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Effects of Maternity Care Coordination on Pregnancy Outcomes: Propensity-Weighted Analyses

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Abstract

Background—Care coordination services that link pregnant women to health-promoting resources, avoid duplication of effort, and improve communication between families and providers have been endorsed as a strategy for reducing disparities in adverse pregnancy outcomes, however empirical evidence regarding the effects of these services is contradictory and incomplete. This study investigates the effects of maternity care coordination on pregnancy outcomes in North Carolina.

Methods—Birth certificate and Medicaid claims data were analyzed for 7,124 women delivering live infants in North Carolina from October 2008 through September 2010, of whom 2,255 received Maternity Care Coordination (MCC) services. Propensity-weighted analyses were conducted to reduce the influence of selection bias in evaluating program participation. Sensitivity analyses compared these results to conventional OLS analyses.

Results—The unadjusted preterm birth rate was lower among women who received MCC services (7.0 percent compared to 8.3 percent among controls). Propensity-weighted analyses demonstrated that women receiving services had a 1.8 percentage point reduction in preterm birth risk; $p<0.05$). MCC services were also associated with lower pregnancy weight gain ($p=0.10$). No effects of MCC were seen for birthweight.

Conclusions—These findings suggest that coordination of care in pregnancy can significantly reduce the risk of preterm delivery among Medicaid-enrolled women. Further research evaluating specific components of care coordination services and their effects on preterm birth risk among racial/ethnic and geographic subgroups of Medicaid enrolled mothers could inform efforts to reduce disparities in pregnancy outcome.

INTRODUCTION

Persistently elevated rates of adverse pregnancy outcomes including low birthweight births among low-income and African-American women are a high-priority public health problem,[1] contributing to the U.S. ranking of 31st among 40 industrialized nations in infant mortality in 2008.[2] Care coordination services, which are activities that help to link pregnant women to an array of health-promoting resources, avoid duplication of effort, and improve communication between families and providers,[3] have long been endorsed as a key strategy for reducing disparities in pregnancy outcomes.[4–7]

The current empirical evidence regarding the effects of care coordination services, however, is contradictory and incomplete. Previous research suggests that such services may play a role in facilitating a range of positive outcomes including increased use of prenatal care,[8] reduction of pregnancy-induced hypertension,[9] decreased maternal tobacco use,[10] decreased rates of preterm delivery and low birthweight,[4,11–16] and reduced frequency and duration of neonatal intensive care admissions.[12] On the other hand, other studies have failed to document similar effects for one or more of these outcomes.[8,9,17,18] The conflicting findings may stem in part from the fact that studies of service effectiveness are subject to selection bias, such that those women receiving services may differ from women who do not in ways that can affect health outcomes of interest. For example, women who seek out care coordination services may have advantages related to resources, medical history, parenting experience, or other factors that can positively influence their pregnancy outcomes. Conversely, it may be that women who are comparatively disadvantaged in these respects are more likely to be referred for services, in hopes of mitigating their heightened risk status. In either case, lack of adequate control for differential characteristics between care coordination recipients and non-recipients is an important limitation in studies evaluating the effects of program participation, and one that characterizes much of the previous research on maternal care coordination and pregnancy outcomes.

The present study uses propensity score methods to reduce the influence of selection bias in investigating the effects of care coordination on pregnancy outcomes in North Carolina. The Maternity Care Coordination (MCC) program in place in North Carolina during the study period was staffed by nurses, social workers, and paraprofessionals who provided a range of services including: health education; facilitating access and utilization of prenatal care;

referrals to community resources such as for housing and transportation; referrals to community agencies for information on pregnancy and newborn care; and counseling to address other issues that cause pregnant women stress or worry.[19] Because one of the risk factors for MCC eligibility is low income, all pregnant Medicaid-eligible women were eligible for MCC services. While the data available do not allow examination of the relative effectiveness of specific components of care coordination in this study, we hypothesized that receipt of the package of beneficial services through care coordination would be associated with improved pregnancy outcomes, including reduced incidence of low birthweight and preterm birth.

METHODS

Data and Sample

Data were drawn from the "Babylove" file, a composite of electronic birth certificate data matched by the North Carolina State Center for Health Statistics to Medicaid newborn records, mothers' Medicaid delivery records, and mothers' Medicaid Maternity Care Coordination (MCC) claims. Records were matched using a combination of first, middle, and last name, date of birth, county of residence, and hospital of birth. Match rates exceeded 90 percent in each year. Local health department characteristics were obtained from state reports and linked to this file using the maternal county of residence.

A random sample of 8,000 live singleton deliveries funded by Medicaid was drawn from births that occurred during the period from October 1, 2008 through September 30, 2010 in the Babylove file, of which 7,987 could be matched to maternal Medicaid claims and eligibility files. Births covered by emergency Medicaid were excluded, thus requiring mothers in the sample to be covered by either full Medicaid or the Medicaid pregnancy waiver program for at least some of their pregnancy. The resulting analytic sample included 7,124 deliveries. In this sample, 2,255 mothers received at least one MCC service during their pregnancy; 4,869 women who were Medicaid or waiver enrollees and had Medicaid-funded deliveries, but did not receive MCC services during their pregnancy, were potential controls for the propensity score analysis.

This study was reviewed and approved by Institutional Review Boards at the University of North Carolina, Chapel Hill, and at the Pennsylvania State University.

Measures

The following outcomes related to infant status at birth were analyzed:

Low Birthweight—Infants were classified as low birthweight if their weight at birth was less than 2,500 grams. *Birthweight* was also analyzed as a continuous outcome.

Preterm Birth—Births at less than 37 weeks completed gestation were classified as preterm. In keeping with National Center for Health Statistics procedures, the primary measure of gestational age used was a calculation of pregnancy length based on the date of the last menstrual period (LMP) and the date of delivery; in the small percentage of cases where LMP was not reported, clinical estimate of gestation was used.

Because care coordination services might be expected to influence maternal health and behaviors during pregnancy, analyses were also performed related to:

Pregnancy Weight Gain—Maternal pregnancy weight gain in pounds was obtained from birth certificate data.

The key policy variable of interest was *Receipt of MCC Services*, defined as receiving at least one 15-minute session of maternity care coordination during pregnancy. The procedure revenue code T1017 was used with a specific combination of provider type and provider specialty codes to identify delivery of MCC services in Medicaid claims, as recommended in the Case Management Program/Service Query Criteria table published by the NC Department of Health and Human Services (http://www.ncdhhs.gov/dma/provider/budgetinitiative/CaseMgmtServicesSummaryCriteria.pdf). The initial meeting during which maternity care coordination services were provided was conducted in-person; subsequent care coordination services could be provided in-person or through telephone or letter.

Risk factors taken into account in the propensity analyses included: *Mother's Age* (under 18, or 35 and over), *Educational Attainment Less than High School Diploma, Race/Ethnicity* (non-Hispanic white, non-Hispanic black, Hispanic, other), mothers' observed health history from Medicaid claims and birth certificate data, including history of *Diabetes*, *Hypertension*, *Mental Health Problems* (schizophrenia, depression, bipolar disorder, trauma, anxiety), *Substance Use*, *Any Prior Births*, *Any Prior Infant Deaths*, *Eligibility for Full Medicaid Benefits or Pregnancy Waiver Benefits*, participation in *Healthy Start (Baby Love Plus)*, and local health department characteristics including *Funding per Capita*, availability of *WIC*, presence of a *High Risk Maternity Clinic*, and *Number of Maternity Care Coordination Staff*.

Analysis

To address the potential for self-selection into the MCC program, propensity score matching was used to balance the observable characteristics between women who did and did not receive MCC services. Potential controls outside the support of the propensity distribution for MCC participants were removed. Variable means by MCC status are reported in Table 1 for the full sample and propensity matched cohorts. All variables balanced with no difference between groups exceeding 0.02 standard deviation units.

We first present a simple regression model of each outcome on the receipt of MCC services. Next, a rich array of covariates from the linked sources of data was added to linear regression models in blocks to determine the extent of selection into the MCC program. That is, the unadjusted OLS model gives the mean difference in outcomes without controlling for selection. As covariates are added to the model, changes from the unadjusted difference indicate the degree of selection bias. We then used inverse propensity weighted linear regression models to estimate the causal effect of MCC participation on each outcome. We also ran a falsification test on two outcomes that were measured prior to pregnancy for the 2274 women who had Medicaid enrollment in the 3 months prior to conception, primary care visits and total Medicaid expenditures. Because these outcomes could not possibly be influenced by MCC receipt, which occurred during pregnancy, they provide a test of

whether important unobservable differences that influence service use remain in the model after balancing with propensity weights. We do not find a statistically significant difference at the p=0.10 level for either of these variables in the propensity weighted models. All models used robust standard errors to account for potential heteroskedasticity.

RESULTS

The first two columns of Table 1 contain unadjusted proportions or means for study variables among MCC recipients and non-recipients. Women who received MCC services were more likely than non-recipients to be younger, to have less than a high school education, to be black, and to have a history of health problems including hypertension, mental health problems, and substance abuse. They were also more likely to receive full Medicaid during pregnancy, indicating lower income, and to be enrolled in the state's Healthy Start initiative (Baby Love Plus), suggesting that women in this group were more likely to be identified as having high-risk status. They were less likely, however, to have had a prior live birth or infant death. Women receiving MCC services were less likely to be served in an area where the local health department offered a high-risk maternity clinic or WIC, and more likely to be in an area where the local health department had comparatively more staff for MCC service provision and generated higher revenue per capita. As shown in the third and fourth columns, after propensity matching the means of all variables in the weighted MCC and control samples were very similar, with the standardized differences (reported in the fifth column) less than 0.02 for all risk factors.

Table 2 provides estimates of the effect of MCC on the pregnancy outcomes of interest. Effects for the full sample are presented for each outcome, shown in the first column without adjustment for risk factors and in the second column adjusted by Ordinary Least Squares (OLS) linear regression. The estimates in the last column are the preferred estimates obtained by inverse propensity weighted linear regression using the balanced, propensity weighted sample.

Regarding preterm birth, the estimate for the full sample using standard controls (column 2) indicates that women who received MCC services were significantly less likely to have a preterm birth. In the propensity-weighted analyses in column 3, the effect among women at comparable risk remained statistically significant. Women who received MCC services had a 1.8 percentage point reduction in the probability of delivering a premature infant. In comparison to the control group rate of 8.3%, the 1.8 percentage point difference represents more than a 20% reduction in the rate of preterm births and thus is a relatively large effect. Results for low birthweight and birthweight analyzed as a continuous variable were in the direction of improved birth weight, but did not show significant effects for MCC participation in adjusted models.

Regarding pregnancy weight gain, the estimates indicate that MCC is associated with an average of 7 pound decrease in weight again. This result is clinically significant, but below conventional statistical significance levels at the p=.10 level in both the multivariate and propensity weighted model.

DISCUSSION

Preterm birth is a leading cause of mortality and morbidity in the first year of life,[20,21] and disproportionately affects infants born to low-income and minority women.[22] Results of the present study suggest that coordination of care in pregnancy can significantly reduce the risk of experiencing premature deliveries in this population. While positive effects on birth outcomes have been associated with care coordination in some previous studies,[4,11–13,15] to our knowledge the present study is the first to analyze state-wide birth certificate and claims data using propensity score methods to reduce the influence of selection bias.

The present analyses also suggest that maternity care coordination can have beneficial effects on pregnancy weight gain. Currently nearly 60 percent of overweight and 40 percent of normal weight women experience excessive weight during pregnancy,[23] which predisposes them to postpartum weight retention and a higher risk of delivering a macrosomic infant.[24] The finding that maternity care coordination is associated with reduced pregnancy weight gain suggests that more widespread availability of such services could reduce the incidence of adverse health consequences among mothers and their newborns.

Propensity-based methods are not, however, equivalent to randomized controlled trials. Although we were able to incorporate a rich array of variables from our linked data sources in the propensity estimation, selection bias from unmeasured covariates may still be a concern. However, our falsification test did not find any differences prior to conception on two broad measures of health prior to pregnancy, primary care visits and Medicaid expenditures. An additional limitation in the present analyses relates to the outcome of preterm birth, in that gestational age is more imprecisely measured than birthweight. Measurement error in the dependent variable, however, is picked up in the error term and does not bias the results unless that error is correlated with included explanatory variables.

In view of the apparent advantage conferred by care coordination related to preterm birth, it may be desirable to expand access to MCC services among high-risk populations, depending on the cost-effectiveness of the intervention. In our North Carolina sample, for example, only about one-third of Medicaid-enrolled women received care coordination services during the study period. Since the average Medicaid cost in North Carolina for a preterm infant in the first year of life is five times greater than the cost to care for a full-term baby ($19,299 vs. $3,588),[25] prevention of additional preterm births among high-risk women through expansion of care coordination services would result in significant savings. Because preterm infants also experience elevated risk of cognitive and behavioral problems in early childhood,[26] more widespread utilization of maternity care coordination services could also lead to reduced expenditures for early intervention and other supportive services for these women’s children.

In 2011, North Carolina replaced MCC with Pregnancy Care Management, a pregnancy medical home model. The Affordable Care Act now also mandates new services including selected screening tests and preventive services to preconceptional and pregnant women not in Medicaid without cost-sharing requirements (http://www.healthcare.gov/news/factsheets/

2010/07/preventive-services-list.html#CoveredPreventiveServicesforWomenIncludingPregnantWomen) that may be beneficial in reducing the incidence of preterm birth. Future research should investigate whether these services and alternative service system structures have similar, or superior, advantageous effects on preterm birth.

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Table 1

Study Variable Means for Full and Propensity-Matched Sample

Study Variable	Unadjusted Proportions/ Means for MCC recipients (full sample) (n=2255)	Unadjusted Proportions/Means for potential controls (full sample) (n=4869)	Propensity weighted Proportions/Means for MCC recipients (n=2255)	Propensity weighted Proportions/Means for controls (n=4455)	Standardized difference in propensity weighted means
Younger than 18 at delivery	9.1%	5.1%	6.6%	6.6%	<0.001
Age 35 or older at delivery	4.4%	7.4%	6.5%	6.4%	0.005
Less than high school education	22.1%	17.4%	19.2%	19.0%	0.005
Education not available	35.7%	37.7%	36.7%	37.0%	0.005
Mother Hispanic ethnicity	8.8%	17.1%	15.0%	14.2%	0.024
Mother African American	45.7%	31.4%	35.8%	35.9%	0.002
Prior history of diabetes	1.6%	2.2%	2.2%	2.0%	0.009
Prior history of hypertension	1.0%	0.9%	0.9%	0.9%	<0.001
Prior history of schizophrenia	0.7%	0.4%	0.5%	0.5%	0.003
Prior history of depression	16.5%	13.0%	14.1%	14.1%	<0.001
Prior history of Bipolar disorder	5.8%	3.3%	4.1%	4.2%	0.004
Prior history of trauma	2.5%	1.5%	1.8%	1.8%	0.001
Prior history of anxiety	10.0%	8.7%	9.1%	9.1%	<0.001
Prior history of any mental health condition	22.1%	17.8%	19.5%	19.4%	0.002
Prior history of substance use treatment	9.8%	7.5%	8.5%	8.3%	0.008
Prior live births	42.7%	62.5%	56.4%	56.1%	0.005
Prior infant death	1.8%	1.9%	2.0%	1.9%	0.006
Participation in Baby Love Plus (Healthy Start)	19.5%	14.3%	15.8%	16.0%	0.006
Receipt of full Medicaid during pregnancy	40.2%	32.8%	35.8%	35.5%	0.005
Receipt of services from an LHD with a high risk maternity clinic	19.4%	22.3%	20.8%	20.8%	<0.001
LHD in region does not offer WIC	7.1%	6.8%	6.5%	6.8%	0.012
MCC staffing per 100,000 population in LHD service area	3.86	3.28	3.54	3.54	0.001
LHD revenue per capita	6.71	6.10	6.45	6.38	0.019
LHD revenue information missing	3.1%	3.5%	3.2%	3.4%	0.010

Table 2

Estimated Effects (Standard Errors[1]) of MCC on Pregnancy Outcomes

Pregnancy Outcome	Unadjusted Simple Regression Estimates	Adjusted Multiple Regression Estimates	Inverse Propensity Weighted Effects
Preterm birth	−0.0129* (0.0067)	−0.0197*** (0.0070)	−0.0176** (0.0073)
Low birthweight	0.0049 (0.0068)	−0.0059 (0.0071)	−0.0033 (0.0072)
Birthweight in grams	−37.80*** (13.44)	8.66 (13.80)	1.31 (14.60)
Pregnancy weight gain (pounds)	−5.51 (3.72)	−8.28* (4.82)	−7.37* (4.23)

[1] All models use robust standard errors to account for potential heteroskedasticity

* =p<.10;

** =p<.05;

*** =p<.01

Adjusted Multiple Regression Estimates use all baseline covariates reported in Table 1 as control variables; IPW estimates use all variables reported in in Table 1 as baseline risk factors.

The results for preterm birth and low birthweight give estimated percentage point differences in prevalence rates between MCC recipients and non-recipients, controlling for covariates. For example, −0.0129 reflects a 1.29% point reduction in the probability of a preterm birth. Results for birthweight and weight gain are in natural units (grams and pounds).