Mitigating Breastfeeding Disparities: Examining the Influence of Maternity Care Practices in U.S. Hospitals

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Introduction

Breastfeeding, a nearly universally available and cost-effective practice, significantly enhances maternal and child health. Mother's milk provides proven health benefits to children by reducing risk of ear and gastrointestinal infections, inflammatory bowel disease, childhood leukemia, asthma, and obesity.[1-7] Not breastfeeding correlates with a higher probability of sudden infant death syndrome,[8] necrotizing enterocolitis,[9] and an infant's respiratory disease hospitalization.[10] For mothers, breastfeeding is linked to lower rates of breast and ovarian cancer,[11] cardiovascular disease,[12] hypertension,[13] and type 2 diabetes.[14]

Despite these well-established benefits and the ability of 95% of mothers to produce milk,[15] one in six American mothers do not initiate breastfeeding at birth, with even higher rates among lower-income and some racial/ethnic groups.[16] Only about 25% of mothers comply with recommendations and exclusively breastfeed through the first 6 months while 1 in 3 still breastfeed at 12 months.[16] In fact, these rates reflect improvements over the last several decades following public health campaigns and implementation of policies to promote and support breastfeeding. During the 20th century, breastfeeding rates declined significantly as more women joined the workforce and commercial infant formula was extensively marketed.[17-18] This shift was compounded by a lack of community and workplace support for lactation.[17] As a result, the breastfeeding rate dropped from 77% for babies born between 1936 and 1940 to about 25% by 1970. [17]

Suboptimal breastfeeding rates have significant financial implications, including annual medical costs estimated at $3.0 billion, non-medical costs such as missed work valued at $1.3 billion, and premature deaths contributing $14.2 billion in 2014 U.S. dollars.[19] Due to substantial disparities in breastfeeding, the health and economic burden associated with inadequate

breastfeeding is unequally distributed in society, with non-Hispanic Black (NHB) mothers and children being one of the most negatively affected groups due to their lowest breastfeeding rates.[20-21] Identifying effective approaches to reducing gaps in breastfeeding among certain racial groups is necessary to ensure equitable access to the benefits of breastfeeding for all infants and mothers.

As experiences during childbirth hospitalization play an important role in establishing breastfeeding,[22] supportive breastfeeding practices in U.S. hospitals could help narrow the existing gaps in breastfeeding initiation and reduce racial disparities. Across the country, access to maternity care practices in support of breastfeeding is unequal and depends on the racial composition of the areas surrounding the hospitals, with less support available in areas with more NHB residents.[23-24] Prior research on hospital-based maternity care practices has primarily used cross-sectional data and focused on assessing the overall impact on breastfeeding initiation and exclusivity, without much consideration of how this impact varies across population groups.[25-28] One exception is the study of Mississippi, Louisiana, Tennessee, and Texas hospitals enrolled in the Communities and Hospitals Advancing Maternity Practices initiative that assessed improvements in compliance with the Ten Steps to Successful Breastfeeding and linked it to a 9.6 percentage points decrease in the difference between breastfeeding initiation rates for white and black infants.[29]

This study assesses how changes in hospital maternity care practices are related to breastfeeding initiation, overall and in the two large population groups with some of the biggest disparities in breastfeeding: non-Hispanic White (NHW) and NHB mothers (referred as 'disparities' throughout the paper). The study has two objectives: 1) to measure the association between hospital-based maternity care practices and both disparities and overall levels of

breastfeeding initiation using cross-sectional data, and 2) to longitudinally link changes in maternity care practices to changes in breastfeeding initiation and disparities over time.

Methods

Data and measures

Data for this analysis was obtained from the National Vital Statistics System (NVSS) and the Centers for Disease Control and Prevention's (CDC) biennial Maternity Practices in Infant Nutrition and Care Survey (mPINC). The restricted-use NVSS offers a detailed record of all live births in the United States, including county identifiers for the infant's birth location.[30-31] The mPINC survey assesses infant feeding and maternity care policies and practices in a biennial census of all U.S. hospitals that provide maternity care services. Participation in the survey is not mandatory, but the high response rate enables data collection for 70% to 75% of eligible U.S. hospitals. Detailed data collection methods of the mPINC survey are described elsewhere.[32-33]

Our analysis of the 2017-2022 NVSS data focused on infants born in hospitals who were alive when their birth certificate was completed, not transferred to another facility within 24 hours of birth, with mothers not admitted to an intensive care unit, and with complete covariate data. California, Michigan and Utah were excluded due to lack of data on breastfeeding initiation or data quality concerns.[34] We used information about counties where infants were born to link infant-level data from the NVSS with the mPINC survey at the county level as the NVSS data doesn't include information about hospitals where births occurred. Considering the biennial nature of the mPINC survey data, we matched the 2018 mPINC score data with births occurring in 2017 and 2018; the 2020 mPINC scores with births from 2019 to 2020, and the mPINC scores for 2022 with births from 2021 and 2022.

Due to non-response, data are not consistently available for participating hospitals across all three biannual waves over 2017-2022 (i.e., an unbalanced panel). To address the issue of missing data on mPINC scores in some years and maximize the available information on maternity care practices, we created two samples. In Sample 1, we have imputed the mPINC score at the hospital level for the years when it was not available and the hospital participated in the two other waves of the survey; for detailed methodology, refer to the "Interpolation of mPINC scores" section in the **Appendix**. Similarly, for hospitals with only one available survey (468 of 2,294 facilities), we used the available score to represent the missing two waves. We justify this approach by noting that the average between-wave absolute change in the mPINC score at the hospital level was 7.74 points, a modest change given the distribution from 18 to 100. We used this sample to assess the variation in the levels of maternity care practices at the county level and their association with breastfeeding initiation and disparities, our analytic goal (n = 16,795,025 (1386 counties); see **Appendix**, **Fig A1** for the sample selection flowchart).

Sample 2 was limited to hospitals with available mPINC score data in all three surveys to conduct a longitudinal analysis of changes in the quality of maternity care practices over time without data imputations. We used this sample to estimate the association between changes in the quality of maternity care practices at the county level and changes in breastfeeding initiation and disparities (n = 14,071,055 (866 counties); see **Appendix, Fig A2**, for the sample selection flowchart). We replicated all cross-sectional analyses using Sample 2 as a sensitivity check for analyses based on Sample 1 with imputed data.

The main variable of interest was hospital policies and practices supportive of breastfeeding as measured by the mPINC scores. The mPINC survey covers six subdomains of maternity care services, including Immediate Postpartum Care, Rooming-In, Feeding Practices,

Feeding Education & Support, Discharge Support and Institutional Management, which were scored from 0 to 100 to generate six subdomain scores. These were averaged to calculate a total mPINC score for every participating hospital, with higher scores indicating better maternity care practices and policies.[35] The mPINC scores, ranging from 0 to 100, were regarded as a continuous variable.

The outcome was breastfeeding initiation, determined from a birth certificate's question about the infant's breastfeeding status at discharge (NVSS). Breastfeeding at discharge entails establishing breastmilk through breastfeeding or pumping during the period between birth and hospital discharge, as extracted from medical records.[36-37] Disparities in breastfeeding initiation between NHW and NHB mothers were determined based on mothers' self-reported race and ethnicity (i.e., Hispanic or non-Hispanic (NH) ethnicity, American Indian or Alaskan Native, Black or African American, Asian, Native Hawaiian or Pacific Islander, White or More than One Race). A set of independent variables was added to reduce confounding, including mothers' self-reported marital status, mother's place of birth (born in the U.S. or elsewhere), smoking three months before and during pregnancy, pre-pregnancy body mass status based on the body mass index (BMI) (i.e., underweight <18.5, normal 18.5-24.9, overweight 25.0-29.9, obesity I 35.0-34.9, obesity II 35.0-39.9 or Extreme Obesity III ≥ 40.0), participation in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), and educational level (less than high school, high school, some college, college or more). The payment source for delivery (private insurance, Medicaid, other) and route of delivery (vaginal spontaneous, vaginal assisted by forceps or vacuum, and cesarean delivery) were gleaned from medical records. Infant characteristics such as birth order, gestational age in weeks, and birth weight were gathered from medical records.

County identifiers based on the residence location and reflected the county population size (more than 100,000 inhabitants; fewer than 100,000 inhabitants). [36-37]

Statistical analysis

We used two statistical methods to assess an infant's likelihood of being breastfed at discharge and disparities in breastfeeding initiation based on the mPINC score of their birth county. First, we used a linear probability model (LPM) to examine cross-sectional variation in the mPINC scores and breastfeeding outcomes using Sample 1. Subsequently, a two-way fixed effects linear model (TWFE) was estimated to explore changes in the mPINC scores and breastfeeding initiation over time using Sample 2.

In the cross-sectional approach, we divided counties into 4 quartiles based on their average mPINC score. The LPM regression computed the average marginal effects of the mPINC score of the birth county on breastfeeding initiation and *disparities* in breastfeeding initiation. This LPM method is less computationally intensive than any other generalized linear model and yields results comparable to those obtained with large samples.[38] The models were adjusted for covariates as described in the previous section. Additionally, state fixed effects were included to address the influence of state-level maternity policies, and year fixed effects were incorporated to account for temporal shocks, such as the COVID-19 pandemic or infant formula shortages. The following model was estimated:

$$Y_{\mathrm{ics}t} = \alpha + \mathrm{GmPINC}_{cst}\gamma + X_{\mathrm{ics}t}\beta + Z_{\mathrm{c}}\delta + \phi_s + \tau_{\mathrm{t}} + \varepsilon_{icst}, \quad (1)$$

where $Y_{\mathrm{ics}t}$ is a binary outcome of breastfeeding initiation for infant i in county c of state s in year t, GmPINC_{cst} is a vector of the four quartiles based on the mPINC scores, $X_{\mathrm{ics}t}$ is a vector of covariates at the mother-infant level, Z_{c} is a vector of county-level urbanization measures, state fixed effects are measured by ϕ_s and year fixed effects as τ_t. Standard errors were clustered at the

county level. In this specification, γ represents a vector of coefficients that capture the likelihood of breastfeeding initiation based on the quality of hospital maternity care practices as measured by the mPINC score for the county of birth. To assess *disparities*, we estimated a variant of equation (1) where we included an interaction between the mother's race/ethnicity (NHB or NHW) and the four mPINC score quartiles. The interaction measures the difference in the adjusted breastfeeding initiation between NHW and NHB mothers based on the level of maternity care practices observed in the county of birth.

Our second approach involved using a county of birth as the primary unit of observation, enabling an assessment of changes over time in the outcomes and treatment of interest. This was achieved by aggregating all measures based on the county and year of birth; for detailed methodology, refer to the "Methods TWFE" section in the **Appendix**. The following linear model was estimated:

$$Y_{\mathrm{cst}} = \alpha + mPINC_{\mathrm{cst}}\theta + \mathrm{X}_{\mathrm{cst}}\beta + \phi_c + \tau_{\mathrm{t}} + \varepsilon_{\mathrm{cst}}, \quad (2)$$

where Y_{cst} represents the breastfeeding initiation rate or the disparity rate (the difference in breastfeeding initiation between NHW and NHB mothers) for county c of state s in year t; mPINC_{cst} is a continuous variable ranging from 0 to 100, and X_{cst} is a vector of covariates. In this specification, θ represents coefficients that capture the relationship between the change in breastfeeding initiation (or disparities) and the change in the quality of maternity practices within counties. The model included county fixed effects ϕ_s and year fixed effects τ_t. Standard errors were clustered at the county level. We estimated two variations of Equation (2): one utilizing logarithms of the outcome, mPINC scores and covariates to interpret results in terms of elasticities, and a second one using the first (2017) and the last year (2022) of the available data only. Analyses

were conducted in Stata 18.[39] The MASKED IRB deemed the study exempt from IRB review (protocol #23-274-910).

Results

Table 1 (**Panel A**) summarizes data on breastfeeding initiation and various maternal and birth characteristics, categorized by quartiles based on the average mPINC score at the county level, including a category for those with no mPINC score available. Breastfeeding initiation rates show a clear upward trend across the mPINC score quartiles, starting at 72.42% in the no-score group and reaching 86.46% in the 4th quartile, with an overall average of 84.25%. Normal birth weight (≥2.5 kg) remains stable across all groups, slightly decreasing from 94.05% in the no-score group to around 91.97% in the 4th quartile. The rate of spontaneous deliveries and gestational age of 37 weeks or more are relatively stable, ranging from 64% to 66% and 92.84% to 90.05%, respectively.

Marital status shows an increasing percentage of married mothers, from 55.42% in the no-score group to 61.53% in the 4th quartile. Maternal BMI has a higher prevalence of normal BMI in higher quartiles, while the prevalence of obesity decreases from 33.10% in the no-score group to 28.93% in the 4th quartile. Educational attainment also improves across quartiles, with a higher percentage of mothers holding a college degree or more, rising from 25.32% in the no-score group to 37.02% in the 4th quartile. Racial and ethnic distributions vary, with a notable increase in Hispanic mothers in the 1st quartile (19.65%) compared to the no-score group (14.24%), and a higher percentage of NHWmothers in the no-score group (60.06%). The proportion of babies born in counties with more than 100,000 inhabitants increases significantly in higher quartiles, peaking at 85.20% in the 2nd quartile. Similarly, a higher percentage of mothers born outside the U.S. is

observed in higher quartiles, reaching 22.04% in the 4th quartile. Payment source for delivery shows a rising trend in private insurance use and a decreasing trend in Medicaid coverage across quartiles. Smoking rates are lower in higher quartiles, with the highest rate in the no-score group at 10.68%. Participation in the Women, Infants, and Children (WIC) program decreases from 36.93% in the no-score group to 31.13% in the 4th quartile.

Table 1 (Panel B) shows very similar patterns to those already commented on in Panel A, with the main difference being an increase in the number of babies born in counties without scores, as the mPINC score is not imputed.

LPM Results

The average adjusted breastfeeding initiation rate increases with each quartile of the mPINC score at the county level (**Table 2, Panel A**). Compared to the 1st quartile (reference group), the 2nd quartile is linked to a 1.66 percentage point increase in breastfeeding initiation ($p<0.05$), the 3rd quartile to a 2.52 percentage point increase ($p<0.01$), and the highest increase of 2.60 percentage points is observed in the 4th quartile ($p<0.01$). These findings remain consistent when analyzing the sample without imputed mPINC scores (Sample 2).

In **Table 2** (**Panel B)**, we explore disparities in breastfeeding initiation rates between NHW and NHB mothers within each quartile of the mPINC score. Main effects analysis reveals modest increases in overall breastfeeding initiation rates independently of race/ethnicity across higher quartiles, with the 3rd quartile showing a statistically significant increase of 1.59 percentage points ($p<0.05$) and the 4th quartile of 1.82 percentage points ($p<0.01$) compared to the 1st quartile. Sample 2 does not show any significant improvements in higher quartiles. The interaction effects between the mPINC score quartiles and maternal race/ethnicity indicate statistically significant reductions in the breastfeeding initiation gap between NHW and NHB mothers as the mPINC

scores improve. Specifically, in Sample 1, the difference in breastfeeding initiation among NHB vs. NHW mothers is reduced by 5.25 percentage points ($p<0.01$) in the 2nd mPINC score quartiles, by 5.49 percentage points ($p<0.01$) in the 3rd quartile and by 5.18 percentage points ($p<0.01$) in the 4th quartile as compared to the lowest quartile. The reduction in the breastfeeding initiation gap between NHW and NHB mothers with higher quality of maternity practices is even more visible in Sample 2, with interaction effects of 4.00 percentage points ($p<0.01$), 5.32 percentage points ($p<0.01$), and 5.63 percentage points ($p<0.01$), respectively.

TWFE Results

An increase in the county mPINC score was found to be associated with a higher rate of breastfeeding initiation, implying that a 10% rise in the mPINC score corresponds to a statistically significant 0.7% increase in the breastfeeding initiation rate over time (**Table 3, Panel A, Column 4**). However, changes in the mPINC score within a short term (2 years), while showing a positive correlation with breastfeeding initiation, appeared to lack statistical significance (**Table 3, Panel A, Column 2**). Looking at the change of *disparities* in breastfeeding initiation over time, we observed a negative association between the mPINC score and breastfeeding *disparities*, implying that a 10% rise in the mPINC score corresponded to a 5% decrease in breastfeeding disparities over time (**Table 3, Panel B, Column 4**). Similarly, immediate changes in the mPINC score, despite indicating a negative correlation with breastfeeding disparities, lacked statistical significance. **(Table 3, Panel B, Column 2)**.

Discussion

This study finds that an increase in the quality of hospital maternity care practices in support of breastfeeding is associated with a significant increase in breastfeeding initiation for all

infants. This suggests that newborns delivered in hospitals with supportive breastfeeding practices and policies, as measured by the mPINC scores, exhibit better in-hospital breastfeeding outcomes. This finding aligns with previous research indicating that better maternity care practices are associated with improved breastfeeding initiation, breastfeeding exclusivity, and breastfeeding duration.[25-28] Additionally, better quality of maternity care practices at the county level was associated with a decrease in disparities in breastfeeding initiation for NHB infants as compared to NHW infants. The most significant improvement in narrowing the disparity gap occurred in the second quartile of maternity care practices, while differences between the second quartile and the third and fourth were not sizeable. This finding is aligned with previous research that found a reduction in racial disparities for NHB infants at hospitals receiving intensive quality improvement and technical assistance interventions to improve compliance with the Ten Steps to Successful Breastfeeding.[29]

Our results suggest that improvements in breastfeeding initiation across all races and the decrease in inequities among NHB infants do not materialize immediately after improvements in maternity care practices; rather, they require time. This may be due to historical, cultural, social, economic, political, and psychosocial factors that are difficult to change in the short run.[40] Historically, racially targeted formula advertisements promoted the false notion that formula provided superior infant nutrition. Specifically, in the case of low-income NHB mothers, human milk was often considered insufficient to fully satisfy their infants' hunger. [40-41] Cultural barriers, as revealed by qualitative studies, show that low-income NHB mothers are reluctant to breastfeed in public, with some considering it inappropriate and disrespectful. As a result, they are unable to integrate breastfeeding into their daily family routines, making the practice difficult to maintain.[40,42] Other significant obstacles that hinder or minimize the impact of improved maternity

practices at the hospital level on breastfeeding initiation for NHB mothers, especially those in lower income brackets, include the lack of paid parental leave and inadequate social and workplace support for breastfeeding.[40,43] Finally, hospitals are not the only source of breastfeeding information; other widely used sources include family, friends, and support groups, making it more difficult to achieve immediate changes in infant feeding behavior.[44]

The mPINC survey is a valuable tool to assist hospitals in assessing and monitoring their level of breastfeeding support services. The CDC provides each hospital participating in the mPINC survey with a customized benchmark report. This report compares the hospital's performance with that of similarly sized hospitals, hospitals within the same state, and all hospitals included in the survey. Hospitals can utilize this information to identify their strengths and areas needing improvement.[45] Given the evidence linking quality maternity care practices to better breastfeeding outcomes, public health initiatives and legislation to enhance hospital-based maternity care should remain a high priority.[46]

This study has several key strengths. Firstly, it utilizes national birth certificate data spanning from 2017 to 2022, employing a standardized definition of hospital-based breastfeeding initiation. This allowed us to assess breastfeeding initiation among nearly all newborn infants from 47 states and the District of Columbia, covering approximately 64% of U.S. live births. Secondly, our analysis is adjusted for a wide range of individual-level covariates. The study also benefits from the utilization of the mPINC survey, which provides a comprehensive survey of maternity care facilities with a notably high response rate. Moreover, the utilization of different methodological approaches, including exploiting cross-sectional and time-series variation in the data contributes to thorough understanding of the association and potential effects of maternity care practices on breastfeeding initiation.

The main limitation of this study is the impossibility to link the mother-infant dyads to the delivery hospital (unavailable in birth certificate data through the NVSS), which prevents accurate measurement of the intensity of treatment. Other limitations include reliance on self-reports by hospital staff in the mPINC survey data. Despite the implementation of a standard protocol to identify a key informant at each hospital, responses may not fully represent all hospital practices accurately.[33] Further, the 2018 redesign of the mPINC survey precluded any comparison of data from surveys conducted in 2018 and later with those from 2007 to 2015, thereby constraining our ability to analyze changes in maternity care practices over time.[32]

Conclusion

Infants born in counties with higher-quality hospital-based maternity care practices are more likely to initiate breastfeeding and experience lower breastfeeding disparities between NHW and NHB infants. This relationship is also evident over time, as counties experiencing greater improvements in the quality of maternity care practices also witness higher increases in breastfeeding initiation rates and greater reductions in the disparity between NHW and NHB infants, although the effects do not appear to be immediate. This research highlights the significance of hospital-based maternity care practices policy, not only in increasing breastfeeding rates but also in playing a role in reducing racial disparities and alleviating the health and economic burden of suboptimal breastfeeding on the non-Hispanic Black population.

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Table 1: Summary Statistics: Analytical Sample, 2017-2022

Panel A: Sample 1	(%) or mean					
	No score available	1st Quartile [1]	2nd Quartile [1]	3rd Quartile [1]	4th Quartile [1]	Total
Breastfeeding Initiation	72.42%	80.81%	85.66%	85.09%	86.46%	84.25%
Birth Weight						
>= 2,5 kg	94.05%	92.46%	91.95%	91.85%	91.97%	92.10%
Final Route & Method of Delivery						
Spontaneous	66.32%	64.29%	63.92%	64.51%	65.14%	64.50%
Gestational age in weeks						
37 weeks and over	92.84%	90.60%	90.08%	90.05%	90.50%	90.36%
Marital Status						
Married	55.42%	57.21%	59.39%	60.17%	61.53%	59.48%
Maternal Body Mass Index (BMI)						
Underweight <18.5	2.99%	3.04%	2.86%	2.85%	2.97%	2.93%
Normal 18.5-24.9	36.70%	38.79%	40.66%	40.08%	41.43%	40.15%
Overweight 25.0-29.9	27.21%	26.78%	27.38%	27.12%	26.67%	27.00%
Obesity > 30.0	33.10%	31.39%	29.11%	29.94%	28.93%	29.92%
Maternal level of education:						
Less than high school	12.65%	12.89%	12.26%	11.16%	10.81%	11.80%
High School Diploma	30.74%	29.07%	25.99%	25.25%	24.47%	26.30%
Some college	31.28%	28.84%	27.17%	26.98%	27.70%	27.74%
College degree or more	25.32%	29.20%	34.58%	36.62%	37.02%	34.17%
Maternal race/ethnicity:						
Hispanic (may be of any race)	14.24%	19.65%	28.12%	20.80%	19.71%	21.92%
Non-Hispanic White	60.06%	57.84%	46.89%	53.43%	56.78%	53.83%
Non-Hispanic Black	17.62%	15.44%	16.10%	17.24%	14.19%	15.81%
County of residence (Population > 100,000)	38.58%	65.05%	85.20%	82.49%	78.55%	81.29%
Mother's Nativity						
Born outside the U.S. (includes possessions)	12.06%	17.08%	25.05%	21.25%	22.04%	21.16%
Payment Source for Delivery						
Private insurance	44.39%	47.82%	49.86%	52.45%	53.38%	50.74%
Medicaid	45.08%	45.39%	42.20%	41.42%	40.74%	42.50%
Other[2]	10.53%	6.78%	7.94%	6.13%	5.87%	6.76%
Prior Births Now Living						
0	37.46%	37.47%	38.99%	39.10%	40.17%	38.89%
1	31.87%	31.82%	32.09%	32.22%	32.51%	32.15%
2 or more	30.68%	30.71%	28.92%	28.67%	27.33%	28.96%
Smoking Status[3]						
Smoker	10.68%	7.95%	4.64%	5.31%	5.77%	6.01%
Women, Infants and Children (WIC)						
WIC participant	36.93%	37.06%	33.73%	30.38%	31.13%	33.15%
mPINC Score[4]	**NA**	68.73	79.98	85.14	92.17	81.43
Total Live Births (N)	346,566	4,205,058	4,198,758	4,353,634	4,037,575	17,141,591

Panel B: Sample 2	(%) or mean					
	No score available	1st Quartile [1]	2nd Quartile [1]	3rd Quartile [1]	4th Quartile [1]	Total
Breastfeeding Initiation	80.55%	81.96%	84.97%	85.57%	86.26%	84.25%
Birth Weight						
>= 2,5 kg	93.04%	92.49%	91.89%	91.54%	91.83%	92.10%
Final Route & Method of Delivery						
Spontaneous	65.64%	65.09%	63.98%	64.13%	64.03%	64.50%
Gestational age in weeks						
37 weeks and over	91.53%	90.54%	89.94%	89.66%	90.25%	90.36%
Marital Status						
Married	56.49%	58.56%	59.68%	58.87%	61.94%	59.48%
Maternal Body Mass Index (BMI)						
Underweight <18.5	2.96%	3.02%	2.77%	2.85%	3.00%	2.93%
Normal 18.5-24.9	37.65%	39.34%	40.61%	39.82%	42.00%	40.15%
Overweight 25.0-29.9	26.99%	26.73%	27.06%	27.25%	26.93%	27.00%
Obesity > 30.0	32.40%	30.90%	29.56%	30.09%	28.07%	29.92%
Maternal level of education:						
Less than high school	12.44%	12.78%	11.91%	12.33%	10.56%	11.80%
High School Diploma	29.44%	27.82%	26.20%	25.46%	24.37%	26.30%
Some college	30.92%	28.89%	27.00%	26.80%	26.32%	27.74%
College degree or more	27.20%	30.52%	34.90%	35.41%	38.76%	34.17%
Maternal race/ethnicity:						
Hispanic (may be of any race)	19.49%	20.05%	24.78%	24.76%	20.83%	21.85%
Non-Hispanic White	59.18%	58.11%	51.21%	48.66%	53.31%	53.83%
Non-Hispanic Black	14.58%	13.60%	15.69%	18.17%	16.07%	15.81%
County of residence (Population > 100,000)	57.70%	70.02%	82.39%	84.80%	83.99%	81.29%
Mother's Nativity						
Born outside the U.S. (includes possessions)	14.65%	17.57%	22.00%	23.26%	24.84%	21.16%
Payment Source for Delivery						
Private insurance	45.64%	49.57%	51.06%	51.20%	53.76%	50.74%
Medicaid	45.50%	43.98%	41.82%	42.83%	40.15%	42.50%
Other[2]	8.87%	6.45%	7.12%	5.98%	6.09%	6.76%
Prior Births Now Living						
0	37.83%	37.50%	38.70%	38.89%	40.26%	38.89%
1	31.79%	31.84%	32.30%	32.00%	32.55%	32.15%
2 or more	30.38%	30.66%	29.00%	29.11%	27.19%	28.96%
Smoking Status[3]						
Smoker	8.59%	7.57%	5.30%	4.81%	4.88%	6.01%
Women, Infants and Children (WIC)						
WIC participant	37.22%	35.09%	33.79%	32.08%	30.31%	33.15%
mPINC Score[4]	**NA**	69.55	79.71	85.02	93.24	84.36
Total Live Births (N)	3,070,536	2,662,186	2,372,997	3,623,786	5,412,086	17,141,591

Notes: (1) mPINC score distribution by quartiles: 1st (<76.89), 2nd (76.89-82.29), 3rd (82.33-88), 4th (>88) (2) Include self-pay, Indian Health Service, CHAMPUS/TRICARE, and Other Government (Federal, State, Local) (3) Smoking three months before and during pregnancy (4) Sample 1 includes imputed mPINC scores, while Sample 2 does not.

Table 2: Adjusted Breastfeeding Initiation Rates by mPINC Score Quartile, 2017–2022.

	Sample 1		Sample 2	
	γ	[95% CI]	γ	[95% CI]
Panel A: Adjusted Breastfeeding Initiation Rates				
Quartile of mPINC score				
1st Quartile (< 76.89)	**Reference**		**Reference**	
2nd Quartile (76.89-82.29)	0.0166**	[0.006 to 0.027]	0.0089	[-0.002 to 0.020]
3rd Quartile (82.33-88)	0.0252***	[0.015 to 0.036]	0.0186***	[0.008 to 0.029]
4th Quartile (>88)	0.0260***	[0.014 to 0.038]	0.0169***	[0.005 to 0.028]
Covariates	Yes		Yes	
Year Fixed Effects	Yes		Yes	
State Fixed Effects	Yes		Yes	
Number of observations	16795025		14071055	
Panel B: Adjusted Breastfeeding Initiation Rates by Race				
Main Effects [**Ref:1st Quartile**]				
2nd Quartile (76.89-82.29)	0.0067	[-0.002 to 0.015]	-0.0007	[-0.010 to 0.009]
3rd Quartile (82.33-88)	0.0159**	[0.006 to 0.026]	0.0067	[-0.003 to 0.016]
4th Quartile (>88)	0.0182***	[0.009 to 0.028]	0.0068	[-0.003 to 0.016]
Interaction Effects [**Ref:1st Quartile#NH White**]				
2nd Quartile#NH Black	0.0525***	[0.027 to 0.076]	0.0400***	[0.011 to 0.069]
3rd Quartile#NH Black	0.0549***	[0.034 to 0.076]	0.0532***	[0.027 to 0.079]
4th Quartile#NH Black [	0.0518***	[0.026 to 0.079]	0.0563***	[0.026 to 0.086]
Covariates	Yes		Yes	
Year Fixed Effects	Yes		Yes	
State Fixed Effects	Yes		Yes	
Number of observations	16795025		14071055	

Note: Panel A uses Equation 1 from the methods section. Panel B uses a variant of Equation 1 that includes an interaction between the infant's race/ethnicity (NHB or NHW) and the four mPINC score quartiles.
*p<0.10 ** p<0.05, *** p<0.01 and 95% confidence interval [CI].
Standard errors are clustered at the county level.

Table 3: Relationship between the mPINC Score and Breastfeeding Initiation or Disparities in Breastfeeding Initiation.

	2017-2022		2017 vs 2022	
	(1)	(2)	(3)	(4)
	θ [95% CI]	θ [95% CI]	θ [95% CI]	θ [95% CI]
Panel A: Breastfeeding initiation				
mPINC score	0.0074 [-0.016 to 0.031]	0.0131 [-0.018 to 0.045]	0.0439** [0.004 to 0.084]	0.0590** [0.009 to 0.109]
Covariates	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes
Adjusted R-sq	0.91	0.88	0.85	0.79
Number of observations	5172	5172	1724	1724
Panel B: Breastfeeding initiation *disparities*				
mPINC score	-0.0003 [-0.001 to 0.000]	-0.1308 [-0.384 to 0.123]	-0.0008* [-0.002 to 0.000]	-0.5002* [-1.041 to -0.022]
Covariates	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes
Adjusted R-sq	0.46	0.53	0.45	0.51
Number of observations	4062	4062	1354	1354

Note: All specifications use Equation 2 from the methods section. Columns 2 and 4 employ logarithms of the outcome, policy variables, and covariates to interpret the results in terms of elasticity. Columns 1 and 2 utilize six years of data, while columns 3 and 4 focus on the years 2017 and 2022.
*$p<0.10$ ** $p<0.05$, *** $p<0.01$ and 95% confidence interval [CI].
Standard errors are clustered at the county level.

Appendix

Interpolation of the mPINC scores

The value of the mPINC score (y) at a given survey year (x) is found as the closest points (x_0, y_0) and (x_1, y_1), such that $x_0 < x$ and $x_1 > x$ where y_0 and y_1 are observed, and calculating:

$$y = \frac{y_1 - y_0}{x_1 - x_0}(x - x_0) + y_0$$

If (x_0, y_0) and (x_1, y_1) cannot be found on both sides of x, the two closest points on the same side of x are found, and the same formula is applied.

If there are multiple observations with the same value for x_0, then y_0 is taken as the average of the corresponding y values for those observations. (x_1, y_1) is handled in the same way.

We have carefully checked the interpolation, and when it led to unrealistically low or high values of the mPINC score, we adjusted the scores to fall within a reasonable range. Specifically, we set a minimum score of 25, based on the lowest score observed in our sample, and a maximum score of 100.

Two Way Fixed Effects (TWFE) Method

The data were organized by collapsing the outcomes of interest, policy, and covariates according to the infant's year and county of birth.

The average rate of breastfeeding initiation was calculated and the average gap of breastfeeding initiation between NHW and NHB mothers was calculated in absolute values.

Covariates included the percentage of White, Black, and Hispanic mothers, the percentage covered by Medicaid, the percentage participating in WIC, the percentage with less than a high school diploma, the percentage with a college education or higher, the percentage of smokers, the percentage of married mothers, the percentage of spontaneous births, the percentage of first time mothers, the percentage of mother with a normal body mass index, the percentage of mothers residing in counties with populations exceeding 100,000 inhabitants, the percentage of mothers born in the U.S., the percentage of babies with a gestational age of 37 weeks and over, the percentage of babies with a delivery weight between 2.5 kg and 8.17 kg. To address multicollinearity, the primary groups of each covariate were retained.

Lastly, the mPINC score at the county-year level was calculated as the average of the mPINC scores of the hospitals present in each county.

Figures

Figure A1. Sample 1 Flowchart

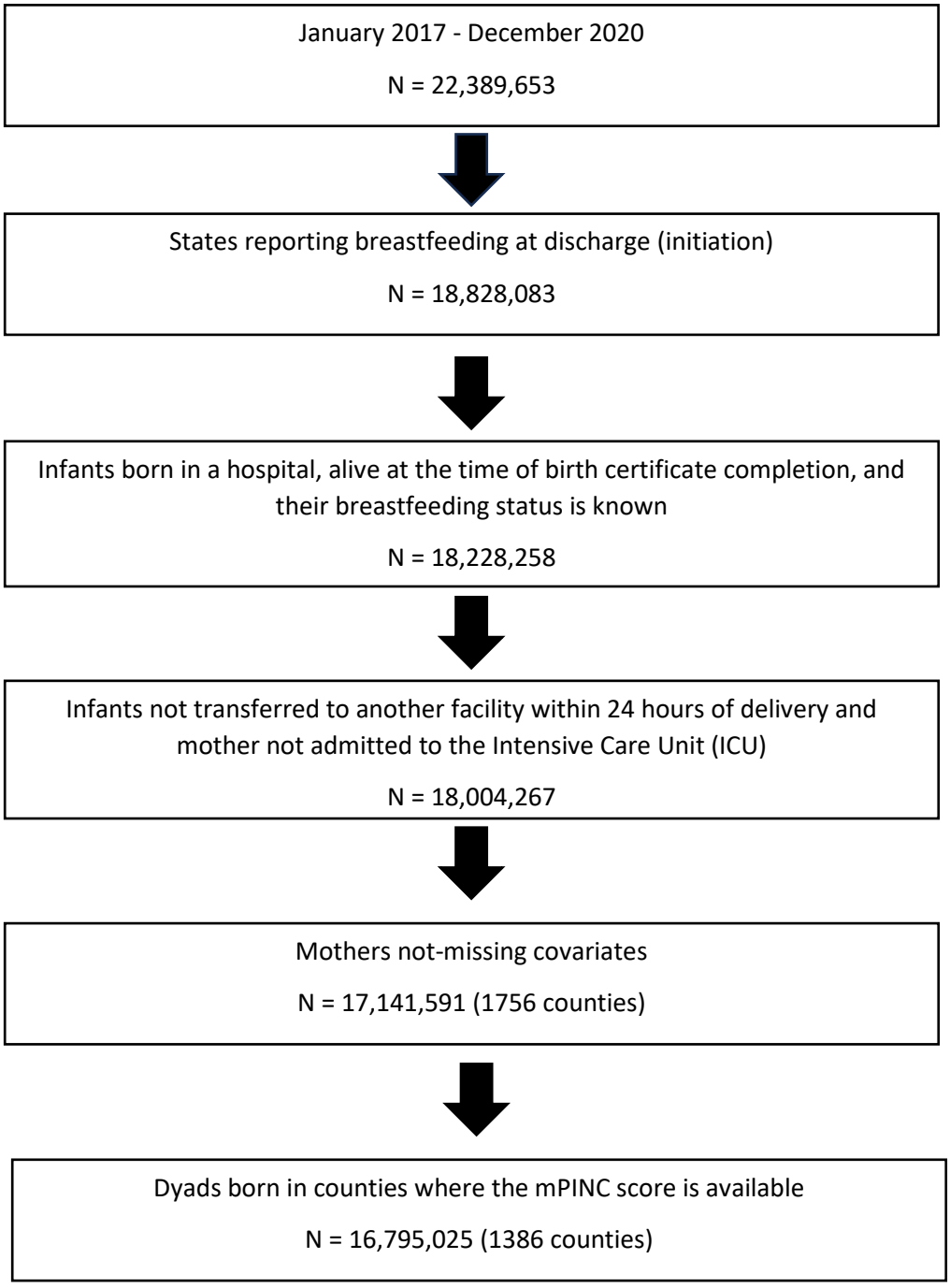

Figure A2. Sample 2 Flowchart