17.39–69.57)	1.14(0.97,1.34)		0.97(0.82,1.16)	
Non-Hispanic (NH) White	2027	30.44(13.04–60.88)	Referent	Referent	8014	52.18(26.09–65.22)	Referent	Referent		
NH Black	812	26.09(13.04–52.18)	1.35(1.12,1.62)	1.20(0.98,1.47)	856	39.13(21.74–60.88)	1.25(1.05,1.48)		1.00(0.83,1.21)	
NH Asian	235	52.18(17.39–78.27)	0.79(0.57,1.10)	0.85(0.59,1.23)	782	52.18(26.09–65.22)	0.96(0.81,1.15)		0.88(0.72,1.07)	
NH Hawaiian/Pacific Islander	55	34.79(13.04–65.22)	0.58(0.18,1.90)	0.52(0.16,1.73)	40	52.18(28.26–92.93)	1.13(0.50,2.56)		0.89(0.36,2.17)	
NH American Indian/Alaska Native	118	36.96(17.39–82.57)	1.32(0.84,2.09)	1.23(0.73,2.06)	113	52.18(26.09–78.27)	0.62(0.37,1.04)		0.52(0.29,0.94)	
2 or more races	436	30.44(13.04–56.53)	1.08(0.84,1.40)	0.99(0.76,1.28)	1073	52.18(26.09–78.27)	0.88(0.73,1.07)		0.85(0.71,1.03)	
Maternal education										
Less than high school	648	26.09(13.04–52.18)	1.33(1.04,1.71)	1.17(0.90,1.52)	154	28.26(13.04–60.88)	1.78(1.18,2.69)		1.46(0.97,2.20)	
High school graduate	1652	26.09(13.04–52.18)	1.53(1.26,1.85)	1.41(1.15,1.72)	1036	30.44(13.04–56.53)	1.87(1.56,2.23)		1.62(1.33,1.98)	
Some college or technical school	1995	26.09(13.04–60.88)	1.28(1.06,1.56)	1.14(0.93,1.39)	2452	39.13(17.39–60.88)	1.35(1.20,1.53)		1.26(1.10,1.44)	
College graduate	1071	52.18(21.74–78.27)	Referent	Referent	9012	52.18(26.09–69.57)	Referent	Referent		
Maternal age										

Characteristic	Federal poverty level 185%			Federal poverty level > 185%				
	N	Median breastfeeding duration, weeks (IQR)	Crude HR for breastfeeding cessation (95% CI)	Adjusted HR for breastfeeding cessation (95% CI)	N	Median breastfeeding duration, weeks (IQR)	Crude HR for breastfeeding cessation (95% CI)	Adjusted HR for breastfeeding cessation (95% CI)
Under 20	67	17.39(8.70–52.18)	0.65(0.22,1.93)	0.52(0.16,1.66)	22	34.79(13.04–47.83)	1.69(0.61, 4.70)	0.93(0.33, 2.62)
20–29	2386	26.09(13.04–52.18)	1.17(1.02,1.34)	1.09(0.94,1.26)	2351	39.13(17.39–60.88)	1.43(1.27,1.62)	1.04(0.90,1.2)
30 or older	2913	34.79(13.04–65.22)	Referent	Referent	10,281	52.18(26.09–65.22)	Referent	Referent
Marital status ^a								
Married	2698	39.13(17.39–65.22)	Referent	Referent	10,942	52.18(26.09–65.22)	Referent	Referent
Unmarried	2668	26.09(13.04–52.18)	1.45(1.26,1.67)	1.33(1.14,1.55)	1712	30.44(13.04–56.53)	1.80(1.58, 2.06)	1.54(1.33,1.79)
Geographic location ^b								
Metropolitan	4239	30.44(13.04–56.53)	Referent	Referent	10,992	52.18(26.09–65.22)	Referent	Referent
Non-metropolitan	1127	30.44(13.04–60.88)	1.15(0.98,1.35)	1.11(0.93,1.34)	1662	43.48(17.39–60.88)	1.09(0.92,1.28)	0.99(0.83,1.17)
Birth order								
First born	1708	26.09(13.04–52.18)	1.07(0.92,1.24)	1.00(0.86,1.16)	5412	43.48(21.74–60.88)	1.28(1.16,1.42)	1.25(1.13,1.40)
Not first born	3658	30.44(13.04–60.88)	Referent	Referent	7242	52.18(26.09–69.57)	Referent	Referent
Complementary food introduction ^c								
<4 months	732	21.74(8.70–52.18)	1.28(1.06,1.55)	1.14(0.94,1.39)	1163	30.44(13.04–52.18)	1.46(1.22,1.74)	1.36(1.14,1.63)
4 months	4491	30.44(13.04–60.88)	Referent	Referent	11,026	52.18(26.09–65.22)	Referent	Referent

Federal poverty level percentage of self-reported family income relative to the federal poverty threshold value depending on the number of people in the household, IQR interquartile range for the median, HR hazard ratios, CI confidence interval.

^aUnmarried includes never married, widowed, separated, divorced, and living with partners.

^bMetropolitan area is defined by the Census Bureau.

^cComplementary foods refer any solids and liquids other than breastmilk and formula. The sample for this variable doesn't sum to the total number because of missing information.