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Examining the Causal Impact of Prenatal Home Visiting on Birth Outcomes: A Propensity Score Analysis

Elizabeth R. Anthony
Case Western Reserve University

Robert L. Fischer
Case Western Reserve University, rlf11@case.edu

Author(s) ORCID Identifier:

Robert L. Fischer

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Abstract

In Ohio, African American babies die at 2.5 to 3 times the rate of White babies. Preterm birth and low birth weight are the leading causes of infant mortality. Home visiting is an evidence-based strategy for serving low-income pregnant women; however, there are few rigorous studies examining its effect on birth outcomes. This study uses a propensity score technique to estimate the causal effect of participation in home visiting on prematurity and low birth weight among a low-income, predominantly African American sample (N=26,814). Home visiting receipt reduced the odds of preterm birth and low birth weight deliveries. Results have important implications for practice as advances in newborn survival have been driven largely by improved medical interventions post-delivery, not primary prevention.

The infant mortality rate, or the number of infants who die before their first birthday, per 1,000 live births, reflects how well a community protects its most vulnerable members. In 2014, the infant mortality rate in the United States was 5.82 (Kochanek, Murphy, Xu, & Tejada-Vera, 2016). That same year, in the State of Ohio, 6.8 infants died per 1,000 live births (Ohio Department of Health, 2015) establishing Ohio's infant mortality rate as one of the highest in the nation (Mathews, MacDorman, & Thoma, 2015). This rate reflects infant mortality across racial groups and masks the significant disparity that exists between African Americans and Caucasians; in Ohio, Black babies die at approximately 2.5 to 3 times the rate of White babies (Ohio Department of Health, 2015). For example, in 2014, the state-wide infant mortality rate for White babies was 5.3 deaths per 1,000 live births compared to a rate of 14.3 deaths for Black babies (Ohio Department of Health, 2015).

Approximately two-thirds of all infant mortality events occur in the neonatal period, the first 28 days of life (Bale, Stoll, Lucas, 2001; Kochanek et al., 2016). According to the Centers for Disease Control and Prevention, preterm birth (less than 37 weeks gestation) and low birth weight (less than 2,500 grams) are the leading causes of neonatal infant mortality. In fact, infants born before 32 weeks gestation or at very low birth weight (less than 1,500 grams) account for less than 2% of all births, but more than 50% of all infant mortality events (Child Health USA, 2014 https://mchb.hrsa.gov/chusa14/health-status-behaviors/infants/preterm-birth-low-birth-weight.html). In 2015, approximately one in 10 infants in the U.S. was born preterm (CDC; https://www.cdc.gov/reproductivehealth/maternalinfanthealth/pretermbirth.htm).

The contributors to preterm birth and low birth weight are varied; clinical, social, behavioral, environmental, economic, generational, and geographical factors affect birth outcomes both independently and in complex, intersecting ways. Access to and receipt of high quality medical care in the preconception and prenatal periods is an essential component to preventing adverse birth outcomes; however, clinical interventions, absent strategies to improve social determinants of health for minority and low-income women, are an insufficient response to infant mortality (Johnson, Posner, Biermann, Cordero, Atrash, Parker et al., 2006). The World Health Organization defines social determinants of health as “the conditions in which people are born, grow, live, work and age and the wider set of forces and systems shaping the conditions of daily life.” Poverty, in particular, is an important social determinant of health, contributes to racial disparities, and negatively affects birth outcomes (Healthy People 2020).

Home visiting is an evidence-based strategy for delivering services to low-income families and pregnant and parenting women to improve a range of outcomes (Paulsell, Avellar, Martin, & Del Grosso, 2010; Sweet & Appelbaum, 2004). Though home visiting programs vary with regard to their specific objectives, curriculum, intensity, and duration, the strategy consistently incorporates voluntary participation, a focus on prevention, education, health services, and referral to additional resources for the purpose of improving child and family wellbeing (Donelan-McCall, Eckenrode, & Olds, 2009). Program content (Gomby, 2007), family engagement, the establishment of a trusting, supportive relationship between the home visitor and family (Gomby, Culross, & Behrman, 1999), as well as the duration and frequency of visits (Olds & Kitzman, 1993), are key mechanisms through which home visiting has been shown to produce behavioral change.

The Department of Health and Human Services, through their Home Visiting Evidence of Effectiveness (HomVEE) initiative, conducted a comprehensive review of the research literature on home visiting program effectiveness. Nineteen of the 45 home visiting program models reviewed were found to have high (experimental design, little differential attrition from conditions) or moderate (experimental design with differential attrition or quasi-experimental design with established baseline equivalency between conditions and covariate controls) evidence of effectiveness. Of the 19 home visiting program models with high or moderate evidence, six examined the association between program participation and birth outcomes, specifically birth weight and gestational age (see Table 1). Of these six programs, two produced favorable effects on low birth weight (Health Access Nurturing Development Services, HANDS, Program and Healthy Families America) and one on preterm birth (the HANDS Program). The remaining evaluations found no difference between treatment and comparison groups.

Given the limited number of rigorous evaluation studies as well as the relatively sparse evidence of effectiveness, the purpose of this study was to estimate the causal effect of participation in a voluntary home visiting program on preterm birth and low birth weight among a low income, predominantly African American sample in an urban setting. The Healthy Start Program, administered by the Division of Healthy Start and Perinatal Services within the United States Department of Health and Human Services, Health Resources and Services Administration, Maternal and Child Health Bureau, was enacted in 1991 to reduce infant mortality and increase access to prenatal care early in the first trimester. As one of the originally funded Healthy Start sites, the Cleveland Department of Public Health's MomsFirst Project is a long-standing, community-based intervention designed to reduce the significant disparities in perinatal health experienced by African Americans in the City of Cleveland. The program's immediate goal is to positively influence the current pregnancy but the program also seeks to promote birth spacing and planning for future healthy pregnancies (http://momsfirst.org/).

MomsFirst Community Health Workers recruit pregnant women, including teens and incarcerated women, who are at highest risk for poor birth outcomes. To be eligible for

MomsFirst, potential participants must be less than 33 weeks pregnant and have experienced at least one ‘severe’ risk (e.g., death of a child before age one, domestic violence, substance use, high risk medical condition) or at least two ‘less severe’ risks (e.g., unstable housing, less than a high school education, lack of health insurance, little or no social support). Participation in the program is voluntary and is not limited to first time mothers only. Participants receive case management, education on such topics as prenatal care, substance use, breastfeeding, family planning, and safe sleep, screening and assessment, and referrals to community agencies for issues that require more intensive services (e.g., housing, food access, insurance coverage, mental health treatment). MomsFirst Community Health Workers can serve pregnant women and their families in their homes or other community-based settings twice a month until their child turns two years old; at least one face-to-face meeting per month must take place in the home.

Due to the voluntary nature of the program, in the absence of an experimental design, we modeled self-selection into treatment (the primary confounding factor) using a propensity score (PS) technique to draw causal inferences within an observational context (Lanza, Moore, & Butera, 2013). It is plausible that a woman’s reasons for electing to participate in home visiting are also associated with the very birth outcomes home visiting seeks to improve. For example, a woman in good physical and mental health may be more likely to participate in home visiting simply because her health status makes it easier to do so. But, her health status also makes it more likely she will deliver a full term baby than a woman in poor physical and mental health. In such cases, the individual difference factors may be responsible for the observed outcome, not participation in home visiting. We used a PS to balance demographic, socioeconomic, and medical history nonequivalence between pregnant women who received MomsFirst and pregnant women who did not. Using a PS technique allowed us to explore the following question: “What is the causal effect of participation versus non-participation in MomsFirst during pregnancy on low birth weight and prematurity?"

Method

Target Population

The MomsFirst program is only available to pregnant women who live in the City of Cleveland. Thus, we restricted the potential match pool to all births with a Cleveland address assuming that these babies were born to women who lived in Cleveland during their pregnancy. We focused on singleton births occurring between 2008 and 2012 (N=26,814). Approximately 15% or 4,065 births from the total population (N=26,814) were to women who participated in MomsFirst during the pregnancy for which we were predicting outcomes. Table 2 presents demographic, socioeconomic, and medical history variables for treatment women and the entire potential match pool before balancing on the PS.

Data Sources and Variables

For this secondary analysis, data were extracted from an integrated data system (IDS) housed at the first author's university. The IDS contains linked administrative records from more than 25 public and private service providers working to improve the wellbeing of children and families living in the county, including MomsFirst, the county's child welfare office, and the Ohio Department of Public Health. Launched in the late 1990's, the IDS now contains information on more than 600,000 children who were born or have lived in the county since 1992. Privacy, data security and the use of records maintained in the IDS are strictly governed by Data Use Agreements (DUA) with each individual data provider and the university's Institutional Review Board (IRB). Variables used to link individuals across data providers include: mother's first and last name, date of birth, home address, child's first and last name, date of birth, home address, and sex. As new data extracts are received, the linkage of records is performed via a combination of deterministic and probabilistic matching algorithms.

To conduct this analysis, we selected a sample of five birth cohorts in the City of Cleveland (2008-2012, N=26,814). Thus, we started with vital statistics birth certificate records. Information on birth weight and gestation, our dependent variables, was obtained from the birth certificate. Infant birth weight was dichotomized with 1 (low birth weight, < 2500g) and 0 (not low birth weight, ≥ 2500g). Weeks gestation was dichotomized as well with 1 (premature, < 37 weeks gestation) and 0 (not premature, ≥ 37 weeks gestation). Subsequently, we identified the babies who were born to mothers who participated in the MomsFirst program during their pregnancy (our independent variable). Treatment status was coded as 1 (received at least one visit from a MomsFirst Community Health Worker) / 0 (did not receive a single home visit from a MomsFirst Community Health Worker).

Variables used to calculate a woman's propensity to receive MomsFirst concerned her socio-demographic and medical history information, all of which are presumed to have occurred before her selection into treatment (see Table 2). With the exception of prior involvement with child welfare (described below), all variables were extracted from her child's birth certificate. Age at conception was coded as <20 years old, between 20 and 34 (reference group), and ≥35 years old. Mother's race/ethnicity had three categories: White (reference group), African American, Other/unknown. The 'other' category included principally Hispanic, Asian, and American Indian. Level of education was classified as either less than high school completion or high school graduate and higher. Marital status was dichotomized into married or not married. Parity was categorized as live birth child or not. WIC receipt and Medicaid paid delivery were dichotomized as No (0) /Yes (1). We included four medical risk history variables in the PS model. Tobacco use three months before pregnancy and chronic hypertension were each dichotomized as No (0) /Yes (1). Previous preterm small infant and previous cesarean each had three levels: no incidence (reference category), incidence, and first live birth-not applicable.

Prior involvement with child welfare was obtained from county administrative records by identifying women in our sample with an open case with child welfare between their 18th birthday and the pregnancy for which we were predicting outcomes. Thus, an open case for any child born in that period was used to indicate prior involvement (dichotomized as 0=no prior involvement, 1=prior involvement). To ensure we did not capture incidents in which the mother herself was a victim of child maltreatment or neglect, we did not include events that occurred prior to her 18th birthday. Therefore, a woman with a child prior to the age of 18 who was the subject of an open case would not be captured in our variable definition. In addition, as we only had data from one county, 0 indicates the absence of prior involvement within that particular county. Thus, we were unable to capture cases in which women lived in other counties with previous children prior to the current pregnancy and had been involved with those counties' child welfare systems.

Study variables had low rates of missing data (range: 0% to 2.6%). We imputed missing observations using multiple imputation by chained equations (Royston, 2007). All variables in the models were utilized in the imputation process and 10 imputed data sets were produced. Estimates from each imputed data set were then combined using Rubin's rules to produce final estimates (Heeringa, West, & Berglund, 2010). All models accounted for clustering at the family level by using mother's identification number.

Analytic Approach

To account for selection bias from pre-existing differences between MomsFirst participants and non-participants, we used the inverse probability of treatment weighting (IPTW) method (Austin, 2011; Austin & Stuart, 2015). To calculate each woman's PS to receive the program, we first estimated a logistic regression model with MomsFirst program participation as the dependent variable and baseline covariates as predictors (listed in Table 2). Based on the derived PS, we then calculated the inverse probability of treatment weights—the reciprocal of the probability of receiving MomsFirst. Given the weights can be unstable for participants with a very low probability of receiving the treatment (Austin, 2011; Brookhart, Wyss, Layton, & Stürmer, 2013), we stabilized the weights using the following formula (Robins, Hernan, & Brumback, 2000):

$$w_i = \frac{P}{PS_i} Z_i + \frac{1-P}{1-PS_i}(1-Z_i)$$

Where,

Z_i=the treatment status for each participant i (treated=1, otherwise=0)

PS_i=individual propensity score for participant i

P=the rate of participants receiving the treatment

We assessed balance in baseline covariates between treated and untreated participants in the weighted sample by using absolute values of standardized differences (cutoff: <0.10). Finally, we conducted a weighted logistic regression model using the stabilized weights, w_i, to estimate the effect of MomsFirst participation on birth weight and gestational age. The results from the final IPTW model were compared to those from a standard approach (logistic regression model).

Results

Descriptive Results

Table 2 presents characteristics of program recipients and the comparison pool of women who gave birth in the City of Cleveland between 2008 and 2012. MomsFirst program participants had lower rates of low birth weight and premature birth outcomes than non-participants. In contrast to the comparison pool, MomsFirst participants were more likely to be younger, African American, and unmarried. With respect to socioeconomic status, participants were less likely to have completed high school or post-secondary education, and more likely to receive WIC and have a Medicaid paid birth. MomsFirst participants were simultaneously more likely to be pregnant with their first child and, among a subsample of participants with previous children, have had prior involvement with the county's child welfare services. MomsFirst participants were less likely to have gestational diabetes and previous cesareans. Finally, compared to non-participants, participants were less likely to report information about their baby's father on the birth certificate.

IPTW Modeling Results

Table 3 shows standardized differences in baseline covariates between participants and non-participants before and after IPTW using the propensity scores. All of the absolute values of standardized differences after IPTW were less than 0.100 (range: 0.005 to 0.098), indicating the IPTW model using the propensity scores was adequately specified.

Table 4 presents the effect of MomsFirst program participation on low birth weight and premature birth outcomes using both standard logistic regression and IPTW modeling approaches. Both approaches produced nearly identical results, with two exceptions: 1) having a Medicaid paid birth significantly predicted having a low birth weight baby in the standard logistic regression model but not the IPTW model; 2) race/ethnicity categorized as other/unknown significantly predicted premature delivery in the standard logistic regression model but not the IPTW model. Odds ratios from the IPTW models were generally closer to 1.0 than odds ratio from the standard logistic regression models.

Low Birth Weight. MomsFirst program participation was associated with 22% reduced odds of delivering a low birth weight baby (see Table 4). Women age 35 and older were more likely than their peers between the ages of 20 and 34 to deliver a low birth weight baby. African American women and women whose race/ethnicity was categorized as other/unknown were more likely than White women to have a low birth weight baby. Odds of having a low birth weight baby were increased by being a first time mother, being involved with child welfare for a previous child, using tobacco three months before pregnancy, experiencing chronic or pregnancy-induced hypertension, and previously delivering a preterm small infant. In contrast, being married, receiving WIC, and having any information about the baby's father on the birth certificate (perhaps a proxy for social and/or financial support) were associated with reduced odds of having a low birth weight baby.

Prematurity. MomsFirst program participation was associated with 17% reduced odds of delivering a premature baby (see Table 4). Similar to the low birth weight IPWT model, women age 35 and older, and those who were African American, used tobacco three months before pregnancy, experienced chronic or pregnancy-induced hypertension, had a previous preterm small infant, and prior involvement with child welfare had significantly higher odds of delivering a premature baby. Again, being married, receiving WIC and having any information about the baby's father on the birth certificate were protective against prematurity. In contrast to low birth weight, gestational diabetes increased the odds of having a premature baby and being a first time parent was not associated with prematurity.

Discussion

In this study, we used a propensity score technique to assess the causal effects of participation in a voluntary home visiting program on the likelihood of having a low birth weight or preterm baby among a sample of women who delivered between 2008 and 2012 in the City of Cleveland. We found that program receipt significantly reduced the odds of experiencing both adverse birth events, with a larger program effect for the low birth weight outcome. These findings are particularly meaningful given that advances in newborn survival over the past several decades have been largely driven by improved medical care for preterm babies, not primary prevention of preterm delivery or growth restriction (Goldenberg & Culhane, 2007). In fact, the majority of prevention interventions have failed to reduce preterm or low birth weight deliveries (Goldenberg & Culhane, 2007).

As presented in the introduction of this paper, only two programs reviewed by the HomVEE initiative demonstrated positive birth outcomes using a rigorous research design or statistical method. Researchers evaluating the HANDS program reported positive effects for program participants with odds ratios of 0.74 for preterm birth and 0.54 for low birth weight (Williams, Cprek, Asaolu, English, Jewell, Smith, Robl, 2017). These results are based on a quasi-experimental design and would be most comparable to our findings from a standard logistic regression model. We believe the odds ratios produced using a propensity score technique represent an improvement in the estimation of the magnitude of the program effect. In an analysis of the Healthy Families America home visiting program, researchers reported an adjusted odds ratio of 0.56 for low birth weight among women randomly assigned to treatment (Lee, Mitchell-Herzfeld, Lowenfels, Greene, Dorabawila, & DuMont, 2009). While this effect is larger in size than the one we report in this study, it is based on a bi-weekly (not bi-monthly) home visitation model.

Another finding to emerge from this analysis is a descriptive profile of the ‘typical’ program participant. As compared to non-participants, women who selected into the program were generally younger, single, receiving public benefits, first time mothers, and less educated. Among a subgroup of women with previous children, participants were more likely than non-participants to have been involved with the county’s child welfare services. This profile suggests the program, as intended, is serving a population with varied and significant needs, all of which place them at higher risk for poor birth outcomes. Yet, even with this risk profile, participants experience fewer adverse birth events than non-participants. In future work, we plan to examine birth outcomes for select subgroups of participants (e.g., teens, child welfare involved women) to determine whether there are areas in which the program could better serve the needs of their clientele.

Relevant literature shows that the most significant predictor of poor birth outcomes is a history of poor birth outcomes (Tucker & McGuire, 2004). Thus, working to ensure a healthy birth for a woman’s first pregnancy is of the utmost importance. However, smoking and poor nutrition also contribute to low birth weight and prematurity and smoking cessation and nutritional interventions have been shown from meta-analyses to reduce the incidence of these adverse birth events (Tucker & McGuire, 2004). In the sample of women in this study, roughly one in five participants reported smoking in the three months prior to their pregnancy. MomsFirst targets these behaviors by providing education on healthy prenatal practices and referrals to more targeted resources. Unfortunately, evidence also indicates that women from lower socioeconomic backgrounds are less likely to quit smoking in the prenatal period compared to their middle class peers (Tucker & McGuire, 2004), perhaps because of underlying socioeconomic factors such as stress, lack of quality medical care or access to it. Rigorous evaluation studies examining the contextual factors that optimize the effectiveness of these interventions in low-income samples are needed.

Strengths and Limitations

This study has several strengths. The use of secondary data maintained in an IDS represents a cost, time, and resource efficient way to evaluate a program without having to collect data. The avoidance of primary data collection solely for evaluation purposes represents a substantial benefit to researchers as program administrators and frontline staff are often reluctant to sacrifice the limited time they have to deliver services to families to data collection. In addition, because the IDS contained birth certificate records for every child born in the city during our timeframe, we had the entire population from which to calculate our propensity score, increasing the external validity of our results. Lastly, the propensity score match represents improved statistical rigor over standard logistic regression procedures based on observational data. In fact, comparison of the results of our analyses shows that the reliance on results of the logistic regression may exaggerate the causal effects of the program.

These strengths are balanced by the following limitations. Although we used IPTW to account for differences between participants and non-participants based on observed baseline characteristics, we could not take into account unobserved or unmeasured confounders. We believe, however, that important confounders that may have influenced treatment selection were included as demonstrated by our ability to achieve balance after weighting with IPTW. This analysis does not address the causal mechanisms through which program participation led to better birth outcomes nor does it indicate for whom the program is most effective. Future research is needed to address these important questions as they have implications for programmatic targeting and scaling.

Conclusions

Evidence from our propensity score analysis indicates the home visiting program examined in this study significantly reduces the odds of experiencing adverse birth events known to contribute to infant mortality. Yet, selective prevention strategies, such as home visiting, that target women at highest risk for poor birth outcomes cannot prevent every single infant mortality event. Given the complexity of the problem and the lives of the women served, home visiting programs cannot always reach women in their first trimester, nor can they always keep them engaged throughout the duration of their pregnancies and into the first few years of their children's lives. While home visiting programs seek to address the social determinants of health contributing to infant mortality, there is only so much Community Health Workers, medical personnel, and social service providers can do in the prenatal period to ensure a healthy birth. Selective prevention strategies must be accompanied by universal attempts to improve the health and life circumstances of low income and minority women.

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Table 1

Effect of home visiting programs that identify low birth weight and preterm birth as outcomes

Program	**Low Birth Weight**			**Preterm Birth**		
	Favorable	Unfavorable	No effect	Favorable	Unfavorable	No effect
Child Parent Enrichment Project	-	-	✓[a]	-	-	-
Early Intervention Program for Adolescent Mothers	-	-	✓[b]	-	-	✓[b]
Health Access Nurturing Development Services (HANDS) Program	✓[c]✓[e]	-	✓[d]	✓[c]✓[d]	-	✓[e]
Healthy Families America	✓[f]	-	-	-	-	✓[f]
Maternal Early Childhood Sustained Home-Visiting Program	-	-	✓[g]	-	-	✓[g]
Nurse Family Partnership	-	-	✓[h]✓[i]	-	-	✓[h]✓[i]

Note. Information in this table was obtained from https://homvee.acf.hhs.gov/Outcome/2/Child-Health/2/1 on May 25, 2017.

[a]Barth (1991)

[b]Koniak-Griffin, Anderson, Verzemnieks, & Brecht (2000)

[c]Williams, Asaolu, English, Jewell, Smith, & Robl (2014a)

[d]Williams, Asaolu, English, Jewell, Smith, & Robl (2014b)

[e]Williams, Asaolu, Enligh, Jewell, Smith, & Robl (2014c)

[f]Lee, Mitchell-Herzfeld, Lowenfels, Greene, Dorabawila, & DuMont (2009)

[g]Kemp, Harris, McMahon, Matthey, Vimpani, Anderson, Schmied, Aslam, & Zapart (2011)

[h]Olds, Henderson, Tatelbaum, & Chamberlin (1986)

[i]Kitzman, Olds, Henderson, Hanks, Cole, & Tatelbaum (1997)

Table 2

MomsFirst participants and the comparison pool on variables used in the analyses

		Variable used in PS Model	Variable used in Final Model	MomsFirst Participants (N=4,065)	Comparison Pool (N=22,749)	p for χ^2 test
Domain	**Variable**			**% or *M***	**% or *M***	
Treatment Status						
	MomsFirst participation	x	x	100.0%	-	
	# of MomsFirst visits			7.0	-	
Birth outcomes						
	Premature birth (<37 weeks)			11.7%	13.0%	.026
	Low birth weight (<2500g)			10.4%	11.9%	.007
Mothers' characteristics						
Demographics	Age	x	x			.000
	<20 years of age			22.1%	8.2%	
	between 20 and 34			74.4%	82.4%	
	35 and older			3.5%	9.4%	
	Race/ethnicity	x	x			.000
	African American			83.0%	55.8%	
	White			13.0%	35.4%	
	Other/unknown			4.0%	9.4%	
	Married		x	7.2%	27.4%	.000
Socioeconomic	High school degree and higher	x	x	51.7%	70.6%	.000
	WIC recipient	x	x	89.1%	67.5%	.000
	Medicaid paid birth	x	x	89.0%	68.1%	.000
Parental Status	First born child	x	x	38.5%	28.9%	.000
	Prior involvement w/ child welfare	x	x	20.7%	17.5%	.000
Behavioral risk	Tobacco use three months before pregnancy	x	x	21.9%	22.9%	.146
Medical risk	Gestational diabetes		x	3.4%	5.3%	.000
	Chronic hypertension	x	x	3.3%	3.4%	.781
	Hypertension during pregnancy		x	6.8%	6.3%	.198
	Previous preterm small infant	x	x	4.9%	5.5%	.100
	Previous cesarean	x	x	11.4%	14.2%	.000
Fathers' Characteristics						
	Any info about father on birth certificate		x	36.6%	60.0%	.000

Table 3

Standardized differences in the comparison pool and IPTW-weighted samples

	Standardized Differences	
Covariates	Raw sample	Weighted Sample
Age <20	0.378	0.036
Age ≥35	-0.246	0.039
African American	0.631	0.056
Other/unknown race/ethnicity	-0.210	-0.030
High school degree and higher	-0.367	-0.068
WIC recipient	0.481	0.095
Medicaid paid birth	0.539	0.084
First born child	0.218	-0.075
Tobacco use three months before pregnancy	0.005	0.097
Chronic hypertension	0.023	0.007
Previous preterm small infant	-0.045	0.005
Previous cesarean	-0.061	0.020
Prior involvement with child welfare	0.088	0.098

Table 4

The effect of MomsFirst on birth outcomes

	Low birth weight						**Premature birth**					
	Standard logistic			**IPTW model**			**Standard logistic**			**IPTW model**		
	OR	**95% CI**		**OR**	**95% CI**		**OR**	**95% CI**		**OR**	**95% CI**	
Treatment status												
MomsFirst	0.690	0.615	0.775	0.715	0.622	0.822	0.781	0.699	0.872	0.832	0.723	0.956
Mothers' characteristics												
Demographics												
Age												
20≤ Age <35 [Reference]	-	-	-	-	-	-	-	-	-	-	-	-
Age <20	1.151	0.998	1.328	1.127	0.969	1.310	1.098	0.950	1.270	1.120	0.959	1.306
Age ≥35	1.440	1.252	1.657	1.400	1.206	1.624	1.506	1.321	1.716	1.484	1.288	1.709
Race/Ethnicity												
White [Reference]	-	-	-	-	-	-	-	-	-	-	-	-
African American	1.715	1.542	1.907	1.724	1.542	1.929	1.424	1.289	1.573	1.384	1.245	1.540
Other/unknown	1.453	1.230	1.716	1.422	1.197	1.690	1.211	1.031	1.421	1.139	0.963	1.346
Married	0.737	0.645	0.842	0.759	0.661	0.872	0.737	0.651	0.834	0.763	0.668	0.871
Socioeconomic												
High school degree and higher	0.959	0.876	1.051	0.961	0.875	1.056	0.951	0.870	1.040	0.951	0.868	1.043
WIC recipient	0.855	0.779	0.938	0.851	0.772	0.937	0.800	0.731	0.875	0.802	0.729	0.881
Medicaid paid birth	1.123	1.006	1.254	1.120	0.997	1.259	1.125	1.012	1.250	1.103	0.984	1.236
Parental status												
First born child	1.251	1.132	1.382	1.251	1.128	1.387	1.015	0.920	1.120	1.007	0.910	1.114
Prior involvement w/ child welfare	1.131	1.018	1.256	1.136	1.018	1.267	1.176	1.063	1.301	1.205	1.080	1.345
Behavioral risk												
Tobacco use three months before pregnancy	1.538	1.406	1.683	1.516	1.380	1.664	1.183	1.080	1.296	1.139	1.036	1.253
Medical risk												
Hypertension												
Pregnancy	1.796	1.566	2.060	1.739	1.509	2.005	2.016	1.765	2.302	1.987	1.732	2.279
Chronic	1.905	1.591	2.281	1.814	1.511	2.177	2.263	1.906	2.687	2.249	1.883	2.686
Gestational diabetes	0.954	0.791	1.150	1.006	0.824	1.228	1.524	1.302	1.785	1.530	1.296	1.807
Previous preterm small infant	3.561	3.126	4.056	3.522	3.083	4.024	4.848	4.278	5.493	4.843	4.256	5.511

Previous cesarean	0.896	0.795	1.010	0.901	0.794	1.023	0.871	0.778	0.976	0.889	0.786	1.006
Father characteristics												
Any info about father on birth certificate	0.799	0.728	0.876	0.815	0.740	0.897	0.862	0.789	0.942	0.882	0.804	0.968
Constant	0.080	0.068	0.096	0.080	0.067	0.096	0.108	0.092	0.127	0.110	0.093	0.130