THE ROLE OF POLICY IN PROMOTING WOMEN'S HEALTH DURING PREGNANCY AND POSTPARTUM

by
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ABSTRACT

This dissertation research, presented in three manuscripts, uses a variety of quantitative methods to inform the role that policy can play to promote healthy behaviors to improve women's health during and after pregnancy.

The first manuscript assessed whether states' adoption of an optional Medicaid enrollment policy known as the "Unborn Child" (UC) option was associated with an increase in prenatal insurance coverage or the receipt of adequate prenatal care. Adoption of the policy was associated with a 12 percentage-point increase in Medicaid enrollment during pregnancy, but was not significantly associated with an increased receipt of adequate prenatal care.

The second manuscript took advantage of a natural experiment based on state variation in the timing of adoption of optional Medicaid enrollment policies to study the policies' effects on prenatal cigarette smoking cessation and adverse birth outcomes. Presumptive eligibility, an optional enrollment policy that permits states to presume a pregnant woman to be eligible while her application is pending, led to a 7.7 percentage-point increase in prenatal smoking cessation. However, optional enrollment policies did not significantly affect adverse birth outcomes.

The third manuscript employed propensity score matching methods to estimate the effect of breastfeeding on maternal weight loss in the 12 months postpartum. Exclusive

breastfeeding for at least 3 months resulted in an increased weight loss of 3.2 pounds at 12 months postpartum; and led to a 6 percentage-point increase in the probability of returning to pre-pregnancy weight or body mass index category.

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PREFACE

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INTRODUCTION

The United States falls far short of other wealthy nations on key health women's health indicators such as maternal mortality, infant mortality, and preterm birth.[1] National policy objectives to improve women's health during pregnancy and postpartum include increasing the proportion of women who receive adequate prenatal care, decreasing cigarette smoking during pregnancy and related adverse birth outcomes, and increasing the proportion of women who breastfeed their infant for at least three months.[2] This dissertation research, presented in three manuscripts, uses a variety of quantitative methods to inform the role of policy in promoting healthy behaviors to improve women's health during pregnancy and postpartum.

The first manuscript assessed whether states' adoption of an optional Medicaid enrollment policy known as the "Unborn Child" (UC) option was associated with an increase in prenatal insurance coverage or the receipt of adequate prenatal care. The UC option permits states to extend prenatal coverage to low-income women who would otherwise have difficulty enrolling in or would be ineligible for Medicaid. Adoption of the policy was associated with a 12 percentage-point increase in Medicaid enrollment during pregnancy, but was not significantly associated with an increased receipt of adequate prenatal care. These findings suggest that additional policy efforts are needed to promote high-quality prenatal care among low-income women.

The second manuscript took advantage of a natural experiment based on state variation in the timing of adoption of optional Medicaid enrollment policies to study the policies' effects on prenatal cigarette smoking cessation and adverse birth outcomes. Presumptive eligibility, an optional enrollment policy that permits states to presume a pregnant woman to be eligible while her application is pending, led to a 7.7 percentage-point increase in prenatal smoking cessation. However, optional enrollment policies did not significantly affect adverse birth outcomes. Results suggest that policies to promote enrollment early in pregnancy can meaningfully increase smoking cessation, but additional interventions are needed to decrease smoking-related adverse birth outcomes.[3]

The third manuscript employed propensity score matching methods to estimate the effects of breastfeeding on maternal weight loss in the 12 months postpartum. Exclusive breastfeeding for at least 3 months resulted in an increased weight loss of 3.2 pounds at 12 months postpartum; and led to a 6 percentage-point increase in the probability of returning to pre-pregnancy weight or body mass index category. Although statistically significant, these effects are below the threshold typically used to gauge clinically significant weight loss. Because retention of pregnancy-related weight is an important contributor to long-term obesity in women, additional interventions and policy efforts are needed to promote postpartum weight loss.

Taken together, this research provides evidence that policy efforts that aim to improve health during pregnancy and postpartum have been effective in increasing some healthy behaviors, including enrollment in health insurance during prenatal care and smoking cessation. Future research is needed to evaluate the effects of expanded coverage under the Affordable Care Act on women's health, but ultimately, to develop strategies to promote social changes that create an environment favorable to healthy pregnancy and postpartum outcomes.[3]

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Insurance coverage and prenatal care among low-income pregnant women: An assessment of states' adoption of the 'Unborn Child' option in Medicaid and CHIP

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ABSTRACT

Background:

The “Unborn Child” (UC) option provides state Medicaid/CHIP programs with a new strategy to extend prenatal coverage to low-income women who would otherwise have difficulty enrolling in or would be ineligible for Medicaid.

Objectives:

To examine the association of the UC option with the probability of enrollment in Medicaid/CHIP during pregnancy and probability of receiving adequate prenatal care.

Research Design:

We use pooled cross-sectional data from the Pregnancy Risk Assessment Monitoring System from 32 states between 2004-2010 (n=81,983). Multivariable regression is employed to examine the association of the UC option with Medicaid/CHIP enrollment during pregnancy among eligible women who were uninsured preconception (n=45,082) and those who had insurance (but not Medicaid) preconception (n=36,901). Multivariable regression is also employed to assess the association between the UC option and receipt of adequate prenatal care, measured by the Adequacy of Prenatal Care Utilization Index.

Results:

Residing in a state with the UC option is associated with a greater probability of Medicaid enrollment during pregnancy relative to residing in a state without the policy

both among women uninsured preconception (88% vs. 77%, p<0.01) and among women insured (but not in Medicaid) preconception (40% vs. 31%, p<0.01). Residing in a state with the UC option is not significantly associated with receiving adequate prenatal care, among both women with and without insurance preconception.

Conclusions:

The UC option provides states a key way to expand or simplify prenatal insurance coverage, but further policy efforts are needed to ensure that coverage improves access to high-quality prenatal care.

INTRODUCTION

After widespread income eligibility expansions in the 1980s and 1990s,[1] state Medicaid programs have become a prominent payer for pregnancy-related care, covering 27% to 70% of births, depending on the state.[2] Medicaid eligibility thresholds for pregnant women are notably higher than those for other adults – nationally, the median eligibility threshold for pregnant women is 185% of the federal poverty level, compared to a median of 61% of the federal poverty level for parents.[3] Prior research has shown Medicaid eligibility expansions increased insurance coverage during pregnancy[4] and early receipt of prenatal care,[5,6] although results have been mixed with respect to effects on birth outcomes.[7-9]

In 2002, federal regulation authorized a new strategy for state Medicaid programs to extend prenatal coverage, known as the "Unborn Child" (UC) option.[10] Under the UC option, states consider a fetus to be a "targeted low-income child" and use funding from the Children's Health Insurance Program (CHIP) to provide coverage of prenatal care and delivery to low-income pregnant women even if they cannot provide documentation of citizenship or residency required for Medicaid's pregnancy eligibility category.[11] CHIP, authorized by federal law in 1997, is a public insurance program intended to provide coverage to children in families who earn too much to qualify for Medicaid but do not have access to private insurance.[12] States have the option to administer CHIP programs separately from Medicaid programs (e.g., contracting with a private health plan to run CHIP), or to administer CHIP as part of their existing Medicaid programs. Roughly threefourths of states administer CHIP separately from Medicaid. By considering the fetus, rather than the pregnant women, to be covered, the UC option allows states to expand coverage to women who are immigrants in the U.S. for less than five years, or undocumented immigrants; and to simplify enrollment for low-income women who have difficulty obtaining the needed documents to prove residence or citizenship. Critics of the policy have expressed concern that the regulation was an attempt to provide fetuses with formal legal rights in an attempt to undermine the legality of abortion.[13] Critics also noted that under the policy, coverage essentially ends for women after birth and recommended postpartum services are not covered.[14]

However, even after substantial expansions of insurance, certain vulnerable groups, such as immigrants, younger women, and those with fluctuating household incomes, may continue to face barriers to accessing coverage.[15-17] Although the UC option is a potentially important way to provide insurance coverage and quality prenatal care to women in these vulnerable groups,[18] no published research has examined how states' adoption of the UC option may be associated with an increased probability of Medicaid/CHIP enrollment during pregnancy, or with the receipt of adequate prenatal care.

The objectives of this study are to examine the association of residence in a state with the UC option and Medicaid/CHIP enrollment during pregnancy and receipt of adequate prenatal care, among women who were eligible for Medicaid coverage. We hypothesize that women residing in states with the policy would have an increased probability of

Medicaid/CHIP enrollment during pregnancy and an increased probability of receiving adequate prenatal care. We also hypothesize that the UC option would have a stronger association with enrollment and with receipt of adequate prenatal care among women who were uninsured preconception relative to women who were insured (but not in Medicaid) preconception. Women who had insurance coverage preconception might not be motivated to seek Medicaid/CHIP coverage even if they are eligible, and might be more likely to receive adequate prenatal care if they do not interrupt ongoing prenatal care by switching health insurance.[19]

METHODS

Data Sources

The Pregnancy Risk Assessment Monitoring System (PRAMS) is a state-specific, population-based survey that collects data about maternal health, behaviors, insurance, and health care before, during, and shortly after pregnancy.[20] PRAMS is administered by participating states in cooperation with the Centers for Disease Control and Prevention.[20] Women are mailed a questionnaire two to four months after delivery, and those who do not respond to the mailed questionnaire after two follow-up mailings are contacted by telephone. Respondents' answers to survey items are linked to birth certificate data items. Data collection is standardized to accommodate multi-state analyses. PRAMS data are available only for states that achieved a response rate of 70% of greater for 2006 and earlier, and a response rate of 65% or greater from 2007 onward. We include 32 of 35 states that had a sufficient response rate to have data available for at least two years between 2004-2010. The sample includes states from all four Census regions, includes two populous states (New York and New Jersey) in which immigrants represent more than 20% of the population, and includes several other states in which immigrants represent more than 12% of the population.[21] Examining characteristics of residents of the states included in our sample compared to the United States as a whole using data from the Census Bureau's Current Population Survey, we observe no large or statistically significant differences (see Appendix A, Table A1).

Table 1.1 shows the year in which each state adopted the UC option, mean Medicaid income eligibility thresholds for pregnant women by state over the study time period, changes in Medicaid income eligibility thresholds for pregnant women between 2004-2010, and whether each state administered a CHIP program separately from Medicaid. Between 2004-2010, 19 states never had the UC option, six states always had the UC option, and seven states adopted the UC option. From 2004-2010, we compare Medicaid/CHIP enrollment during pregnancy and receipt of adequate prenatal care in states that never had the UC option in place, always had the UC option, and pre- and post-UC option in states that adopted the policy during our study time period. In the unadjusted proportions of enrollment and receipt of adequate prenatal care, we observe few differences by states' policy status (see Appendix A, Table A2).

State Medicaid policy variables for each year of the study come from published annual surveys of state Medicaid eligibility and enrollment procedures.[22] To identify state Medicaid policies in place at the time each respondents' pregnancy began,[23] we first calculate the year each respondent's pregnancy began based on the gestational age of the infant at birth. Then, we merge Medicaid policy variables with PRAMS data based on each respondent's state of residence and year her pregnancy began.

Medicaid eligibility is defined for each respondent in her state of residence and year her pregnancy began based on household income as a percentage of the federal poverty level. Starting in 2004, the PRAMS asked about household income during the previous 12 months, and the number of individuals in the household who depended on that income. Income data were measured in categories in increments of $5,000, ranging from less than $10,000 per year to $50,000 or more per year (10 states included categories of income greater than $50,000 per year). To estimate household income, we take the midpoint of each income category and count it as the household income amount.[24] This income value is compared to the annual federal poverty guidelines[25] by household size to convert dollar income to income as a percentage of the federal poverty level. Since PRAMS does not ask about immigration status, we were not able to include this measure as a condition of eligibility for Medicaid.

Sample Selection

This study includes women aged 19-44 in 32 states who were eligible for Medicaid coverage during pregnancy in their state in the year their pregnancy began, based on income and household size. Because we aim to assess the impact of an optional state policy to promote enrollment in Medicaid/CHIP during pregnancy, women who were covered by Medicaid preconception are excluded.

Main Measures

The first outcome is a binary measure of enrollment in Medicaid/CHIP during pregnancy, based on self-reported insurance coverage for prenatal care. The second outcome is receipt of adequate prenatal care, based on the Adequacy of Prenatal Care Utilization Index (APNCU), which measures both initiation of prenatal care and adequacy of received services after prenatal care begins.[26] The APNCU Index includes four values for prenatal care receipt: inadequate, intermediate, adequate, and adequate plus. Following the *Healthy People 2020* policy objective,[27] we dichotomize this measure into adequate (including "adequate" or "adequate plus") vs. not adequate prenatal care (including "intermediate" or "inadequate"). The independent variable of interest is a binary variable indicating whether or not a state had the UC option in each year.

Data Analysis

We use descriptive statistics to calculate sample characteristics, overall and by preconception insurance status. T-tests are employed to test whether the characteristics of Medicaid-eligible women differed by preconception insurance status.

To examine the association between residence in a state with the UC option and the two outcomes (Medicaid/CHIP enrollment during pregnancy and receipt of adequate prenatal care), we conduct multivariable logistic regression, controlling for covariates. Regression analyses are used to examine this relationship the full sample and on two subgroups of interest: women who were uninsured prior to pregnancy, and women who were insured prior to pregnancy, but not in Medicaid.

To better interpret the magnitude of the relationship between residence in a state with the UC option and the outcomes, from the log odds of multivariable logistic regression models, we present predicted probabilities of Medicaid/CHIP enrollment during pregnancy and receipt of adequate prenatal care, by residence in states with or without the UC option. Predicted probabilities are calculated in the full sample, among those uninsured preconception, and among those insured preconception.

Individual-level control variables in the regression analyses include preconception health characteristics (smoking, binge drinking, and obesity), maternal age, parity, educational attainment, household income, race and ethnicity, marital status, pregnancy intention, WIC participation, and mode of survey participation (telephone or mail). Other control variables include state Medicaid income eligibility levels, proportion of Medicaid beneficiaries in a managed-care plan, and state and year indicator variables.[28,29] The state indicator variables allow us to control for unobserved, time-invariant state characteristics such as the political orientation of a state's residents; while the year indicator variables allow us to control for national time trends. All analyses employ survey weights, and standard errors are clustered to account for correlation within each state and year.

RESULTS

A total of 110,181 respondents in 32 states are estimated to be Medicaid-eligible during pregnancy. After excluding the 28,198 women who reported having Medicaid coverage preconception, the final analytic sample includes 81,983 women.

Table 1.2 presents weighted characteristics of Medicaid-eligible women who did not have Medicaid coverage preconception in 32 states, overall and stratified by preconception insurance status. In the full sample, 56% of women were uninsured preconception. Women who were uninsured preconception had lower mean household incomes (113% of federal poverty vs. 165% of federal poverty, $p<0.001$) and had lower educational attainment relative to women who were insured preconception. Women who were uninsured preconception were younger (26 vs. 28, $p<0.001$), less likely to be married (41% vs. 61%, $p<0.001$), had a greater preconception smoking prevalence (35% vs. 25%, $p<0.001$), and were more likely to report that their pregnancy was mistimed (55% vs. 50%, $p<0.001$) relative to women who were insured preconception.

Association between the UC Option and Medicaid/CHIP enrollment

Table 1.3 shows results from the multivariable logistic regression analysis examining the association of the UC option with the odds of enrollment in Medicaid/CHIP during pregnancy among Medicaid-eligible women, overall and stratified by preconception insurance status. In the full sample, we observe a significant association between residing in a state with the UC option and increased odds of enrollment (OR: 1.87; 95% CI: 1.60-2.19). Similar relationships between the UC option and enrollment are observed among women who were uninsured preconception (OR: 2.57; 95% CI: 1.99-3.31) and those who were insured preconception (OR: 1.65; 95% CI: 1.31-2.07).

We observe meaningful differences in the predicted probability of Medicaid/CHIP enrollment among women residing in states with the UC option relative to women residing in states without the policy (Figure 1.1). In the full sample, women residing in states with the UC option have a significantly greater probability of enrolling in Medicaid/CHIP during pregnancy compared to women residing in states without the UC option (69% vs. 57%, $p<0.05$). Among women who were uninsured preconception, those residing in states with the UC option had a greater probability of enrollment compared to women residing in states without the policy (89% vs. 80%, $p<0.05$). Among those who were insured preconception, the probability of switching into Medicaid/CHIP coverage during pregnancy is greater among those women residing in states with the UC option compared to women in states without the policy (41% vs. 31%, $p<0.05$).

Association between the UC Option and receipt of adequate prenatal care using the APNCU

Table 1.4 shows results from the multivariable logistic regression analysis examining the association of the UC option with the odds of receipt of adequate prenatal care among Medicaid-eligible women, overall and stratified by preconception insurance status. No significant association is observed between residence in a state with the UC option and receipt of adequate prenatal care in the full sample (OR: 0.92, 95% CI: 0.76-1.11); or among women who were uninsured preconception (OR: 0.83, 95% CI: 0.64-1.10) or insured preconception (OR: 1.11, 95% CIL 0.91-1.35). Likewise, Figure 1.1 shows no significant differences in the predicted probabilities of receipt of adequate prenatal care between women residing in states with the UC option relative to those in states without the policy, either in the full sample or among women with different preconception insurance status.

DISCUSSION

The “Unborn Child” (UC) option provides states with a new way to extend prenatal coverage to low-income women who would otherwise have difficulty enrolling in or would be ineligible for Medicaid coverage during pregnancy. To our knowledge, this is the first study to provide evidence that residence in a state with the UC option is associated with a significantly greater probability of Medicaid/CHIP enrollment during pregnancy among Medicaid-eligible women. We find that the UC option is not significantly associated with an increased probability of the receipt of adequate prenatal care, however.

Contrary to our hypothesis that the UC option would have a stronger association with enrollment among women who were uninsured preconception relative to women who were insured (but not in Medicaid) preconception, we find the policy had a similar association with Medicaid/CHIP enrollment during pregnancy among women with and without insurance preconception. This finding might suggest that the UC option crowded out private insurance – i.e., that insured women were incentivized to switch into public programs that provide free care and generous benefits.[30,31] However, although the UC option provides access to free prenatal coverage, benefits may be less generous than other types of insurance because states do not provide coverage for postpartum care.[10] Prior to 2009, PRAMS asked women only whether they had Medicaid, other insurance, or no insurance prior to conception. To explore whether private insurance may have been crowded out by the UC option, however, we conduct a subgroup analysis of insured women who were asked in 2009-2010 about the type of insurance they had preconception (n=13,023). Most (89%) had private insurance or military insurance, and the remaining 11% had another type of insurance (e.g., Indian Health Service, charity care, or state program coverage). The UC option was not significantly associated with switching into Medicaid coverage during pregnancy among women with private or military coverage preconception, but was significantly associated with switching into Medicaid coverage among women with other types of health insurance preconception (full results not shown; available from the authors upon request). This subgroup analysis may suggest that the UC option did not crowd out private insurance but rather resulted in increased enrollment among women with other types of public insurance (e.g., state programs) or those who relied on charity care; however, more research is needed on this question.

We do not observe a significant association between the UC option and receipt of adequate prenatal care, among either women with or without insurance preconception. Although the UC option permits to states to expand or simplify prenatal coverage, the policy does not explicitly address access to or quality of care. Our finding suggests that efforts to promote enrollment in prenatal insurance coverage should be paired with efforts to ensure access to high-quality care.[32] Other state policy options under CHIP,[33] including an option permitting states to provide comprehensive prenatal coverage through CHIP and an option permitting states to waive the five-year residency requirement for lawfully residing immigrant pregnant women and children, might be important ways to not only expand coverage but increase receipt of adequate prenatal care. Future research is needed to evaluate the impact of these policies.

There are several limitations to this study. First, our measure of Medicaid eligibility is imperfect. PRAMS does not ask about certain Medicaid eligibility criteria, such as types of income that states might disregard (e.g., child support payments) when determining eligibility, so we are unable to take these criteria into account. We conduct a sensitivity analysis by classifying women as Medicaid-eligible if their household incomes were 10 percentage points higher than the Medicaid income eligibility thresholds (to account for possible disregarded income) in each state and year and re-running the analyses. The magnitude and significance of our results are unchanged. Second, we are unable to differentiate preconception health insurance type in the entire sample because the PRAMS did not ask about more specific categories of preconception health insurance coverage prior to 2009. Although we conduct a subgroup analysis among women with data on preconception insurance type, our ability to describe differences in Medicaid enrollment by preconception insurance type is limited. Third, our outcome, Medicaid/CHIP enrollment during pregnancy, is based on self-report, which may underestimate true enrollment.[34] This limitation is minimized by the fact that in addition to asking about Medicaid coverage, the PRAMS permits states to include state-specific Medicaid/CHIP names as a response to the survey item asking about insurance coverage, thus reducing under-reporting of Medicaid/CHIP coverage.[35] In our sample, 13 of 32 states included state-specific Medicaid/CHIP program names. Fourth, although our data are geographically diverse and representative of these 32 states, results may not be generalizable to the United States as a whole. Finally, the exploratory nature of this study means that causality cannot be inferred from our findings.

Federal reauthorization of the CHIP program, expected in 2015, provides an opportunity for policymakers to consider ways to incentivize states to maximize coverage and quality of prenatal care. This study suggests that the UC option will continue to be an important tool for states. Given that an estimated 17% of low-income, uninsured adults are undocumented or recent immigrants,[36] the UC option provides a way for states to expand prenatal coverage to immigrants who are prohibited from enrolling in Medicaid or receiving subsidies to purchase insurance in the new state insurance exchanges under the Affordable Care Act.[37] Additionally, the UC option will continue to allow states to simplify enrollment for low-income women who face barriers to navigating the Medicaid enrollment process.[15,38] Additional efforts are needed, however, to ensure that prenatal insurance coverage improves access to high-quality care.

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Table 1.1. Characteristics of Medicaid/CHIP programs in 32 states included in the study sample, 2004-2010

State	Year 'Unborn Child' Option adopted	Mean Medicaid income eligibility (% FPL)	Change in Medicaid income eligibility (% FPL)	CHIP program separate from Medicaid
Alaska	N/A	175	0	No
Arkansas	2004	200	0	No
Colorado	N/A	200	65	Yes
Delaware	N/A	200	0	Yes
Georgia	N/A	200	0	Yes
Hawaii	N/A	185	0	No
Illinois	2003	200	0	Yes
Maine	N/A	200	0	Yes
Maryland	N/A	250	0	No
Massachusetts	2005	200	0	Yes
Michigan	2003	185	0	Yes
Minnesota	2003	275	0	No
Mississippi	N/A	185	0	Yes
Missouri	N/A	185	0	Yes
Nebraska	2005	185	0	No
New Jersey	N/A	200	0	Yes
New York	N/A	200	0	Yes
North Carolina	N/A	193	0	Yes
Ohio	N/A	168	50	No
Oklahoma	2008	185	0	No
Oregon	2008	185	0	Yes
Pennsylvania	N/A	185	0	Yes
Rhode Island	2003	250	0	No
South Carolina	N/A	185	0	Yes
Tennessee	2007	207	65	Yes
Texas	2006	185	0	Yes
Utah	N/A	133	0	Yes
Vermont	N/A	200	0	Yes
Washington	2003	185	0	Yes
West Virginia	N/A	150	0	Yes
Wisconsin	2005	241	115	No
Wyoming	N/A	133	0	Yes

Notes: N/A means that the state had not adopted the "Unborn Child" option as of 2010. Mean Medicaid income eligibility guidelines and changes in eligibility guidelines from 2004-2010 are shown as a percentage of the Federal Poverty Level (FPL). Information about whether the state had a CHIP program that was separate from Medicaid shown as of 2010.

Table 1.2. Weighted descriptive characteristics of Medicaid-eligible women in 32 states who were not enrolled in Medicaid prior to pregnancy, 2004-2010, mean or % (95% CIs), overall and stratified by preconception insurance status

	Full Sample	Uninsured preconception[a]	Insured preconception[a]	p-value[a]
N	81,893	45,082	36,901	--
Weighted N	3,724,671	2,070,517	1,654,154	--
Demographics				
Mean maternal age	26.9 (26.8-27.1)	26.1 (25.9-26.2)	28.0 (27.8-28.2)	<0.001
Race and ethnicity				
White	54.6 (50.5-58.6)	50.0 (45.6-54.3)	60.3 (56.6-64.0)	<0.001
Black	17.0 (14.9-19.0)	16.0 (13.9-17.9)	18.3 (16.0-20.5)	<0.01
Asian	2.9 (2.4-3.4)	2.6 (2.0-3.1)	3.3 (2.8-3.8)	0.01
Am. Ind./AK or HI Native	1.5 (1.0-2.1)	1.6 (1.0-2.1)	1.5 (1.0-2.0)	0.75
Other/Multiple races	2.3 (1.9-2.7)	2.1 (1.6-2.5)	2.5 (2.1-3.0)	0.01
Hispanic	21.8 (17.2-26.4)	27.9 (22.5-33.4)	14.1 (10.8-17.4)	<0.001
Married	49.9 (48.5-51.4)	41.2 (39.6-42.9)	60.8 (58.7-62.9)	<0.001
Mean income (% FPL)	135.7 (131.6-139.9)	112.5 (109.7-115.4)	164.6 (160.2-169.2)	<0.001
Maternal education				
Some college or more	43.2 (41.6-44.8)	31.9 (30.8-33.0)	57.4 (55.8-59.0)	<0.001
High school diploma	38.3 (37.3-39.3)	42.1 (41.1-43.1)	33.5 (32.1-34.9)	<0.001
Less than high school	18.5 (17.2-19.8)	26.0 (24.8-27.3)	9.1 (8.0-10.2)	<0.001
At least one previous birth	59.4 (58.2-60.8)	57.2 (55.3-59.1)	62.3 (60.8-63.8)	<0.001
Preconception health characteristics				
Smoking[b]	30.4 (28.8-31.9)	34.8 (32.7-37.0)	24.8 (23.5-26.0)	<0.001
Binge drinking[c]	22.0 (20.9-23.1)	22.3 (21.0-23.6)	21.6 (20.4-22.8)	0.21
Obesity[d]	28.1 (27.2-29.0)	27.4 (26.2-28.6)	29.0 (27.9-30.0)	0.02
Pregnancy intention				
Wanted pregnancy then	34.8 (33.9-35.6)	32.1 (31.2-33.0)	38.1 (36.8-39.4)	<0.001
Mistimed[e]	52.7 (52.0-53.4)	55.0 (54.1-55.8)	49.9 (48.9-51.0)	<0.001
Did not want pregnancy	12.5 (12.0-13.0)	12.9 (12.3-13.6)	11.9 (11.3-12.6)	0.02
Insurance and prenatal care				
Insurance preconception				
Uninsured	55.6 (53.3-57.8)	100.0	0.0	--
Insured (not Medicaid)	44.4 (42.2-46.7)	0.0	100.0	--
Insurance in pregnancy				
Medicaid	61.0 (59.0-63.0)	82.0 (80.3-83.8)	34.8 (32.4-37.1)	<0.001
Not Medicaid	38.9 (36.9-40.9)	17.9 (16.2-19.7)	65.2 (62.9-67.5)	<0.001
Adequate prenatal care[f]	70.8 (69.3-72.3)	66.5 (64.8-68.0)	76.3 (74.8-77.8)	<0.001

a Differences between uninsured and insured women were conducted with T-tests using survey weights, clustering on state and year.
b Smoking defined as smoking any amount of cigarettes in the 3 months prior to pregnancy.
c Binge drinking defined as consuming 4 or more drinks at one sitting on at least one occasion in the 3 months prior to pregnancy.
d Obesity defined as having a body mass index≥30 kg/m^2 based on self-reported preconception height and weight.
e Mistimed pregnancy indicates a pregnancy was wanted sooner or later than it occurred.
f Adequate prenatal care defined using the Adequacy of Prenatal Care Utilization Index.

Note: Medicaid eligibility was defined within each state and year, based on self-reported income for the previous 12 months and household size.

Table 1.3. Predictors of enrollment in Medicaid/CHIP during pregnancy among eligible women in 32 states who were not enrolled in Medicaid prior to pregnancy, overall and stratified by preconception insurance status

	Full sample (n=81,983)	Uninsured preconception (n=45,082)	Insured preconception (n=36,901)
	Odds Ratio (95%CI)	Odds Ratio (95%CI)	Odds Ratio (95%CI)
Medicaid policy			
No "Unborn child" option	Ref	Ref	Ref
"Unborn child" option	1.77 (1.52-2.08)**	2.37 (1.84-3.07)**	1.63 (1.35-1.98)**
Health characteristics			
Non-smoker preconception	Ref	Ref	Ref
Smoker preconception[a]	1.52 (1.41-1.63)**	1.56 (1.36-1.80)**	1.21 (1.11-1.33)**
No binge drinking preconception	Ref	Ref	Ref
Binge drinking preconception[b]	1.19 (1.11-1.28)**	1.40 (1.23-1.59)**	1.12 (1.01-1.25)*
Not obese preconception	Ref	Ref	Ref
Obese preconception[c]	1.06 (1.00-1.13)	1.25 (1.09-1.46)**	1.07 (0.97-1.18)
Demographic characteristics			
Maternal age	0.92 (0.95-0.97)**	0.96 (0.95-0.97)**	0.97 (0.96-0.98)**
First birth	Ref	Ref	Ref
At least one previous birth	0.92 (0.84-1.00)	1.19 (1.06-1.34)**	0.87 (0.78-0.96)**
Maternal education			
Some college or more	Ref	Ref	Ref
High school	1.16 (1.09-1.12)**	0.77 (0.66-0.91)**	1.03 (0.93-1.14)
Less than high school	1.01 (0.90-1.15)	0.46 (0.38-0.56)**	1.08 (0.90-1.29)
Household income			
≥200% FPL	Ref	Ref	Ref
100-199% FPL	1.19 (1.06-1.33)**	0.71 (0.56-0.88)**	0.99 (0.87-1.14)
<100% FPL	2.09 (1.84-2.37)**	0.71 (0.57-0.90)**	1.50 (1.27-1.76)**
Race and ethnicity			
White	Ref	Ref	Ref
Black	0.90 (0.79-1.02)	0.91 (0.76-1.08)	0.93 (0.79-1.09)
Asian	0.78 (0.63-0.95)	0.42 (0.33-0.55)**	0.70 (0.52-0.94)*
Am. Indian/AK or HI Native	0.87 (0.72-1.05)	0.43 (0.30-0.62)**	1.29 (1.05-1.58)*
Other/multiple races	0.83 (0.72-0.97)*	0.60 (0.47-0.77)**	0.73 (0.58-0.92)**
Hispanic	0.69 (0.57-0.82)**	0.32 (0.25-0.40)**	0.88 (0.75-1.02)
Unmarried	Ref	Ref	Ref
Married	0.56 (0.52-0.61)**	0.67 (0.60-0.74)**	0.57 (0.50-0.64)**
Pregnancy intention			
Wanted pregnancy then	Ref	Ref	Ref
Mistimed[d]	1.14 (1.06-1.22)**	1.00 (0.89-1.12)	1.16 (1.04-1.28)**
Did not want pregnancy	1.15 (1.05-1.27)**	1.06 (0.89-1.27)	1.15 (0.99-1.35)
No WIC during pregnancy	Ref	Ref	Ref
WIC during pregnancy	2.29 (2.10-2.49)**	2.43 (2.17-2.71)**	2.50 (2.20-2.83)**

* p<0.05
** p<0.01

a Smoking defined as smoking any amount of cigarettes in the 3 months prior to pregnancy.
b Binge drinking defined as consuming 4 or more drinks at one sitting on at least one occasion in the 3 months prior to pregnancy.
c Obesity defined as having a body mass index≥30 kg/m^2 based on self-reported preconception height and weight.
d Mistimed pregnancy indicates a pregnancy was wanted sooner or later than it occurred.

Notes: Medicaid eligibility was defined within each state and year, based on self-reported income for the previous 12 months and household size. Variables measuring states' Medicaid income eligibility during pregnancy, a variable indicating mode of participation (telephone vs. mail), and indicator variables for state and year were included in all analyses but are not shown.

Table 1.4. Predictors of receipt of adequate prenatal care among Medicaid-eligible women in 32 states who were not enrolled in Medicaid prior to pregnancy, overall and stratified by preconception insurance status

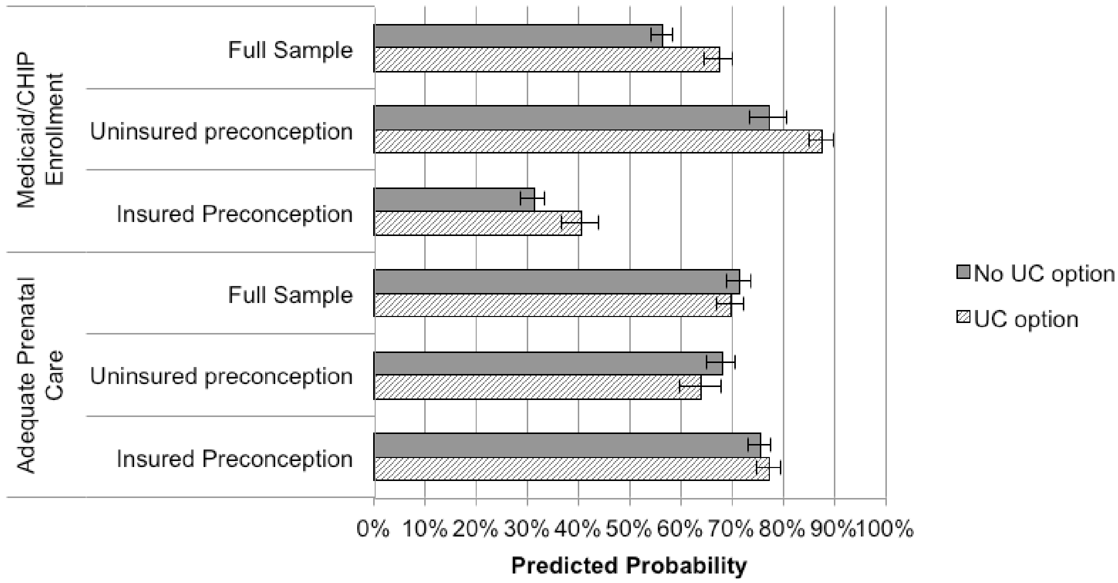
	Full sample (n=81,893)	Uninsured preconception (n=45,082)	Insured preconception (n=36,901)
	Odds Ratio (95%CI)	Odds Ratio (95%CI)	Odds Ratio (95%CI)
Medicaid policy			
No "Unborn child" option	Ref	Ref	Ref
"Unborn child" option	0.92 (0.76-1.11)	0.83 (0.63-1.10)	1.11 (0.91-1.35)
Health characteristics			
Non-smoker preconception	Ref	Ref	Ref
Smoker preconception[a]	0.94 (0.87-1.02)	0.98 (0.90-1.06)	0.95 (0.86-1.05)
No binge drinking preconception	Ref	Ref	Ref
Binge drinking preconception[b]	1.09 (1.02-1.17)*	1.11 (1.00-1.22)	1.07 (0.95-1.20)
Not obese preconception	Ref	Ref	Ref
Obese preconception[c]	1.15 (1.09-1.22)**	1.17 (1.08-1.25)**	1.12 (1.01-1.23)*
Demographic characteristics			
Maternal age	1.02 (1.01-1.02)**	1.01 (1.01-1.02)**	1.02 (1.01-1.02)**
First birth	Ref	Ref	Ref
At least one previous birth	0.86 (0.81-0.93)**	0.82 (0.74-0.90)**	0.94 (0.85-1.04)
Maternal education			
Some college or more	Ref	Ref	Ref
High school	0.91 (0.86-0.96)**	0.94 (0.87-1.02)	0.95 (0.88-1.02)
Less than high school	0.69 (0.63-0.75)**	0.73 (0.66-0.81)**	0.73 (0.63-0.85)**
Household income			
200% or more	Ref	Ref	Ref
100-199%	0.85 (0.78-0.92)**	0.80 (0.70-0.92)**	0.91 (0.80-1.02)
<100%	0.66 (0.60-0.72)**	0.65 (0.58-0.74)**	0.78 (0.68-0.88)**
Race and ethnicity			
White	Ref	Ref	Ref
Black	0.73 (0.67-0.80)**	0.71 (0.63-0.80)**	0.75 (0.66-0.85)**
Asian	0.82 (0.72-0.93)**	0.91 (0.77-1.08)	0.77 (0.64-0.93)**
Am. Indian/AK or HI Native	0.86 (0.74-1.00)	0.79 (0.64-0.97) *	0.96 (0.78-1.18)
Other/multiple races	0.70 (0.58-0.84)**	0.65 (0.48-0.87)**	0.80 (0.62-1.03)
Hispanic	0.90 (0.81-0.99)*	0.93 (0.82-1.05)	0.94 (0.82-1.07)
Unmarried	Ref	Ref	Ref
Married	1.14 (1.06-1.22)**	1.10 (1.00-1.20)	1.11 (1.01-1.24) *
Pregnancy intention			
Wanted pregnancy then	Ref	Ref	Ref
Mistimed[d]	0.85 (0.79-0.91)**	0.82 (0.76-0.89)**	0.91 (0.81-0.99)*
Did not want pregnancy	0.70 (0.64-0.75)**	0.65 (0.59-0.74)**	0.78 (0.68-0.89)**
No WIC during pregnancy	Ref	Ref	Ref
WIC during pregnancy	1.26 (1.18-1.35)**	1.47 (1.32-1.63)**	1.11 (1.01-1.23)*

* p<0.05
** p<0.01

a Smoking defined as smoking any amount of cigarettes in the 3 months prior to pregnancy.
b Binge drinking defined as consuming 4 or more drinks at one sitting on at least one occasion in the 3 months prior to pregnancy.
c Obesity defined as having a body mass index≥30 kg/m^2 based on self-reported preconception height and weight.
d Mistimed pregnancy indicates a pregnancy was wanted sooner or later than it occurred.

Notes: Receipt of adequate prenatal care was defined using the Adequacy of Prenatal Care Use Index. Medicaid eligibility was defined within each state and year, based on self-reported income for the previous 12 months and household size. Variables measuring states' Medicaid income eligibility during pregnancy, a variable indicating mode of participation (telephone vs. mail), and indicator variables for state and year were included in all analyses but are not shown.

Figure 1.1. Predicted probabilities of Medicaid/CHIP enrollment and receipt of adequate prenatal care during pregnancy among eligible women in 32 states, by residence in states with and without the 'Unborn Child' option



Notes: Medicaid eligibility was defined within each state and year, based on self-reported income for the previous 12 months and household size. Receipt of adequate prenatal care measured using the Adequacy of Prenatal Care Utilization index. Predicted probabilities are calculated from multivariable regression models shown in Tables 3 (enrollment) and 4 (adequate prenatal care). Insured preconception means that women had private or other insurance prior to pregnancy but were not enrolled in Medicaid.

APPENDIX A

Table A1. Weighted characteristics of residents of 32 states included in the study sample and United States population, 2004-2010

	32 states % (95% CI)	**US Population % (95% CI)**
Male	48.8 (48.7-48.9)	48.9 (48.8-49.0)
Age		
0-19	29.3 (28.8-29.7)	29.2 (28.9-29.6)
20-34	20.3 (20.0-20.6)	20.3 (20.0-20.5)
35-44	14.3 (14.2-14.5)	14.6 (14.4-14.8)
45-54	14.4 (14.2-14.6)	14.3 (14.2-14.5)
55-64	10.2 (10.0-10.5)	10.2 (10.0-10.4)
65+	11.1 (10.8-11.5)	11.3 (11.0-11.7)
Race		
White	78.9 (77.6-80.1)	79.1 (78.2-80.0)
Black	14.2 (13.0-15.4)	13.3 (12.2-14.3)
Asian	4.0 (3.5-4.4)	4.6 (3.8-5.4)
Am. Ind./AK or HI Native	1.0 (1.0-1.1)	1.1 (1.0-1.3)
Other/multiple races	2.0 (1.7-2.2)	1.9 (1.7-2.0)
Hispanic ethnicity	12.4 (9.7-15.2)	15.5 (12.9-18.1)
Educational attainment[a]		
Less than high school	15.2 (14.7-15.8)	15.7 (15.2-16.1)
High school diploma	23.7 (23.1-24.3)	23.0 (22.4-23.7)
Some college/College degree	32.7 (32.3-33.3)	33.0 (32.9-33.5)
Advanced degree	6.5 (6.2-6.8)	6.4 (6.2-6.6)
U.S. Citizen	93.7 (93.0-94.4)	92.6 (91.6-93.5)
Residents in a Metropolitan Statistical Area	82.1 (80.5-83.8)	83.3 (81.4-85.2)

a Educational attainment calculated only among adults.

Notes: From the Current Population Survey's Annual Social and Economic Supplement, 2004-2010. Robust standard errors are clustered to account for correlation within each state and year.

Table A2. Unadjusted weighted proportions of Medicaid-eligible women in 32 states who enrolled in Medicaid/CHIP during pregnancy or received adequate prenatal care, by state status of the 'Unborn Child' (UC) option, 2004-2010

	Medicaid/CHIP enrollment			Received adequate prenatal care[a]		
	Full sample	Uninsured preconception	Insured preconception[b]	Full sample	Uninsured preconception	Insured preconception[b]
State policy						
Never UC	59.2	79.6	34.4	70.3	66.5	74.9
Always UC	63.6	89.4	34.8	74.6	69.7	79.9
Pre-UC	65.1	81.8	35.5	68.9	66.1	74.1
Post-UC	61.0	78.5	36.7	69.0	63.3	76.9

a Receipt of adequate prenatal care measured using the Adequacy of Prenatal Care Utilization Index.
b Women who were insured preconception were not enrolled in Medicaid.

Notes: From the Pregnancy Risk Assessment Monitoring System, 2004-2010. Women in states that had not adopted the UC option as of 2010 are classified as "Never UC"; women in states that adopted the UC option in 2004 or earlier are classified as "Always UC." Women in states that adopted the UC option between 2004-2010 are divided into "Pre-UC" and "Post-UC."

Effects of state Medicaid enrollment policies on prenatal smoking cessation and adverse birth outcomes

Health Affairs. In press.

ABSTRACT

Prenatal cigarette smoking is an important cause of poor maternal and infant health outcomes in the Medicaid-eligible population that may be alleviated by access to timely, quality prenatal care. Using Pregnancy Risk Assessment Monitoring System data from 2004-2010, we examined the effects of state Medicaid enrollment policies on smoking cessation, preterm birth, and small for gestational age. We used a natural experiment to compare outcomes before and after state Medicaid policies' adoption. Presumptive eligibility, an optional enrollment policy that permits women to receive prenatal care while their Medicaid application is pending, led to a 7.7 percentage-point increase (95% CI: 3.7,11.6) in smoking cessation, but did not reduce adverse birth outcomes. The "unborn child" option, which permits states to provide coverage to women who cannot document citizenship or residency, was not significantly associated with any outcomes. Since Medicaid income eligibility thresholds are likely to remain higher for pregnant women relative to other adults, presumptive eligibility will continue to be an important policy to promote timely prenatal care and smoking cessation.

INTRODUCTION

Prenatal cigarette smoking accounts for a substantial portion of poor maternal and infant health outcomes and infant deaths.[1-3] Although the prevalence of prenatal smoking in the United States has declined in recent decades,[4] low-income women enrolled in Medicaid have nearly twice the prevalence of prenatal smoking compared with the population as a whole.[5] Since the late 1990s, many state Medicaid programs began providing more generous coverage of smoking cessation services for pregnant women.[6]

However, one barrier to obtaining smoking cessation services may be navigating the process of enrolling in Medicaid.[7] The Medicaid application process is complex, requiring documentation verifying income, residency, citizenship, and pregnancy, and may involve waiting weeks for a determination of eligibility.[8] States have several policy options to reduce barriers to Medicaid enrollment during pregnancy. One such policy is known as presumptive eligibility. Under presumptive eligibility, low-income pregnant women are presumed to be Medicaid-eligible when they present for care at participating organizations, and thus can immediately receive care while their Medicaid application is pending.[9] A second policy, known as the "Unborn Child" (UC) option, allows states to consider a fetus to be a "targeted low-income child" and provide coverage of prenatal care and delivery to low-income pregnant women even if they cannot provide documentation of citizenship or residency required for Medicaid's pregnancy eligibility category.[10] These optional enrollment policies can lead to a greater probability of Medicaid enrollment and earlier initiation of prenatal care, thus enabling women to access smoking cessation services earlier in pregnancy. In turn, smoking cessation early in pregnancy has been shown to reduce adverse birth outcomes.[11-13]

No published research has examined the effects of these two optional enrollment policies on prenatal smoking cessation or smoking-related adverse birth outcomes. In the context of a new requirement under the Affordable Care Act (ACA) that all state Medicaid programs provide coverage of counseling and pharmacotherapies for smoking cessation for pregnant women,[14] it is critical to understand how these optional state Medicaid enrollment policies can best promote access to smoking cessation services and improve birth outcomes.

We address this gap in the literature by examining the effects of optional state Medicaid enrollment policies on prenatal smoking cessation, preterm birth, and having a small for gestational age infant. We hypothesized that the two optional enrollment policies (presumptive eligibility, UC option) would lead to a significant increase in the probability of smoking cessation during pregnancy, and would lead to a significant decrease in the probability of preterm birth and having a small for gestational age infant. We also hypothesized that the effects of the two optional enrollment policies (presumptive eligibility, UC option) would be greater in states with more generous coverage of services for smoking cessation during pregnancy as opposed to states with less generous coverage.

METHODS

Data Sources

The Pregnancy Risk Assessment Monitoring System (PRAMS) is a state-representative survey pertaining to maternal health, behaviors, insurance, and health care before, during, and shortly after pregnancy.[15] States mail women a questionnaire two to four months after delivery, and those who do not respond to the mailed questionnaire are contacted by telephone. Respondents' answers to survey items are linked to birth certificate data. PRAMS research data are available for states that achieved a response rate of at least 70% previous to 2007, or a response rate of at least 65% from 2007 onward. Between 2004-2010, 19 of 35 participating states had sufficient response rates in all years and are thus included in our study.

Although our study sample is not nationally representative, it is representative of women residing in these 19 states in each of these years. To assess how similar the 19 states included in the present study are to the U.S. population as a whole, we used the Census Bureau's Current Population Survey to examine key demographic and smoking-related characteristics, and data from the Kaiser Family Foundation to examine Medicaid program characteristics. As shown in Table 2.1, the 19 states included in our study are similar on demographic characteristics to the U.S. population as a whole. Among states in our sample, 17% of women reported currently smoking, the same proportion as women in the U.S. population. A similar proportion of women in our sample reported a quit attempt in the past year, relative to the U.S. as a whole (34% and 33%, respectively). Among the 19 states in our study sample, fewer (51% vs. 63%) had presumptive eligibility in place at any time from 2004-2010 relative to the U.S., and more (32% vs. 25%) had the UC option in place at any time from 2004-2010.

Data on Medicaid presumptive eligibility and UC policies by state and year were collected from published annual surveys of state Medicaid officials regarding their states' eligibility and enrollment procedures for pregnant women.[16] Data on coverage of smoking cessation benefits by state and year were collected from published surveys of state Medicaid officials regarding their states' smoking cessation benefits for pregnant women.[17-22] We also included data on whether states' had prohibited smoking in worksites, bars, and restaurants,[23] and each state's excise tax on cigarettes in each state and year.[24] To identify relevant state Medicaid and tobacco control policies, we first calculated the year each respondent's pregnancy began based on the gestational age of the infant at birth. Then, state-specific Medicaid and tobacco control policy data were merged with PRAMS data based on each respondent's state of residence and year her pregnancy began.

We defined Medicaid eligibility for each respondent in her state and year her pregnancy began based on household income as a percentage of the federal poverty level. PRAMS asked about annual household income and the number of individuals in the household who depended on that income. Income data were measured in categories; we took the midpoint of each income category and counted it as the household income amount.[25] This income value was compared to the annual federal poverty guidelines[26] to calculate income as a percentage of the federal poverty level. Respondents with missing income values (7%) were defined as eligible for Medicaid if they reported being enrolled in

Medicaid during prenatal care, or if they reported that Medicaid paid for their delivery. Examining this measure of Medicaid eligibility, we found state variation in Medicaid take-up rates that were consistent with prior literature using simulation models to estimate Medicaid eligibility and take-up.[27]

Our study included women ages 19-44 in 19 states who smoked any amount during the three months preconception, had a live single birth between 2004 and 2010, and were eligible for Medicaid coverage during pregnancy in their state in the year their pregnancy began. We excluded women who had multiples as preterm birth and small for gestational age are more common in these cases. Because we were interested in studying the effects of Medicaid enrollment policies, which might differentially enroll women with different preconception smoking-related risk factors, our sample included all Medicaid-eligible women, rather than only those women who reported being enrolled in Medicaid during pregnancy. Likewise, women who were covered by Medicaid just prior to pregnancy were excluded.

Measures

The three outcomes of interest included prenatal smoking cessation, preterm birth, and having a small for gestational age infant. Prenatal smoking cessation was a binary variable, defined as women who reported smoking any amount in the three months preconception, but reported quitting smoking by the third trimester of pregnancy. Preterm birth was a binary variable indicating whether an infant was born before 37 weeks' gestation, based on birth certificate data. The PRAMS data contain two measures of small for gestational age: an infant weighing less than the tenth percentile for weight at a given gestational age, and an infant weighing two standard deviations below the mean weight at a given gestational age. We conducted analyses using both measures and observed qualitatively similar results. Because clinical practice guidelines define small for gestational age as infants who weigh less than the tenth percentile for weight at a given gestational age,[28] we present results using that outcome measure.

The primary independent variables of interest were state Medicaid policy variables. For each year, we created indicators of whether or not a state had adopted presumptive eligibility or the UC option; and whether a state had adopted either of the two enrollment policies. Additionally, in each year we created indicators of whether a state Medicaid program provided comprehensive smoking cessation services for pregnant women, defined as coverage of pharmacotherapies (any form of nicotine replacement therapy or bupropion for smoking cessation) and counseling (individual or group for smoking cessation) for smoking cessation.[29]

Individual control variables included maternal age, race/ethnicity, education, marital status, number of cigarettes smoked per day pre-pregnancy, whether or not alcoholic drinks were consumed during pregnancy, parity, pregnancy intention, number of stressors experienced during pregnancy (e.g., involuntary unemployment or a death in the family), preconception insurance status, and previous preterm birth. State-level control variables included whether or not a state prohibited smoking in worksites, bars, and restaurants; state excise taxes on cigarettes; state Medicaid income eligibility thresholds; and whether a state had a high, medium, or low proportion of Medicaid beneficiaries enrolled in a managed care organization. Models also included indicator variables for state and year. State indicator variables allowed us to control for time-invariant state characteristics, while year indicator variables allowed us to control for national-level secular trends.

Data Analysis

To estimate the effects of state Medicaid policies on prenatal smoking cessation, preterm birth, and having a small for gestational age infant, we took advantage of a natural experiment based on state variation in the timing of adoption of optional Medicaid policies. Under this approach, regression models are run using pooled cross-sectional data and including the policy variables of interest, individual control variables, state control variables, and state and year indicators. This allows us to compare outcomes before and after the policies' adoption. States without the policies serve as the comparison group in order to control for secular trends in outcomes. This type of analysis can be conceptualized as a comparative interrupted time-series model with the policy intervention being implemented at different times.[30]

First, to examine the effects of Medicaid policies on the three outcomes, we employed multivariable logistic regression to estimate the effects of each of the state Medicaid enrollment policies on the odds of prenatal smoking cessation, preterm birth, and having a small for gestational age infant, comparing the rates before and after the implementation of the policies and accounting for secular trends. Next, to examine whether the enrollment policies' effects differed by states' generosity of coverage of smoking cessation services, we extended the models to include an interaction term between the state Medicaid enrollment policies (presumptive eligibility, UC option) and a variable indicating whether or not a state had comprehensive coverage of smoking cessation services. To examine the magnitude of the policies' effects on the probability of prenatal smoking cessation, preterm birth, and small for gestational age, we derived average marginal effects from the logistic regression models. Average marginal effects represent the percentage-point changes in outcomes due to the policies, and are helpful in interpreting the results of logistic regression models in a policy context.[31,32]

All models used PRAMS sampling weights, and robust standard errors were calculated to account for correlation within each state and year. This approach resulted in standard errors that were slightly larger than those obtained by clustering standard errors using the PRAMS sampling strata. Our results provide similar but somewhat more conservative estimates of the policies' effects than those using the survey sampling strata.

RESULTS

Our final analytic sample included 24,544 women in 19 states who responded to the PRAMS in 2004-2010. The majority of women (50.9%) were younger than 25, 34.6% were married; and 75.3% were white, 9.6% were black, 8.3% were Hispanic, and 6.8% were other races or ethnicities (Table 2.2). The sample had low socioeconomic status, with a mean household income of 129.9% of the federal poverty level and 66.9% of respondents having a high school education or less. Additionally, 63.9% reported being uninsured just prior to conception. The majority (55.7%) of women reported smoking 10 or fewer cigarettes per day, on average, in the three months preconception, while 33% reported smoking 11-20 cigarettes, 8% reported smoking 21-40 cigarettes, and 3.3% reported smoking 41 or more cigarettes.

The 19 states included in the study had considerable variability in terms of the number of years with Medicaid presumptive eligibility and UC option enrollment policies and coverage of smoking cessation benefits (Table 2.3). Ten states had presumptive eligibility in place at some point during the study period and seven states had the UC option in place at some point during the study time period. Seven states had comprehensive smoking cessation services coverage for the entire study time period, eight states had comprehensive coverage for some of the time period, and four states did not have comprehensive coverage until required by the ACA in October 2010.

Table 2.4 shows average marginal effects of the state Medicaid policies on prenatal smoking cessation, preterm birth, and small for gestational age. States' adoption of presumptive eligibility led to a 7.7 percentage-point increase (95% CI: 3.7 to 11.6 percentage points, $p<0.01$) in the probability of prenatal smoking cessation. Presumptive eligibility did not lead to a significant reduction in preterm birth or small for gestational age. The UC option did not significantly affect prenatal smoking cessation, preterm birth, or small for gestational age. Having either enrollment policy (presumptive eligibility or the UC option) in place was associated with a 6.8 percentage point increase (95% CI: 3.0 to 10.5 percentage points, $p<0.01$) in the probability of prenatal smoking cessation.

Although we observed negative relationships between a state adopting either enrollment policy and adverse birth outcomes, they were not statistically significant.

Next, to examine whether the effects of state Medicaid enrollment policies differed in states with different coverage of smoking cessation services during pregnancy, we calculated the average marginal effects of presumptive eligibility, the UC option, or either enrollment policy in states with and without comprehensive Medicaid coverage of smoking cessation services (Table 2.5). The effects of presumptive eligibility on prenatal smoking cessation did not differ by states' generosity of coverage for smoking cessation services. Presumptive eligibility led to a 7.4 percentage-point increase in the probability of smoking cessation (95% CI: 3.5 percentage points to 11.3 percentage points, $p<0.01$) among women in states with comprehensive coverage and a 7.0 percentage point increase (95% CI: 1.7 to 12.4 percentage points, $p<0.01$) in states without comprehensive coverage. Presumptive eligibility did not have a significant effect on preterm birth or small for gestational age in states with different coverage of smoking cessation services.

In terms of the UC option, no significant effects of the policy were observed on prenatal smoking cessation, preterm birth, or small for gestational age among women in states with and without comprehensive Medicaid coverage of smoking cessation services.

Having adopted either enrollment policy increased prenatal smoking cessation both in states with (6.0 percentage points, 95% CI: 2.0 to 10.0 percentage points, $p<0.01$) and without (7.5 percentage points, 95% CI: 2.5 to 12.6 percentage points, $p<0.01$)

comprehensive coverage of smoking cessation services. Adopting either enrollment policy was not significantly associated with reduced adverse birth outcomes, in states with and without comprehensive Medicaid coverage of smoking cessation services.

Sensitivity analyses

To test the robustness of these findings, we conducted several sensitivity analyses. First, to test the validity of our measure of Medicaid eligibility, we re-ran the analyses with more restrictive (classifying Medicaid eligibility as 10 percentage points lower than the eligibility threshold) and less restrictive (classifying Medicaid eligibility as 10 percentage points greater than the eligibility threshold) definitions of Medicaid eligibility. Our results were unchanged. Second, we conducted the analyses including only women who had Medicaid coverage just prior to conception, among whom we would not expect to see a significant effect of any enrollment policy. As expected, there was no significant effect of presumptive eligibility or the UC option on outcomes among women who had Medicaid coverage before their pregnancy. Third, we conducted analyses to explore whether smoking cessation was driven by women receiving prenatal care in Medicaid in the three states (Colorado, Maine, and Ohio) that adopted presumptive eligibility in our study time period. We examined the effects of presumptive eligibility among women who reported being uninsured just prior to pregnancy, among whom presumptive eligibility would be most helpful in receiving prenatal care. In this subgroup, presumptive eligibility led to an 11.0 percentage-point increase (95% CI: 5.9 to 16.0 percentage points, $p<0.01$) in smoking cessation. Additionally, presumptive eligibility had a stronger association with smoking cessation in the three states that adopted the policy in our study time period relative to states that did not change their enrollment policies. (Results of sensitivity analyses are not shown but are available from the authors upon request).

DISCUSSION

This study examined the effects of state Medicaid enrollment policies on prenatal smoking cessation, preterm birth, and having a small for gestational age infant. The adoption of presumptive eligibility, an optional Medicaid enrollment policy that permits women to receive prenatal care while their application is pending, led to a 7.7 percentage-point increase in prenatal smoking cessation. The adoption of the UC option, a Medicaid enrollment policy that permits states to expand or simplify enrollment for vulnerable groups, was not significantly associated with prenatal smoking cessation, preterm birth, or having a small for gestational age infant. Adopting either of the two enrollment policies led to a 6.8 percentage-point increase in prenatal smoking cessation, but did not reduce adverse birth outcomes. We observed no differences in the effects of presumptive eligibility, the UC option, or having either policy by states' generosity of coverage of smoking cessation services.

These findings suggest that states' adoption of presumptive eligibility promotes prenatal smoking cessation via early initiation of prenatal care, as the policy allows women to receive care while their Medicaid application is pending. Previous literature found an association between adoption of presumptive eligibility and earlier initiation of prenatal care and increased receipt of adequate prenatal care.[33] Adopting presumptive eligibility, however, requires states to formally amend their Medicaid programs with the federal government and enlist participating organizations (e.g., health clinics) to enroll women. Therefore, the policy also may reflect an increased level of cooperation between state Medicaid agencies and providers who serve Medicaid beneficiaries.

In contrast to presumptive eligibility, the UC option expands prenatal coverage to low-income women who would not qualify for Medicaid due to lack of documentation of citizenship or residency. Although the UC option may significantly increase Medicaid enrollment, it might not necessarily lead to improved care for smoking cessation, especially if women are not enrolling early in pregnancy. Our findings suggest that UC option may not increase the quality of prenatal care among women who are enrolling in Medicaid.[34]

It is discouraging that the two optional enrollment policies did not reduce preterm birth or having a small for gestational age infant. However, birth outcomes are influenced by a number of other biological and behavioral factors in addition to smoking, suggesting that smoking cessation interventions may need to be combined with additional interventions to significantly reduce adverse birth outcomes.[35,36] Expanded Medicaid coverage to non-pregnant adults under the ACA could be used to provide interventions to reduce preconception and postpartum smoking as a strategy to improve birth outcomes.[37,38]

Contrary to our expectations, we did not observe significantly greater effects of the two enrollment policies in states with more generous Medicaid coverage of smoking cessation services. This finding is consistent with recent research finding that state Medicaid coverage of smoking cessation services had no significant effects on prenatal smoking cessation or infant birth weight among women who enrolled in Medicaid during pregnancy.[39] Use of pharmacotherapies or counseling for smoking cessation during pregnancy may be low;[40,41] although the PRAMS core questionnaire does not include items about the use of cessation aids, limiting our ability to quantify use of cessation services.

This study has several important limitations. First, our measure of Medicaid eligibility is imperfect. The PRAMS does not ask about certain Medicaid eligibility criteria, such as types of income that states might disregard (e.g., child support payments) when determining eligibility, so we were unable to take these criteria into account. Additionally, household income is measured in categories, which might lead to misclassification in our definition of eligibility. However, our findings were consistent in sensitivity analyses using different definitions of Medicaid income eligibility.

Second, prenatal smoking cessation was based on self-report rather than biochemical validation, which tends to overestimate reported cessation in pregnancy.[42] It is not clear that such over-reporting of cessation would differ by state or across time, however, meaning that this limitation would have the practical effect of biasing our results toward the null. Third, we lack data on whether states required cost-sharing or prior authorization for smoking cessation services, which could provide a barrier to receiving these services. Combining enrollment simplification policies with reductions in these barriers could potentially lead to greater reductions in prenatal smoking. Finally, our estimates of the effects of presumptive eligibility are driven by policy changes in three states (Colorado, Maine, and Ohio), and although our study sample is representative of women in the 19 states included, results may not be generalizable nationally.

This study found that presumptive eligibility, an optional Medicaid enrollment policy to promote early initiation of prenatal care, led to a significant increase in prenatal smoking cessation among Medicaid-eligible women. Given that Medicaid income eligibility thresholds are likely to remain higher for pregnant women relative to other adults,[43] particularly in states that opt not to participate in the Medicaid expansion authorized under the ACA, presumptive eligibility will continue to be an important policy to promote timely prenatal care. Findings that the enrollment policies' effects did not differ by states' generosity of Medicaid coverage of smoking cessation services merit future research to explore patterns of prescribing and use of pharmacotherapies and counseling for smoking cessation during pregnancy. As states are now required to cover these services for pregnant women, it is important to understand the perceived risks and benefits both among patients and providers. Additional research is also needed on the effectiveness of combining smoking cessation interventions with interventions targeting other risk factors to reduce adverse birth outcomes in the Medicaid-eligible population.

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Table 2.1. Characteristics of 19 states in the study sample and United States population as a whole

	19 states (Mean or %)	US Population (Mean or %)
Demographic characteristics		
Mean Age	36	36
Race		
White	78	79
Black	14	13
Asian	5	5
Am. Ind./AK or HI Native	1	1
Other/multiple races	3	2
Hispanic ethnicity	11	16
Educational attainment[a]		
Less than high school	14	16
High school diploma	24	23
Some college/College degree	34	33
Advanced degree	7	6
Smoking characteristics		
Women who smoke cigarettes[b]	17	17
Women who made a quit attempt in prior year	34	33
Medicaid coverage		
Mean income eligibility threshold for pregnant women	197	188
State residents enrolled in Medicaid	20	21
Presumptive eligibility for pregnant women	51	63
'Unborn Child' option	32	25

a Educational attainment is calculated only among adults.
b Cigarette smoking is defined as having ever smoked 100 cigarettes and currently smoking every or some days.

Notes: Demographic characteristics are from the Current Population Survey's Annual Social and Economic Supplement, 2004-2010, employing survey weights. Smoking characteristics are from the Current Population Survey's Tobacco Use Supplement, 2006-2007, employing survey weights. Characteristics of Medicaid coverage were collected from surveys published by the Kaiser Family Foundation.

Table 2.2. Weighted descriptive characteristics of Medicaid-eligible women in 19 states who smoked prior to pregnancy and were not enrolled in Medicaid prior to pregnancy, 2004-2010

	Mean or % (95% CI)
N	24,544
Weighted N	781,643
Demographic characteristics	
Maternal age	
19-24	50.9 (49.2,52.5)
25-34	42.3 (40.9,43.8)
35-44	6.8 (6.0,7.6)
Race and ethnicity	
White	75.3 (72.9,77.6)
Black	9.6 (8.1,11.1)
Asian	1.2 (1.0,1.6)
Am. Indian/AK or HI Native	3.3 (2.2,4.5)
Other/Multiple races reported	2.3 (1.8,2.8)
Hispanic	8.3 (6.8,9.9)
Married	34.6 (32.6,36.6)
Mean household income (% FPL)[a]	129.9 (126.1,133.5)
Maternal education	
Less than high school	21.5 (20.0,23.0)
High school diploma	45.4 (44.0,46.7)
Some college	28.0 (26.3,29.7)
College graduate or more	5.1 (4.4,5.9)
Health factors	
No. cigarettes smoked preconception[b]	
<1-10	55.7 (53.5,57.9)
11-20	33.0 (31.4,34.5)
21-40	8.0 (7.1,8.9)
≥41	3.3 (2.8,3.9)
No. alcoholic drinks during pregnancy[c]	
0	93.9 (93.3,94.5)
<1-3	5.5 (5.0,6.0)
≥4	1.0 (0.38,1.0)
No. stressors before/during pregnancy[d]	
0	11.1 (10.2,12.1)
1-2	32.1 (31.0,33.2)
3-5	40.1 (38.9,41.4)
≥6	16.7 (15.6,17.7)
Pregnancy intention	
Wanted pregnancy then	28.3 (27.0,29.5)
Mistimed (wanted sooner/later)	55.7 (54.2,57.2)
Did not want pregnancy	16.1 (14.9,17.3)
At least one previous live birth	53.2 (51.6,54.8)
Previous preterm birth[e]	13.1 (12.1,14.1)
Insurance and WIC	
Insurance prior to pregnancy	
Uninsured	63.9 (61.7,66.1)
Insured (not Medicaid)	36.1 (33.9,38.3)
Insurance during pregnancy	
Enrolled in Medicaid	71.9 (69.9,74.0)
Not enrolled in Medicaid	28.0 (26.0,30.1)
WIC during pregnancy[f]	74.5 (72.7,76.2)

Table 2.2 footnotes

a Income shown as a percentage of the Federal Poverty Level.
b The number of cigarettes smoked pre-pregnancy is defined as self-reported amount smoked per day, on average, in the 3 months prior to pregnancy.
c Alcoholic drinks is defined as the self-reported average number of drinks consumed each week during the third trimester of pregnancy.
d Stressors include 13 events that occurred in the 12 months before birth, such as involuntary job loss, death of a close friend or family member, divorce/separation, and homelessness.
e Previous preterm birth shown among women with at least one prior live birth.
f Special Supplemental Nutrition Program for Women, Infants and Children (WIC)

Notes: Medicaid eligibility was defined within each state and year, based on self-reported income for the previous 12 months and household size. Smoking prior to pregnancy was defined as smoking any amount in the three months prior to pregnancy.

Table 2.3. State Medicaid enrollment policies and coverage of smoking cessation services in 19 states, 2004-2010

State	No. of years with Presumptive Eligibility	No. of years with 'Unborn Child' option	No. of years with comprehensive smoking cessation coverage[a]
Arkansas	7	0	7
Alaska	0	7	5
Colorado	5	0	6
Georgia	7	0	1
Hawaii[b]	0	0	0
Maine	3	0	7
Maryland[c]	7	0	4
Minnesota	0	7	7
Nebraska	7	6	3
New Jersey[b]	7	0	0
New York	7	0	7
Ohio[b,c]	4	0	0
Oklahoma	7	3	5
Oregon	0	3	7
Rhode Island	0	7	6
Utah	7	0	7
Vermont[b]	0	0	0
Washington	0	7	6
West Virginia	0	0	7

a Comprehensive coverage of smoking cessation services defined as coverage of both pharmacotherapies (any nicotine replacement therapy or bupropion) and counseling for smoking cessation. As of Oct. 2010, federal law required all states to cover both pharmacotherapies and counseling for smoking cessation among pregnant women.
b These states did not have comprehensive coverage until required by the Affordable Care Act as of Oct. 2010.
c Although Maryland and Ohio don't have formal Presumptive Eligibility, they have adopted Presumptive Eligibility-like processes.

Notes: Medicaid eligibility was defined within each state and year, based on self-reported income for the previous 12 months and household size. Smoking pre-pregnancy was defined as smoking any amount in the three months prior to conception.

Table 2.4. Average marginal effects of state Medicaid policies on prenatal smoking cessation, preterm birth, and having a small for gestational age infant, among Medicaid-eligible women in 19 states who smoked preconception

	Prenatal Smoking Cessation	**Preterm Birth**	**Small for Gestational Age[a]**
	Percentage-point change (95% CI)	Percentage-point change (95% CI)	Percentage-point change (95% CI)
Presumptive Eligibility	7.7 (3.7,11.6)**	1.0 (-1.9,3.9)	1.8 (-1.7,5.3)
'Unborn Child' option	-2.1 (-7.2,3.0)	0.16 (-2.7,3.0)	2.8 (-1.3,7.0)
Either enrollment policy	6.8 (3.0,10.5)**	-1.4 (-4.7,2.0)	-3.3 (-6.5,0.37)

* p<0.05
** p<0.01

a Small for gestational age defined as birth weight of less than the 10th percentile at a given gestational age.

Notes: Individual control variables included maternal age, race/ethnicity, education, marital status, number of cigarettes smoked per day pre-pregnancy, whether or not alcoholic drinks were consumed during pregnancy, parity, pregnancy intention, number of stressors experienced during pregnancy, preconception insurance status, and previous preterm birth. State-level control variables included whether or not a state had a ban on worksite smoking; state excise taxes on cigarettes; state Medicaid income eligibility thresholds; and whether a state had a high, medium, or low proportion of Medicaid beneficiaries enrolled in a managed care organization. Models also included indicator variables for state and year.

Table 2.5. Average marginal effects of state Medicaid enrollment policies on prenatal smoking cessation, preterm birth, and having a small for gestational age infant, stratified by state coverage of smoking cessation services, among Medicaid-eligible women in 19 states who smoked preconception

	Prenatal Smoking Cessation	
	Percentage-point change (95% CI)	Percentage-point change (95% CI)
	Comprehensive coverage[a]	*Non-comprehensive coverage*
Presumptive Eligibility	7.4 (3.5,11.3)**	7.0 (1.7, 12.4)**
'Unborn Child' option	-2.1 (-7.3,3.0)	1.0 (-5.1, 7.2)
Either enrollment policy	6.0 (2.0, 10.0)**	7.5 (2.5,12.6)**
	Preterm Birth	
	Percentage-point change (95% CI)	Percentage-point change (95% CI)
	Comprehensive coverage	*Non-comprehensive coverage*
Presumptive Eligibility	1.9 (-1.4,5.2)	1.2 (-2.2,4.7)
'Unborn Child' option	-0.10 (-2.8,2.7)	2.5 (-3.1,8.0)
Either enrollment policy	-2.2 (-5.9,1.5)	1.3 (-2.4,5.1)
	Small for Gestational Age[b]	
	Percentage-point change (95% CI)	Percentage-point change (95% CI)
	Comprehensive coverage	*Non-comprehensive coverage*
Presumptive Eligibility	1.1 (-2.2,4.3)	2.4 (-2.1,7.0)
'Unborn Child' option	4.1 (-1.3,8.4)	-0.56 (-5.1,3.9)
Either enrollment policy	0.81 (-2.0,3.6)	2.1 (-1.9,6.1)

* Significantly different from zero, p<0.05
** Significantly different from zero, p<0.01

a Comprehensive coverage of smoking cessation services defined as coverage of both pharmacotherapies (any nicotine replacement therapy or bupropion) and counseling for smoking cessation.
b Small for gestational age defined as birth weight of less than the 10th percentile at a given gestational age.

Notes: Individual control variables included maternal age, race/ethnicity, education, marital status, number of cigarettes smoked per day pre-pregnancy, whether or not alcoholic drinks were consumed during pregnancy, parity, pregnancy intention, number of stressors experienced during pregnancy, preconception insurance status, and previous preterm birth. State-level control variables included state Medicaid income eligibility thresholds and whether a state had a high, medium, or low proportion of Medicaid beneficiaries enrolled in a managed care organization. Models also included indicator variables for state and year.

Exclusive breastfeeding leads to an increased postpartum weight loss among U.S. women: An analysis from the Infant Feeding Practices Study II

ABSTRACT

Background:

It is unclear whether breastfeeding promotes postpartum weight loss. The objective of this study is to evaluate the effects of breastfeeding on maternal weight in the 12 months postpartum.

Methods:

Using national data from the U.S. Infant Feeding Practices Study II, we employed propensity scores to match women who breastfed exclusively or non-exclusively for at least three months to comparison women who had not breastfed or breastfed for less than three months. The two primary outcomes of interest were the change in weight from a woman's highest pregnancy weight to her post-pregnancy weight at 6 months and at 12 months postpartum. We also examined whether breastfeeding affected the probability of returning to the same body mass index (BMI) category and the probability of returning to a weight that was equal to or less than a woman's pre-pregnancy weight.

Results:

Compared to women who did not breastfeed or breastfed non-exclusively, exclusive breastfeeding for at least 3 months resulted in an increased weight loss of 3.2 pounds (95% CI: 1.4,4.7) at 12 months postpartum, a 6.0-percentage-point increase (95% CI: 2.3,9.7) in the probability of returning to the same or lower BMI category postpartum; and a 6.1-percentage-point increase (95% CI: 1.0,11.3) in the probability of returning to

pre-pregnancy weight or lower postpartum. Non-exclusive breastfeeding did not significantly affect any outcomes.

Conclusions:

Exclusive breastfeeding during the 12-week period after delivery has a small effect on postpartum weight loss and a moderate effect on weight maintenance. Additional interventions are needed to promote the loss of pregnancy-related weight.

INTRODUCTION

Failure to lose pregnancy-related weight in the postpartum period is an important contributor to long-term obesity and related serious chronic conditions among women.[1-5] Pregnancy and the postpartum period provide a window of opportunity to engage women to adopt healthy behaviors. Encouraging breastfeeding may be one way to promote the loss of pregnancy-related weight, due to the caloric expenditures required for lactation[6] as well as related metabolic changes that are favorable to weight loss.[7] Previous literature examining the relationship between breastfeeding and weight loss in the postpartum period has produced mixed results.[8,9] In the U.S. context, several recent studies have employed multivariable regression analyses to examine whether breastfeeding affects maternal weight retention postpartum; results have varied from finding very limited or no association between breastfeeding and postpartum weight[10,11] to a positive and significant association between breastfeeding and weight loss in the postpartum period.[12,13]

A key shortcoming of the literature among U.S. women is selection; that is, women who choose to breastfeed their infants are systematically different than those women who do not choose to breastfeed their infants on important confounders. We address this shortcoming by using propensity score matching in a national cohort of U.S. women to estimate the effect of breastfeeding on the loss of pregnancy-related weight during the postpartum period. This matching approach allows us to balance the distribution of covariates between women who do and do not breastfeed, similar to what would be achieved in a study using experimental methods. We hypothesized that women who breastfed for at least three months would have greater weight loss at six and 12 months postpartum, and would have greater probabilities of returning to their pre-pregnancy body mass index (BMI) category and returning to their pre-pregnancy weight, relative to women who did not breastfeed or breastfed for less than three months.

METHODS

Data

The Infant Feeding Practices Study II (IFPS II) is a national cohort study that followed U.S. women from the last trimester of pregnancy through 12 months postpartum in order to collect detailed information about infant feeding. The Food and Drug Administration and the Centers for Disease Control and Prevention conducted the study, and detailed descriptions of the study design and methods have been published elsewhere.[14] Briefly, women were sampled during their third trimester of pregnancy from a national consumer opinion panel. The study sample is not nationally representative (i.e., the study did not oversample from any particular subgroups), but it includes a nationally distributed group of women. Criteria for eligibility to participate in the IFPS II included neither the woman nor her infant having a medical condition that would affect infant feeding, and that infants were at least 35 weeks' gestation and weighed at least 5 pounds at birth. IFPS II data were collected from May 2005 to June 2007. Participants completed a prenatal questionnaire during the third trimester of pregnancy, a telephone interview close to the birth of their infant, and 10 postpartum questionnaires over the first year after birth (monthly except for months 8 and 11). The questionnaires asked information about demographics, maternal diet, health history, social support, experience with infant feeding education, and breastfeeding and breast milk pumping practices. Response rates were 77% for the month one questionnaire, 79% for the month three questionnaire, 71% for the month six questionnaire, and 65% for the month 12 questionnaire.[14]

Outcomes

The two primary outcomes were the change in weight from a woman's highest pregnancy weight to her post-pregnancy weight at 6 months and at 12 months postpartum, measured continuously in pounds. We also examined two secondary outcomes, among women who were not underweight (i.e., had a BMI$\geq$18.5 kg/m^2) pre-pregnancy: the probability of returning to pre-pregnancy BMI category or lower, and the probability of returning to pre-pregnancy weight or lower. Outcomes were calculated based on self-reported weight and height.

Treatment definitions

To explore the effects of the intensity of breastfeeding on weight change in the postpartum period, we defined two treatment variables. The first treatment variable was a binary measure of exclusive breastfeeding, which was defined as a woman reporting feeding her infant breast milk exclusively (either breastfeeding or bottle feeding of expressed breast milk) for at least the first three months of the infant's life. For this treatment, the comparison group was women who reported not feeding their infant any breast milk as well as women who reported non-exclusive feeding of breast milk, during the first three months. The second treatment variable was a binary measure of non-exclusive breastfeeding for at least three months, defined as a woman reporting non-exclusively feeding her infant breast milk (either breastfeeding or bottle feeding of expressed breast milk) for at least the first three months of the infant's life. The comparison group for this treatment was women who reported not feeding their infant any breast milk or women who reported feeding some breast milk but for a duration shorter than three months.

Although the American Academy of Pediatrics recommends exclusive breastfeeding for six months,[15] we used three months' breastfeeding to define our treatment variables for several reasons. First, it appears plausible that energy expenditures due to lactation in the first three months are sufficient to promote weight loss.[16,17] Second, 40% of infants are fed cereal or other foods at about four months of age, and women commonly report that their infant is not satisfied by breast milk alone between three and five months of age.[18,19] Third, because federal law requires 12 workweeks' medical leave for employed individuals,[20] three months of breastfeeding may represent an actionable goal for many women. In our data, for instance, 38% of women fed their infants breast milk exclusively for at least three months, while only 4% fed their infants breast milk exclusively for at least six months.

Statistical Analysis

We generated propensity scores[21] to match women who reported exclusive or non-exclusive breastfeeding for at least the first three months of their infant's life (the two treatment groups) to those who did not breastfeed for three months (the two control groups), conducting the matching separately for each of our two treatment definitions.

Propensity score matching provided two key advantages over traditional multivariable regression adjustment approaches.[22] First, propensity score matching allowed us to achieve balance on key observed covariates between women who did and did not breastfeed, ensuring that the two groups were comparable on those measures.[23] Second, the matching process was conducted without using data on the outcomes of interest, leading to a study design that was created independently of the expected outcome.[24]

The propensity score model was a logistic regression in which the response variable was a binary measure of breastfeeding (either of the two treatment definitions) and the independent variables were individual-level covariates that have been shown in the literature to be associated with breastfeeding.[25-27] These covariates included maternal demographic factors (age, race/ethnicity, parity, educational attainment, and whether the infant was enrolled in WIC); health/medical factors (pre-pregnancy obesity, prenatal insurance coverage, whether a woman smoked any cigarettes three months postpartum, having a cesarean-section birth, and whether the infant was in the intensive care unit for 3 days or less after birth); and breastfeeding support (whether the infant's pediatrician recommended exclusive breastfeeding, and prenatal breastfeeding intention).

The analyses presented here employ full matching, which is a flexible propensity score matching method that groups all study subjects into matched subclasses, each containing at least one subject from the treatment group and at least one subject from the comparison group.[28] Full matching generates weights for each subject. (See Appendix B for a detailed description of propensity score methods). After conducting the propensity score matching, we used a "doubly robust" analysis by fitting regression models in the weighted matched dataset and also controlling for the observed covariates. Controlling for our observed covariates in the final analytic models helps to further adjust for any remaining differences that existed between study groups after matching.[29] Unadjusted results using the matched datasets were very similar to the doubly robust approach (results not shown, available upon request from authors). We used linear regression for the weight loss outcomes as these outcomes were normally distributed. For the two binary outcomes (return to pre-pregnancy BMI category and return to pre-pregnancy weight), we used logistic regression and then derived predicted probabilities from those results. Outcome models incorporated weights generated by the full matching.

A substantial proportion of women were lost to follow-up during the study; 22% of respondents were missing data on weight at six months and 32% of respondents were missing data on weight at 12 months. We conducted our final analyses including women with complete outcomes data and using multiply imputed outcomes. Results from the complete case and multiple imputation models were consistent in terms of direction, magnitude, and significance; therefore, we present results from the complete case analyses. (See Appendix B for additional imputation model details and results using imputed outcomes).

RESULTS

Baseline characteristics of the study samples are summarized in Table 3.1. The proportion of women who were overweight or obese increased from 50% pre-pregnancy to 56% at 12 months postpartum, and a plurality of women (46%) gained more weight during pregnancy than recommended by the Institute of Medicine guidelines.[30] For each of the two treatment definitions (exclusive and non-exclusive breastfeeding for at least three months), the treatment and matched control groups were highly comparable on the observed covariates.

Effects of breastfeeding on postpartum weight loss

Exclusive breastfeeding for at least three months had a small but significant effect on pregnancy-related weight loss (Figure 3.1, Panel A). Women who breastfed exclusively for at least three months led to a 1.3-pound (95% CI: 0.2,2.5, $p<0.05$) increase in loss of pregnancy-related weight at six months postpartum, relative to those who did not breastfed of breastfed non-exclusively. At 12 months postpartum, exclusive breastfeeding for at least three months led to a 3.2-pound (95% CI: 1.7,4.7, $p<0.05$) increase in loss of pregnancy-related weight, relative to non-exclusive or no breastfeeding (Table 2). These results translate into a 1.4-percentage-point increase in weight loss at six months and 2.7-percentage-point increase in weight loss at 12 months among women who exclusively breastfed for three months relative to women who did not breastfeed or breastfed non-exclusively.

Women who breastfed non-exclusively for at least three months did not experience significantly increased weight loss at six or 12 months postpartum relative to women who did not breastfeed or breastfed non-exclusively for less than three months (Figure 3.1, Panel B; and Table 2).

Effects of breastfeeding on return to pre-pregnancy BMI and pre-pregnancy weight

Women who breastfed exclusively for at least three months had a 6.0 percentage-point increase (95% CI: 2.3,9.7; $p<0.01$) in the probability of returning to pre-pregnancy BMI category relative to women who did not breastfeed or breastfed non-exclusively (Table 3.2). Likewise, women who breastfed exclusively for at least three months had a 6.1 percentage-point increase (95% CI: 1.0,11.3; $p<0.05$) in the probability of returning to pre-pregnancy weight or lower compared to those women who did not breastfeed or breastfed non-exclusively. Consistent with our findings of effects postpartum weight loss, non-exclusive breastfeeding for at least three months did not lead to increased probabilities of returning to pre-pregnancy BMI category or pre-pregnancy weight, compared with non-exclusive breastfeeding for less than three months or no breastfeeding.

DISCUSSION

This study found that exclusive breastfeeding in the first three months postpartum led to a 2.7 percentage-point increase in loss of pregnancy-related weight in the 12 months postpartum. Exclusive breastfeeding had a moderate impact on returning to pre-pregnancy BMI category and pre-pregnancy weight, relative to no breastfeeding or breastfeeding non-exclusively. In contrast, non-exclusive breastfeeding for at least three months did not significantly impact weight loss or weight maintenance. These findings inform efforts to optimize the typical U.S. maternity leave period by providing new evidence of a maternal health benefit of breastfeeding during this window.

The increase in postpartum weight loss due to breastfeeding was below the 5%-10% threshold typically used to gauge clinically meaningful weight loss.[31] Although lactation requires additional energy expenditures, breastfeeding may also be associated with an increased caloric intake. Even if women who breastfeed their infants make healthier dietary choices,[32] total caloric intake may be more important in predicting the loss of pregnancy-related weight.[33] It is notable that exclusive breastfeeding had a larger impact on the probability of returning to pre-pregnancy BMI category and pre-pregnancy weight, suggesting that breastfeeding might have a role in preventing excessive retention of pregnancy weight.

Contrary to expectations, we did not observe any effects of non-exclusive breastfeeding for at least three months on weight loss or weight maintenance outcomes. These null findings might be due to variation in the intensity of breastfeeding among women who were non-exclusively breastfeeding. For example, at three months postpartum, 23% of women who breastfed non-exclusively reported feeding breast milk four or fewer times daily, 33% reported feeding breast milk five or six times daily, and 43% reported feeding breast milk six times or more daily.

We created binary measures of exclusive and non-exclusive breastfeeding for three months, which might raise the question as to whether the effects we observed for exclusive breastfeeding are due to breastfeeding patterns that occur after three months. In our sample, among women who breastfed exclusively for at least three months, 11% continued to breastfeed exclusively through six months, and 55% continued to breastfeed non-exclusively through 12 months. Although our data and analytic strategy limits our ability to examine the does-response by duration of breastfeeding on postpartum weight change, our results do inform efforts to promote breastfeeding in the context of the short period of maternity leave in the U.S.

This is the first study to our knowledge to employ propensity score matching to estimate the causal effect of breastfeeding on postpartum weight loss. Our methods provide advantages over traditional multivariable regression adjustment in that balance was achieved between treatment and matched control groups on a range of covariates, and the matching was conducted in the absence of information about outcomes. A potential limitation in our ability to make claims about causality is that there may still be unobserved confounding variables. We have attempted to minimize the likelihood of an unobserved confounder affecting our results by including a range of observed and known confounders in our matching models. We also conducted a sensitivity analysis using bias formulas proposed by Vanderweele and Arah to estimate the "true" results adjusted for a possible unmeasured confounder.[34] Assuming the unmeasured confounder doubled the odds of exclusive breastfeeding for 3 months, we found that our results we robust to confounding with a prevalence of the unmeasured confounder up to three times greater in the exclusive breastfeeding versus matched control group (results not shown; available upon request from the authors).

Several additional limitations to this study should be noted. First, all measures of maternal weight were self-reported, which tends to underestimate weight.[35] However, we do not expect under-reporting weight to be differential by treatment group or over time. In addition, since we are measuring the change in weight, this limitation is minimized. Second, our data are not nationally representative, so results might not be generalizable to the entire population. Although our sample was nationally distributed, it appeared that respondents had a relatively high socioeconomic status. Therefore, care should be taken not to generalize findings to low socioeconomic status groups, particularly if the effects of breastfeeding on loss of pregnancy weight could be modified by socioeconomic status. Third, a substantial proportion of women were lost to follow-up in our data, which resulted in missing outcomes data. We aimed to minimize this limitation by running both complete case analyses and analyses in which the outcomes were imputed, and our findings were consistent using these two approaches. Finally, the IFPS II followed women for 12 months postpartum, so we were not able to examine longer-term effects of breastfeeding.

This study does not support the notion that breastfeeding is the foremost weight loss mechanism following delivery. However, it suggests that even in the span of a 12-week leave period, exclusive breastfeeding may have a small but significant effect on weight loss. Additional interventions and policy efforts are needed to promote postpartum weight loss in order to prevent obesity among U.S. women.

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Table 3.1. Characteristics of the study samples at baseline

	Sample for exclusive breastfeeding analyses[a] (N=2,102)		Sample for non-exclusive breastfeeding analyses[b] (N=1,305)	
	Exclusive breastfeeding (N=797)	Non-exclusive or no breastfeeding (N=1,305)	Non-exclusive breastfeeding (N=521)	No breastfeeding (N=784)
Baseline weight characteristics				
Pre-pregnancy Body Mass Index				
Underweight (<18.5 kg/m^2)	2.8 (1.5,4.0)	2.0 (1.2,2.9)	2.8 (1.6,4.4)	2.4 (1.1,3.7)
Healthy weight (18.5-24.9 kg/m^2)	46.4 (42.7,50.2)	44.0 (41.0,47.1)	39.7 (34.9,44.6)	38.4 (34.2,42.6)
Overweight (25-29.9 kg/m^2)	28.6 (25.2,31.9)	29.5 (26.7,32.2)	28.3 (23.9,32.8)	33.4 (29.4,37.5)
Obese (≥30 kg/m^2)	22.3 (19.1,25.4)	24.5 (21.9,27.1)	29.1 (24.6,33.6)	25.8 (22.0,29.6)
Weight gain during pregnancy				
Gained≤IOM guidelines[c]	13.3 (10.8,15.6)	15.6 (13.6,17.5)	18.7 (15.3,22.1)	14.4 (11.9,16.9)
Gained within IOM guidelines[c]	42.0 (38.5, 45.4)	41.7 (39.0,44.4)	36.0 (31.8,40.2)	37.2 (33.7,40.6)
Gained>IOM guidelines[c]	44.8 (41.3,48.3)	42.7 (40.0,45.4)	45.3 (40.9,49.6)	48.4 (44.9,52.0)
Other matching variables				
Demographic characteristics				
Mean age, years	30.0 (29.7,30.3)	29.7 (29.5,30.0)	29.7 (29.3,30.2)	29.8 (29.4,30.2)
Race				
White	90.5 (88.4,92.5)	89.6 (88.0,91.3)	80.4 (77.0,83.8)	80.3 (77.5,83.1)
Black	1.8 (1.0,2.7)	2.0 (1.3,2.8)	5.2 (3.2,7.1)	4.9 (3.4,6.4)
Hispanic	4.1 (3.0,5.2)	4.1 (3.0,5.2)	7.7 (5.4,10.0)	8.8 (6.8,10.8)
Other/multiple races	3.9 (2.5,5.2)	4.2 (3.1,5.3)	6.7 (4.6,8.9)	6.0 (4.3,7.6)
Education				
≤High school diploma	11.3 (9.1,13.5)	10.2 (8.5,11.8)	15.7 (12.6,18.9)	15.2 (12.7,17.7)
Some college	33.8 (30.5,37.0)	32.3 (29.8,34.9)	39.9 (35.7,44.1)	42.9 (39.4,46.4)
College degree or higher	55.0 (51.5,58.4)	57.5 (54.8,60.2)	44.3 (40.1,48.6)	41.9 (38.4,45.4)
Infant enrolled in WIC[d]	5.3 (3.7,6.8)	5.9 (4.7,7.2)	14.4 (11.4,17.4)	15.8 (13.2,18.4)
At least one previous live birth	76.9 (74.0,79.8)	74.3 (71.9,76.6)	72.0 (68.1,75.8)	68.0 (64.7,71.3)
Health/Medical characteristics				
Insured during prenatal care	95.2 (93.4,96.7)	95.2 (94.1,96.4)	96.0 (94.3,97.7)	97.4 (96.3,98.5)
Smoked postpartum[e]	3.8 (2.4,5.1)	4.6 (3.4,5.6)	9.6 (7.1,12.1)	9.5 (7.4,11.6)
C-section birth	24.7 (21.7,27.7)	26.2 (23.9,28.6)	27.8 (24.0,31.7)	24.4 (21.4,27.5)
Infant in the NICU[f]	2.0 (1.0,3.0)	1.7 (1.0,2.5)	3.8 (2.2,5.5)	2.9 (1.7,4.1)
Breastfeeding support				
Pediatrician recommended breastfeeding[g]	59.8 (56.4,63.3)	59.4 (56.7,62.0)	49.9 (45.6,54.2)	48.4 (44.9,51.9)
Intended to breastfeed[h]	89.7 (87.6,91.8)	91.4 (89.8,92.9)	69.5 (65.5,73.4)	71.8 (68.7,75.0)

Table 3.1 footnotes

a Exclusive breastfeeding defined as feeding an infant breast milk exclusively for at least three months. Matched control group defined as exclusive or non-exclusive feeding of breast milk less than three months or never breastfeeding.
b Non-exclusive breastfeeding defined as feeding an infant breast milk non-exclusively for at least three months. Matched control group defined as feeding an infant any breast milk less than three months or never breastfeeding.
c a Institute of Medicine (IOM) guidelines recommend gestational weight gain of 28-40 pounds for women with pre-pregnancy BMI<18.5 kg/m^2; 25-35 pounds for women who have pre-pregnancy BMI of 18.5-24.9 kg/m^2; 15-25 pounds for women with pre-pregnancy BMI of 25-29.9 kg/m^2; and 11-20 pounds for women with pre-pregnancy BMI≥30 kg/m^2.
d The infant was enrolled in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) one month after delivery.
e Obesity pre-pregnancy was› defined as women having a body mass index≥30 kg/m2, based on self-reported height and weight.
f Smoking was defined as reporting smoking any amount of cigarettes each day at three months postpartum.
g The infant was in an intensive care unit for three days or less after delivery.
h Women reported one month after delivery that their infant's pediatrician recommended exclusive breastfeeding of the infant.
i Women reported during their third trimester of pregnancy that they intended to breastfeed their infant exclusively for the first few weeks.

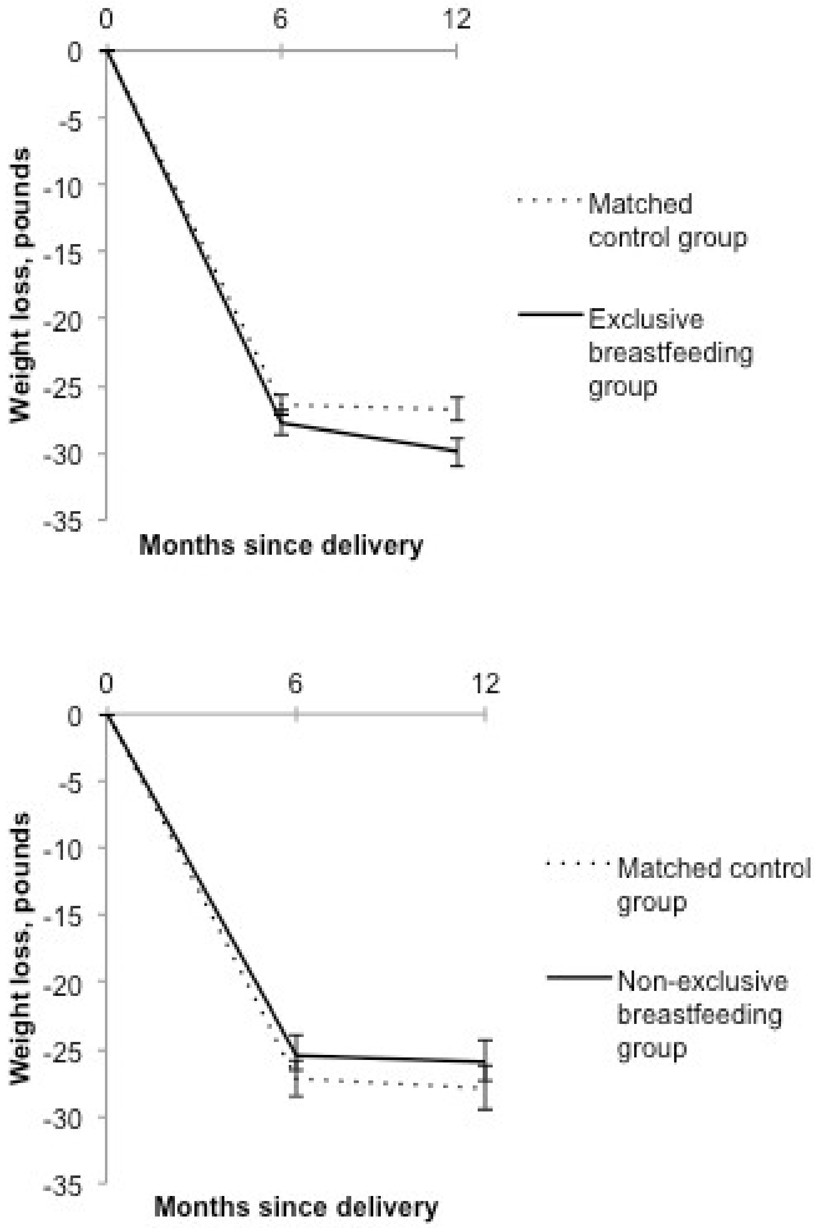
Table 3.2. Effects of exclusive and non-exclusive breastfeeding for three months on postpartum weight loss, the probability of returning to pre-pregnancy Body Mass Index (BMI) category, and the probability of returning to pre-pregnancy weight

Outcome	Exclusive breastfeeding[a]	Non-exclusive breastfeeding[b]
	Pounds (95% CI)	Pounds (95% CI)
6 month postpartum weight loss	1.3 (0.15,2.5)*	-1.8 (-3.57,0.05)
12 month postpartum weight loss	3.2 (1.7,4.7)*	-1.9 (-4.1,0.20)
	Percentage-point change (95% CI)	Percentage-point change (95% CI)
Return to pre-pregnancy BMI category[c,d]	6.0 (2.3,9.7)**	-0.06 (-5.1,4.9)
Return to pre-pregnancy weight[c,e]	6.1 (1.0,11.3)*	-1.0 (-7.7,5.6)

*p<0.05
**p<0.01

a Exclusive breastfeeding defined as feeding an infant breast milk exclusively for at least three months. Matched control group defined as exclusive or non-exclusive feeding of breast milk less than three months or never breastfeeding.
b Non-exclusive breastfeeding defined as feeding an infant breast milk non-exclusively for at least three months. Matched control group defined as feeding an infant any breast milk less than three months or never breastfeeding.
c Excluding women who were underweight (had a BMI<18.5 kg/m^2) pre-pregnancy.
d Defined as having a greater BMI category 12 months postpartum relative to pre-pregnancy BMI category.
e Defined as weight at 12 months postpartum≤pre-pregnancy weight.

Figure 3.1. Effects of exclusive and non-exclusive breastfeeding for three months on weight loss at 6 and 12 months postpartum



Notes: Exclusive breastfeeding defined as feeding an infant breast milk exclusively for at least three months. Matched control group defined as exclusive or non-exclusive feeding of breast milk less than three months or never breastfeeding. Non-exclusive breastfeeding defined as feeding an infant breast milk non-exclusively for at least three months. Matched control group defined as feeding an infant any breast milk less than three months or never breastfeeding. Doubly robust analyses adjusted for matching covariates shown in Table 2.

APPENDIX B

Propensity Score Matching Methods

To create samples of treatment groups and matched control groups, we conducted propensity score matching using several matching methods and examined the extent to which matching achieved balance on key observed covariates. We created two different treatment definitions: 1) exclusive breastfeeding for at least three months relative to non-exclusive or no breastfeeding; and 2) non-exclusive breastfeeding for at least three months relative to non-exclusive breastfeeding for less than three months or no breastfeeding. Using the "Matchit" package in the R statistical software,[1,2] for each treatment definition, we separately conducted matching using five different matching methods and examined the balance achieved with each method. The five different matching methods we employed were:

1. *1:1 nearest-neighbor matching without replacement:* In this method, each study subject in the treatment group is matched to a comparison subject with the closest propensity score. Comparison subjects who are not matched to treatment subjects are not included in the matched dataset.
2. *1:1 nearest-neighbor matching with replacement:* This method selects one match in the comparison group for each subject in the treatment group, allowing the comparison group matches to be used more than one time. Comparison subjects are weighted proportional to the number of times they are selected as a match. Comparison subjects who are not matched to treatment subjects are not included in the matched dataset.

3. *Mahalanobis matching within calipers:* This method uses 1:1 nearest neighbor matching but requires that matched subjects have very similar propensity scores (within 0.2 propensity score standard deviations) as well as very close values on educational attainment and intention to breastfeed. These variables were chosen because they are highly predictive of breastfeeding initiation and duration. Comparison subjects who are not matched to treatment subjects are not included in the matched dataset.
4. *Full matching:* This method uses all study subjects, grouped into matched subclasses containing at least one subject from the treatment group and at least one subject from the comparison group. The matched subclasses are formed in a way that allows subjects in the treatment group who are similar to many subjects in the comparison group to be matched with many comparison subjects; and allows subjects in the treatment group who have few similar individuals in the comparison group to be matched with few comparison subjects. The outcome analyses use weights generated from the full matching subclasses.
5. *Subclassification with 10 subclasses:* This method matches all study subjects, grouping treated and comparison subjects into 10 subclasses with similar values of propensity scores. Effect estimates are obtained separately within each subclass and then aggregated across subclasses.

To examine balance, we compared the standardized bias (i.e., the weighted difference in means divided by the standard deviation in the full sample who were not in the treatment group) across covariates, comparing the unmatched data to the matched data using the five different methods. An absolute standardized bias<0.20 was used as a guideline indicating good matching.[1] Figures B1 and B2 show box and whiskers plots of the absolute standardized biases for the covariates used in the matching models, comparing the unmatched data and the matched data using the five different matching methods, for each of the two treatment definitions. As shown in the figures, full matching provides excellent balance across covariates in both treatment definitions.

Approach to Missing Outcome Data

In our study sample, 22% of women were missing data on their weight at 6 months postpartum and 32% of women were missing data on their weight at 12 months postpartum. Missing outcomes was due mostly to loss to follow-up: 62% of women had data on both outcomes, 16% were missing data for both outcomes, 16% had data for month 6 but not month 12, and 6% had data for month 12 but not month 6.

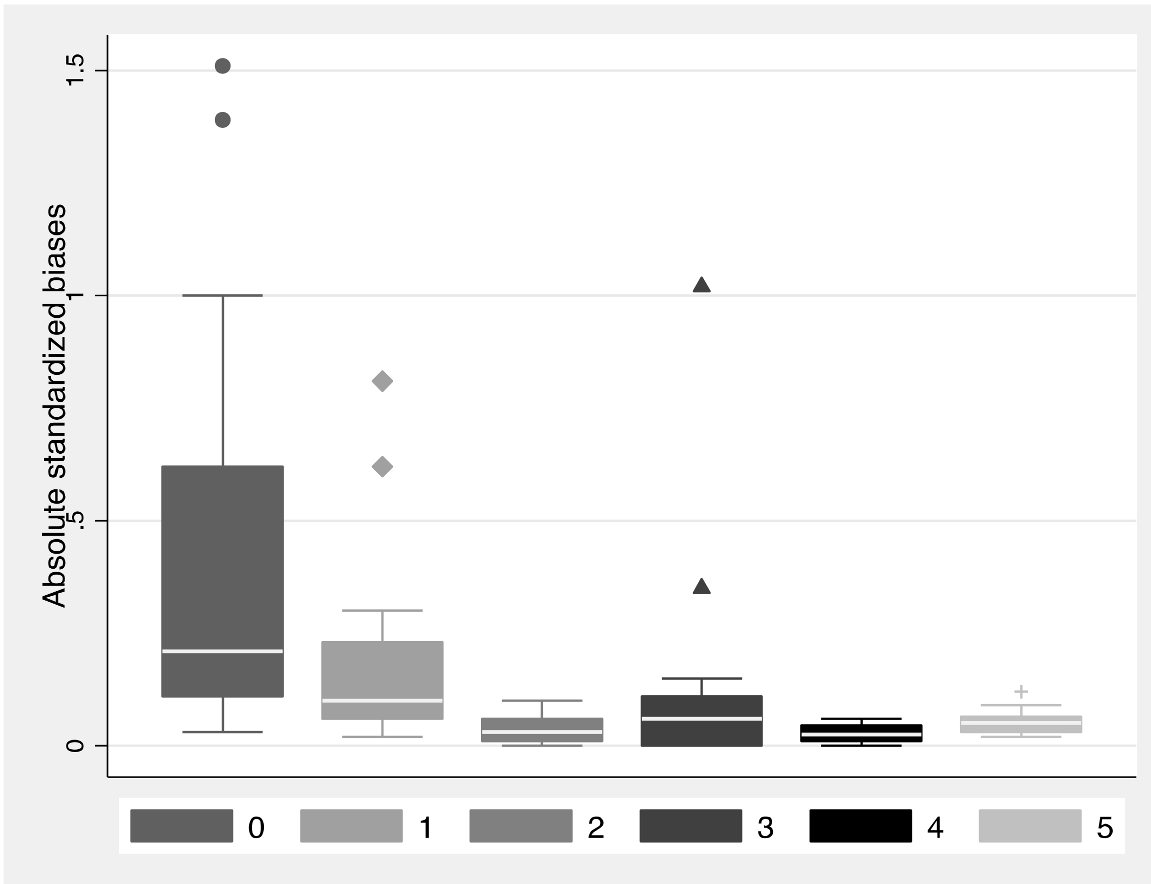
We examined matching covariates by missing data status and found that data were not missing completely at random; rather, missingness appeared to be correlated with lower socioeconomic status. Having missing outcome data was significantly correlated with lower age, lower educational attainment, and infant enrollment in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC).

Previous literature has suggested that imputing outcomes data needlessly adds noise to analyses;[3] however, White and colleagues suggest that imputing outcomes using auxiliary variables may in fact improve estimates.[4] We constructed a flexible regression model including the following variables: age, age squared, treatment status, infant enrollment in WIC, education, race/ethnicity, pre-pregnancy obesity status, gestational weight gain, parity, postpartum smoking status, whether delivery was via caesarian section, whether an infant was in the neonatal intensive care unit, and indicators variables for state of residence; interaction terms between the treatment variable and WIC enrollment, education, race/ethnicity, and pre-pregnancy obesity; and interaction terms between pre-

pregnancy obesity and gestational weight gain and education. The imputation models used linear regression for the two continuous outcomes (weight loss at 6 months postpartum and weight loss at 12 months postpartum). For the two binary outcomes (return to pre-pregnancy BMI category and return to pre-pregnancy weight) the imputation models used logistic regression and did not include pre-pregnancy obesity status in the imputation models. Twenty imputations were run for each of the four outcomes.

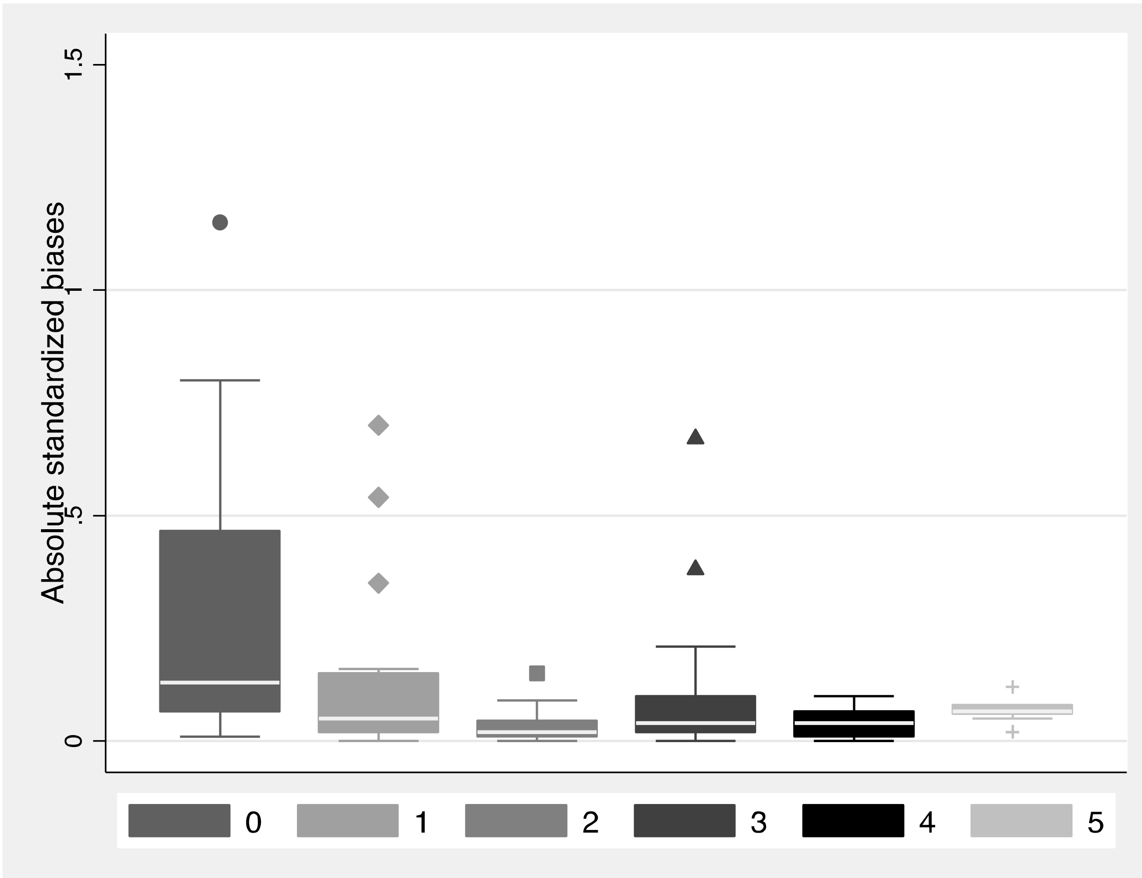
Then, we conducted our analyses using both complete cases and multiply imputed outcomes. As shown in Table B1, we observed results that were virtually identical in terms of their direction, magnitude, and significance. For one outcome, return to pre-pregnancy weight at 12 months postpartum, the effect of exclusive breastfeeding is not statistically significant using the imputed outcomes; however, the coefficient and 95% confidence interval is very close to the complete-case analysis.

Figure B1. Box and whiskers plots of the absolute standardized biases, comparing unmatched IFPS II data with matched data using five different matching methods, where treatment is exclusive breastfeeding for at least three months



Notes: IFPS II data is the Infant Feeding Practices Study II. Matching methods are: 0: Unmatched, 1: 1:1 nearest-neighbor matching without replacement, 2: 1:1 nearest-neighbor matching with replacement, 3: Mahalanobis matching within calipers, 4: Full matching, 5: Subclassification with 10 subclasses.

Figure B2. Box and whiskers plots of the absolute standardized biases, comparing unmatched IFPS II data with matched data using five different matching methods, where treatment is non-exclusive breastfeeding for at least three months



Notes: IFPS II data is the Infant Feeding Practices Study II. Matching methods are: 0: Unmatched, 1: 1:1 nearest-neighbor matching without replacement, 2: 1:1 nearest-neighbor matching with replacement, 3: Mahalanobis matching within calipers, 4: Full matching, 5: Subclassification with 10 subclasses.

Table B1. Effects of breastfeeding on outcomes, comparing complete case analyses to imputed outcomes analyses

Outcome	Treatment: Exclusive breastfeeding	Treatment: Non-exclusive breastfeeding
	Coefficient (95% CI)	Coefficient (95% CI)
Weight loss at 6 months postpartum, complete case[a]	1.33 (0.15,2.50)*	-1.77 (-3.57,0.05)
Weight loss at 6 months postpartum, imputed outcomes[a]	1.37 (0.03,2.71)*	-0.73 (-2.83,1.37)
Weight loss at 12 months postpartum, complete case[a]	3.19 (1.73,4.65)*	-1.97 (-4.14,0.20)
Weight loss at 12 months postpartum, imputed outcomes[a]	2.46 (0.71,4.23)*	-1.61 (-4.21,1.00)
Return to pre-pregnancy BMI category at 12 months postpartum, complete case[b,c]	0.48 (0.17,0.79)**	-0.004 -0.39,0.38)
Return to pre-pregnancy BMI category at 12 months postpartum, imputed[b,c] outcomes	0.40 (0.02,0.79)*	0.04 (-0.42,0.49)
Return to pre-pregnancy weight or lower at 12 months postpartum, complete case[c]	0.25 (0.04,0.47)*	-0.05 (-0.34,0.24)
Return to pre-pregnancy weight or lower at 12 months postpartum, imputed outcomes[c]	0.26 (-0.01,0.54)	-0.05 (-0.33,0.24)

*p<0.05
**p<0.01

a Analyses employed linear regression.
b BMI is body mass index.
c Analyses employed logistic regression, excluding women who were underweight (had a BMI<18.5 kg/m^2) pre-pregnancy.

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CONCLUSION

Given that pregnancy and the postpartum period provide a window of opportunity to motivate healthy behaviors that may have spillover effects, policies and interventions targeted at women during this period remain important public health strategies.[1] The research presented in this dissertation adds to a body of literature that has found that such targeted efforts alone, however, are unlikely to markedly improve suboptimal women's and infants' health outcomes.[2] Research presented in the first and second manuscripts suggests that although optional state Medicaid policies for women in the pregnancy eligibility category may improve what might be considered important process measures (obtaining insurance coverage for prenatal care and smoking cessation), such policies are not moving adverse birth outcomes that are critical and stubborn public health problems. The third manuscript provides new evidence that breastfeeding has a statistically significant but not clinically meaningful impact on postpartum weight loss, suggesting that promoting postpartum weight loss, and ultimately preventing long-term obesity in women, will require multi-pronged approaches that are compatible with breastfeeding.

Implementation of the most sweeping health reforms in decades in the United States, with the policy goal of achieving near-universal health insurance coverage, holds potential for improving pregnancy and birth outcomes via better access to care for women before and between pregnancies.[3-5] It is increasingly clear, however, that dramatic policy changes are needed to eradicate social inequalities in women's opportunities to live healthfully throughout adulthood.[6-8] To this end, both theoretical and empirical research is needed to investigate a new health policy paradigm that allows for a blurring of the distinction between promoting health and paying for health services.

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