

# Estimation of Breastfeeding Rates in the United States from the National Immunization Survey: Effect of a Sampling Change from Landline and Cellular Telephones to Cellular Telephones Only

## Executive Summary

From 2011 to 2017, the National Immunization Survey (NIS) used a landline and cellular telephone sampling frame (referred to as dual-frame) to survey households with young children. Because cell phones have replaced landline phones in many US households, starting in January 2018, the NIS sampling frame was changed to include only cell phone sampling (referred to as single cell-frame). To estimate the effect of this change in sampling on national and state breastfeeding estimates, we examined data from the 2016 and 2017 NIS surveys to assess the difference in breastfeeding rates derived from the dual-frame and single cell-frame for infants born in 2015.

## Key Findings

- Among infants born in 2015, the change from dual frame to single cell-frame sampling of respondents had a minimal effect on national estimates of all 6 breastfeeding indicators examined (ever breastfed, breastfed at 6 and 12 months, exclusive breastfeeding through 3 and 6 months, and formula supplementation before 2 days among breastfed infants); national prevalence estimates differed by 0.2 percentage points or less.
- The sampling change had a slightly larger effect on estimates of breastfeeding at the state level, with some states showing higher rates and some showing lower rates from the dual-frame compared to the single cell-frame estimates. Across the 6 indicators examined, the magnitude of the difference ranged from 0.0 to 5.4 percentage points, and was less than 2.0 percentage points for about 90% of the state estimates.
- We caution against making comparisons of current single cell-frame estimates of breastfeeding rates to previous dual-frame estimates at the state level.

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## Estimation of Breastfeeding Rates in the United States from the National Immunization Survey: Effect of a Sampling Change from Landline and Cellular Telephones to Cellular Telephones Only

Ruowei Li, MD, PhD<sup>1</sup>; Cria G. Perrine, PhD<sup>1</sup>; Jian Chen, MS<sup>1</sup>

<sup>1</sup>Division of Nutrition, Physical Activity, and Obesity, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, Atlanta Georgia

### Introduction

The Centers for Disease Control and Prevention (CDC) uses data from the National Immunization Survey (NIS) to estimate national and state breastfeeding rates among US infants. Because cellular telephones have replaced landline telephones in many US households, the NIS sampling frame has changed from a landline and cellular phone sample (referred to as “dual-frame”) to a cellular phone sample only (referred to as single cell-frame) starting in January 2018. Thus beginning with 2016 births (NIS survey years 2017 and 2018), breastfeeding estimates will be based on NIS single-cell sampling. This study used data from the 2015 birth (2016 and 2017 NIS) to compare the differences in breastfeeding estimates between dual-frame and cell samples as 2017 is the last year when NIS has both landline and cell samples for comparisons. The purpose of this study was to examine the effect of this sampling change on breastfeeding estimates including ever breastfeeding, breastfeeding at 6 and 12 months, exclusive breastfeeding through 3 and 6 months, and formula supplementation before 2 days among breastfed infants.

### Methods

The National Immunization Survey is an ongoing, random-digit-dialed telephone survey conducted quarterly in 50 states and the District of Columbia among households with children aged 19–35 months.<sup>1</sup> The primary purpose of the National Immunization Survey is to estimate vaccination coverage nationally and by state and selected urban areas. Breastfeeding questions have been included in the NIS survey since 2001. From 2006 on, four questions have been used to assess whether an infant was ever breastfed, how long the infant was breastfed, how long the infant was exclusively breastfed (breast milk with no solids or other liquids except vitamin/mineral supplements or medications), and the age at which infant formula was introduced while breastfeeding.<sup>2</sup> Prior to 2011, the NIS used landline random digit dialing (RDD) to survey households with young children. From 2011 to 2017, the NIS expanded its landline sampling frame to add cellular telephone samples (dual frame). Starting in January 2018, the NIS sampling frame changed from dual-frame landline and cell phone sampling to single cell-frame sampling.

NIS survey interviews are conducted with the person in the household most knowledgeable about the eligible child’s vaccination history. Starting with the 2011 survey year, eligible children were those aged 19–35 months any time during the sampling quarter. Because

children are aged 19-35 months at the interview, each annual NIS-Child survey includes children born in 3 calendar years. Two survey years are combined to estimate breastfeeding rates among children born in the same calendar year.<sup>2,3</sup> For this report, we combined 2016 and 2017 NIS survey years to estimate breastfeeding rates for infants born in 2015. The 2015 births included 17,673 children in the dual-frame sample and 16,238 children in the single cell-frame sample; thus more than 90% of the dual-frame sample was comprised of participants sampled by cell phone. The same cell phone respondents are included in both the dual-frame and single cell-frame samples for this analysis, but the value of their sampling weights are different. Council of American Survey Research Organizations (CASRO) response rates were 55.7% for the landline sample and 32.1% for the cell phone sample for the 2016 survey, and 51.9% and 25.0%, respectively, for the 2017 survey.

We estimated the prevalence of breastfeeding initiation, 6- and 12-month breastfeeding duration, and 3- and 6-month exclusive breastfeeding duration and 95% Confidence Intervals (CI) as weighted percentages. We also calculated the weighted percentage and 95% CI of breastfed infants who were supplemented with infant formula before they were 2 days old. The rate of formula supplementation within the first 2 days was calculated among infants who were breastfeeding at 2 days of age whereas the breastfeeding initiation, duration, and exclusivity rates were calculated among all infants surveyed. All indicators were estimated separately for the dual-frame and single cell-frame using weights provided by CDC's National Center for Immunization and Respiratory Diseases.<sup>2,4</sup> The weighting procedures take into account variation in sampling rates, differential response rates, and differential coverage in the sample compared to the target population. In addition, the weighting procedures for the single cell-frame sample have included adjustment for non-coverage of children living in homes without cell phones and multiple cell phones. Analyses were conducted using statistical software that accounts for complex sample design. The differences between the dual-frame and single cell-frame prevalence estimates were calculated by subtracting the latter estimates from the former estimates. A 95% CI for each difference between the estimated value of the dual-frame and single cell-frame was estimated using a procedure developed by NORC at the University of Chicago that accounts for the non-independence of the samples.<sup>5</sup> The procedure uses a condition on the common (cell) sample and assumes that the estimated difference is distributed as a normal random variable with conditional mean and conditional variance. A Taylor series approximation is used to estimate the conditional variance. Differences were considered not statistically significant if the 95% confidence interval around the difference included zero.

## Results

### National Estimates

Among infants born in 2015, there were no statistically significant differences between the dual-frame and single cell-frame sample estimates for all 6 breastfeeding indicators examined (Table 1). The differences had an absolute value of 0.2 percentage points or less and were not statistically significant. For example, the national estimate ( $\pm$ half width 95%CI) for the percentage of infants ever breast fed based on a dual-frame was 83.2% ( $\pm$ 1.0), 0.2 ( $\pm$ 0.6) percentage points lower than the 83.4% ( $\pm$ 1.2) estimated for the single cell-frame sample.

## State Estimates (Table 2 and Table 3)

The comparison of dual-frame and single cell-frame estimates at the state level revealed considerable variability, with some states showing higher rates and some showing lower rates among the dual-frame samples in comparison to cell samples (Table 2). While several states had statistical significantly different breastfeeding estimates between the dual-frame and cell sample, the magnitude of the difference was less than 2.0 percentage points for about 90% of the state estimates, with median absolute differences ranging from -0.4 percentage points for ever breastfed and exclusively breastfed 3 months to 0.1 percentage points for formula supplementation before 2 days (Table 3).

## Discussion

The change from a dual-frame to single cell-frame telephone sample of respondents had a minimal effect on national estimates of all breastfeeding indicators examined. Dual-frame prevalence estimates for breastfeeding indicators differed from single cell-frame estimates by 0.2 percentage point or less for infants born in 2015. There was considerable variability in state estimates of breastfeeding, with some states showing higher rates and others showing lower rates among dual-frame than cell sample estimates.

CDC has released annual breastfeeding rates for infants born from 2000 to 2015.<sup>6</sup> The data prior to 2009 births were based on the landline surveys of NIS. For 2009 to 2015 births, data were based on dual-frame samples when NIS expanded its landline sampling frame to add cellular telephone samples. The previous evaluation for the impact of sampling change from landline to dual-frame indicated that adding a cell phone sample to the NIS survey had a minimal effect on national estimates for ever breastfeeding and exclusive breastfeeding by less than one percentage point for infants born in 2010, but it had slightly larger effects on national estimates for the duration of any breastfeeding by 1.5 and 1.6 percentage points for breastfed at 6 months and at 12 months, respectively.<sup>4</sup> In comparison to this previous evaluation of the impact of the sampling change from landline to dual frame, the current evaluation shows that the impact of the sampling change from dual-frame to single cell-frame is even smaller with the maximum difference being only up to 0.2 percentage points at the national level. Similar to the previous evaluation, there are larger differences at the state level.

Beginning with 2016 births (NIS survey years 2017 and 2018), breastfeeding estimates will be based on NIS single-cell sampling. The results of this analysis provide context for interpretation of trends in estimates; however, we will be unable to conduct a similar analysis with later years of data since landline data are no longer collected. The response rate for the cell sample is lower than the landline sample, thus there may be some bias in estimates from the single cell-frame sample, but we have no reason to believe that this would affect our comparison of breastfeeding estimates for the two sampling frames. As the number of children living in households with only cell phone service has increased, it is becoming less efficient to collect data from both landline and cell samples.

Based on these findings, we believe that the sampling change from dual-frame to single cell-frame has minimal impact on breastfeeding rates at the national level but we urge caution in making comparisons of current breastfeeding estimates from single cell-frame to more recent dual-frame estimates at the state level.

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### References

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Table 1. National Breastfeeding and Formula Supplementation Rates Among Infants Born in 2015 based on Dual-Frame and Single Cell-Frame Sampling— National Immunization Surveys 2016 and 2017

<i>Indicator</i>	<i>Dual-frame Sample</i>		<i>Cell Sample</i>		<i>Difference</i>
	<i>n</i>	<i>Percentage ±half 95% CI</i>	<i>n</i>	<i>Percentage ±half 95% CI</i>	<i>Percentage ±half 95% CI</i>
Ever breastfed	17673	83.2±1.0	16238	83.4±1.2	-0.2±0.6
Breastfed at 6 months	17673	57.6±1.4	16238	57.6±1.5	0.0±0.6
Breastfed at 12 months	17673	35.9±1.3	16238	35.8±1.4	0.1±0.2
Exclusively breastfed 3 months	17102	46.9±1.4	15712	46.7±1.5	0.2±0.2
Exclusively breastfed 6 months	17102	24.9±1.2	15712	24.9±1.3	0.0±0.6
Formula supplementation before 2 days	15019	17.2±1.2	13875	17.2±1.3	0.0±0.2

Table 2. State Breastfeeding and Formula Supplementation Rates Among Infants Born in 2015 based on Dual-Frame and Single Cell-Frame Sampling— National Immunization Surveys 2016 and 2017

Indicator	State	Dual-Frame Sample		Cell Sample		Difference
		n	Percentage ±half 95% CI	n	Percentage ±half 95% CI	
Ever breastfed	Alabama	328	68.1±6.4	315	67.8±6.7	0.3±5.7
Ever breastfed	Alaska	281	93.1±3.2	251	93.6±3.4	-0.5±1.7
Ever breastfed	Arizona	296	82.7±5.7	275	83.1±5.9	-0.4±1.0
Ever breastfed	Arkansas	287	73.8±6.9	272	74.6±7.0	-0.8±1.5
Ever breastfed	California	374	87.2±5.4	336	85.9±6.8	1.3±2.0
Ever breastfed	Colorado	281	90.9±4.3	263	90.8±4.4	0.1±1.4
Ever breastfed	Connecticut	321	86.3±4.6	278	87.2±5.0	-0.9±1.2
Ever breastfed	Delaware	251	77.4±6.3	223	78.4±6.7	-1.0±3.2
Ever breastfed	District of Columbia	310	83.0±5.7	277	83.2±6.2	-0.2±2.1
Ever breastfed	Florida	394	82.6±5.2	357	83.0±5.6	-0.4±2.4
Ever breastfed	Georgia	351	84.0±5.0	330	82.0±5.8	2.0±3.8
Ever breastfed	Hawaii	277	90.6±4.2	263	90.4±4.3	0.2±2.2
Ever breastfed	Idaho	226	90.1±4.1	203	89.1±4.6	1.0±3.2
Ever breastfed	Illinois	535	80.3±4.3	505	81.2±4.4	-0.9±1.3
Ever breastfed	Indiana	289	78.8±5.9	276	79.4±5.9	-0.6±1.6
Ever breastfed	Iowa	240	81.5±5.7	224	79.9±6.4	1.6±2.8
Ever breastfed	Kansas	219	83.6±6.3	198	84.3±6.6	-0.7±2.9
Ever breastfed	Kentucky	270	73.9±6.0	250	75.1±6.2	-1.2±3.1
Ever breastfed	Louisiana	385	67.0±6.3	349	68.7±6.6	-1.7±1.7
Ever breastfed	Maine	320	85.3±5.1	307	85.5±5.2	-0.2±4.8
Ever breastfed	Maryland	415	91.0±5.0	383	91.4±5.0	-0.4±0.2
Ever breastfed	Massachusetts	341	87.4±5.7	303	88.1±6.1	-0.7±2.7
Ever breastfed	Michigan	277	77.7±6.4	257	76.9±7.1	0.8±0.9
Ever breastfed	Minnesota	282	89.2±4.9	266	89.8±4.8	-0.6±0.7
Ever breastfed	Mississippi	348	63.2±6.3	326	62.7±6.4	0.5±4.9
Ever breastfed	Missouri	263	82.3±5.8	250	82.8±6.0	-0.5±7.0
Ever breastfed	Montana	220	83.9±6.4	199	84.8±6.7	-0.9±1.9
Ever breastfed	Nebraska	229	82.2±6.0	212	81.7±6.2	0.5±2.7
Ever breastfed	Nevada	286	83.5±4.9	258	83.5±5.3	0.0±1.6
Ever breastfed	New Hampshire	273	87.4±4.7	247	87.7±5.0	-0.3±1.2
Ever breastfed	New Jersey	411	82.8±4.8	353	82.7±5.4	0.1±1.5

Ever breastfed	New Mexico	282	87.7±4.6	257	87.5±4.7	0.2±0.6
Ever breastfed	New York	655	85.1±3.3	564	85.0±3.7	0.1±0.8
Ever breastfed	North Carolina	317	84.9±5.7	301	85.7±5.9	-0.8±2.0
Ever breastfed	North Dakota	234	81.7±5.8	214	82.5±5.8	-0.8±2.5
Ever breastfed	Ohio	325	81.9±5.3	301	82.1±5.6	-0.2±0.9
Ever breastfed	Oklahoma	276	75.9±6.1	262	74.4±6.5	1.5±1.4*
Ever breastfed	Oregon	247	89.4±4.7	224	90.0±4.6	-0.6±1.6
Ever breastfed	Pennsylvania	666	83.8±4.9	597	83.1±5.3	0.7±4.1
Ever breastfed	Rhode Island	279	81.4±5.1	250	82.8±5.5	-1.4±2.7
Ever breastfed	South Carolina	300	76.4±6.2	279	78.0±6.4	-1.6±5.2
Ever breastfed	South Dakota	238	83.3±6.0	224	82.7±6.1	0.6±1.2
Ever breastfed	Tennessee	275	75.7±6.9	255	74.9±7.3	0.8±1.1
Ever breastfed	Texas	1888	85.0±2.6	1773	85.9±2.6	-0.9±1.5
Ever breastfed	Utah	255	89.7±4.6	237	89.9±4.9	-0.2±1.1
Ever breastfed	Vermont	249	89.3±4.5	216	88.6±5.1	0.7±1.2
Ever breastfed	Virginia	405	81.7±7.2	365	87.1±7.1	-5.4±8.4
Ever breastfed	Washington	312	92.4±4.0	293	92.6±4.1	-0.2±0.5
Ever breastfed	West Virginia	320	68.6±6.3	285	70.5±6.4	-1.9±1.5
Ever breastfed	Wisconsin	254	82.2±6.0	235	82.9±6.0	-0.7±1.2
Ever breastfed	Wyoming	316	90.0±4.1	300	90.6±4.0	-0.6±0.8
Breastfed at 6 months	Alabama	328	39.1±6.1	315	38.4±6.3	0.7±2.0
Breastfed at 6 months	Alaska	281	69.2±6.0	251	68.9±6.5	0.3±0.8
Breastfed at 6 months	Arizona	296	55.3±7.0	275	56.1±7.3	-0.8±1.2
Breastfed at 6 months	Arkansas	287	45.2±7.0	272	46.6±7.2	-1.4±4.1
Breastfed at 6 months	California	374	66.7±7.7	336	66.3±8.6	0.4±7.2
Breastfed at 6 months	Colorado	281	63.9±7.2	263	64.6±7.3	-0.7±3.2
Breastfed at 6 months	Connecticut	321	59.6±6.5	278	59.8±7.3	-0.2±4.7
Breastfed at 6 months	Delaware	251	55.6±7.2	223	56.4±7.7	-0.8±5.7
Breastfed at 6 months	District of Columbia	310	65.5±6.7	277	67.2±7.2	-1.7±6.3
Breastfed at 6 months	Florida	394	54.0±6.8	357	53.3±7.3	0.7±0.3*
Breastfed at 6 months	Georgia	351	55.5±6.5	330	52.1±6.8	3.4±4.9
Breastfed at 6 months	Hawaii	277	65.6±6.4	263	66.0±6.5	-0.4±2.4
Breastfed at 6 months	Idaho	226	62.1±7.2	203	62.8±7.5	-0.7±1.2
Breastfed at 6 months	Illinois	535	53.0±5.0	505	53.3±5.3	-0.3±1.0
Breastfed at 6 months	Indiana	289	53.5±6.8	276	53.5±6.9	0.0±3.0
Breastfed at 6 months	Iowa	240	51.4±7.2	224	50.3±7.9	1.1±3.5
Breastfed at 6 months	Kansas	219	58.2±7.7	198	56.8±8.0	1.4±2.3
Breastfed at 6 months	Kentucky	270	48.6±6.9	250	49.2±7.2	-0.6±2.2
Breastfed at 6 months	Louisiana	385	39.0±5.8	349	39.3±6.2	-0.3±2.6
Breastfed at 6 months	Maine	320	62.1±6.3	307	62.0±6.4	0.1±3.4
Breastfed at 6 months	Maryland	415	66.8±8.3	383	66.9±8.4	-0.1±1.7
Breastfed at 6 months	Massachusetts	341	55.6±7.3	303	58.7±8.0	-3.1±5.3
Breastfed at 6 months	Michigan	277	55.6±7.4	257	54.8±8.2	0.8±1.7
Breastfed at 6 months	Minnesota	282	65.3±7.2	266	66.7±7.2	-1.4±3.1
Breastfed at 6 months	Mississippi	348	35.4±5.8	326	35.4±5.9	0.0±0.8
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Breastfed at 6 months	Ohio	325	53.1±6.5	301	52.3±6.8	0.8±2.6
Breastfed at 6 months	Oklahoma	276	49.0±6.8	262	47.9±7.0	1.1±1.6
Breastfed at 6 months	Oregon	247	72.5±6.8	224	74.1±7.0	-1.6±2.6
Breastfed at 6 months	Pennsylvania	666	59.2±6.6	597	57.3±7.0	1.9±2.0
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Breastfed at 12 months	Delaware	251	33.4±7.0	223	35.0±7.4	-1.6±5.2
Breastfed at 12 months	District of Columbia	310	43.6±6.6	277	43.5±7.2	0.1±3.2
Breastfed at 12 months	Florida	394	33.5±6.4	357	32.6±6.6	0.9±0.6*
Breastfed at 12 months	Georgia	351	34.9±6.1	330	32.7±6.2	2.2±1.1*
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Breastfed at 12 months	Maine	320	41.8±6.2	307	42.4±6.4	-0.6±0.7
Breastfed at 12 months	Maryland	415	41.1±8.2	383	40.0±8.4	1.1±3.0
Breastfed at 12 months	Massachusetts	341	36.8±6.8	303	38.2±7.5	-1.4±4.6
Breastfed at 12 months	Michigan	277	34.6±6.8	257	33.3±7.0	1.3±1.7
Breastfed at 12 months	Minnesota	282	38.9±6.9	266	40.2±7.5	-1.3±2.5
Breastfed at 12 months	Mississippi	348	18.3±4.4	326	18.1±4.4	0.2±1.0

Breastfed at 12 months	Missouri	263	33.1±6.4	250	33.1±6.5	0.0±2.5
Breastfed at 12 months	Montana	220	40.5±7.8	199	41.3±8.1	-0.8±1.3
Breastfed at 12 months	Nebraska	229	40.2±7.3	212	39.2±7.4	1.0±4.8
Breastfed at 12 months	Nevada	286	30.6±6.0	258	31.2±6.5	-0.6±0.7
Breastfed at 12 months	New Hampshire	273	45.6±6.5	247	45.5±6.8	0.1±1.9
Breastfed at 12 months	New Jersey	411	36.1±5.6	353	38.0±6.3	-1.9±1.1
Breastfed at 12 months	New Mexico	282	35.1±6.3	257	36.1±6.6	-1.0±2.3
Breastfed at 12 months	New York	655	38.3±4.3	564	38.6±4.9	-0.3±0.4
Breastfed at 12 months	North Carolina	317	33.2±6.3	301	33.5±6.6	-0.3±1.6
Breastfed at 12 months	North Dakota	234	33.4±7.0	214	34.3±7.4	-0.9±4.4
Breastfed at 12 months	Ohio	325	30.7±5.8	301	29.3±5.9	1.4±1.1*
Breastfed at 12 months	Oklahoma	276	31.0±6.1	262	29.9±6.1	1.1±1.6
Breastfed at 12 months	Oregon	247	51.7±7.5	224	51.9±7.9	-0.2±2.0
Breastfed at 12 months	Pennsylvania	666	39.0±6.5	597	36.4±6.7	2.6±3.6
Breastfed at 12 months	Rhode Island	279	30.9±5.7	250	32.1±6.6	-1.2±5.9
Breastfed at 12 months	South Carolina	300	28.0±5.9	279	28.0±6.1	0.0±1.8
Breastfed at 12 months	South Dakota	238	42.7±7.3	224	42.3±7.3	0.4±4.6
Breastfed at 12 months	Tennessee	275	34.4±6.7	255	34.2±6.9	0.2±2.9
Breastfed at 12 months	Texas	1888	35.2±3.2	1773	35.3±3.3	-0.1±0.4
Breastfed at 12 months	Utah	255	40.8±7.0	237	40.4±7.2	0.4±4.9
Breastfed at 12 months	Vermont	249	51.3±6.8	216	50.8±7.7	0.5±0.9
Breastfed at 12 months	Virginia	405	39.3±8.2	365	38.6±9.0	0.7±4.2
Breastfed at 12 months	Washington	312	48.2±7.1	293	49.6±7.6	-1.4±3.5
Breastfed at 12 months	West Virginia	320	24.3±5.0	285	24.1±5.1	0.2±3.1
Breastfed at 12 months	Wisconsin	254	39.3±6.7	235	39.4±6.9	-0.1±1.2
Breastfed at 12 months	Wyoming	316	38.6±6.0	300	38.6±6.1	0.0±0.9
Exclusively breastfed 3 months	Alabama	319	34.1±5.8	306	34.0±6.1	0.1±2.7
Exclusively breastfed 3 months	Alaska	266	65.3±6.4	236	65.5±6.8	-0.2±1.9
Exclusively breastfed 3 months	Arizona	288	51.8±6.9	268	51.4±7.2	0.4±3.3
Exclusively breastfed 3 months	Arkansas	278	39.0±6.9	263	39.9±7.1	-0.9±0.6
Exclusively breastfed 3 months	California	358	53.0±8.2	321	49.9±9.2	3.1±5.1
Exclusively breastfed 3 months	Colorado	276	57.2±7.4	258	57.9±7.5	-0.7±1.4
Exclusively breastfed 3 months	Connecticut	308	45.5±6.5	269	45.2±7.4	0.3±1.2
Exclusively breastfed 3 months	Delaware	242	47.2±7.4	218	48.5±7.9	-1.3±3.3
Exclusively breastfed 3 months	District of Columbia	305	52.6±6.8	272	53.0±7.4	-0.4±1.6
Exclusively breastfed 3 months	Florida	384	41.6±6.7	347	41.9±7.1	-0.3±6.6
Exclusively breastfed 3 months	Georgia	334	43.8±6.6	314	42.0±6.8	1.8±4.9
Exclusively breastfed 3 months	Hawaii	268	54.9±6.6	255	55.6±6.7	-0.7±6.7
Exclusively breastfed 3 months	Idaho	219	52.4±7.3	197	53.4±7.7	-1.0±4.6
Exclusively breastfed 3 months	Illinois	514	39.6±4.8	485	38.2±5.0	1.4±0.6*
Exclusively breastfed 3 months	Indiana	281	47.5±6.8	269	47.5±6.9	0.0±1.5
Exclusively breastfed 3 months	Iowa	229	51.6±7.2	213	49.6±7.7	2.0±2.8
Exclusively breastfed 3 months	Kansas	212	50.4±7.9	192	48.6±8.5	1.8±4.9
Exclusively breastfed 3 months	Kentucky	257	39.8±6.9	238	39.5±7.2	0.3±1.7
Exclusively breastfed 3 months	Louisiana	377	39.4±5.9	343	40.2±6.2	-0.8±4.8
Exclusively breastfed 3 months	Maine	307	52.5±6.5	294	53.3±6.7	-0.8±4.3
Exclusively breastfed 3 months	Maryland	394	50.1±8.6	362	45.7±8.9	4.4±6.8
Exclusively breastfed 3 months	Massachusetts	332	46.5±7.3	295	49.9±8.0	-3.4±3.5

Exclusively breastfed 3 months	Michigan	266	44.1±7.2	247	44.9±8.0	-0.8±1.9
Exclusively breastfed 3 months	Minnesota	270	56.3±7.6	255	58.0±7.7	-1.7±1.9
Exclusively breastfed 3 months	Mississippi	341	28.2±5.3	321	28.8±5.5	-0.6±0.8
Exclusively breastfed 3 months	Missouri	256	52.7±7.3	243	52.1±7.5	0.6±4.2
Exclusively breastfed 3 months	Montana	216	56.8±8.1	195	57.7±8.5	-0.9±1.9
Exclusively breastfed 3 months	Nebraska	219	46.7±7.6	203	47.1±7.8	-0.4±8.4
Exclusively breastfed 3 months	Nevada	278	44.1±6.7	251	45.4±7.1	-1.3±0.6
Exclusively breastfed 3 months	New Hampshire	265	55.9±6.5	239	57.6±7.0	-1.7±3.8
Exclusively breastfed 3 months	New Jersey	392	40.6±5.8	335	40.5±6.5	0.1±2.5
Exclusively breastfed 3 months	New Mexico	273	53.0±6.8	249	53.8±7.1	-0.8±1.3
Exclusively breastfed 3 months	New York	631	42.8±4.5	543	43.5±5.1	-0.7±0.7
Exclusively breastfed 3 months	North Carolina	307	48.1±7.1	291	49.0±7.4	-0.9±0.9
Exclusively breastfed 3 months	North Dakota	227	46.2±7.3	209	46.0±7.6	0.2±1.4
Exclusively breastfed 3 months	Ohio	318	44.4±6.3	295	44.4±6.6	0.0±1.2
Exclusively breastfed 3 months	Oklahoma	274	44.2±6.7	260	43.3±6.9	0.9±2.9
Exclusively breastfed 3 months	Oregon	238	57.8±7.9	215	59.2±8.2	-1.4±1.6
Exclusively breastfed 3 months	Pennsylvania	651	48.9±6.7	585	48.2±7.1	0.7±0.6*
Exclusively breastfed 3 months	Rhode Island	266	47.9±6.5	239	50.3±7.2	-2.4±1.9
Exclusively breastfed 3 months	South Carolina	290	42.7±6.9	269	44.5±7.3	-1.8±5.4
Exclusively breastfed 3 months	South Dakota	231	54.3±7.5	218	53.4±7.5	0.9±1.6
Exclusively breastfed 3 months	Tennessee	272	34.5±6.6	253	34.8±6.8	-0.3±3.5
Exclusively breastfed 3 months	Texas	1832	48.0±3.5	1718	48.8±3.6	-0.8±0.9
Exclusively breastfed 3 months	Utah	240	49.7±7.4	222	48.7±7.7	1.0±3.7
Exclusively breastfed 3 months	Vermont	241	62.8±6.9	209	62.2±7.5	0.6±4.3
Exclusively breastfed 3 months	Virginia	393	45.6±8.6	353	48.0±9.5	-2.4±10.2
Exclusively breastfed 3 months	Washington	303	58.9±7.2	284	57.4±7.7	1.5±2.3
Exclusively breastfed 3 months	West Virginia	305	36.3±6.1	271	37.9±6.4	-1.6±4.4
Exclusively breastfed 3 months	Wisconsin	252	48.8±7.1	233	50.2±7.3	-1.4±3.3
Exclusively breastfed 3 months	Wyoming	307	56.8±6.4	292	57.4±6.5	-0.6±1.6
Exclusively breastfed 6 months	Alabama	319	20.6±4.8	306	20.1±5.0	0.5±3.1
Exclusively breastfed 6 months	Alaska	266	42.1±6.3	236	42.4±6.7	-0.3±3.7
Exclusively breastfed 6 months	Arizona	288	26.3±5.8	268	26.1±6.1	0.2±4.1
Exclusively breastfed 6 months	Arkansas	278	20.4±5.5	263	21.5±5.8	-1.1±2.7
Exclusively breastfed 6 months	California	358	26.3±6.9	321	26.8±7.7	-0.5±3.3
Exclusively breastfed 6 months	Colorado	276	22.4±5.7	258	23.2±6.0	-0.8±6.1
Exclusively breastfed 6 months	Connecticut	308	23.6±5.6	269	23.6±6.2	0.0±1.9
Exclusively breastfed 6 months	Delaware	242	23.6±6.3	218	25.9±6.9	-2.3±3.1
Exclusively breastfed 6 months	District of Columbia	305	29.1±5.9	272	28.7±6.5	0.4±0.8
Exclusively breastfed 6 months	Florida	384	21.3±5.5	347	21.3±5.6	0.0±5.3
Exclusively breastfed 6 months	Georgia	334	22.1±5.4	314	21.6±5.5	0.5±3.6
Exclusively breastfed 6 months	Hawaii	268	32.9±6.2	255	33.9±6.4	-1.0±2.5
Exclusively breastfed 6 months	Idaho	219	28.4±6.5	197	28.2±6.8	0.2±2.2
Exclusively breastfed 6 months	Illinois	514	19.5±3.6	485	18.0±3.7	1.5±2.6
Exclusively breastfed 6 months	Indiana	281	31.7±6.3	269	32.0±6.3	-0.3±1.5
Exclusively breastfed 6 months	Iowa	229	29.5±6.7	213	27.4±6.9	2.1±2.6
Exclusively breastfed 6 months	Kansas	212	26.1±6.9	192	26.6±7.3	-0.5±3.1
Exclusively breastfed 6 months	Kentucky	257	21.1±6.0	238	21.4±6.2	-0.3±1.7
Exclusively breastfed 6 months	Louisiana	377	20.2±4.7	343	20.3±4.9	-0.1±0.8

Exclusively breastfed 6 months	Maine	307	34.1±6.0	294	34.3±6.2	-0.2±3.1
Exclusively breastfed 6 months	Maryland	394	26.2±7.4	362	21.7±7.2	4.5±8.6
Exclusively breastfed 6 months	Massachusetts	332	26.6±6.4	295	28.6±7.2	-2.0±6.2
Exclusively breastfed 6 months	Michigan	266	23.9±6.0	247	23.3±6.4	0.6±3.9
Exclusively breastfed 6 months	Minnesota	270	37.2±7.3	255	38.3±7.5	-1.1±1.3
Exclusively breastfed 6 months	Mississippi	341	13.0±3.7	321	13.2±3.9	-0.2±0.1
Exclusively breastfed 6 months	Missouri	256	31.3±6.6	243	29.6±6.7	1.7±3.2
Exclusively breastfed 6 months	Montana	216	35.7±7.6	195	35.6±7.9	0.1±2.0
Exclusively breastfed 6 months	Nebraska	219	25.4±6.1	203	25.4±6.4	0.0±6.2
Exclusively breastfed 6 months	Nevada	278	20.8±5.3	251	20.3±5.6	0.5±3.5
Exclusively breastfed 6 months	New Hampshire	265	30.2±5.8	239	30.6±6.2	-0.4±1.8
Exclusively breastfed 6 months	New Jersey	392	24.4±5.0	335	23.8±5.6	0.6±4.4
Exclusively breastfed 6 months	New Mexico	273	27.6±6.0	249	28.7±6.3	-1.1±3.0
Exclusively breastfed 6 months	New York	631	21.4±3.7	543	20.9±4.1	0.5±1.0
Exclusively breastfed 6 months	North Carolina	307	27.0±6.2	291	28.2±6.6	-1.2±7.0
Exclusively breastfed 6 months	North Dakota	227	29.1±6.8	209	29.7±7.1	-0.6±2.2
Exclusively breastfed 6 months	Ohio	318	23.7±5.2	295	24.2±5.5	-0.5±1.8
Exclusively breastfed 6 months	Oklahoma	274	21.6±5.3	260	21.7±5.4	-0.1±5.3
Exclusively breastfed 6 months	Oregon	238	33.4±6.9	215	33.7±7.3	-0.3±0.3
Exclusively breastfed 6 months	Pennsylvania	651	25.6±5.5	585	23.5±5.8	2.1±3.9
Exclusively breastfed 6 months	Rhode Island	266	28.9±5.8	239	30.5±6.7	-1.6±4.1
Exclusively breastfed 6 months	South Carolina	290	24.4±5.9	269	24.8±6.1	-0.4±1.1
Exclusively breastfed 6 months	South Dakota	231	32.2±6.8	218	31.6±6.8	0.6±1.8
Exclusively breastfed 6 months	Tennessee	272	22.7±5.5	253	23.1±5.7	-0.4±0.8
Exclusively breastfed 6 months	Texas	1832	24.1±2.8	1718	24.8±2.9	-0.7±1.3
Exclusively breastfed 6 months	Utah	240	27.8±6.6	222	27.9±6.8	-0.1±5.0
Exclusively breastfed 6 months	Vermont	241	38.0±6.8	209	40.1±7.6	-2.1±2.5
Exclusively breastfed 6 months	Virginia	393	26.6±7.5	353	26.1±8.1	0.5±6.6
Exclusively breastfed 6 months	Washington	303	29.1±6.4	284	27.8±6.7	1.3±1.2*
Exclusively breastfed 6 months	West Virginia	305	20.2±4.8	271	20.4±5.0	-0.2±4.2
Exclusively breastfed 6 months	Wisconsin	252	28.3±6.0	233	29.9±6.4	-1.6±2.9
Exclusively breastfed 6 months	Wyoming	307	28.8±5.6	292	29.1±5.7	-0.3±1.4
Formula supplementation < 2 days	Alabama	240	11.8±4.6	228	12.5±4.9	-0.7±2.4
Formula supplementation < 2 days	Alaska	259	11.4±4.5	233	11.3±4.6	0.1±1.4
Formula supplementation < 2 days	Arizona	254	15.8±5.5	238	16.0±5.7	-0.2±2.3
Formula supplementation < 2 days	Arkansas	228	12.6±4.9	219	12.5±4.8	0.1±1.6
Formula supplementation < 2 days	California	338	15.1±6.5	306	16.1±7.5	-1.0±1.6
Formula supplementation < 2 days	Colorado	254	10.6±4.4	239	11.1±4.6	-0.5±1.9
Formula supplementation < 2 days	Connecticut	275	20.3±5.8	240	18.4±6.1	1.9±0.9*
Formula supplementation < 2 days	Delaware	202	14.4±5.5	180	12.5±5.4	1.9±4.3
Formula supplementation < 2 days	District of Columbia	272	14.0±4.9	244	13.7±4.8	0.3±2.0
Formula supplementation < 2 days	Florida	325	23.9±6.7	298	24.1±7.0	-0.2±2.0
Formula supplementation < 2 days	Georgia	300	20.6±5.7	281	20.8±5.7	-0.2±0.9
Formula supplementation < 2 days	Hawaii	252	17.3±5.2	239	16.6±5.3	0.7±7.2
Formula supplementation < 2 days	Idaho	201	9.5±4.2	179	8.8±4.2	0.7±2.5
Formula supplementation < 2 days	Illinois	450	20.7±4.4	426	20.0±4.6	0.7±0.3*
Formula supplementation < 2 days	Indiana	234	11.8±4.6	226	12.5±4.8	-0.7±2.7
Formula supplementation < 2 days	Iowa	196	8.4±4.0	182	8.9±4.4	-0.5±1.3

Formula supplementation < 2 days	Kansas	185	13.5±5.8	171	13.6±6.0	-0.1±1.7
Formula supplementation < 2 days	Kentucky	199	19.8±6.8	191	20.1±7.1	-0.3±2.1
Formula supplementation < 2 days	Louisiana	292	15.7±5.1	271	16.1±5.4	-0.4±4.6
Formula supplementation < 2 days	Maine	284	13.3±4.7	273	13.4±4.8	-0.1±2.3
Formula supplementation < 2 days	Maryland	380	19.1±7.0	352	22.8±8.0	-3.7±3.7
Formula supplementation < 2 days	Massachusetts	311	13.7±5.2	278	12.6±5.7	1.1±2.5
Formula supplementation < 2 days	Michigan	225	13.2±4.9	210	13.0±4.9	0.2±3.7
Formula supplementation < 2 days	Minnesota	255	7.2±3.8	241	7.3±4.1	-0.1±1.0
Formula supplementation < 2 days	Mississippi	240	25.1±6.9	223	25.2±7.1	-0.1±0.1
Formula supplementation < 2 days	Missouri	224	14.0±5.6	215	14.9±5.9	-0.9±1.0
Formula supplementation < 2 days	Montana	192	9.2±4.6	178	8.8±4.7	0.4±0.8
Formula supplementation < 2 days	Nebraska	191	17.5±6.1	175	16.7±6.3	0.8±0.7*
Formula supplementation < 2 days	Nevada	241	23.7±7.2	218	22.1±7.2	1.6±2.0
Formula supplementation < 2 days	New Hampshire	244	11.4±4.8	223	10.5±4.5	0.9±3.4
Formula supplementation < 2 days	New Jersey	350	25.7±5.6	301	23.5±5.9	2.2±2.1*
Formula supplementation < 2 days	New Mexico	245	11.6±4.4	222	11.5±4.7	0.1±2.1
Formula supplementation < 2 days	New York	564	26.5±4.2	486	24.8±4.7	1.7±2.2
Formula supplementation < 2 days	North Carolina	284	15.6±5.4	272	15.4±5.5	0.2±1.0
Formula supplementation < 2 days	North Dakota	192	10.8±4.7	176	11.6±5.1	-0.8±0.6
Formula supplementation < 2 days	Ohio	273	12.6±4.7	256	12.0±4.7	0.6±0.6
Formula supplementation < 2 days	Oklahoma	217	16.8±6.1	206	17.4±6.5	-0.6±2.8
Formula supplementation < 2 days	Oregon	223	13.4±5.6	202	11.9±5.6	1.5±2.1
Formula supplementation < 2 days	Pennsylvania	558	14.5±5.4	504	15.0±5.8	-0.5±3.6
Formula supplementation < 2 days	Rhode Island	230	18.3±5.6	208	17.5±5.8	0.8±1.1
Formula supplementation < 2 days	South Carolina	242	15.2±6.1	228	15.1±6.4	0.1±1.7
Formula supplementation < 2 days	South Dakota	205	11.7±5.0	192	11.7±5.1	0.0±1.2
Formula supplementation < 2 days	Tennessee	219	21.3±7.3	205	20.3±7.5	1.0±7.0
Formula supplementation < 2 days	Texas	1628	18.3±2.9	1536	18.0±3.0	0.3±1.2
Formula supplementation < 2 days	Utah	231	20.1±6.2	216	21.0±6.5	-0.9±0.7
Formula supplementation < 2 days	Vermont	226	9.9±4.3	196	9.5±4.6	0.4±1.2
Formula supplementation < 2 days	Virginia	366	20.9±7.2	338	21.3±8.3	-0.4±4.2
Formula supplementation < 2 days	Washington	289	12.7±5.1	271	13.7±5.7	-1.0±3.3
Formula supplementation < 2 days	West Virginia	229	14.9±5.7	207	14.8±6.0	0.1±9.4
Formula supplementation < 2 days	Wisconsin	219	15.6±5.7	203	15.1±5.8	0.5±1.5
Formula supplementation < 2 days	Wyoming	286	9.4±4.2	273	9.5±4.3	-0.1±1.3

\*difference is statistically significant

Table 3. Distribution of State Difference on Breastfeeding and Formula Supplementation Rates Among Infants Born in 2015 based on Dual-Frame and Single Cell-Frame Sampling— National Immunization Surveys 2016 and 2017

	Percentiles						
	min	P5	P25	P50	P75	P95	max
Ever breastfed	-5.4	-1.7	-0.9	-0.4	0.3	1.5	2.0
Breastfed at 6 months	-3.2	-1.6	-0.8	-0.3	0.3	1.4	3.4
Breastfed at 12 months	-1.9	-1.4	-0.8	0.0	0.6	2.2	3.0
Exclusively breastfed 3 months	-3.4	-2.4	-1.0	-0.4	0.6	2.0	4.4
Exclusively breastfed 6 months	-2.3	-2.0	-0.6	-0.2	0.5	2.1	4.5
Formula supplementation before 2 days	-3.7	-1.0	-0.4	0.1	0.7	2.0	2.2