THE DUKE ENDOWMENT

Evaluation of the Nurse Family Partnership in North Carolina

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Key Findings

1. NFP participation was associated with reduction in the rate of "very preterm" births (28-31 weeks) and NICU admission in the hospital clustered model. Both these outcomes are known to be associated with healthier infants and reduced costs.

2. NFP participation has a sizable and significantly different effect on women based on their race and ethnicity. When disaggregated by race, all specific categories of preterm birth were significantly reduced for both White and Black/African American women. The effect of NFP on Black/African American women was double that of White women.

3. The most appropriate control population is the hospital clustered model using repeated standard errors. Confidence intervals were consistently smallest using this methodology.

Overview and Purpose

This is the periodic update on the evaluation of the Nurse Family Partnership program in North Carolina focused on the priority health outcomes of women and infants. During this period, we refined our methodology to more precisely estimate the effect of NFP participation on the health of women and children. In this report, we will report the estimated effect of participation on birthweight, gestational age, NICU admission, and breastfeeding initiation. We will also discuss the differential treatment effect of participation by maternal race as well as variation in estimation between statewide, county and hospital level analysis.

As previously reported, this study focuses on NFP participants in North Carolina and proximal health outcomes as well as health care costs. This study is limited by its relatively small sample size used to analyze uncommon outcomes, suggesting the ability to detect programmatic effects may be limited. In other words, because of the relatively small sample, *a priori* we might expect to conclude there is no effect when there truly is.

Review of Methods

Sample

This evaluation matched NFP program participation with birth certificate data to examine potential effects on maternal and infant health outcomes. Information on 1027 NFP clients was obtained, including 36 that had no valid delivery date (these were discarded). Using maternal birthdate, infant birthdate and county of residence, 908 of the 991 remaining records (92%) NFP participants were matched to their infant's birth record. Among those that did not match exactly, additional efforts were

made to match records with potential entry errors of birthdates; no additional records could be matched confidently.

While birth certificate and NFP participation data were available for year 2009-2013, comparability of measures over the time period presented challenges. In 2010, North Carolina implemented components of the nationally revised Standard Certificate of Live Birth, thereby altering the way many social, demographic and health attributes were recorded for women and infants. Among those indicators that were changed were maternal education, neonatal intensive care unit (NICU) admission, maternal smoking habits, and maternal body mass index. In light of the importance of these attributes in comparing NFP participants to similar non-participants and incomparability pre and post 2010, the first two years of participation data and birth records were excluded from analysis.

Finally, the comparison sample was adjusted to resemble participants in Nurse Family Partnership. Women with higher order births (any previous live birth) and those that did not have Medicaid as the primary source of payment at the time of delivery were excluded. Multiples (from both the NFP and comparison sample) were excluded to avoid biasing gestational age and birthweight estimates. Figure 1 shows the sample construction that yielded an analytic sample of 564 NFP participants and 61,429 controls.

Figure 1. Analytic Sample Design

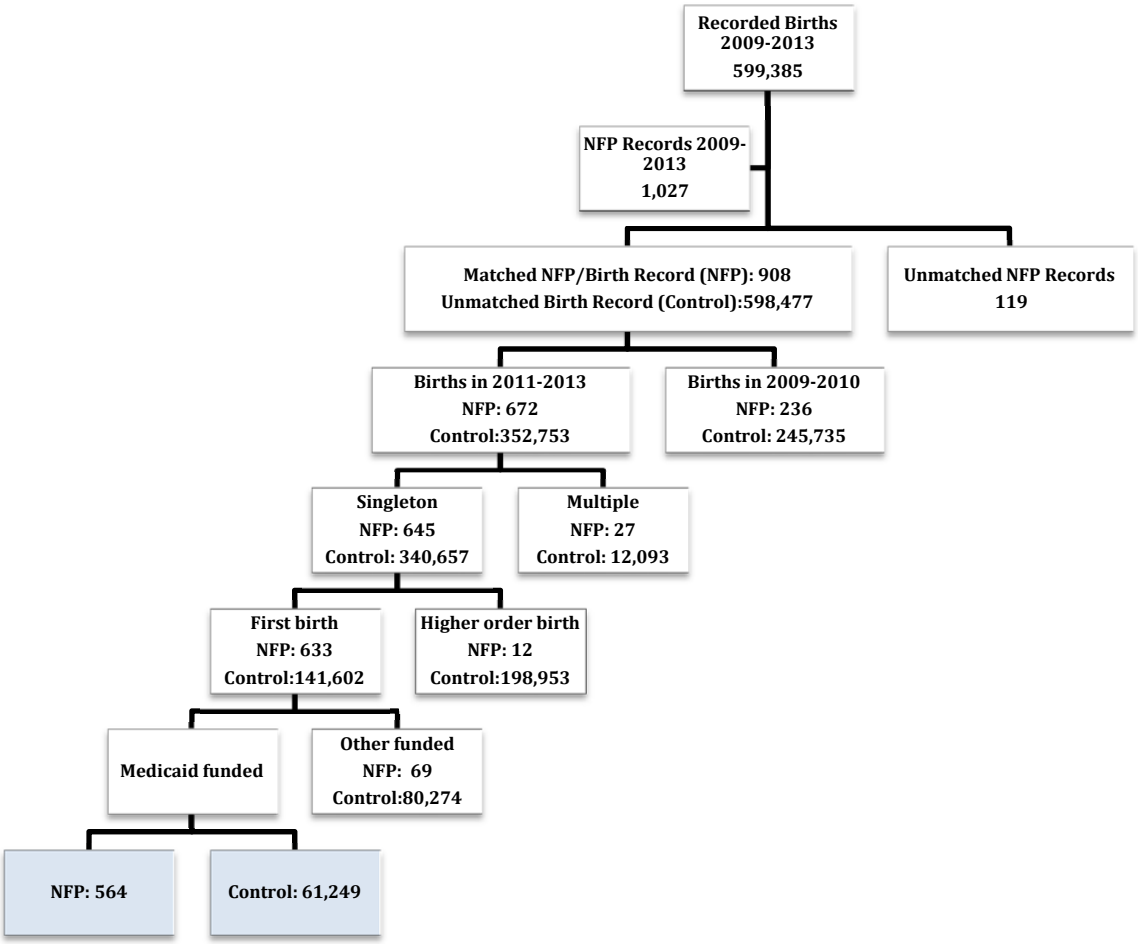


Table 1. Weighted sample means and proportions of covariates

	NFP Participants	Controls
Maternal age (years)	21.93	22.10
Under 20 (%)	33.99	31.97
Hispanic (%)	10.81	9.22
White (%)	45.55	48.76
Black (%)	39.99	37.61
American Indian/Alaskan Native (%)	2.09	2.15
High school education or less (%)	26.74	25.95
Married (%)	19.15	20.53
WIC participant (%)	91.20	85.74
Smoker, preconceptive (%)	20.89	21.14
Obese (%)	26.32	24.77

Analysis

There are multiple ways to measure the effect of the program. For example, we could estimate "What would happen to the average pregnant woman if they received NFP?", "What would the outcomes be for the NFP recipients been if they had not received NFP?", or "What would outcomes be if the non-NFP recipients received NFP?" These analyses each pose different questions that could produce highly variable outcomes. For this analysis, we have estimated the "average effect on the treated". Using NFP participants, we predict what their outcomes would have been without the intervention by looking at "similar" women who did not receive NFP.

Likewise, there are multiple ways to identify "controls". We adopted three strategies to assess comparability across three levels of aggregation: a) S*tatewide* uses all women in North Carolina, b) *Hospitals* uses only controls delivering in hospitals used by NFP participants that year, and c) *Counties* use only controls delivering in those counties also containing NFP participants that year.[1] These alternative methods offer different controls, and thus results should differ. If they all provide similar results, this is support for the evidence.

Based on these decisions, inverse propensity for treatment weights (IPTW) scores were generated to assist in the comparison between the NFP participants and the control sample.[2] This method adjusts the control sample to more closely resemble the NFP participants using key attributes such as maternal age, race, ethnicity, education, and marital status. IPTWs aim to reduce the standardized differences between the treatment (NFP) and control population to less than 10%, thereby making comparative analysis possible; our approach met this threshold for all key covariates (maternal age, race and ethnicity, maternal education, marital status, smoking behaviors and obesity status). A doubly-robust logistic regression with clustered standard errors was used to examine the effect of Nurse Family Partnership participation on several maternal and infant outcomes. This approach protects against errors in the propensity weighting as well as mis-modeling by using the same covariates in both weighting and as control covariates.(1) Clustered standard errors were also used to account for unobserved similarities in populations within hospitals and counties. Finally, a bootstrapping technique was used to run 100 repetitions of the model to obtain more precise standard errors.

In addition to examining treatment effects for the full sample of participants, we measured how the program may have affected women differently by maternal age, race and ethnicity. We created differential treatment estimates for women under 20 years of age, women 20 years of age and older, white women, black women, and Hispanic women using the hospital clustered model. This approach is

[1] This is similar to the approach used by South Carolina in their preliminary evaluation of NFP.

[2] An excellent resource is Austin P. An Introduction to Propensity Score Methods for Reducing the Effects of Confounding in Observational Studies. Multivariate Behav Res. 2011 May; 46(3): 399–424. 2011. doi: 10.1080/00273171.2011.568786

important if we expect the treatment effect to vary by maternal characteristics (e.g., more effective for younger mothers).

Results

This evaluation examined a series of eight health outcomes believed to be affected by participation in a perinatal support program such as Nurse Family Partnership. These outcomes included

- preterm birth (including any preterm birth, and moderate preterm birth, very preterm birth and extreme preterm birth separately),
- low birthweight (including any low birthweight, moderate low birthweight and very low birthweight separately),
- NICU admission and
- breastfeeding initiation recorded at hospital discharge.

We controlled for (a quadratic model of) maternal age, race/ethnicity, education, marital status, WIC participation, adequacy of prenatal care and smoking behaviors before and during pregnancy.

Table 2 summarizes the results across all three types of control specifications (state, county, and hospital). In both the statewide-control and county-control models, NFP did not have a statistically significant effect on any outcome other than the rate of very preterm birth (Figure 2a and 2c). In the hospital–control model, NFP statistically reduced the rate of very preterm birth and NICU admissions (Figure 2b). However, given the clear trends across models suggesting NFP may have been improving outcomes but our sample was not powered to show statistical significance, we further unpacked the sample by maternal race/ethnicity.

Figure 3 shows the effect of NFP participation on the outcomes by maternal race and ethnicity. We restricted this analysis only to White, Black/African American, and Hispanic women due to sample size. Our findings show a clear statistically significant trend in reducing all specific stages of preterm birth for White and Black/African American women. In addition to showing sizable reductions in preterm birth, the effect size is markedly larger and statistically different for Black/African American women as compared with White women.

In addition to maternal race and ethnicity, we explored how maternal age (less than 20 years old and 20 years and older) may have resulted in differential treatment. While none of the results showed significance, the data trended to suggest women 20 years and older benefited more from NFP participation than their younger counterparts. There was not enough variation in marital status among NFP participants to test for potential variation on this characteristic.

Implications of Findings

The study has a number of key findings:

<u>The greatest evidence for NFP effectiveness comes when using controls from within the hospitals used by NFP.</u> This is similar to the pattern of findings seen by SCDHEC's preliminary analysis, where statewide controls showed little evidence but increased specificity of the control enhanced the evidence of an effective program. This is intuitive, as NFP participants are likely far more similar to mothers at NFP hospitals than to mothers across the state. Given the IPTW approach, the hospital-control method is similar to the matched hospital method in Comparison Group 3.

<u>NFP appears to be effective at reducing the rate of NICU and the risk of very preterm birth.</u> The results from the hospital-control model suggests it cut the rate of NICU by approximately 20 percent (from 7.5 to 5.9) and the risk of very preterm birth by two thirds. These are considerable effects.

<u>When stratified by race/ethnicity, NFP appears to be most effective for African-American mothers.</u> By subaggregating the observations, we identified a sizable difference in effectiveness across race/ethnicity, with the largest improvement occurring in African-American mothers. These positive

treatment effects are not detectable without disaggregating the data modeling specifically by race and ethnicity. Our findings support continuing to assess the effects of Nurse Family Partnership on the state, county and hospital level but also within subgroups. Further analysis of the variation in treatment effects will be possible when we begin working with the Medicaid claims data.

Table 2. Probability of Outcome Dependent Upon NFP Participation, controlling for maternal age, race/ethnicity, education, marital status, WIC participation, adequacy of prenatal care and smoking before and during pregnancy

	Probability of Outcome Without NFP	Probability of Outcome With NFP	Difference attributable to participation in NFP	95% Confidence Interval	
Model A: Statewide Control Model					
All Low birthweight (<2500g)	10.89%	11.44%	0.55%	2.28%	-1.18%
Low birthweight (1500-2499g)	10.04%	9.70%	-0.34%	0.99%	-1.67%
Very low birthweight (<1500g)	1.32%	1.76%	0.45%	1.13%	-0.24%
All Preterm (<37 weeks)	12.47%	12.50%	0.04%	1.93%	-1.86%
Moderate preterm (32-36 weeks)	10.93%	10.86%	-0.08%	1.55%	-1.71%
Very preterm (28-31 weeks)	1.59%	0.66%	-0.92%	-0.67%	-1.18%
Extremely preterm (<28 weeks)	0.61%	0.87%	0.26%	0.65%	-0.13%
NICU admission	6.31%	6.13%	-0.17%	1.20%	-1.54%
Breastfeeding initiation	61.89%	66.00%	4.10%	6.54%	1.67%
Model B: Hospital Control Model					
All Low birthweight (<2500g)	12.58%	11.66%	-0.92%	0.86%	-2.70%
Low birthweight (1500-2499g)	11.37%	10.21%	-1.16%	0.29%	-2.61%
Very low birthweight (<1500g)	1.74%	1.64%	-0.10%	0.55%	-0.75%
All Preterm (<37 weeks)	13.59%	12.64%	-0.95%	1.05%	-2.96%
Moderate preterm (32-36 weeks)	11.45%	11.13%	-0.32%	1.47%	-2.11%
Very preterm (28-31 weeks)	2.13%	0.71%	-1.42%	-1.13%	-1.70%
Extremely preterm (<28 weeks)	0.89%	0.76%	-0.12%	0.22%	-0.47%
NICU admission	7.46%	5.93%	-1.53%	-0.08%	-2.98%
Breastfeeding initiation	64.29%	66.55%	2.26%	4.65%	-0.13%
Model C: County Control Model					
All Low birthweight (<2500g)	12.55%	11.69%	-0.86%	0.93%	-2.65%
Low birthweight (1500-2499g)	11.40%	10.19%	-1.20%	0.24%	-2.65%
Very low birthweight (<1500g)	1.69%	1.66%	-0.03%	0.63%	-0.69%
All Preterm (<37 weeks)	13.49%	12.67%	-0.82%	1.19%	-2.83%
Moderate preterm (32-36 weeks)	11.37%	11.14%	-0.23%	1.56%	-2.02%
Very preterm (28-31 weeks)	0.87%	0.78%	-0.09%	0.26%	-0.44%
Extremely preterm (<28 weeks)	2.13%	0.72%	-1.42%	-1.14%	-1.70%
NICU admission	7.35%	5.99%	-1.36%	0.10%	-2.82%
Breastfeeding initiation	64.45%	66.49%	2.05%	4.45%	-0.35%

Figure 2a. Estimated effect of Nurse Family Partnership on select health outcomes with 95% confidence intervals – STATEWIDE CONTROL

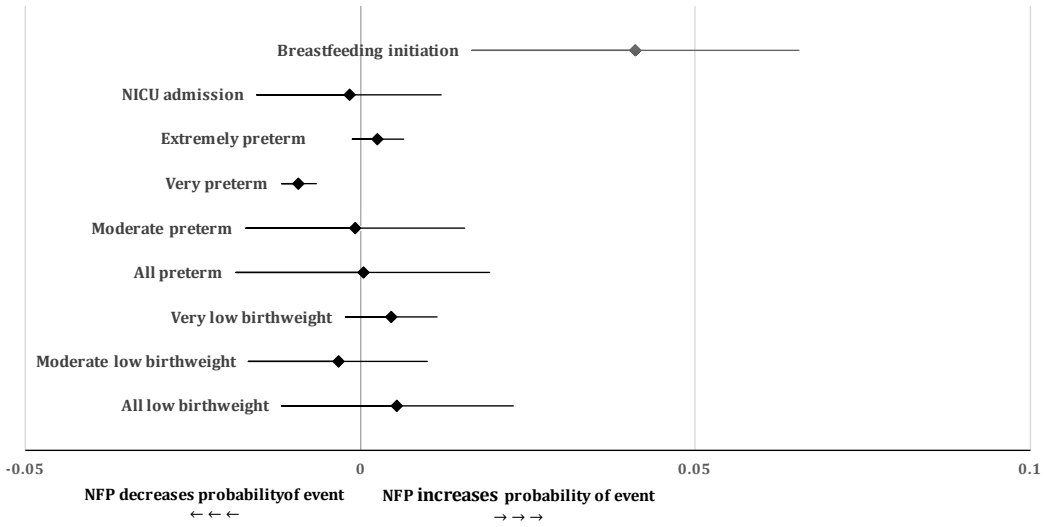


Figure 2b. Estimated effect of Nurse Family Partnership on select health outcomes with 95% confidence intervals – HOSPITAL CONTROL

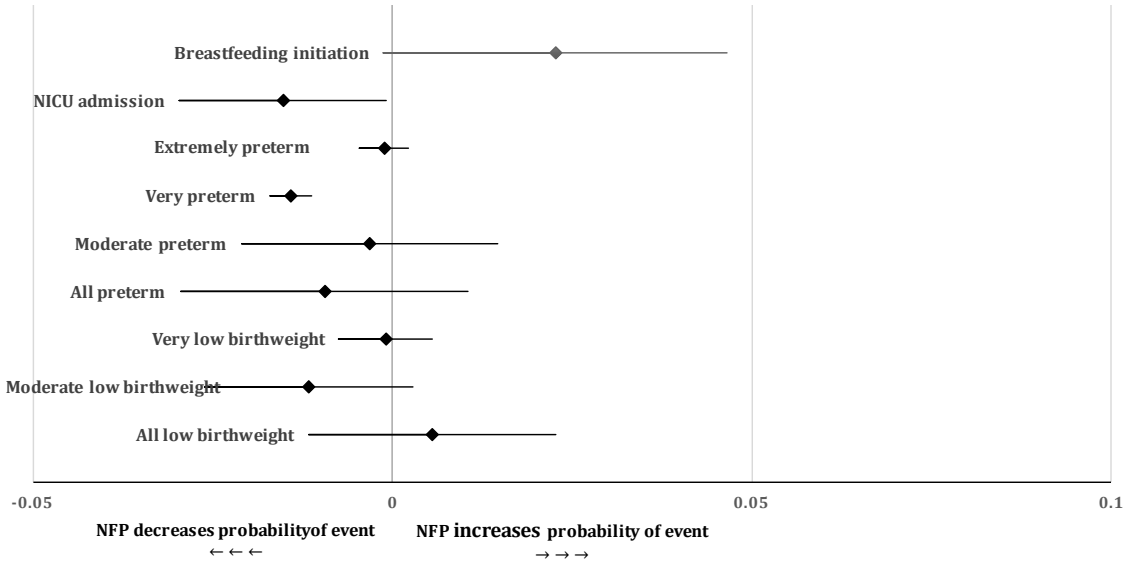


Figure 2c. Estimated effect of Nurse Family Partnership on select health outcomes with 95% confidence intervals – COUNTY CONTROL

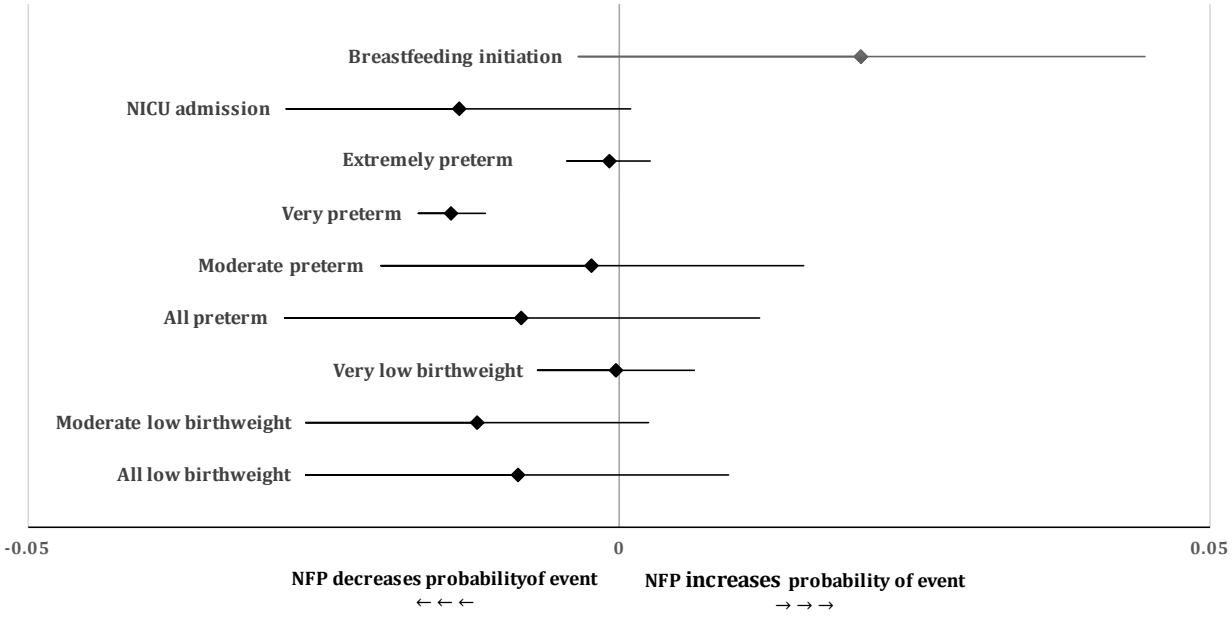
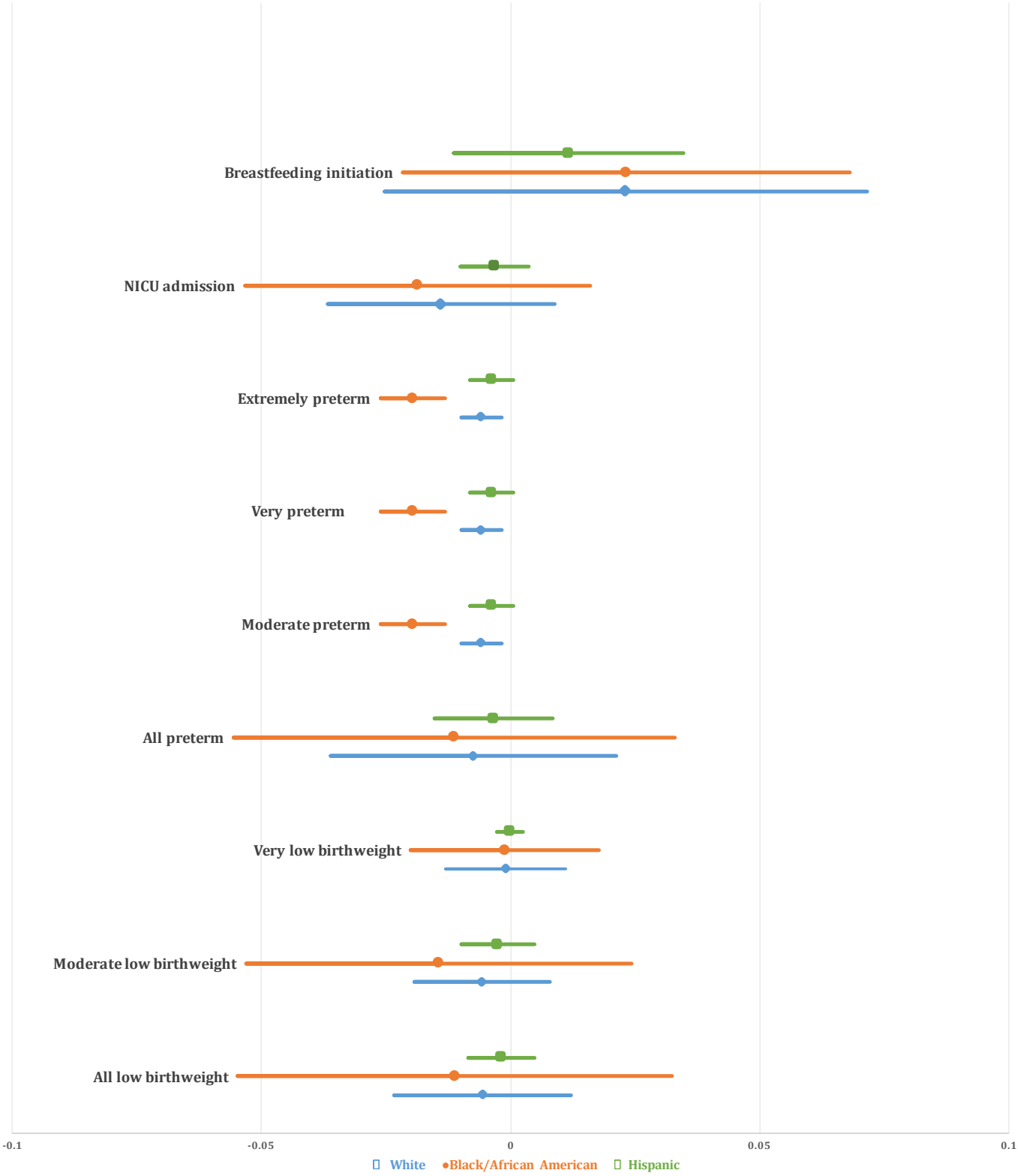

Breastfeeding initiation
NICU admission
Extremely preterm
Very preterm
Moderate preterm
All preterm
Very low birthweight
Moderate low birthweight
All low birthweight
-0.05
0
0.05
NFP decreases probabilityof event
← ← ←
NFP increases probability of event
→ → →

Figure 3. Changes in outcome attributable to NFP participation, by race/ethnicity (hospital control)



Next Steps

This next stage of the evaluation will use the existing data merged with Medicaid claims to further examine the effects of Nurse Family Partnership participation on health outcomes and healthcare expenditures. The claims data will offer a richer source of information on the severity of poor birth outcomes as well additional diagnoses to further control the model and isolate estimated treatment effects. In addition to further evaluating NFP's impact on health, we will use the claims to assess real costs to Medicaid as well as model the financial implications of averted poor birth outcomes and NICU admissions.

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