RESEARCH ARTICLE

The impact of the Medicaid high-risk ob care management program in New York State

Young Joo Park PhD¹ | Stephen Weinberg PhD² | Lindsay W. Cogan PhD^{3,4}

¹School of Public Administration, University of New Mexico, Albuquerque, New Mexico

²Rockefeller College of Public Affairs and Policy, University at Albany-State University of New York, Albany, New York

³New York State Department of Health, Albany, New York

⁴School of Public Health, University at Albany-State University of New York, Albany, New York

Correspondence

Young Joo Park, PhD, School of Public Administration, University of New Mexico, Social Sciences Building 3007, 1 University of New Mexico, Albuquerque, NM 87131-0001.
Email: park@unm.edu

Abstract

Objectives: To examine the effect of high-risk obstetrics (HROB) care management on infant health and Medicaid expenditures.

Data Sources/Study Setting: Medicaid administrative data and vital statistics from 2011 to 2013. In New York State, all Medicaid managed care plans provide HROB care management to their members.

Study Design: We conducted a retrospective cohort study with a nonequivalent control group. Selection bias was addressed by using probit and OLS models with the Heckman correction and inverse probability weight with regression adjustment.

Principal Findings: While program enrollment was associated with poor infant health outcomes (low birthweight, very low birthweight, preterm delivery, and gestational age), correcting for sample selection substantially improved most of these outcomes. All infant health outcomes significantly improved as the number of weeks in the program increased. We found that a 1-week increase in program duration is associated with a 0.01 percentage point decrease in low birthweight and a 0.03 percentage point decrease in very low birthweight. Further, a 1-week increase in program duration decreases the probability of preterm delivery by 0.01 percentage points and increases gestational age by 0.14 days. Medicaid expenditures for maternity care and newborn delivery were not significantly or materially affected by program enrollment or program duration.

Conclusions: High-risk obstetrics care management appears to successfully identify individuals with high-risk pregnancies and improve health without substantially increasing medical expenses.

KEYWORDS

health care expenditures, maternal and perinatal care and outcomes, Medicaid

1 | INTRODUCTION

Medicaid plays a central role in maternal and infant care in the United States. In 2010, Medicaid financed nearly 49 percent of births in the United States (45.8 percent in New York State).¹ Understanding the Medicaid managed care program for maternal care and delivery is important for infant health and health care expenditures in the United States. In this study, we looked at Medicaid health plan

administered care management programs that are targeted at high-risk pregnant women.

Studies evaluating the effect of care management programs for pregnant women on birth outcomes have shown mixed results, especially on the question of whether these interventions improve infant health outcomes (eg, birthweight).² A recent systematic review on maternity care coordination and pregnancy outcomes showed that only 44 percent of studies found a significant increase in

birthweight among studies using birthweight as the main outcome.³ According to Carabin et al,⁴ care management program participation does not significantly improve infant health outcomes, such as low birthweight (LBW), among married women. Also, the number of visits or hours spent with a case manager did not significantly reduce LBW among enrollees in the Family Case Management Program in Illinois.⁵ However, several scholars have criticized these previous studies for having small sample sizes, sample selection biases, and poor measurement of program intensity.^{6,7} These latter scholars have found that the incidence of LBW was lower for women enrolled in a pregnancy care management program compared to those who were not, after adjusting for underlying differences in population characteristics using propensity score matching.⁸ Taking into account prenatal care management dosage, characterized by the amount of contact time, duration of enrollment, and breadth of intervention, they have found that pregnancy management programs significantly reduce the likelihood of LBW.^{6,7} This study extends that literature by introducing evidence from an additional care management program, New York State Medicaid Managed Care, that includes evidence on both program enrollment and program duration (ie, the number of weeks of enrollment).

1.1 | New York State Medicaid High-Risk Obstetrics (HROB) care management program

Beginning in 2011, the New York State Department of Health required all Medicaid managed care plans to provide care management programs as well as collect and report standardized care management data on Medicaid members who are being monitored by, in outreach with, or in an active/enrolled segment with the health plan administered program. While the types of care management programs differ by plan (eg, behavioral health, catastrophic, chronic adults, HIV/AIDS, pediatrics), all have implemented a HROB Care Management program.

Health plans choose which patients to invite into the program. They identify high-risk pregnant women according to the plans' own criteria, using measures such as previous pregnancy-related issues (eg, preterm birth, LBW, preeclampsia in prior pregnancy, and hypertension); alcohol, tobacco, or drug use; maternal age (≤ 17 or ≥ 35); maternal medical conditions; maternal psychological issues; prenatal care visit schedule issues; utilization of emergency department or antenatal inpatient hospitalization; current pregnancy-related complications; or other relevant issues. The conditions of previous preterm birth, alcohol or drug use, being <17 years old, and having diabetes made a woman eligible for the program across all health plans.

Since it is a nonmandatory program, program enrollment and duration are dependent on individual decisions. Thirty-six percent of identified high-risk pregnant women enrolled in the program over the 3-year period examined in this analysis (Appendix S1 presents enrollment rates by health plan). On average, the targeted women enrolled in the program 3.9 weeks after health plans reached out to them. The average high-risk pregnant women enrolled in the program 14 weeks before delivery. The program duration before

delivery date is, on average, 11 weeks (program duration first quartile 4 weeks; second quartile 10 weeks; third quartile 17 weeks). Approximately 2 percent of women participated in the program for more than 30 weeks.

After identifying high-risk pregnant women, plans offer services including risk assessment, psychological services, health education, treatment, referrals, appointment reminders, and transportation by collaborating with OB providers. There is little variation in the types of services that health plans in New York State provide (though the quality of service may vary in unmeasured ways).

This study examines whether the New York State Medicaid Managed Care HROB care management program (hereafter referred to as the HROB Care Management program) improves various infant health outcomes, namely the probability of LBW, very low birthweight (VLBW), preterm delivery, and gestational age, and whether it reduces Medicaid expenditures for maternity care and newborn delivery and care. To minimize the measurement issues discussed above, we used both program participation and duration as separate independent variables. Using probit and OLS regression with sensitivity analysis (the Heckman sample selection model and inverse probability weight with regression adjustment) to address selection issues, we evaluated the HROB Care Management Program with an array of outcome measures.

2 | METHODS

2.1 | Data sources

Data for this analysis come from three sources. First, we used the health plan–submitted care management data with Medicaid identifier to restrict the study population and identify HROB Care Management program enrollment status. Second, we used New York State and New York City Vital Statistics data, which includes information on the pregnancy, birth, and health condition(s) for both the mother and baby. Lastly, we merged Medicaid enrollment, encounter, and claims data from the New York State Department of Health, Office of Health Insurance Program's Data Mart to calculate total Medicaid expenditures for both maternal and newborn care.

2.2 | Study population

Our initial dataset includes 81 431 women with high-risk pregnancies reported by health plans between 2011 and 2013. We excluded (a) individuals who lost Medicaid eligibility, (b) those whose expected delivery date was after the study period ended (ie, expected delivery date $\geq$ February 2014), and (c) women with multiple births during the study period, because we cannot confidently identify which services are associated with which birth. Out of the 65 449 pregnant women (the population used in the Heckman selection model), we further eliminated women without a delivery record, which left 57 519 observations for our baseline models (probit and OLS models). The treatment group was women who enrolled in the program, and the control group was women who did not enroll in the program.

2.3 | Variables

2.3.1 | Outcome variables

We evaluated infant health outcomes using four outcome measures: (a) the probability of LBW, (b) the probability of VLBW, (c) the probability of preterm delivery, and (d) gestational age.⁹⁻¹¹ These infant health outcomes are widely used to explain infant mortality in the United States.^{12,13} Due to the significance of these infant health outcomes in understanding neonatal morbidity and mortality in addition to health care costs,¹⁴ the risk factors causing them such as obesity, diabetes, and abuse have also been studied in the literature.¹⁵⁻¹⁷ LBW is defined as an infant birthweight of 2500 g or less, and VLBW is those with birthweight of 1500 g or less.¹⁸ Preterm deliveries are those that occur before 37 completed weeks of gestation.¹⁹

To evaluate financial outcomes, we estimated the expenditures to New York State's Medicaid program for prenatal care and newborn delivery and care, including neonatal intensive care, using the New York State Medicaid global fee program. New York and many other states pay Medicaid plans a lump sum "kick payment" for each delivery, calculated by plan and region, based on the plans' expenditures for maternal care and newborn delivery over the previous year.²⁰

2.3.2 | Main effect variables

Main effect variables are (a) whether high-risk pregnant women (as identified by health plans) enrolled in the HROB Care Management program more than zero days, and (b) if they enrolled, how long they remained enrolled in the HROB Care Management program. We measured the duration of program enrollment as the number of weeks between the enrollment date and program end date (or between the enrollment date and delivery date if women continued in the program).

2.3.3 | Control variables

We first controlled for the number of weeks with prenatal care and previous pregnancy history (three dummy variables for previous infant death, previous spontaneous abortion or miscarriage (loss of fetus <20 weeks), and previous stillbirth (loss of a fetus >20 weeks). Second, we further controlled for the factors that put a pregnancy at risk: (a) existing health conditions, (b) mothers' age, (c) lifestyle factors, and (d) condition of pregnancy. These variables correspond to the list of factors indicating high-risk pregnancy as determined by the National Institutes of Health.²¹ More specifically, existing health conditions were addressed with the inclusion of dummy variables for pre-existing hypertension, pre-existing diabetes, obesity, and HIV/AIDS. Dummy variables for teen pregnancy and first-time pregnancy after age 35 were used to account for age-related risk factors. Lifestyle risk factors included two dummy variables for alcohol use and illegal drug use, and three continuous variables for daily cigarette smoking (during the 3 months prior to pregnancy, during the first trimester, and during the second trimester).

Conditions of pregnancy included dummy variables for gestational hypertension, gestational diabetes, and eclampsia. Third, we also controlled for demographic variables as proxies for resources (level of education, employment status, and race). Finally, we controlled for Medicaid's geographic fiscal region, health plan, and year.

2.4 | Analytic methods

2.4.1 | Baseline model specifications

We used probit and OLS analyses to estimate the effects of the HROB Care management program on infant health (LBW, VLBW, preterm delivery, and gestational age) and Medicaid expenditures. The baseline model estimates infant health outcomes and Medicaid expenditures as a function of two independent variables, program enrollment and program enrollment duration, and control variables: (a) The probit model estimates the effect of the program participation and enrollment duration on the probability of LBW, VLBW, and preterm delivery; and (b) the OLS model estimates the effect of the program participation and enrollment duration on gestational age. Various control variables discussed above (weeks of prenatal care, previous pregnancy history, and pregnancy risk factors such as existing health conditions, mothers' age, lifestyle factors, and conditions of pregnancy, as well as demographic factors) are included. Medicaid's geographic fiscal regions, health plans, and year are also included in all models.

2.4.2 | Sensitivity analysis

First, to estimate the effect of the HROB Care Management program on infant health outcomes, we used the Heckman sample selection model. The Heckman sample selection model is used under conditions in which the dependent variable is not always observed.²² Although we used data from the entire population of pregnant women identified as high risk, we were only able to analyze the effect of the program on infant health outcomes using data containing a birth record (90 percent of the total population). In other words, there is a selection bias, since we were only able to observe infant health outcomes such as birthweight and physical conditions above a certain level. To adjust for the bias caused by this inherent truncation, we included two equations: (a) the regression to estimate the portion of the sample whose outcome is observed in the selection process and (b) the regression model to predict the outcome variables, LBW, VLBW, preterm delivery, and gestational age.

Selection model: Infant health outcomes are observed if

$$\gamma_0 + \gamma_1 * \text{Health Plans} + \gamma_2 * \text{Fiscal Region} > 0$$

Regression mode:

Infant health outcomes

$$= \beta_0 + \beta_1 * \text{Care Management (Program Enrollment or Duration)} + \beta_2 * \text{controls} | \gamma_0 + \gamma_1 * \text{Health Plans} + \gamma_2 * \text{Fiscal Region} > 0$$

TABLE 1 Descriptive statistics on unadjusted baseline characteristics of high-risk pregnant women and identified babies in New York State from 2011 to 2013 (N = 57 519^d)

	Total		Enrollees		Nonenrollees		P-value ^c
Variable	Mean	SD	Mean	SD	Mean	SD	
Dependent variables							
Low birthweight, %	7.49	26.33	8.24	27.50	7.07	25.62	.00
Very low birthweight, %	1.31	11.38	1.57	12.43	1.17	10.74	.00
Preterm delivery, %	14.71	35.42	15.62	36.31	14.20	34.90	.00
Gestational age	273.74	20.30	273.25	20.70	274.01	20.06	.00
Costs ^a , \$	10 937.65	5845.11	10 913.54	6247.21	10 951.33	5603.98	.46
Control variables							
Prenatal care days	27.06	6.98	27.35	6.69	26.90	7.14	.00
Pre-existing hypertension, %	1.95	13.83	2.32	15.04	1.74	13.09	.00
Pre-existing diabetes, %	1.21	10.92	1.71	12.98	0.92	9.54	.00
Obesity, %	6.98	25.48	7.48	26.31	6.70	25.00	.00
AIDS, %	0.44	6.64	0.50	7.05	0.41	6.40	.13
Gestational hypertension, %	3.18	17.54	3.26	17.76	3.13	17.41	.38
Gestational diabetes, %	6.95	25.44	8.22	27.47	6.24	24.18	.00
Eclampsia, %	0.46	6.80	0.45	6.70	0.47	6.85	.74
Teen pregnancy, %	7.53	26.39	6.51	24.67	8.11	27.30	.00
First-time pregnancy after age 35, %	1.07	10.30	1.25	11.09	0.97	9.82	.00
Alcohol use, %	0.66	8.08	0.61	7.80	0.68	8.24	.31
Cigarette smoking, per day							
3 mo prior pregnancy	0.96	4.07	1.05	4.21	0.91	3.98	.00
First 3 mo	0.59	2.90	0.69	3.12	0.54	2.76	.00
Second 3 mo	0.43	2.29	0.51	2.47	0.38	2.17	.00
Illegal drug, %	2.51	15.66	2.68	16.15	2.42	15.37	.06
Previous infant death	0.01	0.13	0.01	0.16	0.01	0.11	.00
Previous loss of a fetus < 20 wks	0.02	0.20	0.02	0.21	0.02	0.19	.07
Previous loss of a fetus > 20 wks	0.32	0.76	0.35	0.80	0.30	0.74	.00
Education ^b	3.25	1.49	3.28	1.48	3.23	1.49	.00
Employed, %	33.09	47.05	33.30	47.13	32.97	47.01	.41
Caucasian, %	44.51	49.70	44.14	49.66	44.72	49.72	.18
Black, %	29.95	45.81	29.72	45.70	30.08	45.86	.37
Asian, %	10.64	30.84	12.21	32.75	9.75	29.67	.00
Other race, %	6.21	24.13	6.16	24.04	6.23	24.18	.71
Number of observations	57,519		36 700		20 819		

Note: Low birthweight (LBW) is defined as a birthweight of an infant of 2500 g or less. Very low birthweight (VLBW) is <1500 g.

^aMedicaid costs for maternity care and newborn delivery.

^bEducation is an ordinal measure from 1 to 9 and included as dummy variables in all models.

^cThe P-value is two-sided.

^dThis table presents observations with birth outcomes.

[Correction added on 22 November 2019, after first online publication: the equation symbol " γ_1 " has been inserted between "controls" and " $\gamma_0 + \gamma_1$ " on the above formula.]

Note: we drew most of the control variables for the baseline model from the vital statistics dataset, which is available only for observations with recorded births. Thus, the selection equation cannot include these

variables. In the regression model, as discussed above, "controls" include weeks of prenatal care, previous pregnancy history, and pregnancy risk factors, Medicaid's geographic fiscal region, health plan, and year.

Second, to minimize potential bias in outcomes between the treatment (HROB Care Management program enrollees) and control groups (nonenrollees), we used an inverse probability

TABLE 2 The effect of care management program enrollment on clinical birth outcomes using the Heckman sample selection model (N = 65 449^a)

	LBW	VLBW	Preterm delivery	Gestational age
Program enrollment (on the date of delivery)	0.04*** (0.01)	0.19*** (0.04)	0.09*** (0.02)	-1.03*** (0.22)
Program enrollment (<1 wk)	0.06 (0.05)	0.07 (0.17)	0.05 (0.08)	-0.16 (0.99)
Program enrollment (≥ 1 wk)	0.02* (0.01)	-0.09 (0.06)	-0.01 (0.02)	0.18 (0.26)
Prenatal care weeks	-0.02*** (0.00)	-0.06*** (0.00)	-0.04*** (0.00)	0.72*** (0.01)
Pre-existing hypertension	0.29*** (0.03)	0.70*** (0.07)	0.40*** (0.04)	-6.44*** (0.60)
Pre-existing diabetes	0.01 (0.04)	-0.00 (0.11)	0.30*** (0.05)	-4.03*** (0.76)
Obesity	0.01 (0.02)	0.02 (0.06)	0.05* (0.03)	-0.55 (0.32)
AIDS	0.06 (0.06)	-0.49 (0.37)	0.19 (0.10)	-2.18 (1.23)
Gestational hypertension	0.33*** (0.03)	0.62*** (0.06)	0.36*** (0.03)	-4.61*** (0.47)
Gestational diabetes	-0.04* (0.02)	-0.18* (0.07)	0.08** (0.03)	-1.72*** (0.33)
Eclampsia	0.57*** (0.07)	0.70*** (0.12)	0.64*** (0.08)	-10.10*** (1.20)
Teen pregnancy	0.05** (0.02)	-0.01 (0.06)	-0.04 (0.03)	0.95** (0.33)
First-time pregnancy after age 35	0.10** (0.04)	0.27* (0.13)	0.10 (0.06)	-0.90 (0.79)
Alcohol use	0.01 (0.05)	0.02 (0.19)	0.02 (0.08)	-0.85 (1.01)
Cigarette smoking	0.00* (0.00)	0.01* (0.01)	0.00 (0.00)	0.04 (0.04)
3 mo prior pregnancy				
First 3 mo	0.00 (0.00)	-0.01 (0.01)	-0.01 (0.01)	0.03 (0.07)
Second 3 mo	0.01 (0.00)	-0.00 (0.01)	0.02* (0.01)	-0.14 (0.07)
Illegal drug	0.09** (0.03)	0.06 (0.10)	-0.03 (0.05)	0.59 (0.58)
Previous infant death	0.07* (0.03)	0.03 (0.11)	0.15** (0.05)	-2.80*** (0.64)
Previous loss of a fetus	0.09*** (0.02)	0.16** (0.05)	0.10** (0.03)	-1.14** (0.40)
<20 wks				
>20 wks	0.02*** (0.01)	0.06** (0.02)	0.06*** (0.01)	-0.85*** (0.11)
Employed	-0.02** (0.01)	0.03 (0.04)	-0.01 (0.02)	0.00 (0.18)

(Continues)

TABLE 2 (Continued)

	LBW	VLBW	Preterm delivery	Gestational age
Black	0.10*** (0.01)	0.18*** (0.04)	0.12*** (0.02)	-1.75*** (0.19)
Asian	-0.05*** (0.01)	-0.26** (0.09)	-0.04 (0.03)	-0.99*** (0.29)
Other race	0.11*** (0.02)	0.11 (0.07)	0.06* (0.03)	-1.05** (0.35)
Constant	-0.62*** (0.07)	-1.28*** (0.21)	-0.15 (0.11)	261.59*** (1.10)
Level of education controlled	Yes	Yes	Yes	Yes
Health plan controlled	Yes	Yes	Yes	Yes
Region controlled	Yes	Yes	Yes	Yes
Year controlled	Yes	Yes	Yes	Yes
Observations	63 331	63 331	62 738	62 738

Note: Standard errors in parentheses. Omitted race category for fiscal region is "Caucasian."

Low birthweight (LBW) is defined as a birthweight of an infant of 2500 g or less. Very low birthweight (VLBW) is <1500 g.

^aThe Heckman selection model includes observations without birth outcomes. First-stage selection models are reported in Appendix S4.

*** $P < .001$;

** $P < .01$;

* $P < .05$.

weighting regression adjustment (IPWRA) model. This model estimates the average treatment effect of HROB Care Management program participation and enrollment duration on various infant health outcomes. By combining two approaches, inverse probability weighting and regression adjustment, we made both of these adjustments in the same model, instead of creating two separate models.^{23,24}

3 | RESULTS

Table 1 lists the descriptive statistics on unadjusted baseline characteristics of the high-risk pregnant women and babies as identified by program enrollment in New York State from 2011 to 2013. The average probabilities of LBW, VLBW, and preterm delivery are 7.5 percent, 1.3 percent, and 14.7 percent, respectively. The average gestational age is 274 days (full-term). Women enrolled in the program have slightly but significantly poorer birth outcomes than those who did not enroll in the program (LBW 8.2 vs 7.1 percent; VLBW 1.6 vs 1.2 percent; preterm delivery 15.6 vs 14.2 percent; gestational age 273.3 vs 274.0 days). Program enrollees have slightly lower Medicaid costs than nonenrollees, but the difference is not statistically significant. The enrollment rate in the HROB Care Management program (the number of women enrolled in the HROB Care Management program divided by the number of high-risk pregnant women identified by health plans) was 36.2 percent. Summary statistics for control variables are also presented in Table 1. For example, while there is no significant difference in the proportion of Caucasian and black individuals, respectively, among program enrollees and nonenrollees (Caucasian: 44.72 percent vs

44.14 percent, P -value = .18; black: 30.08 percent vs 29.72 percent, P -value = .37), the proportion of Asians among enrollees is significantly lower than the proportion of those among nonenrollees (9.75 percent vs 12.21 percent, P = .00).

Tables 2 and 3 show the effect of the HROB Care Management program on infant health outcomes, with the observations restricted to live births. Table 2 presents the effects of HROB Care Management program enrollment on four infant health outcomes (LBW, VLBW, preterm delivery, and gestational age) using the Heckman Sample Selection Model (Appendix S2 presents the first-stage Heckman selection model for Table 2). We found negligible or minimal effects of enrollment in the program on all infant health outcomes (LBW, VLBW, preterm delivery, and gestational age) for those who enrolled in the program for more than zero days. The IPWRA model presents the same results (see Appendix S3). While program enrollment on the date of delivery is associated with worse infant health outcomes, this is because of selection bias: women with poor birth outcomes more often choose to enroll in the program.

In Table 3, we tested the effect of program duration on infant health outcomes for women who enrolled in the program. At the average enrollment duration of 11 weeks, if high-risk women are enrolled in the program, a 1-week increase in program duration is associated with a decrease in the probability of LBW (a 0.01 percentage point decrease, $P < .001$), VLBW (a 0.03 percentage point decrease, $P < .001$), and preterm delivery (a 0.01 percentage point decrease, $P < .001$). Furthermore, a 1-week increase in program duration results in a slight increase in gestational age (0.14 days, $P < .001$). We also found similar effects of program duration on four infant health outcomes using the Heckman sample selection model (see Appendices S4 and S5).

TABLE 3 The effect of care management program on clinical birth outcomes among program enrollees using linear regression and probit analysis (N = 20 819)

	LBW	VLBW	Preterm delivery	Gestational age
Weeks enrolled in program	−0.01*** (0.00)	−0.03*** (0.01)	−0.01*** (0.00)	0.14*** (0.02)
Prenatal care weeks	−0.04*** (0.00)	−0.06*** (0.00)	−0.05*** (0.00)	0.84*** (0.02)
Pre-existing hypertension	0.48*** (0.07)	0.57*** (0.11)	0.31*** (0.07)	−6.41*** (0.94)
Pre-existing diabetes	−0.06 (0.09)	−0.03 (0.15)	0.34*** (0.08)	−3.85*** (1.09)
Obesity	0.03 (0.05)	0.08 (0.09)	0.09* (0.04)	−1.55** (0.53)
AIDS	0.03 (0.18)		0.10 (0.15)	−2.18 (1.97)
Gestational hypertension	0.48*** (0.06)	0.55*** (0.10)	0.31*** (0.06)	−5.03*** (0.79)
Gestational diabetes	−0.18*** (0.05)	−0.24* (0.10)	0.05 (0.04)	−1.10* (0.51)
Eclampsia	0.75*** (0.14)	0.58** (0.21)	0.59*** (0.14)	−10.91*** (2.07)
Teen pregnancy	0.05 (0.05)	−0.03 (0.11)	−0.07 (0.05)	0.78 (0.59)
First-time pregnancy after age 35	0.11 (0.11)	0.18 (0.20)	0.09 (0.10)	−0.49 (1.24)
Alcohol use	0.06 (0.16)	−0.20 (0.35)	−0.05 (0.14)	0.09 (1.77)
Cigarette smoking	0.01* (0.01)	0.02 (0.01)	0.00 (0.01)	0.09 (0.06)
3 mo prior pregnancy				
First 3 mo	−0.01 (0.01)	−0.02 (0.02)	−0.01 (0.01)	0.08 (0.12)
Second 3 mo	0.01 (0.01)	0.00 (0.02)	0.02* (0.01)	−0.31** (0.12)
Illegal drug	0.17* (0.08)	0.02 (0.16)	−0.15 (0.08)	1.79 (0.95)
Previous infant death	0.11 (0.07)	−0.03 (0.18)	0.18** (0.06)	−3.74*** (0.93)
Previous loss of a fetus	0.08 (0.05)	0.16* (0.08)	0.04 (0.05)	−0.61 (0.66)
<20 wks				
>20 wks	0.04* (0.02)	0.06* (0.03)	0.05*** (0.01)	−0.98*** (0.18)
Employed	−0.06 (0.03)	0.05 (0.06)	−0.03 (0.02)	0.10 (0.30)
Black	0.23*** (0.03)	0.16** (0.06)	0.15*** (0.03)	−2.07*** (0.33)
Asian	−0.14* (0.05)	−0.19 (0.13)	−0.04 (0.04)	−0.92* (0.46)

(Continues)

TABLE 3 (Continued)

	LBW	VLBW	Preterm delivery	Gestational age
Other race	0.14** (0.06)	0.20 (0.11)	0.03 (0.05)	-0.31 (0.59)
Constant	-0.12 (0.19)	-0.38 (0.34)	0.39* (0.17)	248.26*** (2.19)
Level of education controlled	Yes	Yes	Yes	Yes
Health plan controlled	Yes	Yes	Yes	Yes
Region controlled	Yes	Yes	Yes	Yes
Year controlled	Yes	Yes	Yes	Yes
Observations	20 172	20 070	19 934	19 938
Pseudo R ²	0.09	0.22	0.08	0.11 ^a

Note: Standard errors in parentheses. Caucasian is omitted race category. Low birthweight (LBW) is defined as a birthweight of an infant of 2500 g or less. Very low birthweight (VLBW) is < 1500 g.

^aR².

***P < .001;

**P < .01;

*P < .05.

Figure 1 shows the predicted values from the estimates in Table 3. The figure shows the relationship between program duration and each infant health outcome variable (LBW, VLBW, preterm delivery, and gestational age). As program duration increases, the probability of LBW, VLBW, and preterm delivery decreases. While there is approximately a 0.04 percent probability of delivering a LBW infant for an average woman who was enrolled in the program during the entire pregnancy period, the probability is doubled if she

did not enroll in the program at all (Figure 1A). Similarly, while approximately 0.002 percent of full-term program enrollees delivered VLBW infants, the probability for those who did not enroll in the program at all is approximately 0.018 percent (Figure 1B). Another similar pattern is observed for gestational age: While approximately 0.8 percent of women experience preterm delivery if they enrolled in the program, the probability is also doubled for those who did not enroll in the program (Figure 1C). Furthermore, as program duration

FIGURE 1 The effect of care management program on clinical birth outcomes among program enrollees using linear regression and probit analysis from Table 3 (N = 20 819). Note: Low birthweight (LBW) is defined as a birthweight of an infant of 2500 g or less. Very low birthweight (VLBW) is <1500 g

TABLE 4 The effect of care management program on costs using linear regression analysis (N = 57 519 in program enrollment model; N = 20 819 in duration model)

Dependent variable: costs to Medicaid (\$)	Program enrollment model	Program duration model
Program enrollment	3.21 (53.73)	
Weeks enrolled in program		-12.40* (5.82)
Prenatal care weeks	-66.08*** (3.42)	-70.37*** (6.28)
Pre-existing hypertension	1017.60*** (174.21)	1211.89*** (283.11)
Pre-existing diabetes	-17.27 (218.11)	57.65 (325.70)
Obesity	179.31 (93.43)	302.15 (159.20)
AIDS	-350.47 (351.77)	-452.14 (575.93)
Gestational hypertension	725.27*** (136.08)	567.04* (235.95)
Gestational diabetes	-297.15** (93.57)	-376.95* (153.47)
Eclampsia	595.40 (349.29)	1048.62 (617.50)
Teen pregnancy	-129.89 (94.75)	-119.27 (177.05)
First-time pregnancy after age 35	-211.51 (227.47)	-168.78 (371.19)
Alcohol use	-265.97 (291.90)	158.85 (523.75)
Cigarette smoking	11.05 (10.41)	27.40 (18.51)
3 mo prior pregnancy		
First 3 mo	-8.53 (20.40)	-58.15 (35.95)
Second 3 mo	-0.63 (21.88)	52.94 (37.64)
Illegal drug	273.99 (166.28)	438.19 (281.61)
Previous infant death	-32.49 (188.33)	-65.79 (276.49)
Previous loss of a fetus	233.55* (118.71)	274.00 (197.12)
<20 wks		
>20 wks	51.00 (31.62)	100.23 (52.85)

(Continues)

TABLE 4 (Continued)

Dependent variable: costs to Medicaid (\$)	Program enrollment model	Program duration model
Employed	-36.36 (51.47)	-23.86 (89.94)
Black	270.84*** (55.94)	219.26* (98.95)
Asian	106.03 (82.29)	219.14 (138.41)
Other race	90.77 (100.78)	181.54 (177.04)
Constant	10 368.77*** (299.06)	11 281.74*** (653.54)
Level of education controlled	Yes	Yes
Health plan controlled	Yes	Yes
Region controlled	Yes	Yes
Year controlled	Yes	Yes
Observations	54 641	19 847
R ²	0.03	0.03

Note: Standard errors in parentheses. Caucasian is omitted race category. Low birthweight (LBW) is defined as a birthweight of an infant of 2500 g or less. Very low birthweight (VLBW) is <1500 g. We also used generalized linear models with gamma distribution and log link function to correct potential bias. The coefficients of program enrollment and weeks enrolled in program are not statistically significant. This suggests that our findings on the minimal effects of the program on costs are robust.

*** $P < .001$;

** $P < .01$;

* $P < .05$.

increases, gestational age increases. The estimation shows that the gestational age of newborns whose mothers are enrolled in the program during the entire pregnancy period is approximately 6 days longer, compared to those who are not enrolled (Figure 1D).

Finally, we estimated the effect of the HROB Care Management program on Medicaid expenditures; that is, the lump sum "kick payment" made by Medicaid to managed care plans in Table 4. We found that, although program enrollment is associated with an increase in Medicaid expenditures by \$3.21, this relationship is not statistically significant. In addition, as program enrollment duration increases by 1 week, expenditures to Medicaid decrease by \$12.40, but given that the average Medicaid kick payment, for a delivery is \$10 931, the impact on expenditures is minimal.

4 | DISCUSSION

This study investigates the effect of participation in the HROB Care Management program in New York State on infant health and on Medicaid maternal care and delivery expenditures. This paper supports that the HROB Care Management program improves infant

health outcomes for women identified and enrolled early in their pregnancies. Although program enrollment was not associated with any decrease in LBW, VLBW, and preterm delivery or an increase in gestational age, the program duration improves all four infant health outcomes. Therefore, the negative or weak enrollment effects on infant health reflect selection bias, rather than the program causing poorer infant health outcomes. The results from different model specifications also provide confidence that the program is effectively targeting high-risk pregnant women and improving infant health outcomes. On the expenditure side, neither program enrollment nor program duration practically affects Medicaid expenditures.

Turning to clinical significance, we found that a 1-week increase in program duration is associated with a 0.01 percentage points decrease in LBW. This means that if a woman enrolled in the program for 30 weeks, the probability of LBW decreases by 0.3 percentage points. Similarly, a 1-week increase in program duration decreases the probability of VLBW by 0.03 percentage points or by 0.9 percentage points for a woman enrolled for 30 weeks. A 1-week increase in program duration decreases the probability of preterm delivery by 0.01 percentage points or by 0.3 percentage points for a woman enrolled for 30 weeks. Further, a 1-week increase in program duration is associated with 0.14-day increase in gestational age or a 4.2-day increase for a woman enrolled for 30 weeks. For the average program duration of 11 weeks, the effect is a 0.11 percentage point drop in LBW, a 0.33 percentage point drop in VLBW, a 0.11 percentage point drop in preterm delivery, and a 1.5-day increase in gestational age. As implemented in New York State, these programs' effects are modest at best, but are substantially larger for women who enroll earlier.

This study helps to resolve contradictory findings in the literature. First, this study confirms that program enrollment itself does not improve birth outcomes and Medicaid costs even after adjusting for selection bias. This finding is consistent with previous findings that OB care management program enrollments have no or minimal effect on reducing LBW and VLBW. Even though we extend this work by employing a series of health outcome measures, including preterm delivery, gestational age, and Medicaid expenditures and adjust for selection bias, this null finding is consistent with previous evidence. Second, we demonstrate that longer duration improves birth outcomes by giving the opportunity to provide better primary care and to communicate much more information to high-risk pregnant women. As Slaughter, Issel, Handler, Rosenberg, Kane, Stayner 7 emphasized, our findings underline the importance of program intensity. We call for future research to focus on program intensity such as duration and implementation processes to better understand whether the program is adequately designed to address the high-risk groups' needs.

This study has six limitations. First, we only examined Medicaid expenditures. Medicaid payments made to managed care plans do not include out-of-pocket costs to mothers or other societal costs. In addition, due to data limitations, we did not include HROB

program implementation costs, which are potentially important for accurate cost-benefit analysis. Second, there is a generalizability issue to states beyond New York, as Medicaid expansion may differ for pregnant women in other states. Third, there might be a self-selection bias. Program enrollment and program duration are dependent on individual decisions since it is a nonmandatory program. In addition, women who enroll early may have more social support. Fourth, we could not identify which aspects of the care management program affect each outcome. We estimated the average effect of these programs as currently implemented in New York State. However, the effect may be strongly influenced by larger health plans with higher enrollment and better outcomes and vary substantially across plans. A qualitative approach to understanding different plan practices is required for future research on what components of care management are most helpful. Fifth, although these four infant health outcomes are predictors of infant mortality, we were not able to directly evaluate infant mortality because of data limitations.²⁵ Last, we could not consider secular trends before implementation of the HROB Care Management program due to data limitations.

While enrollment in the Medicaid Managed Care HROB Care Management program in New York State appears to have no effects on infant health outcomes, this is likely due to the program's success in identifying individuals with high-risk pregnancies and helping to bring such pregnancies to healthy birth, which is evidenced by improved infant health outcomes as program duration increases. Similarly, care management programs may not reduce maternity and newborn expenditures in settings with substantial mortality risks, both because higher-risk patients may be more likely to enroll and because a successful program leads to higher survival rates for higher-risk newborns. This has broad-scale policy implications, as our results imply that health plans could achieve better infant health outcomes without a significant financial burden.

Most importantly, early identification of high-risk pregnant women significantly increases the positive effects of care management programs. When the number of days enrolled in the program increases, infant health outcomes improved consistently across different measures (ie, probability of LBW, VLBW, and preterm delivery, and gestational age). As discussed, it currently takes health plans 3.9 weeks to enroll women in the program after they identify the target population. In addition, the treatment group, on average, remained enrolled in the program for only 11 weeks of their total pregnancies. Therefore, in addition to providing support for the success of OB care management programs, the results of this study suggest that it is critical for state governments and managed care plans to work together to more quickly identify high-risk pregnant women and help them enroll in these programs to take advantage of their benefits.

ORCID

Young Joo Park <https://orcid.org/0000-0001-6123-3279>

REFERENCES

- Markus AR, Andres E, West KD, Garro N, Pellegrini C. Medicaid covered births, 2008 through 2010, in the context of the implementation of health reform. *Womens Health Issues*. 2013;23(5):e273-e280.
- Issel LM, Forrestal SG, Slaughter J, Wiencrot A, Handler A. A review of prenatal home-visiting effectiveness for improving birth outcomes. *J Obstet Gynecol Neonatal Nurs*. 2011;40(2):157-165.
- Kroll-Desrosiers AR, Crawford SL, Simas T, Rosen AK, Mattocks KM. Improving pregnancy outcomes through maternity care coordination: a systematic review. *Womens Health Issues*. 2016;26(1):87-99.
- Carabin H, Cowan LD, Beebe LA, Skaggs VJ, Thompson D, Agbangla C. Does participation in a nurse visitation programme reduce the frequency of adverse perinatal outcomes in first-time mothers? *Paediatr Perinat Epidemiol*. 2005;19(3):194-205.
- Silva R, Thomas M, Caetano R, Aragaki C. Preventing low birth weight in Illinois: Outcomes of the family case management program. *Matern Child Health J*. 2006;10(6):481-488.
- Slaughter JC, Issel LM. Developing a measure of prenatal case management dosage. *Matern Child Health J*. 2012;16(5):1120-1130.
- Slaughter JC, Issel LM, Handler AS, Rosenberg D, Kane DJ, Stayner LT. Measuring dosage: A key factor when assessing the relationship between prenatal case management and birth outcomes. *Matern Child Health J*. 2013;17(8):1414-1423.
- Mason M, Poole-Yaeger A, Lucas B, Krueger C, Ahmed T, Duncan I. Effects of a pregnancy management program on birth outcomes in managed Medicaid. *Manag Care (Langhorne, Pa)*. 2011;20(4):39-46.
- Alexander GR, Korenbrot CC. The role of prenatal care in preventing low birth weight. *Future Child*. 1995;5:103-120.
- Roman L, Raffo JE, Zhu Q, Meghea CI. A statewide Medicaid enhanced prenatal care program: impact on birth outcomes. *JAMA Pediatr*. 2014;168(3):220-227.
- Hillemeier MM, Domino ME, Wells R, et al. Effects of maternity care coordination on pregnancy outcomes: propensity-weighted analyses. *Matern Child Health J*. 2015;19(1):121-127.
- McCormick MC. The contribution of low birth weight to infant mortality and childhood morbidity. *N Engl J Med*. 1985;312(2):82-90.
- Branum AM, Schoendorf KC. Changing patterns of low birthweight and preterm birth in the United States, 1981-98. *Paediatr Perinat Epidemiol*. 2002;16(1):8-15.
- Eichenwald EC, Stark AR. Management and outcomes of very low birth weight. *N Engl J Med*. 2008;358(16):1700-1711.
- McDonald SD, Han Z, Mulla S, Beyene J. Overweight and obesity in mothers and risk of preterm birth and low birth weight infants: systematic review and meta-analyses. *BMJ*. 2010;341:c3428.
- Murphy CC, Schei B, Myhr TL, Mont JD. Abuse: A risk factor for low birth weight? A systematic review and meta-analysis. *Can Med Assoc J*. 2001;164(11):1567-1572.
- Whincup PH, Kaye SJ, Owen CG, et al. Birth weight and risk of type 2 diabetes: a systematic review. *JAMA*. 2008;300(24):2886-2897.
- World Health Organization. *International Statistical Classification of Diseases and Related Health Problems*. Geneva, Switzerland: World Health Organization; 2010:2.
- World Health Organization. *Fact Sheets: Preterm Birth*. Geneva, Switzerland: World Health Organization; 2018.
- Schwalberg R, Mathis SA, Giffen M, Mohamadi L, Zimmerman B, Sines E. *Medicaid Coverage of Perinatal Services: Results of a National Survey*. California: Kaiser Family Foundation; 2013.
- National Institutes of Health. *What Are the Factors that Put a Pregnancy at Risk?*. Maryland: 2017.
- Heckman JJ. Sample selection bias as a specification error. *Econometrica*. 1979;47(1):153-161.
- Glynn AN, Quinn KM. An introduction to the augmented inverse propensity weighted estimator. *Polit Anal*. 2010;18(1):36-56.
- Guo S, Fraser MW. *Propensity Score Analysis: Statistical Methods and Applications*, Vol. 11: California: Sage Publications; 2014.
- U.S. Department of Health and Human Services. *Child Health USA 2011*. 2011. Maryland: U.S. Department of Health and Human Services.

SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

How to cite this article: Park YJ, Weinberg S, Cogan LW. The impact of the Medicaid high-risk ob care management program in New York State. *Health Serv Res*. 2020;55:71-81. <https://doi.org/10.1111/1475-6773.13236>