PRETERM BIRTH PREDICTION AND RECEIPT OF POSTPARTUM CONTRACEPTION AMONG PARTICIPANTS OF NORTH CAROLINA'S PREGNANCY MEDICAL HOME PROGRAM

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ABSTRACT

CHRISTINE MARIE TUCKER: Preterm Birth Prediction and Receipt of Postpartum Contraception among Participants of North Carolina's Pregnancy Medical Home Program
(Under the direction of Carolyn T. Halpern)

The purpose of this dissertation is to determine which combination of risk factors from Community Care of North Carolina's Pregnancy Medical Home risk screening form is most predictive of preterm birth and to compare receipt of postpartum contraception for women who experienced a recent preterm birth with women who had a term birth. This retrospective cohort includes pregnant Medicaid beneficiaries screened by the program who delivered a live birth in North Carolina between September 2011 and September 2012. Data come from Community Care of North Carolina's Case Management Information System, Medicaid claims, and birth certificates. The first paper of the dissertation designed and internally validated a predictive model of preterm birth using variables from the Pregnancy Medical Home risk screen. Logistic regression models and bootstrapping techniques indicated that the optimal combination of risk factors for PTB prediction include non-Hispanic black race, smoking during pregnancy, underweight, multi-fetal gestation, chronic disease (diabetes, hypertension, asthma, renal disease, and other chronic conditions), cervical insufficiency, nulliparity, and previous adverse reproductive outcomes (history of preterm birth, low birth weight baby, fetal death, and second trimester loss). Salient risk factors were identified for subgroups by parity and

race/ethnicity including obesity, food insecurity, unsafe or unstable housing, and a short interpregnancy interval. Evaluation of the Pregnancy Medical Home risk screen provides insight to increase its sensitivity and specificity to improve identification of women early in pregnancy at highest risk for preterm birth. The second paper compared the prevalence of contraceptive receipt and effectiveness in Medicaid claims among women with and without a recent preterm birth using logistic and multinomial logistic regression. Contraceptive receipt was 50% (25% for the most effective methods) for women who delivered preterm at 90 days postpartum compared to 52% (28% for the most effective methods) among women who delivered full term. Women with a recent preterm birth with more than two children had lower odds of receiving contraception compared to equal parity women who delivered at term (OR = 0.84, 95% CI: 0.74, 0.96). Care management should focus on the provision of effective methods of contraception to women with a recent preterm birth.

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LIST OF ABBREVIATIONS

aOR	adjusted odds ratio
API	Asian/Pacific Islander
BMI	body mass index
BIF	Bootstrap Inclusion Fraction
CA	California
CMIS	Case Management Information System
CCNC	Community Care of North Carolina
CI	confidence interval
DMA	Division of Medical Assistance
DPH	Division of Public Health
GED	General education development
HEDIS	Healthcare Effectiveness Data and Information Set
HELLP	Hemolysis, elevated liver enzymes, low platelet count
ID	identification
IOM	Institute of Medicine
IPI	interpregnancy interval
IUC	intrauterine contraception
LMP	last menstrual period
LCA	latent class analysis
LARC	Long-acting reversible contraception
LBW	low birth weight
MD	Maryland
MPW	Medicaid for pregnant women
NCHS	National Center for Health Statistics

NSFG	National Survey of Family Growth
NHB	Non-Hispanic black
NHW	Non-Hispanic white
NC	North Carolina
n	number
OE	obstetric estimate
OR	odds ratio
p	p-value
PMH	Pregnancy Medical Home
PRAMS	Pregnancy Risk Assessment and Monitoring System
PTB	preterm birth
ROC	Receiver operating characteristic
SCHS	State Center for Health Statistics
SQL	Structured Query Language
U.S.	United States
17p	17alpha hydroxyprogesterone

CHAPTER 1. INTRODUCTION

PRETERM BIRTH AND HEALTH DISPARITIES

Preterm birth (deliveries <37 completed weeks of gestation) is a major cause of infant mortality and morbidity.[1,2] In 2009, 35% of infant deaths were ‘‘preterm-related.’’[2] Preterm birth (PTB) is associated with an array of short- and long-term health consequences. As detailed in the Institute of Medicine’s (IOM) report on PTB, preterm infants are at higher risk for neonatal intensive care admission, prolonged hospital stay due to morbidity in the first few weeks of life, re-hospitalization in the first years of life, and other longer-term outcomes such as respiratory, gastrointestinal, and neurodevelopmental complications.[3] These health complications have a large societal cost as well as an emotional cost to parents and families. The IOM estimated the total annual economic burden of PTB in the United States in 2005 to be at least $426.2 billion.[3] This translates into $51,600 spent per infant born preterm.[3]

In the most recently available natality data from 2012, the prevalence of PTB was 11.55% nationally and highest for non-Hispanic black women (16.53%), followed by Hispanic women (11.58%), and non-Hispanic white women (10.29%).[4] The Healthy People 2020 goal is to reduce the preterm birth rate to 11.40%.[5]

Racial-ethnic disparities in PTB over the past decade have not declined and the reasons for these disparities remain poorly understood.[6-8] Goldenberg et al. (1996) found that maternal height, weight, blood pressure, diabetes, and smoking

were associated with preterm birth, however these factors did not explain the increased risk of PTB among black women compared to white women in Alabama.[9] In contrast, among a sample of low-income urban black women in Baltimore, MD, chronic disease pre-pregnancy was significantly associated with PTB.[10] This finding is consistent with the "weathering hypothesis" that poorer overall health among black women in the United States contributes to their greater burden of preterm birth[11] and supports the life course framework in the study of disparities in birth outcomes.[12]

In addition to the prevalence of co-morbidities, other potential explanations for these disparities include differential access to care and quality of care, psychosocial stress, poverty, social context or environmental exposures, racism, preconception health differentials, infection/inflammation, and genetic factors.[13–16] Unfortunately previous attempts to reduce disparities have not been successful.[13] Improvement of birth outcomes in the United States hinges on our ability to better understand and reduce this racial gap.[13,17]

In North Carolina, the setting of this dissertation, the prevalence of PTB is higher than the national average. In 2012, the National Center for Health Statistics (NCHS) calculated that 12% of births in NC were preterm.[4] Racial/ethnic disparities in preterm birth have persisted for generations with non-Hispanic black women having the highest rates (16%).[4,18] The concentration of PTB in communities of lower socioeconomic status places a burden on publicly financed health care.[19] Over half of deliveries resulting in live births and 47% of prenatal care provided in NC in 2012 were covered by Medicaid.[18] According to the NC State Center for Health Statistics (SCHS), the PTB rate was 13% among resident live births to women on Medicaid in

2012, which appears lower than estimate for NC as a whole calculated by the NCHS using last menstrual period.[20]

Risk Screening for Preterm Birth Prevention

Since the 1970s, a multitude of researchers have attempted to develop risk screening tools to identify women early in pregnancy who will eventually deliver preterm.[21,22] Despite enhanced understanding of multiple factors that increase the risk of PTB, no predictive model to date has been accurate enough to justify its use in the clinical setting.[3,21–23] Previous risk scoring systems have only been able to identify a small proportion of women who have a PTB as high risk (low sensitivity), while a large proportion who have a PTB have been labeled as low risk (high false negative rate).[21]

Risk screens typically consist of a questionnaire filled out by the patient or an oral history taken by the provider around the time of the first prenatal visit; sometimes a re-screen is conducted later in pregnancy to update the information.[21] Screening tools elicit information on sociodemographic factors, obstetric history, and characteristics of the current pregnancy in asymptomatic women.[21] Risk factors are often added together to form a composite risk score. The weighting of each risk factor and the threshold at which women are considered to be high risk is often determined based on clinical knowledge or statistical analysis.[21] From logistic regression models, predicted probabilities for each participant can be calculated and plotted using receiver operating characteristic (ROC) curve analyses to identify a threshold at which women should be considered high risk.[21]

To determine the usefulness of risk scoring systems in clinical practice, the sensitivity, specificity, and positive and negative predictive values of the instruments in relation to preterm birth can be calculated. More recently, methods to internally validate predictive models have been used such as split sample validation, cross-validation, and bootstrapping.

One example of an evaluation of a previous risk scoring system comes from the preterm birth prediction assessment system study conducted by Mercer et al. in the early 1990s.[24] In this study, nearly 3,000 women with singleton pregnancies were recruited at 10 centers of the Maternal-Fetal Medicine Units Network prior to 24 weeks gestation and assessed for information on demographic factors, home and work environment, drug and alcohol use, and medical history. The outcome of interest was spontaneous PTB prior to 37 weeks of gestation.

Predictive models were developed separately among nulliparous and multiparous women using 85% of the sample and then validated in the remaining 15% of the sample. For nulliparous women, black race, a poor social environment, paid employment, lung disease, a higher Bishop score (a score given to the cervix assessed by vaginal exam), low body mass index (BMI), and contractions were predictive of spontaneous preterm birth.[24] Among multiparous women, a prior spontaneous preterm delivery, vaginal bleeding, low BMI, and increasing Bishop score was predictive of spontaneous PTB.

These models were then validated in the remaining 15% of the sample to determine their predictive value. Predicted probabilities for each woman were calculated and a threshold of 20% was chosen to delineate women at high or low

risk. For nulliparous women, the sensitivity, specificity, positive predictive value, and negative predictive value of the model were 18.2, 95.4, 33.3, and 90.2, respectively.[24] Though this assessment system was able to accurately predict women who did not go on to have a spontaneous PTB (high specificity), its ability to detect women who would have a spontaneous preterm delivery was poor (low sensitivity). The likelihood ratio for a positive test (women with a 20% probability or higher) was 3.9 (95% confidence interval (CI) 1.3–12.0) and the likelihood ratio for a negative test (women with less than a 20% probability) was 0.9 (95% CI 0.7–1.0).

Model performance was slightly more selective for the multiparous sample, however other measures of test performance were lower. The sensitivity, specificity, positive predictive value, and negative predictive value of the model among multiparas were 24.2, 92.1, 30.8, and 89.4, respectively.[24] The likelihood ratio for a positive test was 2.9 (95% CI 1.4–6.1) and for a negative test was 0.8 (95% CI 0.7–1.0). The authors concluded that despite 84.6% of predictions being correct, the system does not identify most women who subsequently have a spontaneous preterm delivery.[24]

In a systematic literature review of 19 articles through 2002 assessing risk scoring tools, Honest et al. (2004) concluded that there is a wide range of accuracy in predicting spontaneous PTB before 37 weeks.[21] Risk screening tools are more discriminating for multigravid women given the importance of past reproductive characteristics on the risk of PTB.[21,25] The review also noted that the evidence was of relatively poor quality.

Aside from the Creasy risk scoring system, others have not been evaluated outside the populations in which they were developed nor evaluated prospectively.[21] Further, few studies have specifically examined births prior to 34 weeks gestation despite the fact that most of the neonatal mortality and morbidity occurs in that range and risk factors may differ depending on the gestational age at which PTB occurs.[21]

A recently published Cochrane review found no trials evaluating the use of risk scoring systems on PTB and thus concluded that the role of risk scoring systems in the prevention of PTB is unknown.[26] More accurate tools with better quality information are needed that improve the identification of women at increased risk of PTB in clinical practice.[21] To achieve this, research that studies multiple risk factors and evaluates risk-screening tools among large and diverse prospective cohorts is warranted.[3,21,26]

Risk screening is intended to guide caregivers' and women's decision-making about the management of their pregnancy as well as target costly interventions to women at highest risk.[21,26,27] The utility of a risk scoring system depends on the prevention and treatment options available to women identified as high risk.[21] Possible interventions that could be paired with a risk scoring tool include channeling high-risk women into intensive multidisciplinary care,[28] individualized risk reduction counseling to women focusing on modifiable risk factors,[22] and ensuring that the birth occurs in a facility with a neonatal intensive care unit.[26] Medical treatments that could complement a risk scoring tool include prevention of a subsequent spontaneous PTB through progesterone administration,[29] attempting to delay birth

through tocolytics (drugs that dampen the contractions),[26] and administration of antenatal corticosteroids to improve neonatal outcomes.[23,30]

Interconception Strategies for Preterm Birth Prevention

Once a woman has been identified as high risk for PTB or has experienced a PTB, interconception care strategies can help to mitigate future risk. In a 12-step plan to reduce disparities in birth outcomes, Lu and colleagues' (2010) first recommendation is to provide interconception care to women with prior adverse pregnancy outcomes.[31] Although an entire package of health care and support services has been proposed in the interconception period,[32] this dissertation focuses on one area—postpartum contraception to optimize interpregnancy intervals (IPIs) and avoid unintended pregnancies.

Women who have experienced a PTB are at higher risk for having a subsequent preterm birth.[33–35] In the Preterm Birth Prediction Study, there was a 2.5-fold increase in the risk of spontaneous preterm delivery among women with a prior spontaneous delivery, particularly those occurring before 28 weeks gestation, compared to women with no prior spontaneous delivery.[36] Black women have been shown to have a higher recurrence of preterm delivery as compared to white women.[37] Little is known about the specific health-related conditions and behaviors that account for this increased risk.[38]

Two interconception care strategies to reduce PTB are increasing interpregnancy intervals and avoiding unintended pregnancies, particularly among women who have experienced a previous PTB.[39] A short interval between pregnancies is associated with an increased risk of PTB.[40–46] Infants conceived less

than six months following a live birth had an odds ratio of 1.4 (95% CI 1.3–1.5) for PTB as compared to those conceived 18 to 23 months after a live birth.[46] These findings, that a birth interval of 18 to 23 months is protective, have been documented among both black and white women.[44,47] Furthermore, short IPIs are also associated with an increased risk of recurrent PTB among women who experienced a previous PTB. [48] DeFranco et al. (2007) found that as the IPI decreased, the risk of recurrent PTB after adjusting for other important risk factors increased.[48]

In the United States, nearly half of all pregnancies are unintended.[49] Women whose pregnancies are unintended are more likely to deliver preterm.[50,51] This finding has not been consistent among studies, however. For instance, in one study, the risk of preterm birth was increased among unintended pregnancies for white and immigrant Latina women but not for black or U.S.-born Latina women.[52] It is also not clear whether this is a causal association or whether the finding reflects residual confounding based on differences in sociodemographics and health behaviors of women who have unintended versus intended pregnancies.[50]

Given the increased risks associated with a history of PTB, short IPIs, and unintended pregnancy, it is recommended that women wait at least 12 months between delivery and subsequent conception, particularly those with a previous PTB.[48] To successfully space births and to avoid unintended pregnancies, women need access to contraception in the postpartum period. However, data on postpartum contraceptive practices among women with a previous PTB are lacking.[38]

To our knowledge only one study has specifically examined postpartum contraception use among women with a recent PTB.[38] In this community-based randomized control trial, the Philadelphia Collaborative Preterm Prevention Project, women with a recent delivery of a living singleton infant at fewer than 35 weeks of gestation were followed at 6 months postpartum to assess the relationship between their desire to prevent or delay subsequent pregnancies and the effectiveness of their contraceptive use. Over half of the 658 women who participated in the six-month assessment wanted to delay a pregnancy but reported using contraceptive methods classified as low or moderate in effectiveness, such as withdrawal or no method at all.[38] However the reasons why so many expressed wanting to delay pregnancy but did not use a more effective method of contraception are unknown. The only variable that significantly predicted the use of a less effective contraceptive method among women wanting to delay pregnancy was low education.[38]

Despite the contribution this study makes to the dearth of research on postpartum contraception among women at high risk for PTB, the sample, which was part of a randomized control trial, was young and selective with only half of trial participants being retained at the six-month assessment.[38] Thus the generalizability of these findings to a broader population of women experiencing a recent PTB is questionable. More generalizable research on postpartum contraception use among women with a prior PTB is warranted to inform strategies to optimize pregnancy intervals and avoid unintended pregnancies, thereby reducing recurrent PTB risk.

STUDY OVERVIEW

This dissertation analyzes risk screening data collected from a retrospective cohort of pregnant women with Medicaid coverage during pregnancy who delivered a live birth in North Carolina between September 2011 and September 2012. The purpose of this dissertation is to develop and validate a risk scoring model for PTB based on risk factors from the PMH risk screening tool among women screened early in pregnancy to more effectively identify and target women at highest risk for PTB for care management. In Chapter 2, the combination of risk factors most predictive for different groups of women by parity and race-ethnicity is presented. In Chapter 3, receipt of postpartum contraception and method type are compared between women who delivered preterm and those who delivered full term to inform interconception strategies for the prevention of PTB.

CHAPTER 2. PREDICTING PRETERM BIRTH AMONG PARTICIPANTS OF NORTH CAROLINA'S PREGNANCY MEDICAL HOME PROGRAM

INTRODUCTION

In 2012, the National Center for Health Statistics (NCHS) calculated that 12.0% of births in North Carolina were preterm, higher than the national average of 11.6%.[4] Racial/ethnic disparities in PTB have persisted for generations with non-Hispanic black (NHB) women having the highest rate (16%).[4,18] In NC, the PTB rate is higher among births covered by Medicaid.[53] The concentration of PTB in populations of lower socioeconomic status places a burden on publicly financed health care.[19]

In response to high rates of PTB in NC, Community Care of North Carolina (CCNC) launched the Pregnancy Medical Home (PMH) contract in partnership with the North Carolina Division of Medical Assistance (DMA) in 2011. CCNC, a not-for-profit organization, manages the care of Medicaid recipients statewide. The PMH program seeks to provide evidence-based, high-quality maternity care to improve birth outcomes in the pregnant Medicaid population.[54] Eighty-five percent of all NC prenatal care providers (over 380 practices and clinics) serve as PMHs, including obstetricians, family physicians, federally qualified health centers, rural health clinics, local health departments, and nurse midwives.[55,56]

Patients at highest risk of preterm birth are identified through a standardized risk screening administered at the first prenatal visit and are referred for pregnancy care

management to address modifiable risk factors. Risk screening is intended to target care management services to women at highest risk and guide caregivers' and women's decision-making about the management of their pregnancy.[21,26,27] As a result of screening, local health departments working in partnership with CCNC networks provide pregnancy care management services to women. The level of service provided is in proportion to the individual's identified needs. Care managers closely monitor the pregnancy through regular contact with the physician and patient to promote a healthy birth outcome. Additionally, eligible women with a history of spontaneous PTB or preterm rupture of the membranes who are currently pregnant with a singleton are offered 17alpha hydroxyprogesterone (17p). Pregnancy care management services continue through the postpartum period, which is defined by Medicaid as ending on the last day of the month in which the sixtieth postpartum day occurs.

The risk screening tool includes over 40 demographic, psychosocial, current pregnancy, and obstetric history risk factors. About 10 conditions are considered priority risk factors and will automatically trigger an assessment by a pregnancy care manager.[56] Priority risk factors include:

- current or recent tobacco or substance use;
- unsafe living environment (e.g., homelessness, inadequate housing, intimate partner violence, sexual abuse);
- presence of chronic disease (e.g., diabetes, hypertension, human immunodeficiency virus, systemic lupus erythematosus, mental illness);
- fetal complication (fetal anomaly, fetal chromosomal abnormality, intrauterine growth restriction, oligohydramnios, polyhydramnios, and others);
- multi-fetal gestation;
- previous PTB or low birth weight (LBW) baby;
- delayed or inconsistent prenatal care; and

- hospitalization or emergency department use during pregnancy.

The healthcare provider can also check a box to request pregnancy care management.

The priority risk factors were chosen based on evidence reviewed by a multidisciplinary workgroup. The goal was to identify risk factors with the strongest associations with PTB, with consideration given to modifiable factors that drive increased use of the healthcare system and could be addressed through care management.

It was anticipated that the risk screening would prioritize about half of pregnant Medicaid beneficiaries for care management. However, in practice the screening tool is not as specific as intended. Between January and June 2012, more than 75% of pregnant Medicaid patients (20,288) were screened, of which two-thirds had a least one priority risk factor.[56] Under the current prioritization scheme, the priority population exceeds the capacity of the pregnancy care management program. Furthermore, it is not known whether the current priority risk factors are identifying those women at highest risk for PTB.

The purpose of this analysis is to determine which combination of risk factors from the PMH screening tool best predicts PTB among women who entered care early enough to benefit from the care management intervention. To better target specific high-risk populations, we will examine whether certain risk factors are more predictive by parity and race/ethnicity. Analysis of the PMH risk screening tool linked to birth certificate data provides a unique opportunity to evaluate new and detailed clinical risk factor data not typically available for a large and diverse sample of

women with Medicaid identified early in pregnancy. Information gained through this evaluation will help better target resources to those most likely to benefit from intervention and tailor care management to specific risk profiles.

METHODS

Data Source

We conducted a retrospective cohort analysis using data from CCNC's Case Management Information System (CMIS), Medicaid claims, and birth certificates. Birth certificate data are matched to Medicaid delivery claims in the Division of Medical Assistance (DMA) data warehouse using Structured Query Language (SQL) Server Integration Services Fuzzy Lookup component software, producing a match rate of 95%.

The risk screening is administered at the first prenatal visit (median of 13 weeks gestation) and is entered into CMIS. The provider collects a medical history and checks a box for the presence of a risk factor. Psychosocial questions like pregnancy intention are self-administered in English, Spanish, or Russian, or may be completed through a patient interview. Risk screening forms must be provided within 7 days of completion to the pregnancy care manager, who in turn must conduct an assessment within 30 days. Providers may rescreen the patient at any time during the pregnancy if high-risk conditions are suspected.

To link to risk screening data during the gestational period for the index delivery, the obstetric estimate (OE) of gestation from the birth certificate was subtracted from the infant's date of birth to calculate the mother's last menstrual period (LMP) date. The risk screening with the earliest date conducted during the

gestational period was linked to the index birth via the mother's Medicaid identification number (ID).

All women with a valid risk screening collected between August 31, 2011, and May 20, 2012, and with a corresponding delivery between September 1, 2011, and September 30, 2012, were eligible for this analysis (n=22,612). Women were excluded if they were screened before 6 weeks or at or after 24 weeks gestation (n=6,002), if they had only Emergency Medicaid (n=7), or had a live birth prior to 24 weeks gestation (n=62). Additionally, women missing data on risk factors from the screening that could not be substituted with birth certificate data were excluded (n=1,093, or 6.6%). The final sample size was 15,428 women (Figure 2.1).

All study procedures were reviewed and approved by the Institutional Review Board for the Protection of Human Subjects at the University of North Carolina at Chapel Hill.

Measures

Preterm birth (less than 37 weeks completed gestation) was defined using the OE of gestation from the birth certificate. This method differs from the NCHS calculation based on last menstrual period.[57] We evaluated all of the risk factors collected on the PMH Risk Screening tool in relation to PTB and grouped them as follows: psychosocial, current pregnancy, obstetric history, and sociodemographic and program characteristics. Risk factors were dichotomous (yes/no) unless otherwise noted.

Psychosocial Characteristics

Pregnancy intention was collapsed into three categories: intended (wanted to be pregnant sooner/now) [referent], unintended (wanted to be pregnant later/did not want to be pregnant then or any time in future), or don't know. Missing information on smoking (2%) was substituted with values from the birth certificate (kappa for non-missing 3-category smoking 0.69). Smoking was a 4-part categorical variable: never or <100 cigarettes ever [referent], stopped smoking before found out was pregnant, stopped smoking after found out was pregnant, and smoke now but cut down, or smoke same amount since found out was pregnant. Questions on whether the participant's parent, friend, and/or partner had a problem with alcohol or other drug use were combined into one substance abuse variable equal to one if any member had a substance problem. Questions assessing drug and alcohol use before pregnancy and in the past month were dichotomized as any (rarely, sometimes, or frequently) [referent] vs. none.

Current Pregnancy Characteristics

Delayed prenatal care was defined as initiation after 14 weeks gestation. A short IPI was fewer than 12 months between the last live birth and current pregnancy. Recurrent urinary tract infections was defined as more than two in the past six months or more than five in the past two years. Communication barrier included participants with a disability, literacy issues, or non-English speakers. Hypertensive disorders of pregnancy included eclampsia, preeclampsia, gestational hypertension, and HELLP syndrome. About 18% of women were missing BMI on the risk screening; these data were substituted with BMI calculated from birth certificates

(kappa for non-missing 4-category BMI 0.78) and categorized into four groups: underweight (<18.5), normal (18.5-24.9) [referent], overweight (25.0-29.9), or obese (≥30).

Obstetric History

For multivariate modeling, fetal death (>20 weeks) and second trimester pregnancy loss were combined into one variable, as was a history of cervical insufficiency and cervical insufficiency in the current pregnancy.

Sociodemographic and Program Characteristics

We used several measures from birth certificates and Medicaid claims including maternal age, race/ethnicity, parity, and Medicaid program status. Age at delivery was calculated by subtracting the mother's date of birth in Medicaid claims from the delivery date on birth certificates and categorized as ≤18, 19–34 [referent] and ≥35. Race/ethnicity from the birth certificate was categorized as non-Hispanic white [referent], non-Hispanic Black, Asian/Pacific Islander, American Indian/Alaska Native, and Hispanic. Multiple or "other" race participants were reassigned in the following priority: Hispanic, Black, Asian/Pacific Islander, and American Indian/Alaska Native. Parity from the birth certificate was calculated by adding the number of live births now living and now dead and dichotomized as nulliparous vs. parous [referent]. Medicaid program status was collapsed into Medicaid for Pregnant Women or any other category of Medicaid. Additional information about the participant's PMH program involvement came from CMIS, including whether or not she received care management or 17p treatment.

Analysis

Descriptive statistics and bivariate analyses (including Pearson's chi-square tests) were used to compare the distributions of all the risk factors from the risk screening tool and PTB. We examined crude associations between risk factors and PTB using logistic regression. Any risk factor from the risk screening (sociodemographic, psychosocial, current pregnancy, and obstetric history characteristics) that was significant at the $p<0.05$ level in the Pearson's chi-square tests or in the crude logistic regression model was included in the first full model. Backwards stepwise elimination was used to determine the optimal combination of risk factors for PTB, eliminating variables with a p-value greater than 0.05. All analyses were conducted using Stata version 13.0 (StataCorp. 2013. *Stata Statistical Software: Release 13*. College Station, TX: StataCorp LP.)

To obtain an unbiased internal assessment of the predictive performance of the final model in the full sample, we used bootstrapping.[58,59] After fitting the model in the original dataset, we conducted backwards stepwise deletion in 1,000 bootstrap samples with replacement from the original sample and present bias-corrected (BC) confidence intervals (CIs) from the bootstrap results.

To test whether particular risk factors were predictive for different groups, we conducted stratified analysis and tested for interaction by parity (nulliparous vs. parous) and race/ethnicity (non-Hispanic black and non-Hispanic white). Covariates were included as effect measure modifiers in the adjusted interaction models if the Wald p-value was less than 0.05, there were sufficient observations in each cell ($n \geq 10$), and there was evidence of heterogeneity in the stratified analysis (either the

confidence intervals for each level of the potential modifier did not overlap or they overlapped but neither included the other point estimate). For the race/ethnicity interaction model, we excluded Hispanic (n=1,243), Asian/Pacific Islander (n=383), and American Indian/Alaska Native (n=436) participants due to small cell sizes and based on our interest in disparities between non-Hispanic black (NHB) and non-Hispanic white (NHW) women.

We calculated the predicted probability of PTB for each woman using the linear predictor from the final model. We used receiver operating characteristic (ROC) curve analyses to determine the high-risk threshold for PTB at the point on the curve where the sum of sensitivity and specificity was highest. Using this cutoff, we calculated measures of model performance such as the sensitivity, specificity, and positive and negative predicted values.

Additionally, we conducted several sensitivity analyses. We compared sample characteristics to the population of live births occurring in NC during this same time frame. To examine whether the intervention affected associations between risk factors and PTB, we compared model selection in the full sample to women who did not receive care management and women who did not receive 17p treatment. To examine how sensitive model selection was to our definition of PTB, we examined stricter classifications of <32 and <34 weeks completed gestation given that the bulk of mortality and morbidity occur in earlier gestational ages and there may be different physiological mechanisms involved according to the timing of PTB.

RESULTS

Sociodemographic and Program Characteristics

The prevalence of PTB was 11.0% (Table 2.1), higher than the rate we calculated among all resident live births in NC during the same time period (10.1%), even with the additional 0.4% of births at less than 24 weeks that were excluded from our sample. Compared to all resident live births in NC from September 2011–September 2012, our Medicaid sample screened before 24 weeks gestation was younger, less educated, less likely to be married, and more likely to be NHB or American Indian/Alaska Native and less likely to be NHW or Hispanic. Also, women in our sample were more likely to smoke, be underweight or obese, and be nulliparous.

Preterm birth was more frequent among NHB women, those 35 years or older, unmarried women and women born in the United States (Table 2.1). Women who screened positive for one or more priority risk factors and received care management (61%) had a higher prevalence of PTB than women who were not care managed. Administration of 17p was documented in only 2% of the sample; 23% of those women had a PTB.

Psychosocial Characteristics

Table 2.2 displays the frequency of experiencing a PTB by current pregnancy characteristics. Women who answered “don’t know” about their pregnancy intention, whose living situation was unsafe or unstable, or who used drugs or alcohol in the past month of pregnancy had a higher prevalence of PTB. Over 20% of women

continued to smoke after they found out they were pregnant, and among them, the PTB prevalence was 13%.

Current Pregnancy Characteristics

Table 2.3 displays current pregnancy characteristics including chronic diseases and other conditions that affected the current pregnancy. A high percentage of births with multi-fetal gestation, fetal complications, and cervical insufficiency resulted in a PTB. Nearly 17% of women had a chronic condition. Among the chronic diseases assessed, women with diabetes, hypertension, asthma, renal disease, and other chronic conditions (e.g., thyroid disease and anemia) had a higher prevalence of PTB. Women with hypertensive disorders had a higher prevalence of PTB. Fifteen percent of women had providers who requested an assessment and these women had a higher prevalence of PTB than women whose providers did not request an assessment.

Obstetric History Characteristics

The prevalence of prior adverse pregnancy outcomes ranged from 0.3% for a history of cervical insufficiency to 7.5% for a previous PTB. All of the obstetric history variables assessed affected prevalence of PTB (Table 2.4) with the exception of postpartum depression.

Tables 2.5 and 2.6 show the crude odds ratios and 95% confidence intervals. Older and NHB women had higher odds of PTB. Among the psychosocial risk factors, answering “don’t know” about their pregnancy intention, unsafe or unstable housing, continued smoking during pregnancy, past substance abuse, and alcohol or drug use in the past month were statistically significant predictors of PTB.

Women with multi-fetal gestation, fetal complications, chronic disease, or cervical insufficiency all had elevated odds ratios for PTB, as did women whose provider requested that they receive a pregnancy care assessment (Table 2.6). Underweight and obese women also had an increased risk of PTB. Women who obtained late prenatal care, had a communication barrier, or were having their first pregnancy had reduced odds of PTB. All prior adverse pregnancy outcomes were associated with elevated odds of PTB with the exception of postpartum depression.

Predictive Model of Preterm Birth

The final predictive model in the full sample included 15 variables (Table 2.7). Bias-corrected confidence intervals from model selection generated using 1,000 bootstrap replications are presented in Table 2.7 and are similar to 95% CIs in the original sample. Individual dummy variables that were not significant but part of a variable that was a significant predictor were also included in the model. Non-Hispanic black race (OR=1.40, BC 95% CI: 1.25, 1.56) continued to be a statistically significant predictor of PTB once a variety of psychosocial, current pregnancy, and obstetric history risk factors were included. The only psychosocial risk factor that remained in the final model was continuing to smoke throughout pregnancy (OR=1.37, BC 95% CI: 1.21, 1.57), but those who quit after finding out they were pregnant were not at increased risk. Among current pregnancy characteristics, underweight remained a statistically significant risk factor, however obesity was no longer associated with an elevated risk of PTB.

Of the chronic diseases, diabetes, hypertension, asthma, renal disease, and “other” remained in the final model. Nulliparous women had 1.20 times the odds of

PTB as parous women (BC 95% CI: 1.06, 1.33) when adverse reproductive history variables were included in the model. Among the adverse obstetric history risk factors, a history of PTB, delivering a LBW infant, and fetal death/second trimester loss remained statistically significant at $p<0.05$. Additionally, for each risk factor that was included in the first full model before backwards stepwise selection, we present the bootstrap inclusion fractions, or the percent of bootstrap samples in which each risk factor appeared (Table 2.8).

Parity and Race/Ethnicity

Two risk factors, food insecurity and BMI, had associations with PTB that differed by parity (Table 2.9). Parous women had an elevated risk of PTB associated with food insecurity (OR = 1.41, 95% CI: 1.04, 1.91) but nulliparous women did not (OR = 0.81, 95% CI: 0.58, 1.13). As previously documented, obesity was associated with a higher risk of PTB among nulliparous women only (OR for obese = 1.31, 95% CI: 1.07, 1.59),[60–62] while obesity appeared protective for PTB among parous women (OR = 0.74, 95% CI: 0.62, 0.87).

Two risk factors varied by race/ethnicity. Unsafe or unstable housing was associated with an increased risk of PTB among NHW women (OR = 1.46, 95% CI: 1.06, 2.02) but not NHB women (Table 2.10). An interpregnancy interval (IPI) of less than 12 months was associated with an increased risk of PTB birth among NHB women only (OR =1.39, 95% CI: 1.02, 1.88).

Table 2.11 compares risk factors currently prioritized by the PMH program to risk factors in our final model in the full sample and those significant among subgroups. Approximately half of the PMH program's prioritized risk factors

remained in our models (Table 2.11, column B). Several risk factors that remained in the final model and interaction analyses are not prioritized by the program (Table 2.11, column C). Several more that are prioritized by the PMH program did not remain in the final model or subgroup analyses (quitting smoking once finding out about pregnancy, current or recent drug or alcohol use, intimate partner violence, sexual abuse, HIV, SLE, seizure disorder, mental illness, and fetal complications) (Table 2.11, column D).

Test Characteristics

The ROC of the final model was 0.66 (Figure 2.2). The point on the curve that optimized both sensitivity and specificity was a predicted probability of 0.11. Using 0.11 or higher as our risk cutoff, 22% of women screened positive. The sensitivity was 44%, specificity 81%, positive predictive value 22%, and negative predictive value 92% (Table 12). Seventy-six percent were correctly classified. However, this risk cutoff is quite restrictive and refers fewer women for care management than the program has resources to serve. For most risk factors, it would take several in combination to reach this threshold. Furthermore, the percent of women who screen negative and go on to have a PTB is 56% according to a 0.11 cutoff. A lower cutoff of 0.085 fits the program's capacity to intervene with half of women. Although the specificity and PPV are reduced, fewer women who go on to have a PTB are missed (false negative rate is 29%).

The ROC for our model with interaction terms for parity and race/ethnicity was slightly improved (0.67). Formal test of the equality of the ROC curves showed that this improvement was statistically significant ($p<0.05$). Finally, for comparison to the

PMH program's current prioritization scheme, we calculated test characteristics based on the number of women having at least one priority risk factor. The ROC was lower (0.64, p <0.0001). The test characteristics demonstrated the poorer performance, with the exception of sensitivity and the false negative rate for true PTB, of the current prioritization scheme in which every risk factor is weighted the same and 71% of women screen positive.

Sensitivity Analyses

We compared model selection in the full sample with women who did not receive care management (n=6,081). Given the smaller sample size, most measures were stronger in magnitude and less precise (Figure 2.3). All variables from the final model in the full sample remained statistically significant predictors of PTB at p<0.05 except smoking, underweight, asthma, renal disease, and LBW. Next we excluded women who received 17p treatment (n=339), and model selection yielded results similar to the full sample except that LBW and "other" chronic conditions fell out of the model and current pregnancy hypertensive disorders and pregnancy intentions remained in the model (Figure 2.4).

We examined stricter definitions of PTB (<32 and <34 weeks). Narrowing the gestational age window resulted in fewer factors that were significant predictors (Figure 2.5). When PTB was defined as less than 32 weeks, underweight, asthma, renal disease, and "other" chronic conditions fell out of the model. For PTB less than 34 weeks, underweight, asthma, renal and "other" chronic conditions were no longer significant predictors at p<0.05.

DISCUSSION

We evaluated the PMH risk screening tool to determine the optimal combination of risk factors most predictive of PTB and internally validated our predictive model among a large and diverse cohort of women screened early in pregnancy. The final predictive model included: non-Hispanic black race, continuing to smoke during pregnancy, underweight, multi-fetal gestation, chronic diseases (diabetes, hypertension, asthma, renal disease, and other), cervical insufficiency, nulliparity, and a history of PTB, LBW, and fetal death/second trimester loss. To provide care management to those at greatest risk and reduce PTB rates and associated costs, the PMH program should target resources to women with these risk factors.

Our final predictive model improves on the current PMH prioritization scheme, which weights all priority risk factors equally and screens in 70% of women. The specificity and PPV of our final predictive model are higher than those of the priority risk factor model (specificity: 81% vs. 31% and PPV: 22% vs. 12%). The sensitivity of our final model is lower than the priority risk factor model (44% vs. 79%), but comparable to the sensitivity of other risk scoring systems, typically below 40%.[24,25,28,30,63–65] However, comparison across studies is hampered by differing outcome definitions, by mode of delivery (spontaneous vs. all), and by gestational age (early PTB <32 vs. <37 weeks), as well as different PTB prevalence and scores for a positive test.

Previous research suggests that inclusion of endemic risks to specific populations may improve the validity of screening tools.[28] Therefore we tested for

interaction by parity (because risk scoring tools are more discriminating for multigravida women given the importance of obstetric history)[21,25] and by race/ethnicity. Addition of variables that were highly predictive of PTB among certain subgroups (food insecurity, obesity, unsafe or unstable housing, and short IPIs) slightly improved the predictive ability of the model. The PMH program should consider including these as priority risk factors given their importance among vulnerable subgroups, particularly nulliparous and NHB women.

Based on our final model in the full sample and our interaction analyses, we have several recommendations for revising the risk screen. First, variables currently prioritized that remained in our final model should continue to be prioritized (current smoking, diabetes, hypertension, asthma, renal disease, other chronic conditions, multi-fetal gestation, and previous PTB and LBW) (Table 2.11, column B). Given the current tool's lower sensitivity and PPV, which refers any woman for assessment with at least one priority risk factor and counts all factors equally, applying weights to the risk factors based on the odds ratios from the final model could increase the predictive value of the tool by decreasing the prevalence of a positive test.

Second, to direct resources where they are most needed, some priority risk factors that did not remain in the final model should be deprioritized (Table 2.11, column D). For instance, 17% of women stopped smoking once they found out they were pregnant and were care managed despite the fact that their risk of PTB was not substantively higher than women who quit before pregnancy or never smoked. Forty-four percent (n=1,178) of these women do not have any other priority risk factors; thus, deprioritizing women who quit smoking would enable care managers to

focus on higher-risk women. Delayed prenatal care could be dropped as a priority risk factor because this had an inverse relationship with PTB, likely due to the increased likelihood of women entering care late to be younger, Hispanic, foreign-born, and less likely to have had a previous adverse outcome or carry multiples. This would remove 1,148 women who had no other priority risk factor. Among the 1,148 that would no longer be eligible for care management, 181 cases of PTB would be missed. Before risk factors are removed from the priority list, it will be important to verify through similar analyses that these factors are not highly predictive of other important maternal and child outcomes that the program aims to impact.

Third, consideration should be given to adding several risk factors that remained in the final models but are not currently prioritized (Table 2.11, column C). Adding underweight (n=703, 5%), cervical insufficiency (n=102, 1%), and fetal death/second trimester loss (n=317, 2%) is advisable because they are likely to increase the predictive value of the tool. Additionally, some of these risk factors are amenable to intervention, which is an important consideration for the PMH program. In all, 1,122 high-risk women would be added, a net reduction of 1,204 women.

Two additional risk factors not currently prioritized by the program, nulliparity and NHB race, remained significant in our final model (Table 2.11, Column C). Questions remain whether these risk factors can be modified by care management given our limited knowledge of the mechanisms placing these women at higher risk and whether or not the PMH program has the resources to care manage such a large proportion of the population, many of whom do not have any other priority risk factor.

We sought to identify risk factors that would be amenable to intervention within these groups. Eleven percent (n=1,792) of nulliparous women were obese, of which 31% had no other priority risk factor. Given the increased risk of PTB among obese nulliparous women, intervening on obesity may be one strategy to focus resources on a subgroup of nulliparous women more likely to benefit from intervention.

Only one risk factor, a short interpregnancy interval, increased the odds of PTB differentially for NHB women. About 6% or 353 NHB women had a short IPI, of which 25% had no other priority risk factor. Previous studies have shown that black women are 1.8 times more likely to have short IPIs compared to whites, particularly intervals less than six months.[40,45,66,67] Our findings are consistent with the "weathering hypothesis," that poorer overall health among black women in the United States contributes to their greater burden of PTB.[11] Perhaps a short interval between pregnancies compounds the risk for black women who may have poorer health over the life course.[12]

NHB women who had short intervals were more likely to report their pregnancy as unintended compared to other women with short intervals in our sample (69% vs. 56%). However, the odds of PTB associated with a short IPI among NHB women remained elevated when we controlled for pregnancy intention and other potential confounders like age, parity, education, marital status, chronic diseases, and previous adverse outcomes (OR = 1.37; 95% CI: 1.00, 1.87) (results not shown).

Interaction between short IPI and race has been tested in previous studies but not supported,[40,47,66,67] with the exception of one study among military women in which Rawlings et al. (1995) documented higher PTB rates among intervals less than nine months for blacks.[45,66] Differing results between our findings and those lacking interaction could be because our measure of short IPI (<12 months) is based on physician report versus vital or medical records. Additionally, we include women of higher parity whereas other studies included first and second births only.[66] In our sample, NHB women were more likely to have short IPIs among higher-order births (parity $\geq$2) than NHW women (55% NHB vs. 48% NHW).

Unfortunately no other risk factors assessed explained the increased risk among NHB women, as has been observed in previous studies.[9] The risk screening tool does not assess factors such as racism, discrimination, stress, and unequal access to opportunities or resources from which disparities originate.[13,68] Prioritizing all NHB women for care management may be the best starting point toward eliminating this gap among pregnant women on Medicaid in NC. Although reducing the risk of short IPIs among black women is one way to reduce disparities in PTB,[66] there is some evidence that social support and care coordination in the prenatal and interconception period could potentially reduce rates of poor birth outcomes among black women.[69–72] Primary health care and social support for low-income black women in Georgia following an adverse reproductive outcome helped achieve longer IPIs and fewer subsequent adverse pregnancy outcomes.[69] If care management is offered to all black women and decreases in PTB are documented, future research

could determine which aspects of care management are most influential and provide insight into closing the gap in racial/ethnic disparities in birth outcomes.

Although psychosocial factors (aside from smoking) were not significant among the full sample, we found two factors that were predictive of PTB among subgroups—food insecurity and housing. Food insecurity, defined as being hungry from not being able to eat or being unable to afford food in the past 12 months, was a significant predictor of PTB among parous women only. To our knowledge, this is a new finding, perhaps because our assessment does not account for household size like other measures of food insecurity. We hypothesize that this finding captures the stress associated with having food insecurity in the context of providing for a family compared to food insecurity among nulliparous women without other children to feed. A study conducted among black and white women in central NC showed that perceived stress was the predominant psychosocial indicator associated with food insecurity, even when adjusting for demographic and other psychosocial variables.[73]

Our study contributes to the emerging literature on the complex influences of the interaction of the social environment and race/ethnicity. Unsafe or unstable housing was associated with PTB among NHW women but not NHB women. This echoes previous work by Dole and colleagues (2004) in NC who found that blacks were more likely than whites to report low perceived neighborhood safety but had no increased risk associated with it.[37] Also, O'Campo and colleagues (2008) found that neighborhood deprivation was more strongly associated with PTB for whites than blacks despite blacks being more likely to live in deprived areas.[74,75]

There are several limitations to this analysis. We excluded 6.6% of women due to missing data. Excluded women were more likely to be older, parous, non-white, foreign-born, married, less educated, to use substances and smoke, live in unsafe or unstable housing, have a fetal complication, and have a provider who requested a care management assessment. We substituted missing values for BMI and smoking and used parity and race/ethnicity from the birth certificate because the data were more complete. Thus inferences for these risk factors are based on how they are reported on the birth certificate, which may differ from the risk-screening tool. If data collection and quality for these measures are not improved, efforts to identify and target women with these risk factors will be hampered. Additionally we were unable to examine two priority risk factors (missed two or more prenatal care appointments and hospital use during pregnancy) due to small numbers.

Numbers for current pregnancy characteristics were low for conditions that are often not detected until later in the pregnancy such as hypertensive disorders of pregnancy, likely due to our screening cutoff prior to 24 weeks. Another possible explanation is that current pregnancy and obstetric history variables are assessed by a single check box (rather than yes/no), thus it is possible the provider neglected to check a condition that was present. Instead of being counted as missing, it was counted as an absence of the condition. This could lead to a lower prevalence of these factors and an underestimation of the effects. For example, hypertensive disorders in the current pregnancy showed evidence of interaction with parity such that nulliparous women had elevated odds of PTB associated with it. However, due to small cell sizes ($n<5$), we did not include it in the final models. Still, it warrants

reexamination among women screened later in pregnancy. We compared the prevalence of chronic conditions on the risk screening to those from birth certificates in our sample and the prevalence on the risk screen was higher. For example, the prevalence of chronic diabetes and hypertension was 1.47% and 2.90% from the risk screen and 0.97% and 2.26% from the birth certificate. This suggests that chronic disease reporting on the risk screen may be more complete than the birth certificate.

We chose a 24-week cutoff because we wanted to ensure that measurement of exposures occurred before the outcome and to identify risk factors that were predictive of PTB among women who entered care early enough to benefit from the care management intervention. Thus the final predictive model may not capture risk factors that are predictive of PTB among women screened later in pregnancy. We examined the selectivity of our sample by comparing sample characteristics to those of women screened after 24 weeks of completed gestation. Nearly three-fourths of women were screened prior to 24 weeks and 79% of PTBs occurred to them. Women screened after 24 weeks were more likely to be Hispanic, foreign-born, report an unintended pregnancy, and have a previous live birth. They were less likely to be NHB, to smoke or abuse substances, or to have had a previous adverse reproductive outcome. By excluding women screened at 24 weeks or beyond, we were more likely to miss lower-risk women. If we had not excluded these women, the prevalence of PTB would be 10.93% instead of 11.01%.

Over 60% of women included in our analysis received care management versus usual care based on having one or more priority risk factors. The program's

care management activities could potentially reduce the association between risk factors and PTB, biasing our predictive model.[28] For example, women with a prior spontaneous PTB are at higher risk for a subsequent PTB, but through the PMH program, 2% were documented as receiving progesterone (17p) treatment, which could underestimate the effect of prior PTB.[22] In an attempt to reduce potential intervention effects, we conducted our analysis among women screened at program inception in 2011. Our sensitivity analyses showed slight changes in selected variables for the final model when women receiving care management and 17p treatment were removed, likely due to the smaller sample size.

Finally, obstetric estimate of gestation was used as our outcome measure. Several studies have examined the validity of OE since its addition to the 2003 revision of the birth certificate and concluded that OE may undercount the rate of PTB.[76–80] We acknowledge that OE may underestimate PTB and make our estimate of PTB look better than the national prevalence based on LMP calculated by NCHS, however, we chose to use OE because LMP was missing more observations in our sample and LMP has its own limitations.[78,79]

Despite these limitations, our analysis provides insight into how the evidence-based PMH program can increase the sensitivity and specificity of their tool. The PMH risk screen assesses many factors, several of which have never been assessed in previous tools, with the ability to intervene in real time to guide decision-making about pregnancy management. Patient-specific predicted probabilities from our final model can be calculated for each woman screened, which is an improvement over the current prioritization scheme that does not weight risk factors.

The improved specificity can help prevent care managers from becoming overburdened serving too many women, which could lead to a “watering down” of the intervention. Based on linkage from birth certificates, Medicaid claims, and PMH risk screens, salient risk factors for PTB were identified for vulnerable subgroups that will allow for better targeted prevention approaches that could promote health equity in birth outcomes. At the same time, we recognize that identifying women at highest risk is only the first step. The utility of a risk scoring system depends on the prevention and treatment options available to women identified as high risk.[21] More evidence on the ability of and mechanisms through which care management reduces poor birth outcomes and associated costs is needed.

FIGURES AND TABLES

Figure 2.1. Analysis sample.

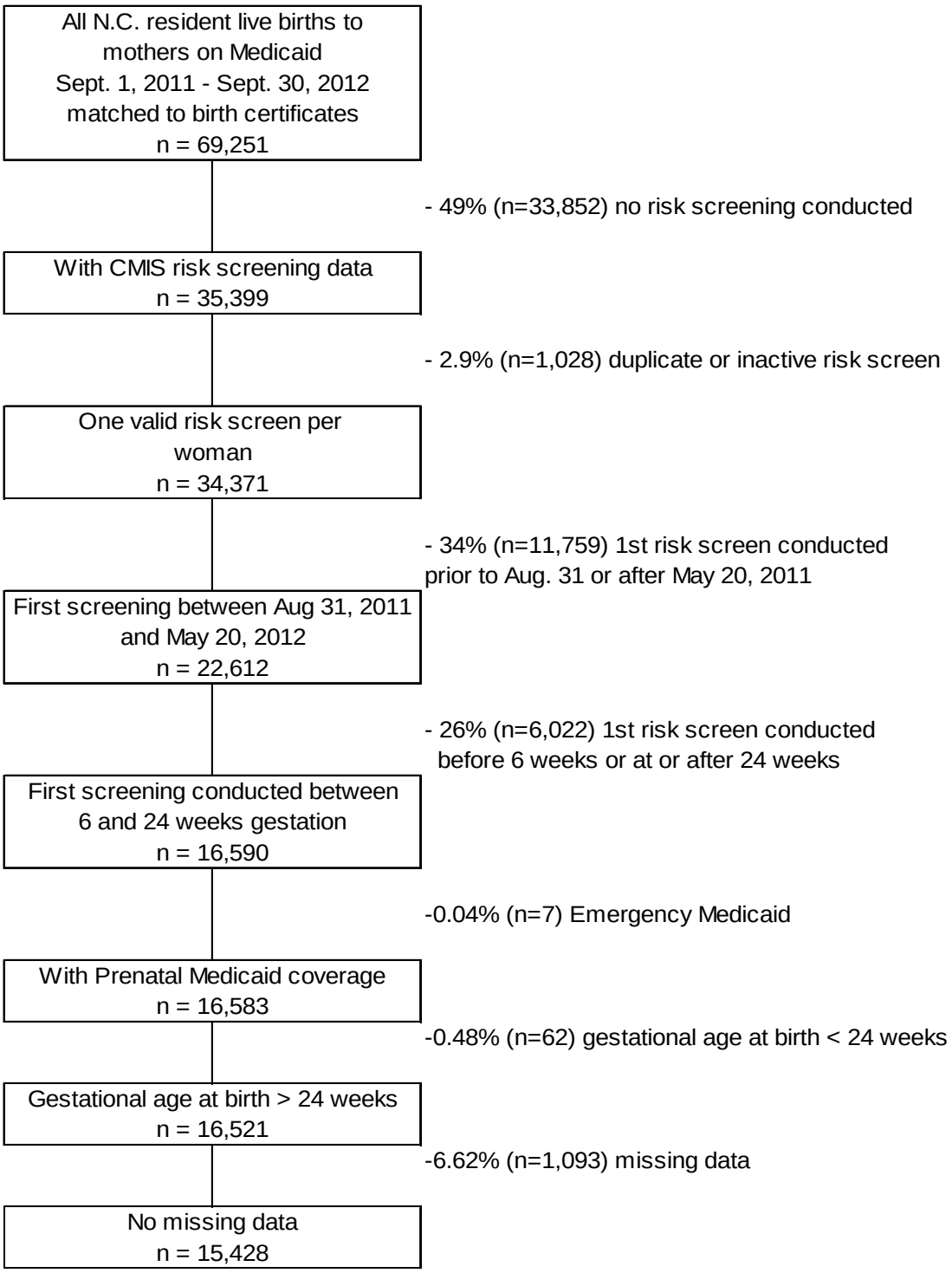


Table 2.1.

Sociodemographic and Program Characteristics among Women Screened by the Pregnancy Medical Home Program, Stratified by Preterm Birth (n=15,428)

	Total	Term 37–42 weeks		Preterm 24–36 weeks		
	(Col %)	N	%	N	%	p-value*
Sociodemographics						
Age at Delivery						0.008
≤18	(10.36)	1427	89.30	171	10.70	
19-34	(84.44)	11616	89.16	1412	10.84	
≥35	(5.20)	687	85.66	115	14.34	
Race/Ethnicity						0.0001
Non-Hispanic White	(46.37)	6461	90.31	693	9.69	
Non-Hispanic Black	(40.26)	5402	86.96	810	13.04	
Asian/Pacific Islander	(2.48)	344	89.82	39	10.18	
American Indian/Alaska Native	(2.83)	389	89.22	47	10.78	
Hispanic	(8.06)	1134	91.23	109	8.77	
U.S. Born						0.011
No	(6.44)	909	91.45	85	8.55	
Yes	(93.56)	12821	88.82	1613	11.18	
Married at Conception or Birth						0.002
No	(70.92)	9682	88.48	1260	11.52	
Yes	(28.99)	4035	90.23	437	9.77	
Missing (n=14)	(0.09)	13	-------	1	-------	
Education Level						0.144
< High School	(25.40)	3468	88.49	451	11.51	
High School Graduate or GED	(35.51)	4912	89.65	567	10.35	
Some College or More	(39.03)	5343	88.72	679	11.28	
Missing (n=8)	(0.05)	7	-------	1	-------	
Program Characteristics Medicaid for Pregnant Women (MPW)						0.0001
No	(34.15)	4602	87.36	666	12.64	
Yes	(65.85)	9128	89.84	1032	10.16	

Received Care Management						0.0001
No	(39.42)	5522	90.81	559	9.19	
Yes	(60.58)	8208	87.81	1139	12.19	
Received 17p[†]						0.0001
No	(97.80)	13505	89.50	1584	10.50	
Yes	(2.20)	225	66.37	114	33.63	
Sample Size (n)	**100.00**	**13730**	**88.99**	**1698**	**11.01**	

Source: Pregnancy Medical Home Case Management Information System, North Carolina Birth Records, and Medicaid Claims Data from September 1, 2011, to September 30, 2012.
(Col %) = column percent; N = frequency; % = row percent. *p-value from the Pearson chi-square test calculated without missing. †Eligible women with a history of spontaneous preterm birth or preterm rupture of the membranes who are currently pregnant with a singleton (n = 542) are offered 17alpha hydroxyprogesterone (17p).

Table 2.2.

Psychosocial Characteristics among Women Screened by the Pregnancy Medical Home Program, Stratified by Preterm Birth (n=15,428)

	Total	Term 37–42 weeks		Preterm 24–36 weeks		
	(Col %)	N	%	N	%	p-value*
Pregnancy Intention						0.007
Intended	(26.65)	3685	89.64	426	10.36	
Unintended	(54.81)	7545	89.23	911	10.77	
Don't know	(18.54)	2500	87.38	361	12.62	
Physical Violence (past year)						0.392
No	(95.97)	13183	89.04	1623	10.96	
Yes	(4.03)	547	87.94	75	12.06	
Intimate Partner Violence						0.296
No	(99.62)	13680	89.01	1689	10.99	
Yes	(0.38)	50	84.75	9	15.25	
Forced Sex (ever)						0.703
No	(98.23)	13489	89.01	1666	10.99	
Yes	(1.77)	241	88.28	32	11.72	
Food Insecurity (past year)						0.189
No	(94.72)	13017	89.07	1597	10.93	
Yes	(5.28)	713	87.59	101	12.41	
Unsafe or Unstable Housing						
No	(93.80)	12900	89.14	1571	10.86	0.021
Yes	(6.20)	830	86.73	127	13.27	
Smoking Status						0.0001
Never or Fewer than 100 Cigs	(50.17)	6935	89.60	805	10.40	
Stopped before Pregnancy	(10.27)	1440	90.85	145	9.15	
Stopped after Pregnancy	(17.17)	2365	89.28	284	10.72	
Cut down since Pregnancy/Smoke Same Amount	(22.39)	2990	86.57	464	13.43	
Parent/Friend/Partner Substance Problem						0.839
No	(77.70)	10671	89.02	1316	10.98	
Yes	(22.30)	3059	88.90	382	11.10	

Past Substance Problem						0.051
No	(95.72)	13158	89.10	1610	10.90	
Yes	(4.28)	572	86.67	88	13.33	
Alcohol/Drug Use before Pregnancy						0.344
No	(45.31)	6239	89.26	751	10.74	
Yes	(54.69)	7491	88.78	947	11.22	
Alcohol/Drug Use Past Month						0.006
No	(88.85)	12233	89.24	1475	10.76	
Yes	(11.15)	1497	87.03	223	12.97	
Sample Size (n)	**100.00**	**13730**	**88.99**	**1698**	**11.01**	

Source: Pregnancy Medical Home Case Management Information System, North Carolina Birth Records, and Medicaid Claims Data from September 1, 2011, to September 30, 2012.
(Col %) = column percent; N = frequency; % = row percent. *p-value from the Pearson chi-square test

Table 2.3.

Current Pregnancy Characteristics among Women Screened by the Pregnancy Medical Home Program, Stratified by Preterm Birth (n=15,428)

	Total	Term 37–42 weeks		Preterm 24–36 weeks		
	(Col %)	N	%	N	%	p-value*
Body Mass Index						0.004
Underweight	(4.54)	600	85.59	101	14.41	
Normal weight	(37.92)	5254	89.81	596	10.19	
Overweight	(24.12)	3310	88.93	412	11.07	
Obese	(33.41)	4566	88.57	589	11.43	
Multifetal Gestation						0.0001
No	(99.03)	13661	89.41	1618	10.59	
Yes	(0.97)	69	46.31	80	53.69	
Fetal Complication						0.015
No	(99.63)	13685	89.03	1686	10.97	
Yes	(0.37)	45	78.95	12	21.05	
Chronic Conditions						
Diabetes						0.0001
No	(98.53)	13572	89.28	1629	10.72	
Yes	(1.47)	158	69.60	69	30.40	
Hypertension						0.0001
No	(97.10)	13397	89.43	1583	10.57	
Yes	(2.90)	333	74.33	115	25.67	
Asthma						0.0001
No	(95.18)	13103	89.23	1582	10.77	
Yes	(4.82)	627	84.39	116	15.61	
Mental Illness						0.811
No	(94.53)	12981	89.01	1603	10.99	
Yes	(5.47)	749	88.74	95	11.26	
HIV						0.443
No	(99.88)	13715	89.00	1695	11.00	
Yes	(0.12)	15	83.33	3	16.67	
Seizure						0.611
No	(99.16)	13617	89.01	1682	10.99	
Yes	(0.84)	113	87.60	16	12.40	
Renal Disease						0.013
No	(99.82)	13710	89.02	1691	10.98	
Yes	(0.18)	20	74.07	7	25.93	

Systemic Lupus Erythematosus						0.568
No	(99.87)	13713	89.00	1695	11.00	
Yes	(0.13)	17	85.00	3	15.00	
Other Chronic Condition						0.001
No	(95.91)	13193	89.16	1604	10.84	
Yes	(4.09)	537	85.10	94	14.90	
Current or Recent Drug/Alcohol Use						0.406
No	(94.09)	12926	89.05	1590	10.95	
Yes	(5.91)	804	88.16	108	11.84	
Delayed Prenatal Care (>14 weeks)						0.001
No	(79.65)	10883	88.57	1405	11.43	
Yes	(20.35)	2847	90.67	293	9.33	
Cervical Insufficiency						0.0001
No	(99.47)	13684	89.17	1662	10.83	
Yes	(0.53)	46	56.10	36	43.90	
Gestational Diabetes						0.667
No	(99.59)	13675	89.00	1690	11.00	
Yes	(0.41)	55	87.30	8	12.70	
Vaginal Bleeding in Second Trimester						0.060
No	(99.62)	13682	89.02	1687	10.98	
Yes	(0.38)	48	81.36	11	18.64	
Hypertensive Disorders of Pregnancy						0.0001
No	(99.28)	13644	89.08	1673	10.92	
Yes	(0.72)	86	77.48	25	22.52	
Short Interpregnancy Interval (<12 mos)						0.120
No	(94.51)	12990	89.09	1591	10.91	
Yes	(5.49)	740	87.37	107	12.63	
Current Sexually Transmitted Infection						0.158
No	(97.82)	13439	89.05	1653	10.95	
Yes	(2.18)	291	86.61	45	13.39	
Recurrent Urinary Tract Infection						0.379
No	(98.86)	13577	89.02	1675	10.98	
Yes	(1.14)	153	86.93	23	13.07	
Provider Requests Pregnancy Assessment						0.017
No	(84.93)	11694	89.25	1409	10.75	
Yes	(15.07)	2036	87.57	289	12.43	

Communication Barrier						0.012
No	(97.66)	13394	88.90	1673	11.10	
Yes	(2.34)	336	93.07	25	6.93	
Sample Size (n)	**100.00**	**13730**	**88.99**	**1698**	**11.01**	

Source: Pregnancy Medical Home Case Management Information System, North Carolina Birth Records, and Medicaid Claims Data from September 1, 2011, to September 30, 2012.
(Col %) = column percent; N = frequency; % = row percent. *p-value from the Pearson chi-square test

Table 2.4.

Obstetric History Characteristics among Women Screened by the Pregnancy Medical Home Program, Stratified by Preterm Birth (n=15,428)

	Total	Term 37–42 weeks		Preterm 24–36 weeks		
	(Col %)	N	%	N	%	p-value*
Nulliparous						0.029
No	(57.24)	7817	88.52	1014	11.48	
Yes	(42.76)	5913	89.63	684	10.37	
Non-spontaneous Preterm Birth						0.0001
No	(96.10)	13283	89.59	1543	10.41	
Yes	(3.90)	447	74.25	155	25.75	
Spontaneous PTB or Rupture of Membranes						0.0001
No	(96.45)	13344	89.68	1536	10.32	
Yes	(3.55)	386	70.44	162	29.56	
Low Birth Weight						0.0001
No	(98.11)	13514	89.28	1622	10.72	
Yes	(1.89)	216	73.97	76	26.03	
Fetal Death						0.0001
No	(98.81)	13601	89.22	1643	10.78	
Yes	(1.19)	129	70.11	55	29.89	
Neonatal Death						0.0001
No	(99.53)	13680	89.09	1675	10.91	
Yes	(0.47)	50	68.49	23	31.51	
Second Trimester Pregnancy Loss						0.0001
No	(98.94)	13611	89.17	1653	10.83	
Yes	(1.06)	119	72.56	45	27.44	
Three or More First Trimester Losses						0.038
No	(98.90)	13588	89.05	1671	10.95	
Yes	(1.10)	142	84.02	27	15.98	
Cervical Insufficiency						0.0001
No	(99.69)	13704	89.10	1676	10.90	
Yes	(0.31)	26	54.17	22	45.83	
Gestational Diabetes						0.093
No	(98.42)	13521	89.05	1663	10.95	
Yes	(1.58)	209	85.66	35	14.34	

Postpartum Depression						0.644
No	(98.59)	13539	89.01	1672	10.99	
Yes	(1.41)	191	88.02	26	11.98	
Hypertensive Disorders of Pregnancy						0.001
No	(96.16)	13227	89.16	1608	10.84	
Yes	(3.84)	503	84.82	90	15.18	
Sample size (n)	**100.00**	**13730**	**88.99**	**1698**	**11.01**	

Source: Pregnancy Medical Home Case Management Information System, North Carolina Birth Records, and Medicaid Claims Data from September 1, 2011, to September 30, 2012.
(Col %) = column percent; N = frequency; % = row percent. *p-value from the Pearson chi-square test.

Table 2.5.

Crude ORs for Sociodemographic, Program, and Psychosocial Characteristics and Preterm Birth among Women Screened by the Pregnancy Medical Home Program (n=15,428)

	Unadjusted		
	OR	**(95% CI)**	**p-value**
Sociodemographics			
Age at Delivery			
≤18 years	0.99	(0.83, 1.17)	
19-34 years (ref)	---	---	
≥35 years	1.38	(1.12, 1.69)	***
Race/Ethnicity			
Non-Hispanic White (ref)	---	---	
Non-Hispanic Black	1.40	(1.26, 1.56)	***
Asian/Pacific Islander	1.06	(0.75, 1.49)	
American Indian/Alaska Native	1.13	(0.82, 1.54)	
Hispanic	0.90	(0.73, 1.11)	
U.S. Born	1.35	(1.07, 1.69)	**
Married at Conception or Birth	0.83	(0.74, 0.93)	***
Education Level			
< High School	1.02	(0.90, 1.16)	
High School Graduate or GED	0.91	(0.81, 1.02)	
Some College or more (ref)	---	---	
Program Characteristics			
Medicaid for Pregnant Women (MPW)	0.78	(0.70, 0.87)	***
Received Care Management	1.37	(1.23, 1.53)	***
Received 17p[†]	4.32	(3.43, 5.44)	***
Psychosocial Characteristics			
Pregnancy Intention			
Intended	---	---	
Unintended	1.04	(0.93, 1.18)	
Don't know	1.25	(1.08, 1.45)	***
Physical Violence (past year)	1.11	(0.87, 1.43)	
Intimate Partner Violence	1.46	(0.72, 2.97)	
Forced Sex (ever)	1.08	(0.74, 1.56)	
Food Insecurity (past year)	1.16	(0.93, 1.43)	
Unsafe or Unstable Housing	1.26	(1.04, 1.53)	**

Smoking Status			
Never or Fewer than 100 Cigarettes	---	---	
Stopped before Pregnancy	0.87	(0.72, 1.04)	
Stopped after Pregnancy	1.04	(0.90, 1.19)	
Cut down since Pregnancy/Smoke Same Amount	1.34	(1.18, 1.51)	***
Parent/Friend/Partner Substance Problem	1.01	(0.90, 1.14)	
Past Substance Problem	1.26	(1.00, 1.58)	*
Alcohol/Drug Use before Pregnancy	1.05	(0.95, 1.16)	
Alcohol/Drug Use Past Month	1.24	(1.06, 1.44)	***

Source: Pregnancy Medical Home Case Management Information System, North Carolina Birth Records, and Medicaid Claims Data from September 1, 2011, to September 30, 2012. OR = odds ratio, CI = confidence interval. *p<0.1, **p<0.05, ***p<0.01

Table 2.6.

Crude Odds Ratios for Current Pregnancy and Obstetric History Characteristics and Preterm Birth among Women Screened by the Pregnancy Medical Home Program (n=15,428)

	Unadjusted		
	OR	**(95% CI)**	**p - value**
Current Pregnancy Characteristics			
Normal weight	---	---	
Underweight	1.48	(1.18, 1.86)	***
Overweight	1.10	(0.96, 1.25)	
Obese	1.14	(1.01, 1.28)	**
Multifetal Gestation	9.79	(7.07, 13.56)	***
Fetal Complication	2.16	(1.14, 4.10)	**
Chronic Conditions			
Diabetes	3.64	(2.73, 4.85)	***
Hypertension	2.92	(2.35, 3.64)	***
Asthma	1.53	(1.25, 1.88)	***
Mental Illness	1.03	(0.83, 1.28)	
HIV	1.62	(0.47, 5.60)	
Seizure	1.15	(0.68, 1.94)	
Renal Disease	2.84	(1.20, 6.72)	**
Systemic Lupus Erythematosus	1.43	(0.42, 4.88)	
Other Chronic Condition	1.44	(1.15, 1.80)	***
Current or Recent Drug/Alcohol Use	1.09	(0.89, 1.34)	
Delayed Prenatal Care (>14 weeks)	0.80	(0.70, 0.91)	***
Cervical Insufficiency	6.44	(4.15, 10.00)	***
Gestational Diabetes	1.18	(0.56, 2.48)	
Vaginal Bleeding in the Second Trimester	1.86	(0.96, 3.59)	*
Hypertensive Disorders of Pregnancy	2.37	(1.51, 3.71)	
Short Interpregnancy Interval (<12 mos)	1.18	(0.96, 1.46)	
Current Sexually Transmitted Infection	1.26	(0.92, 1.73)	
Recurrent Urinary Tract Infection	1.22	(0.78, 1.89)	
Provider Requests Pregnancy Assessment	1.18	(1.03, 1.35)	**
Communication Barrier	0.60	(0.40, 0.90)	**
Obstetric History			
Nulliparous	0.89	(0.81, 0.99)	**
Non-spontaneous Preterm Birth	2.99	(2.47, 3.61)	***
Spontaneous Preterm Birth or Rupture of Membranes	3.65	(3.01, 4.41)	***
Low Birth Weight	2.93	(2.25, 3.83)	***
Fetal Death	3.53	(2.56, 4.86)	***

Neonatal Death	3.76	(2.29, 6.17)	***
Second Trimester Loss	3.11	(2.20, 4.40)	***
Three or More First Trimester Losses	1.55	(1.02, 2.34)	**
Cervical Insufficiency	6.92	(3.91, 12.23)	***
Gestational Diabetes	1.36	(0.95, 1.96)	*
Postpartum Depression	1.10	(0.73, 1.67)	
Hypertensive Disorders of Pregnancy	1.47	(1.17, 1.85)	***

Source: Pregnancy Medical Home Case Management Information System, North Carolina Birth Records, and Medicaid Claims Data from September 1, 2011, to September 30, 2012.
OR = odds ratio, CI = confidence interval. *p<0.1, **p<0.05, ***p< 0.01

Table 2.7.

Final Predictive Model for Preterm Birth with Bias Corrected Confidence Intervals from Bootstrapping among Women Screened by the Pregnancy Medical Home Program (n=15,428)

	OR	BC (95% CI)	p-value
Characteristics			
Non-Hispanic White	---	---	
Non-Hispanic Black	1.40	(1.25, 1.56)	***
Asian/Pacific Islander	1.20	(0.82, 1.65)	
American Indian/Alaska Native	1.10	(0.82, 1.53)	
Hispanic	1.02	(0.81, 1.24)	
Never or Fewer than 100 Cigarettes	---	---	
Stopped Smoking before Pregnancy	0.90	(0.73, 1.08)	
Stopped Smoking after Pregnancy	1.04	(0.88, 1.20)	
Cut Down since Pregnancy/Smoke Same Amount	1.37	(1.21, 1.57)	***
Underweight	1.55	(1.21, 1.93)	***
Normal weight	---	---	
Overweight	1.06	(0.91, 1.21)	
Obese	0.93	(0.83, 1.08)	
Multifetal Gestation	10.78	(7.66, 16.22)	***
Chronic Diabetes	3.04	(2.20, 4.08)	***
Chronic Hypertension	2.34	(1.82, 2.98)	***
Asthma	1.36	(1.07, 1.68)	***
Renal Disease	2.58	(0.81, 6.45)	**
Other Chronic Condition	1.30	(1.00, 1.63)	**
Cervical Insufficiency (current or history)	2.87	(1.72, 4.43)	***
Nulliparous	1.20	(1.06, 1.33)	***
Parous	---	---	
Non-spontaneous Preterm Birth History	2.76	(2.18, 3.39)	***
Spontaneous Preterm Birth or Rupture of Membranes History	3.39	(2.71, 4.28)	***
Low Birth Weight History	1.35	(0.97, 1.84)	**
Fetal Death/Second Trimester Loss History	1.73	(1.24, 2.35)	***

Source: Pregnancy Medical Home Case Management Information System, North Carolina Birth Records, and Medicaid Claims Data from September 1, 2011, to September 30, 2012.
**p< 0.05, ***p< 0.01. All variables in the model are significant at p<0.05 unless they are part of a group of indicators in which not all indicators are statistically significant.
OR = odds ratio; BC = bias corrected; CI = confidence interval

Table. 2.8.

Bootstrap Inclusion Fractions in Predicting Preterm Birth (n=1,000)

Risk Factors*	**N**	**%**
≤18 years	323	32.30
≥35 years	323	32.30
Non-Hispanic Black	998	99.80
Hispanic	998	99.80
Asian/Pacific Islander	998	99.80
American Indian/Alaska Native	998	99.80
Unintended Pregnancy	496	49.60
Don't Know Pregnancy Intention	496	49.60
Unsafe or Unstable Housing	312	31.20
Stopped Smoking before Pregnancy	993	99.30
Stopped Smoking after Pregnancy	993	99.30
Cut Down since Pregnancy/Smoke Same Amount	993	99.30
Alcohol/Drug Use before Pregnancy	70	7.00
Alcohol/Drug Use Past Month	91	9.10
Underweight	928	92.80
Overweight	928	92.80
Obese	928	92.80
Multifetal Gestation	1000	100.00
Fetal Complication	219	21.90
Chronic Diabetes	999	99.90
Chronic Hypertension	1000	100.00
Asthma	785	78.50
Renal Disease	506	50.60
Other Chronic Condition	550	55.00
Current or Recent Drug/Alcohol Use	171	17.10
Cervical Insufficiency (current or history)	978	97.80
Hypertensive Disorders in Current Pregnancy	417	41.70
Provider Requests Assessment	375	37.50
Nulliparous	821	82.10
Non-spontaneous Preterm Birth History	1000	100.00
Spontaneous Preterm Birth or Rupture of Membranes History	1000	100.00
Low Birth Weight History	483	48.30
Fetal Death/Second Trimester Loss History	929	92.90
Neonatal Death History	329	32.90
Three or More First Trimester Losses	100	10.00
Gestational Diabetes History	55	5.50
Hypertensive Disorders of Pregnancy History	55	5.50

*All risk factors included in the comprehensive model before backwards stepwise deletion in the full sample (n=15,428). N= number; % = percent of 1,000 models in which the variable was selected. Variables in the final predictive model were selected >50% of the time with the exception of low birth weight history.

Table 2.9.

Adjusted Odds Ratios for Food Insecurity and Body Mass Index on Preterm Birth among Women Screened by the Pregnancy Medical Home Program, Stratified by Parity (n=15,428)

	Nulliparous			Parous			Effects Differ
	OR	(95% CI)	p-value	OR	(95% CI)	p-value	
Full Sample							
Food Insecurity	0.81	(0.58, 1.13)		1.41	(1.04, 1.91)	**	Yes
Underweight	1.43	(1.01, 2.01)	**	1.73	(1.26, 2.38)	***	No
Normal weight	---	---		---	---		No
Overweight	1.20	(0.97, 1.48)		0.94	(0.79, 1.13)		Yes
Obese	1.31	(1.07, 1.59)	***	0.74	(0.62, 0.87)	***	Yes

Source: Pregnancy Medical Home Case Management Information System, North Carolina Birth Records, and Medicaid Claims Data from September 1, 2011 to September 30, 2012. The model includes all variables in the main effects model. **p<0.05, ***p<0.01. Effects differ refers to whether the effects of food security and body mass index variables on the odds of preterm birth differ between nulliparous and parous women.

Table 2.10.

Adjusted Odds Ratios for Housing and Short Interpregnancy Interval on Preterm Birth among Women Screened by the Pregnancy Medical Home Program, Stratified by Race/Ethnicity (n=13,336)

	Non-Hispanic Black			Non-Hispanic White			Effects Differ
	OR	**(95% CI)**	**p**	**OR**	**(95% CI)**	**p**	
Black & White Sample							
Unsafe or Unstable Housing	0.88	(0.65, 1.19)		1.46	(1.06, 2.02)	**	Yes
Short Interpregnancy Interval (<12 mos)	1.39	(1.02, 1.88)	**	0.72	(0.49, 1.06)		Yes

Source: Pregnancy Medical Home Case Management Information System, North Carolina Birth Records, and Medicaid Claims Data from September 1, 2011 to September 30, 2012. The model includes all variables in the final predictive model. **p<0.05. Effects differ refers to whether the effects of housing and short interpregnancy interval on the odds of preterm birth differ between non-Hispanic white and non-Hispanic black women.

Table 2.11.

Comparison of Risk Factors Prioritized by the Pregnancy Medical Home Program to Risk Factors in the Final Predictive Model in the Full Sample and Subgroup Analyses

A. Current PMH Priority Risk Factors	B. Priority Risk Factors in Final Models	C. Non-Priority Risk Factors in Final Models	D. Priority Risk Factors not in Final Models
Current or Recent Smoking	Current Smoking		Recent Smoking
Current or Recent Substance Use			Current or Recent Substance Use
Unsafe or Unstable housing, IPV, Sexual Abuse	Unsafe or Unstable Housing (White)		IPV, Sexual Abuse
All Chronic Diseases	Diabetes, Hypertension, Asthma, Renal, Other (White)		HIV, Lupus, Seizure, Mental illness
Fetal Complications			Fetal Complications
Multiple Gestation	Multiple Gestation		
Previous Preterm Birth or Low Birth Weight	Previous Preterm Birth or Low Birth Weight		
Delayed or *Missed Prenatal Care Hospitalization or Emergency Department Use*			Delayed Prenatal Care
Provider Requests Care Management			Provider Requests Care Management
		Non-Hispanic Black	
		Nulliparity	
		Underweight	
		Cervical Insufficiency	
		Fetal Death/Second Trimester Loss	
		Food Insecurity (Parous)	
		Obesity (Nulliparous)	
		Short Interpregnancy Interval (Black)	

Italics denotes factors from the Pregnancy Medical Home (PMH) risk screen that were not evaluated. Parentheses denotes the subgroup for which this risk factor was a significant predictor of preterm birth.

Figure 2.2. Receiver Operating Characteristic (ROC) curve for the final predictive model of preterm birth among women screened by the Pregnancy Medical Home program (n=15,428).

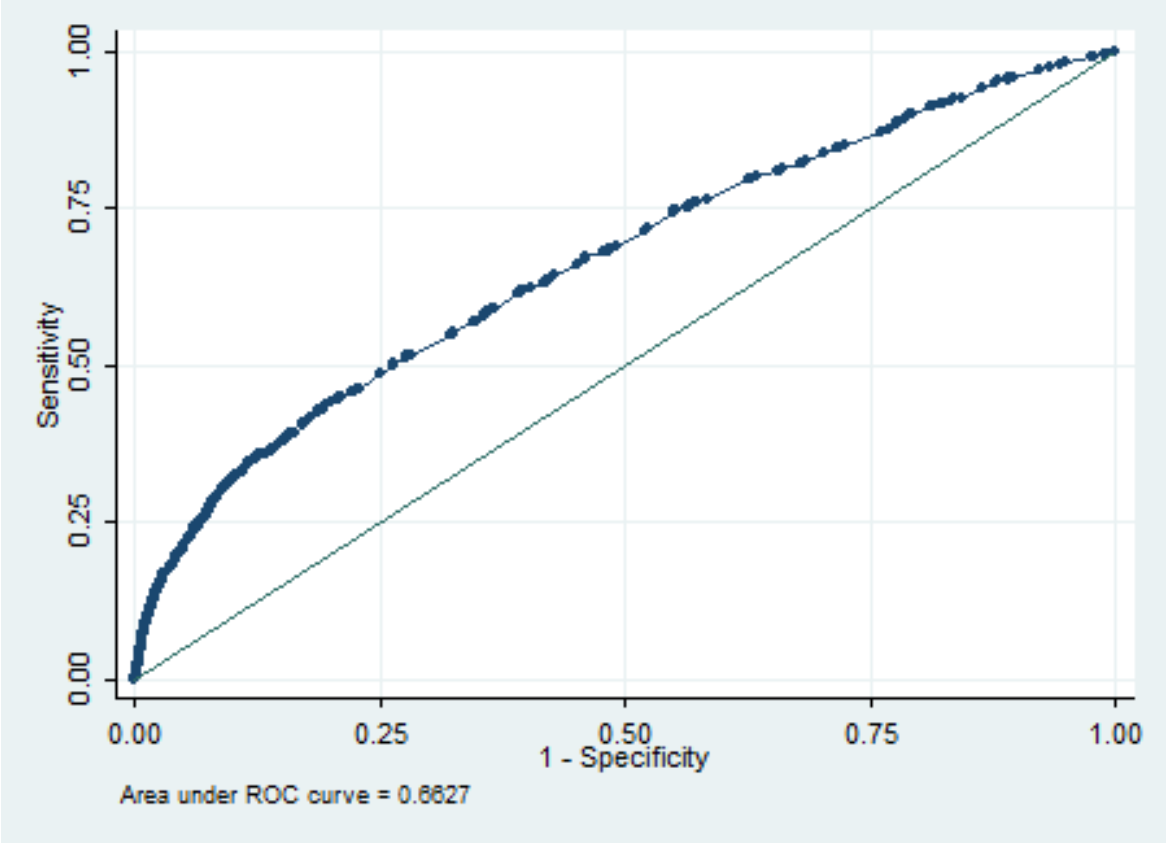
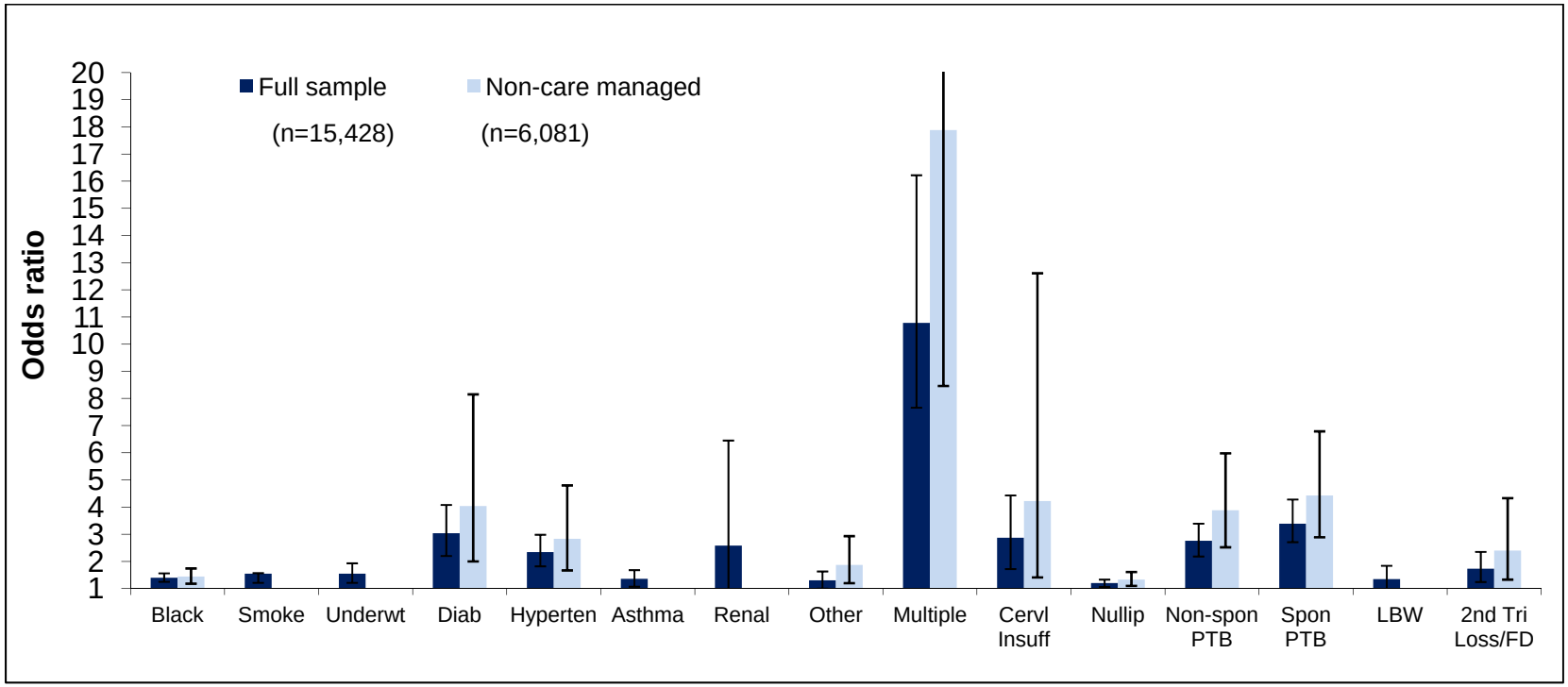


Table 2.12.

Test Characteristics of Models Predicting Preterm Birth among Women Screened by the Pregnancy Medical Home Program (n=15,428)

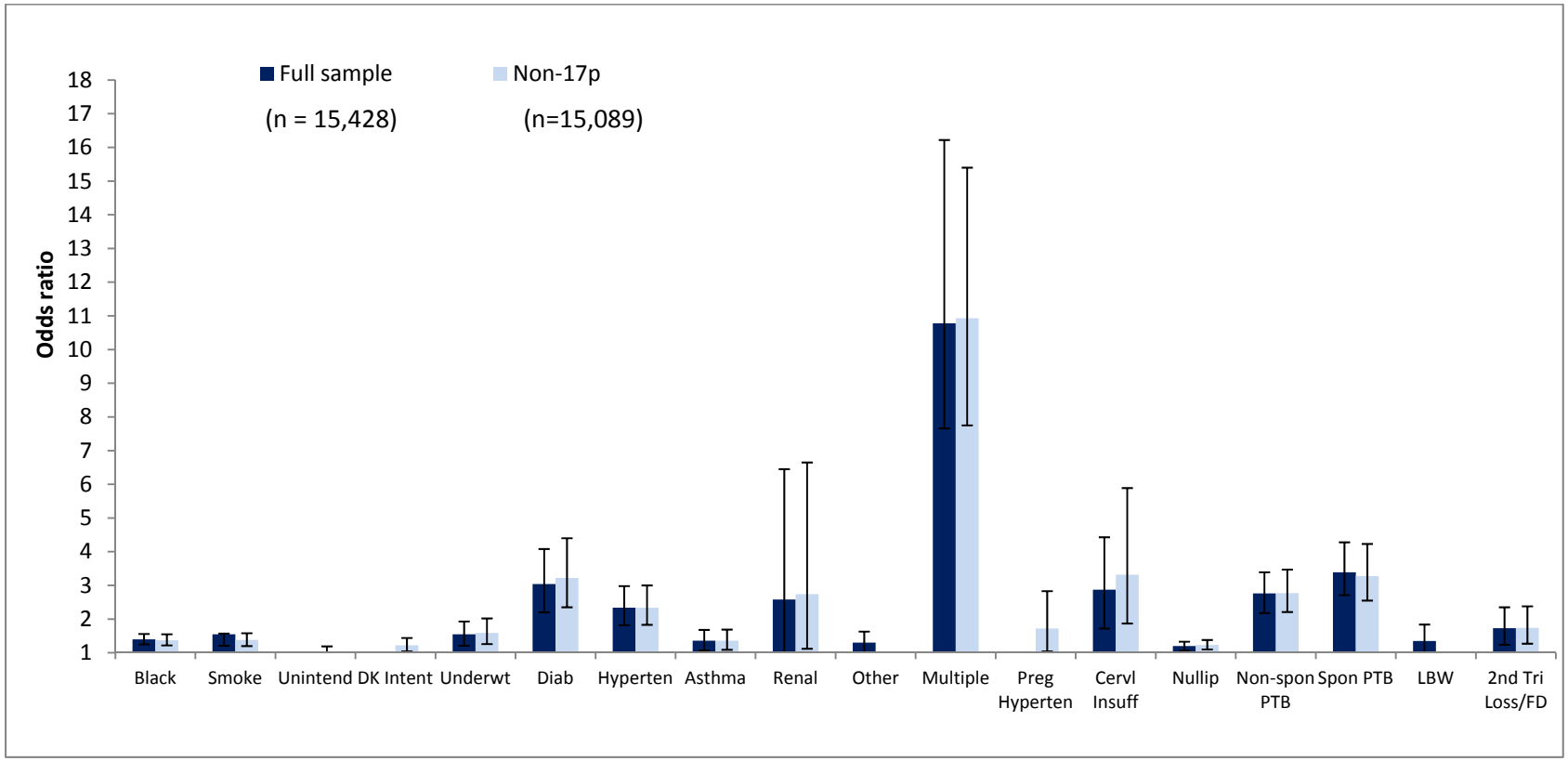
Test Characteristic	Final Model 0.11	Final Model 0.085	Interaction Model 0.11	Priority Risk Factor Model
Area Under Curve	0.66	0.66	0.67	0.64
Sensitivity	0.44	0.72	0.50	0.79
Specificity	0.81	0.48	0.74	0.31
Positive Predictive Value	0.22	0.15	0.19	0.12
Negative Predictive Value	0.92	0.93	0.92	0.92
False Negative Rate	0.56	0.29	0.50	0.21
Correctly Classified	0.76	0.51	0.71	0.36
Prevalence of a Positive Test	0.22	0.54	0.23	0.70

Figure 2.3. Sensitivity analyses comparing odds ratios and 95% confidence intervals from model selection in the full sample and among women not receiving care management.



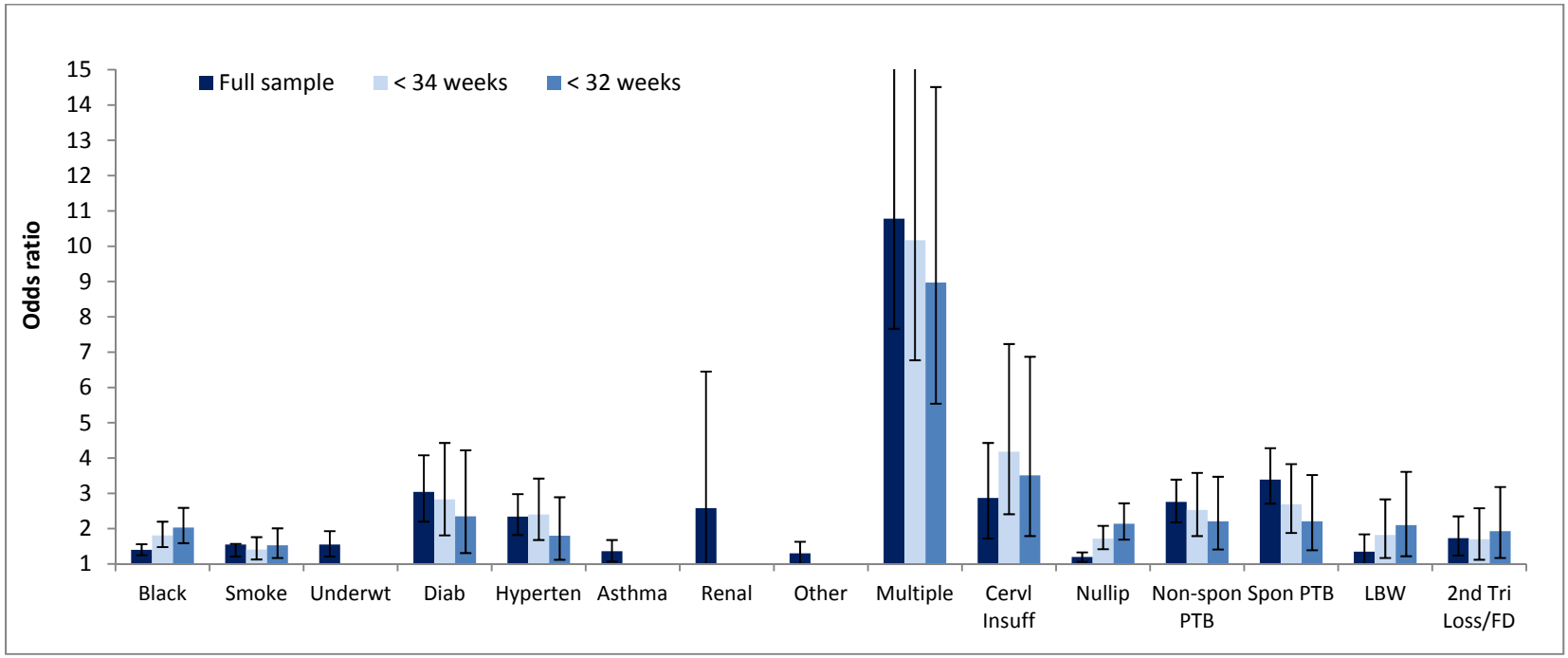
Black is non-Hispanic black race. Smoke refers to women who continued to smoke after they found out they were pregnant. Underwt is underweight. Diabetes and Hyperten are chronic diabetes and hypertension. Renal is renal disease. Other is “other” chronic conditions. Multiple is multi-fetal gestation. Cervical Insuf is cervical insufficiency in the current or a previous pregnancy. Nullip is nulliparous. Non-spon PTB and Spon PTB is non-spontaneous and spontaneous preterm birth. LBW is low birthweight. 2nd Tri Loss/FD refers to second trimester loss or fetal death.

Figure 2.4. Sensitivity analyses comparing odds ratios and 95% confidence intervals from model selection in the full sample and among women not receiving 17p.



Black is non-Hispanic black race. Smoke refers to women who continued to smoke after they found out they were pregnant. Unintend and DK Intent refer to unintended pregnancy and don't know pregnancy intention. Underwt is underweight. Diab and Hyperten are chronic diabetes and hypertension. Renal is renal disease. Other is "other" chronic conditions. Multiple is multi-fetal gestation. Preg Hyperten refers to hypertensive disorders of current pregnancy. Cervical Insuf is cervical insufficiency in the current or a previous pregnancy. Nullip is nulliparous. Non-spon PTB and Spon PTB is non-spontaneous and spontaneous preterm birth. LBW is low birthweight. 2nd Tri Loss/FD refers to second trimester loss or fetal death.

Figure 2.5. Sensitivity analyses comparing odds ratios and 95% confidence intervals from model selection with different outcome definitions (less than 37, 34, and 32 weeks gestation).



Black is non-Hispanic black race. Smoke refers to women who continued to smoke after they found out they were pregnant. Underwt is underweight. Diabetes and Hyperten are chronic diabetes and hypertension. Renal is renal disease. Other is "other" chronic conditions. Multiple is multi-fetal gestation. Cervical Insuf is cervical insufficiency in the current or a previous pregnancy. Nullip is nulliparous. Non-spon PTB and Spon PTB is non-spontaneous and spontaneous preterm birth. LBW is low birthweight. 2nd Tri Loss/FD refers to second trimester loss or fetal death.

CHAPTER 3. RECEIPT OF POSTPARTUM CONTRACEPTION AMONG WOMEN WITH AND WITHOUT A RECENT PRETERM BIRTH

INTRODUCTION

Preterm birth (PTB) prior to 37 weeks completed gestation is the most frequent cause of infant death and the leading cause of long-term neurological disabilities in the United States.[3] The strongest and most consistent predictor of preterm birth is a history of PTB.[33–36] A previous PTB can double the risk of a future PTB.[8] For reductions in PTB to be realized, interconception care strategies are especially needed for these high-risk women. Black women have been shown to have a higher recurrence of preterm delivery as compared to white women.[37] Thus interventions in the interconception period also have the potential to reduce disparities in PTB.[31]

Two interconception care strategies that have the potential to reduce recurrent PTB risk are optimizing interpregnancy intervals and avoiding unintended pregnancies.[39,81] A short interval between pregnancies is associated with an increased risk of PTB.[40–47] Infants conceived less than six months following a live birth had an odds ratio of 1.4 (95% CI 1.3–1.5) for PTB as compared to those conceived 18 to 23 months after a live birth.[46] Short interpregnancy intervals (IPIs) are also associated with an increased risk of recurrent PTB among women who experienced a previous PTB.[48] Nationally representative estimates from the 2006–2010 National Survey of Family Growth indicated that 35% of second or higher-order

births within five years of the survey interview had interpregnancy intervals of less than 18 months.[82] Women whose pregnancies are unintended are also more likely to deliver preterm.[50,51] It is not clear whether this is a causal association or whether the finding reflects residual confounding based on differences in sociodemographics and health behaviors of women who have unintended versus intended pregnancies.[50] In the United States, nearly half of all pregnancies are unintended.[49]

To successfully space births and avoid unintended pregnancies, women need access to highly effective methods of contraception.[81] Analysis of postpartum contraceptive provision in publicly funded programs in California documented that women who received postpartum contraception 90 days after delivery were 0.66 (95% CI: 0.63, 0.69) times as likely to have a short IPI (less than 18 months) for their subsequent pregnancy than women not receiving contraception.[83] Furthermore, women who received long-acting reversible contraception (LARC) had 3.89 (95% CI: 3.55, 4.26) times the odds and women who received user-dependent hormonal contraception had 1.89 (95% CI: 1.90, 1.98) times the odds of an optimal pregnancy interval compared to women receiving barrier methods only.[84] These studies provide evidence that postpartum contraception obtained early in the postpartum period, particularly highly effective methods, can help women achieve optimal pregnancy intervals. A systematic review conducted by Hogue and colleagues (2011) estimated that 4% of preterm births among whites and 8% among African Americans could be averted by increasing IPIs to 18–23 months.[66]

Finally, women who use contraception consistently and correctly are much less likely to have unintended pregnancies. According to national data reported by

the Guttmacher Institute, the two-thirds of women who use contraceptives consistently and correctly account for only 5% of all unintended pregnancies in a given year. This is in contrast to the 16% of women who do not use any contraceptives and who account for half of all unintended pregnancies.[85]

Data on whether postpartum contraceptive practices differ between women with and without a previous preterm birth are lacking.[38] A study of 300 postpartum women from a randomized control trial conducted in NC in 2011–2012 assessed women's intentions to use LARC. A slightly lower percentage of women delivering preterm intended to use LARC (36.7% versus 38% of women delivering at term), but these differences were not statistically significant.[86]

In the Philadelphia Collaborative Preterm Prevention Project, Bloch et al. (2012) followed women with a recent delivery before 35 weeks of gestation and at 6 months postpartum assessed pregnancy intention and contraceptive method effectiveness. Over half of the sample wanted to delay a pregnancy but reported using low or moderately effective methods, such as withdrawal, or no method at all.[38] The reasons why women who wanted to delay pregnancy but did not use more effective methods of contraception were largely unexplained. Low educational attainment was the only variable that significantly predicted the use of a less-effective contraceptive method among women wanting to delay pregnancy.[38] The authors concluded that less-effective method use among women with lower education was perhaps due to a lack of knowledge and less access to health services.[38]

The primary purpose of this analysis was to compare receipt of contraception in the postpartum period for women who experienced a preterm birth with contraception receipt among women who had a term birth. There is some evidence from qualitative data that women consumed with caring for a premature infant, particularly infants with an earlier gestational age who have an increased likelihood of health problems, have less time for self-care.[68] Therefore we hypothesized that women with a PTB would have a lower likelihood of contraceptive receipt compared to women who delivered full term.

Furthermore, the experience of caring for a very preterm infant (less than 32 weeks completed gestation), whose risk for adverse neonatal outcomes and developmental impairments are greatest,[87–89] may make it even more difficult for women to obtain family planning services within 90 days following delivery. Thus we hypothesized that the association would be even stronger for women with very preterm births as compared to women who delivered moderately preterm (32 to less than 37 weeks completed gestation) or full term.

We also hypothesized that this association might vary for women with different parity. Qualitative data from the Philadelphia Collaborative Preterm Prevention Project has also documented that low-income women with children may forgo their own health care to prioritize their children's needs when faced with multiple burdens.[68] Thus we expected the likelihood of contraceptive receipt among women with a recent PTB to be even lower among women with higher parity. We explored these hypotheses while controlling for key sociodemographic, reproductive, chronic health, and healthcare access characteristics.

Our second aim was to describe method effectiveness in this sample and compare between women who delivered preterm and full term. Because we hypothesized that women who delivered preterm would have a lower likelihood of receiving contraception, we expected that they would also be less likely to receive moderately or highly effective methods of contraception than women who delivered at term.

To answer these research questions we used data from North Carolina, where the preterm birth rate has been historically higher than the U.S. average. Approximately 12% of births were preterm in 2012 compared to 11.6% for the national average,[4,90] and, according to the Pregnancy Risk Assessment and Monitoring System (PRAMS) in 2011 in NC, 13.8% of mothers reported a previous PTB.[91] Among women who gave birth in 2011 in NC and had a previous delivery, 41.6% had less than 18 months between the date of conception and the date of the previous delivery.[92] Also in 2011, 42.7% of pregnancies ending in a live birth were unintended; this rate was 56% for Medicaid recipients.[93] These data suggest that strategies addressing short IPIs and unintended pregnancy could impact PTB rates among publicly insured women in NC.

In response to high rates of PTB in North Carolina, Community Care of North Carolina (CCNC) launched the Pregnancy Medical Home program in partnership with the North Carolina Division of Medical Assistance (DMA) in 2011. CCNC, a not-for-profit organization, manages the care of Medicaid recipients statewide. The PMH program seeks to provide evidence-based, high-quality maternity care to improve birth outcomes in the pregnant Medicaid population,[54] which comprises 47% of all

pregnancies.[53] Medicaid provides emergency coverage of the delivery only for another 8% of births.[53] Patients at risk of poor birth outcomes are identified through a standardized risk screening administered at the first prenatal visit and are referred for pregnancy care management to address their risk factors. Pregnancy care management services continue through the postpartum period, which is defined by Medicaid as ending on the last day of the month in which the sixtieth postpartum day occurs. During the postpartum period, PMH practices receive an incentive payment for performing a postpartum visit, which must address the patient's reproductive life plan and involve arranging ongoing care beyond the maternity period such as referral to the Family Planning Waiver. Given that 65% of our cohort qualified for Medicaid through the Medicaid for Pregnant Women (MPW) category and thus may lose coverage within 90 days of delivery, we were particularly interested in whether women received contraception during this time period and, if they did receive it, how effective were the methods they received.

METHODS

Data Source

We conducted a retrospective cohort analysis using data from three sources: birth certificates, Medicaid delivery and contraceptive claims, and the risk screening form from CCNC's Case Management Information System (CMIS). Birth certificate data are matched to Medicaid delivery claims in the Division of Medical Assistance (DMA) data warehouse using SQL Server Integration Services Fuzzy Lookup component software, producing a match rate of 95%. The risk screening is administered at the first prenatal visit at a median of 17 weeks gestation and is

entered into CMIS. The provider collects a medical history and checks a box for the presence of a risk factor; psychosocial questions like pregnancy intention are self-administered in English, Spanish, or Russian, or may be completed through a patient interview. The risk screening was linked to the index birth via the mother's Medicaid ID.

All women with a corresponding delivery ending in a live birth between September 1, 2011, and September 30, 2012, with a valid risk screening by the PMH program were eligible for analysis (n=34,845). To examine contraception received within 90 days of delivery, Medicaid claims for contraceptive methods were linked with dates of service through December 31, 2012. Women were excluded if they had only Emergency Medicaid (n=13), had a live birth prior to 24 weeks gestation (n=108), or had a hysterectomy within 90 days of delivery as indicated by Medicaid claims or on the birth certificate (n=25). We excluded 2,052 (5.9%) women missing observations on the following covariates of interest: marital status, breastfeeding at discharge, pre-pregnancy body mass index (BMI), parity, and pregnancy intention. The final sample size was 32,647 women (Figure 3.1).

All study procedures were reviewed and approved by the Institutional Review Board for the Protection of Human Subjects at the University of North Carolina at Chapel Hill.

Measures

The primary outcome was receipt of any contraception (yes or no) during the 90-day postpartum period. Family planning services covered under Medicaid include consultation, examination, and treatment prescribed by a physician or under a

doctor's supervision, lab exams and tests, and medically approved methods, supplies, and devices to prevent conception including Depo-Provera and Lunelle injectables, ParaGard and Mirena IUCs, oral contraceptives, Implanon/Nexplanon implantable devices, diaphragm fitting, sterilization (tubal ligation and the Essure procedure) and Ortho Evra patch.[94]

Any women with at least one outpatient pharmacy claim, physician drug program claim, or physician claim for insertion of a long-acting method or for performing a sterilization procedure for the following contraceptive methods or procedures during the 90 day postpartum period were classified as having received a method of contraception: tubal ligation or Essure procedure, implant, intrauterine device, injectable, patch, ring, oral contraceptives, or diaphragm fitting. We also classified women as receiving long-acting reversible contraception (LARC) if they received any intrauterine contraception (implant or intrauterine device). Women could be classified as receiving more than one method type, thus the types of methods are not mutually exclusive. Emergency contraception was not included because we were interested in primary prevention measures.

As a second outcome, we examined contraceptive method effectiveness tiers (most, moderate, and least [referent]) based on contraceptive failure rates in the United States.[95,96] The most effective tier included women who received a sterilization procedure or who had an implant or intrauterine contraception (IUC) placed. The moderately effective tier included injectable, patch, ring, oral contraceptives, or diaphragm. The least effective tier included women who had no contraceptive claim during the 90-day postpartum period. For the effectiveness tier

outcome, women who received multiple types of contraception were classified by the most effective method received so tiers are mutually exclusive. Likewise, 81 women (0.25%) who had an implant or IUC removal were classified in the most effective tier even if they had a claim for a less effective method or no claim at all after the removal claim date.

Our measures of contraceptive receipt and effectiveness do not capture methods not billed by Medicaid such as withdrawal, condoms, vasectomy, natural family planning or rhythm method, lactational amenorrhea, or abstinence. Women using these methods were classified as not receiving any contraception and as the least effective method tier.

The main exposure of interest was preterm birth (less than 37 weeks completed gestation) defined using the obstetric estimate of gestation from the birth certificate. Additionally, we examined a narrower definition of preterm birth (less than 32 weeks) for sub-analyses. We tested for interaction by parity. Parity was calculated from the birth certificate by adding the number of live births now living and now dead and dichotomized as two births or less vs. more than two births [referent]. We added one to the measure to include the most recent birth.

The remaining variables from our conceptual model (Figure 3.2) were evaluated as potential confounders. Reproductive health characteristics from the risk screen included a short interpregnancy interval (IPI), defined as less than 12 months between the last live birth and conception of the current pregnancy, a previous PTB, and a previous low birth weight (LBW) infant. Pregnancy intention, also assessed on the risk screening, was collapsed into four categories: intended (wanted to be

pregnant sooner/now) [referent], wanted to be pregnant later (mistimed), did not want to be pregnant then or any time in future (unwanted), or don't know. We used a proxy for breastfeeding, whether the infant was being breastfed at discharge (yes/no), as reported on the birth certificate.

We controlled for chronic health conditions (pre-pregnancy BMI, diabetes, and hypertension) because there is some evidence that contraceptive receipt may vary by chronic disease status and chronic conditions could function as competing medical priorities to women's family planning needs.[97] BMI was calculated using the participant's weight and height from the risk screening and categorized into four groups: underweight (<18.5), normal (18.5–24.9) [referent], overweight (25.0–29.9), or obese (≥30). About 18% were missing BMI; these data were substituted with a categorical BMI measure calculated from birth certificates (kappa for non-missing 4-category BMI 0.78). Chronic diabetes and hypertension from the risk screening were dichotomous.

We included several covariates to control for healthcare access including Medicaid program status, delayed prenatal care, language spoken, and rurality. Medicaid program category from claims data was collapsed into MPW versus any other category of Medicaid. Most women in our sample qualify for Medicaid because of pregnancy and thus do not have coverage prior to pregnancy or beyond 90 days after delivery, while women qualifying under other categories have continuous coverage. Delayed prenatal care from the risk screening was defined as initiation after 14 weeks gestation. Non-English speaking was also assessed on the risk screening. County of delivery from the birth certificate was used to categorize

women into three groups: metropolitan, micropolitan (urban areas based around an urban cluster), and rural according to North Carolina's core-based statistical area as defined by the U.S. Office of Management and Budget.[98]

Sociodemographic characteristics from birth certificates included age, race/ethnicity, nativity, marital status, and education level. Age at delivery was calculated by subtracting the mother's date of birth from the delivery date and categorized as ≤18, 19–34 [referent], and ≥35. Race/ethnicity was categorized as non-Hispanic white [referent], non-Hispanic black, Asian/Pacific Islander (API), American Indian/Alaska Native, Hispanic, and Other. Marital and U.S.-born status were dichotomous. Educational attainment was collapsed into four groups: less than high school [referent], high school graduate or GED, some college or Associate's degree, or college graduate or more.

Analysis

Descriptive statistics and bivariate analyses (including Pearson's chi-square tests) were used to compare the distributions of sociodemographic, health, and access characteristics by our main exposure, PTB (Table 3.1), and outcome, receipt of contraception (Table 3.2). We then examined the distribution of contraception receipt, method type, and effectiveness tier by PTB (Table 3.3). To address the primary and secondary aim of the analysis, we calculated the crude and adjusted association between PTB and contraceptive receipt using logistic regression (Table 3.4) and between PTB and contraceptive effectiveness using multinomial logistic regression (Table 3.5). To examine the impact of very preterm birth on contraceptive

receipt, we repeated all analyses using less than 32 weeks gestation as our key exposure (Tables 3.6–3.9).

We tested for interaction by parity using an a priori alpha level of significance of 0.05. We assessed for confounding by all other covariates from our conceptual model by checking whether covariates appeared to have a strong effect with the exposure, the outcome in the unexposed, or both, and by calculating the change in the odds ratio between the crude and adjusted. We kept covariates in the final models, even if they were not significantly associated with contraceptive receipt or effectiveness, if they showed evidence of confounding in bivariate analyses and did not largely impair the precision of estimates in the final models.

To examine the robustness of our findings to exclusions on missing data, we compared crude estimates from the complete case analysis to crude estimates from all available data including women who had been excluded due to missing data on key covariates. All analyses were conducted using Stata version 13.0 (StataCorp. 2013. *Stata Statistical Software: Release 13*. College Station, TX: StataCorp LP.)

RESULTS

The cohort included 32,647 women who had a live birth between September 2011 and September 2012. Median age was 24 years. One-third of the sample was married and one-fourth had not completed high school. Seventy percent of women had two or fewer births (including the most recent birth), and 55% reported that their most recent birth was unintended (44% mistimed and 11% unwanted). Nearly 6% had an interpregnancy interval less than 12 months. Not counting the most recent delivery, a previous PTB was reported by 7.5% of women and 1.9% of women had a

previous LBW baby. Over half were overweight or obese. The majority of women (65%) were covered under MPW and resided in metropolitan areas. About a quarter of all women entered prenatal care late, after 14 weeks of gestation.

The prevalence of preterm birth was 10.1% (95% CI: 9.80, 10.46) (Table 3.1). PTB was more common among women 35 years or older, those born in the United States, and those who were unmarried. Black women and women from “other” race/ethnicities had a higher rate of PTB. A short IPI and pregnancies reported as unwanted or “don’t know” were more likely to be preterm. Higher parity, a previous PTB and LBW infant were strong risk factors for PTB. The prevalence of PTB was lower among women who reported breastfeeding at discharge and was higher among women who were underweight or had diabetes or hypertension. Women with MPW status had a lower prevalence of PTB, as did non-English speakers and women residing in micropolitan or rural areas.

The prevalence of any contraceptive claim within 90 days of delivery was 52% (Table 3.2). Contraception receipt was more common among women 18 or younger, white or American Indian/Alaska Native women, and those born in the United States. High school graduates and women who had some college education had a higher prevalence of contraceptive receipt. Women with more than two births had a reduced prevalence of contraceptive receipt compared to women with two births or fewer (49.3%, 95% CI: 48.28, 50.32 vs. 52.9%, 95% CI: 52.29, 53.57). Women with a previous PTB or LBW baby had a lower prevalence of contraceptive receipt. Contraception receipt was higher among women breastfeeding at discharge and women who did not have a short IPI. Women whose last birth was mistimed had

the highest prevalence of contraception receipt among all pregnancy intentions examined. Of note, nearly 11%, or 3,550 women, reported early in pregnancy of the index birth that they did not want to be pregnant then or any time in the future, yet only half had a contraceptive claim postpartum. Obese women were more likely to have received contraception. MPW status was associated with an increased prevalence of contraceptive receipt. Women who entered prenatal care in the first trimester, English speakers, and residents of micropolitan or rural areas were also more likely to have received contraception.

Among the entire sample, oral contraceptives were the most common form of contraception received (15.3%), followed by IUCs (13.8%), injectables (9.2%), and sterilization (8.5%) (Table 3.3). Less than one-third of mothers received the most effective methods of contraception and only one-fourth received a moderately effective method.

Women with a recent preterm birth had a slightly lower prevalence of any contraception receipt within 90 days postpartum (50%, 95% CI: 48.25, 51.66 vs. 52%, 95% CI: 51.55, 52.69) (Table 3.3). Specifically, women who delivered preterm were less likely to have a claim for an IUC and more likely to receive injectables. Due to these differences in method type, women who delivered preterm were classified as less likely to receive the most effective methods but not moderately effective methods. The prevalence of any contraceptive receipt among women with more than two births who had a PTB was 44% (95% CI: 41.53, 47.40) compared to 50% (95% CI: 48.87, 51.04) of their counterparts with a term birth. Among women with two or fewer births, 53% received any contraception regardless of PTB status.

To answer our primary research question, we examined the log odds of any contraceptive receipt by preterm birth. Women who delivered preterm had 8% lower odds of receiving any contraception, OR = 0.92 (95% CI: 0.85, 0.99) (Table 3.4). The association between PTB and any contraceptive receipt differed by parity, such that women with a PTB and more than two births were significantly less likely to receive any contraception, OR = 0.84 (95% CI: 0.74, 0.96), than women with more than two births who had a term birth. There was no difference between gestational age at delivery and any contraceptive receipt among women with two births or fewer, OR = 1.01 (95% CI: 0.92, 1.10).

Women who had a PTB were less likely to receive the most effective methods of contraception, OR = 0.87 (95% CI: 0.80, 0.95), in the crude multinomial logit model (Table 3.5). This association remained statistically significant in the adjusted model, aOR = 0.89 (95% CI: 0.81, 0.97). Women with and without a preterm birth did not appear to differ in their receipt of moderately-effective contraception.

Because we hypothesized that women with very early PTB (<32 weeks) would be even less likely to receive any contraception due to the increased strain of caring for a premature infant, we conducted sub-analyses with very preterm birth (n=582, 1.8%) as our key exposure measure (Table 3.6). Fewer women with a very PTB received any contraception (46.6%) compared to women delivering at or after 32 weeks (52.0%) (Table 3.7). The crude odds ratio was even more reduced than for women delivering at less than 37 weeks (0.80, 95% CI: 0.68, 0.95). The adjusted estimates for any contraceptive receipt for a very PTB were decreased for both parity groups (Table 3.8). The adjusted OR for very PTB among women with more

than two births was 0.64 (95% CI: 0.46, 0.90) compared to their counterparts who delivered at or after 32 weeks of gestation. Among women with two births or fewer, the odds ratio for any contraceptive receipt associated with a very preterm delivery was 0.89 (95% CI: 0.73, 1.08). The adjusted association between very PTB and the most effective tier was 0.57 (95% CI: 0.45, 0.71) compared to women delivering at or after 32 weeks of gestation (Table 3.9).

There were a number of other factors from our conceptual model that were associated with any contraceptive receipt and the effectiveness tier. All sociodemographic factors except for marital status were significantly associated with any contraceptive receipt and effectiveness tier. Adjusting for other covariates, young age increased the odds of receiving both a moderate and the most effective method (Table 3.5). All minority groups had a lower odds of obtaining the most effective methods compared to whites; however, this difference was statistically significant only for black, API, and Hispanic women. U.S.-born women had higher odds of moderately-effective method receipt. Women who graduated from high school or had some college education were more likely than women who did not finish high school to receive moderate and the most effective methods.

Similarly, there were a number of reproductive health factors associated with any contraceptive receipt and effectiveness. Focusing on contraceptive effectiveness, women with more than two births were more likely to be categorized as receiving the most effective method types and less likely as receiving moderately effective methods due to a much higher rate of sterilization in this group. Compared to women whose last live birth was intended, all other groups had a higher likelihood

of receiving the most effective methods. The odds of receiving the most effective method were 1.34 times (95% CI: 1.25, 1.44) and 1.48 times (95% CI: 1.35, 1.63) the odds of receiving the most effective method for women with mistimed and unwanted births, respectively, compared to women with intended births. Mothers with short IPIs were less likely to receive moderately effective methods but more likely to receive the most effective methods.

Only one chronic health condition affected any contraceptive receipt and effectiveness tier. Specifically, underweight women were less likely and overweight and obese women were more likely to receive the most effective methods, but there were no differences in receipt of moderately effective methods. This effect was largely driven by a higher percentage of sterilization claims for obese women than non-obese women (11.7% vs. 6.9%).

Finally, all but one of the healthcare access factors were associated with any contraceptive receipt and effectiveness tier in the fully adjusted models. MPW status and residing in a micropolitan area were associated with higher likelihoods of receiving the most effective methods. Delayed prenatal care was negatively associated with receipt of both moderate and the most effective methods.

Our sensitivity analysis fitting crude models using all available data including women with missing data on covariates of interest (n=2,052, 6%), rather than the complete case sample, indicates that interpretation of our findings does not change based on these exclusions. Excluded women were more likely to be older in age, Asian or Pacific Islander, foreign-born, have lower education, and reside in rural areas. They were less likely to be American Indian, have delayed prenatal care, or

reside in a micropolitan area. The crude OR for preterm birth and any contraceptive receipt including women with missing data of 0.91 (95% CI: 0.85, 0.97) was very close to our crude estimate of 0.92 (95% CI: 0.85, 0.99) in our complete case analysis sample.

DISCUSSION

Our analysis documents that in NC, a state with a higher than average preterm birth rate, any contraceptive receipt from Medicaid in the early postpartum period for women with a recent preterm birth was low. Fifty-two percent of all women received some form of contraception, but only 28% (95% CI: 27.11, 28.08) received the most effective methods. Among women who were at highest risk of recurrent PTB as a result of having recently had a PTB, the prevalence of contraceptive receipt was slightly lower (50%), and only 25% received the most effective methods. Finally, the prevalence of contraceptive receipt was just 44% for women who had more than two births and whose most recent birth was preterm, compared to 50% among their counterparts with term births. Our findings support the call for improved family planning services to be an integral part of preterm birth prevention efforts for reductions in PTB to be realized.[81]

We found support for our main hypothesis that PTB was associated with a decreased likelihood of any contraception receipt. Once we adjusted for sociodemographic, reproductive, and chronic health variables and healthcare access characteristics, this association remained statistically significant among women with more than two births only. Higher parity women had a 15% reduced odds of receiving any contraception if they had a recent PTB compared to equal parity

women with a full term birth. However, delivering preterm did not have as much of an impact on any contraceptive receipt among lower parity women.

Though our data do not provide direct information to test why women with a recent PTB and more than two births were less likely to be dispensed contraception, we speculate that these findings reflect the difficulty low-income women encounter early postpartum to obtain family planning services when trying to meet the demands of caring for a preterm infant in addition to other children. Lu and colleagues (2006) note that women who have a PTB may require multiple services in the interconception period, particularly if their children have disabilities and special healthcare needs, and that fragmentation of service delivery can deter access to care particularly for low-income women with multiple burdens.[32] In a longitudinal ethnographic study among African American women of preterm infants who participated in an interconceptional PTB risk reduction intervention in Philadelphia, Hogan et al. (2013) observed that having multiple children compounds the demand for women with a recent preterm delivery who spend much of their time attending health or social service visits for their children.[68] Women would forgo their own health care to make sure their children's needs were met first.[68] Even when traditional barriers were removed in this trial by providing transportation, child care, and flexible clinic hours, fewer women than expected attended interconception care visits.[99]

Further support for our hypothesis was found when we narrowed the gestational age window of our exposure to 32 weeks. Women with more than two births and a very preterm infant had 36% lower odds of receiving contraception than

women who delivered at or after 32 weeks gestation with more than two births. Among women with two births or fewer, the odds of contraceptive receipt was reduced (aOR = 0.89, 95% CI: 0.73, 1.08) compared to women with two births or fewer delivering at 32 weeks or later, but was not statistically significant. Perhaps the trauma and stress associated with the experience of a preterm delivery,[100–102] or the experience of caring for a very preterm infant whose risk for adverse neonatal outcomes and developmental impairments are greatest[87–89] may make it even more difficult for women to prioritize family planning services within 90 days following delivery. The Postpartum Plus Prevention Program conducted in one NC hospital among mothers of medically fragile infants in the NICU found that provision of contraception needed to be immediately available, but engaging in true reproductive life planning was difficult before six months because mothers were consumed with meeting the more urgent needs of their infants.[103]

Another potential explanation is that family planning is less of a priority for their providers, who are busy addressing other health needs for these women and infants given their more complicated postnatal circumstances. For women attending multiple appointments for the care of a preterm infant, clinic protocols that continually provide contraceptive counseling and method provision may facilitate the uptake of contraception.[83,104]

We also found that women with a recent preterm delivery were less likely to receive the most effective methods of contraception, controlling for potential confounders, OR = 0.89 (95% CI: 0.81, 0.97). This was largely driven by the fact that women with a recent preterm delivery were less likely to receive an IUC. Evaluation

data from an interconceptional program for women with a previous adverse pregnancy outcome in Chicago may provide some insight into the low rates of highly effective contraception in our sample.[105] In this intervention that helped women to set reproductive goals and ensured access to contraception, many women reported using less effective contraception despite not wanting to get pregnant within six months.[105] Their perceptions about the effectiveness of methods were inconsistent with clinical effectiveness. For example, almost one-quarter of women considered withdrawal and the calendar method to be somewhat to very effective, while half reported the IUC to be somewhat or very effective.[105–106] Moreover, meeting the objectives of the interconception care program was hindered because of more pressing socioeconomic issues perceived by program participants such as housing and employment. To increase uptake of the most effective methods, more education on the effectiveness of contraceptive methods is needed[105] and perhaps better ways of presenting this information.[106] Furthermore, women need additional support to meet the more pressing socioeconomic demands so that they can then prioritize interconception health and contraception.

Our analysis provides baseline data from which the PMH program can work to increase postpartum contraceptive receipt and effectiveness to reduce PTB and resulting mortality and morbidity among women with Medicaid and their infants in NC. Care coordination provided by the PMH program will be essential for these women.[32] Other than the first postpartum visit, women on Medicaid during pregnancy may have limited access to health care between pregnancies.[32] Despite research on the importance of the postpartum visit for contraceptive uptake,[83,107]

national performance measures from Healthcare Effectiveness Data and Information Set (HEDIS) indicate that only 64.4% of Medicaid deliveries had a postpartum visit on or between 21 and 56 days after delivery in 2010.[108]

Care managers can play a vital role in helping women schedule and attend their postpartum visit and by working with providers to ensure that contraceptive counseling and method dispensing is offered to women throughout the postpartum period. Given the high risk of these women for recurrent PTB, contraceptive counseling should include information on the medical risks of short pregnancy intervals.[83] Another key activity for care managers will be to connect women who are losing Medicaid coverage to the Family Planning Waiver. According to data from NC PRAMS in 2011, less than half of Medicaid recipients surveyed had heard of the Medicaid Family Planning Waiver or Be Smart Program.[109]

Finally, evaluation data from interconception interventions mentioned previously suggest that these efforts will not be successful in helping them achieve their reproductive plans without paying attention to the context of women's lives more holistically and the multiple burdens they encounter.[32,68,69,72,99,105,110–112] To support women more holistically, 90 days of Medicaid coverage and care management services in the postpartum period is insufficient. Efforts to support ongoing medical coverage among women with adverse birth outcomes, such as through an Interconception Care Waiver or access to exchange plans, would potentially enable more women to achieve optimal pregnancy spacing.[113]

The association between preterm birth and any contraceptive receipt among parous groups remained significant when we controlled for confounders traditionally

included in studies examining postpartum contraception such as age, race/ethnicity, nativity, and education level,[38,84] as well as for measures of healthcare access. As has been found in other studies, any contraception receipt was highest among mothers 18 or younger and decreased with increasing age[38,84] and with increasing parity.[38,114] Contraceptive receipt ranged from a low of 42% among Asian and Pacific Islander women to 55% among non-Hispanic whites. Postpartum contraceptive receipt was also lowest among Asian and Pacific Islander women in a study analyzing Medicaid claims in CA and PRAMS data from 12 states.[83,115] Foreign-born women in our study were less likely to receive contraception. Contraceptive receipt generally increased with education level but bottomed out for women who were college graduates or higher, as is the trend among nationally representative contraceptive use data from the National Survey of Family Growth (NSFG).[114]

Linkage of risk factor data from the Pregnancy Medical Home program with birth certificates and Medicaid claims enabled us to examine and control for a number of novel factors including chronic conditions and healthcare access. Pre-pregnancy BMI was the only chronic condition that remained predictive in final models. Underweight women were less likely to receive any contraception, and the most effective methods in particular, while overweight and obese women were more likely to receive any contraception and more effective methods (mostly sterilization). Receipt of postpartum contraception did not differ by the presence of diabetes or hypertension.

The literature on chronic conditions and postpartum contraception is limited and findings are mixed.[116–118] We speculate that the increased likelihood for the

most effective methods, but not moderately effective methods, among overweight and obese women may reflect patient or provider perceptions that sterilization may be more appropriate given the increased health risks and possible increased failure rates of hormonal methods among these women.[119,120] Given the increased risk of pregnancy complications among women with chronic conditions, including PTB, further research is warranted to clarify how individual conditions influence contraceptive use.

We examined several barriers to healthcare access. In our analysis, women with MPW status were 1.11 times as likely to receive contraception and more likely to receive both moderate and most effective methods than women who qualified for Medicaid under other categories. This finding is contrary to reports from PRAMS in 12 states that showed the most effective method use was more common among women with pre-pregnancy Medicaid coverage compared to those without coverage prior to pregnancy.[115] It is possible that women with MPW coverage were more motivated to obtain contraceptive methods, particularly those that do not require regular contact with the healthcare system, because their Medicaid coverage ends 90 days after delivery while non-MPW women who maintain coverage longer do not feel the same urgency.[121] One limitation of this research is that we do not capture contraceptive receipt among women who start a method after 90 days postpartum, which may explain the discrepant findings with PRAMS data.

With regard to other access characteristics, women who entered prenatal care late, who did not speak English, and who lived in metropolitan areas were less likely to receive any contraception. We did not assess why women entered prenatal

care late and thus we cannot determine whether individual selection factors or structural barriers on the health delivery side explain why women with delayed prenatal care were less likely to receive both moderate and the most effective methods. Delayed prenatal care has been associated with a lower likelihood of highly effective methods in PRAMS data as well.[115] Though non-English speakers were less likely to have received contraception, this finding did not persist in multivariate models likely due to the strong association between nativity and spoken language.

Our finding that residing in a rural or micropolitan area was associated with higher odds of moderate and the most effective methods was surprising given literature that rural residents face more barriers to health care.[122,123] However, one other study analyzing postpartum contraception use in PRAMS from Michigan in 2004–2008 also found that women living in rural areas were more likely to use highly effective methods compared to their urban counterparts.[124] Anecdotal evidence in NC suggests that there may be fewer private practices per patient serving Medicaid beneficiaries in urban than non-urban areas, causing safety net providers to be overburdened, thereby making it difficult for women to obtain care. In our sample, delayed prenatal care was more common among urban women (27%) compared to 18% and 14% in micropolitan and rural areas, respectively. Whether or not this trend continues in the postpartum period is unknown, but our data suggest that urban women may encounter more barriers, both prenatally and for postpartum contraception. An alternate explanation may be that women residing in rural areas may request methods that do not require follow-up.

Among women who delivered preterm, 54% of pregnancies were unintended, yet only 52% of women with unintended pregnancies received contraception 90 days after delivery. For comparison, nationally in 2009 according to PRAMS data, 43% of women's most recent pregnancies were unintended and 47% who were not trying to get pregnant reported using contraception at the time of conception.[125] The low prevalence of postpartum contraception in our sample among women at high risk for recurrent PTB highlights the need for increased efforts to provide family planning to these women. Despite the low prevalence of contraception among women with unintended pregnancies, on a positive note, these women were more likely to receive the most effective methods compared to women with intended pregnancies.

We qualitatively compared the prevalence estimates of contraceptive receipt in our sample to those of other studies analyzing postpartum contraception with Medicaid claims in California and PRAMS in NC. The prevalence of a contraceptive claim in our sample (52%) was higher than a recent study, which estimated that 41% of 117,644 women in CA served by California's Medicaid program (Medi-Cal) or its family planning expansion program (Family PACT) had a contraceptive claim within 90 days of delivery.[83] Their study excluded women who had a documented sterilization at the time of the delivery, which may in part explain the higher prevalence in our sample.

According to NC PRAMS in 2011, 88% of women surveyed 2–9 months postpartum reported that they or their partner were doing something to keep from getting pregnant.[126] The higher prevalence in PRAMS is expected given it includes methods not captured by Medicaid claims. The prevalence of methods not captured

by Medicaid claims in PRAMS was 2% for vasectomy, 5% for rhythm or natural family planning, 30% for condoms, 18% for withdrawal, and 8% for abstinence (note these categories are not mutually exclusive and emergency contraception was assessed in PRAMS but individual prevalence was not reported).[126] The lower prevalence observed in our data may also reflect that PRAMS is self-reported data and allows more time for a women to obtain contraception (2–9 months postpartum).

We also compared the prevalence of methods captured in our sample with Medicaid recipients from the 2011 NC PRAMS data. Tubal ligation was 13.9% among Medicaid recipients in PRAMS versus 8.5% in our sample; oral contraception was 21.5% vs. 15%; injectable was 17.1% vs. 9.2%; IUC was 20.9% vs. 13.8%.[126] The remaining methods were reported only for the full PRAMS sample, which includes privately insured women. Prevalence of reporting an implant was 2% vs. 5% in our sample; and the patch, ring, morning-after pill, or diaphragm grouped together were 3.7% vs. 2.1% in our sample minus the morning-after pill.[126] In summary, contraceptive prevalence was higher for all methods in PRAMS except for implants.

There are several limitations to using Medicaid contraceptive claims data. First and foremost, we were not able to identify contraceptives that did not get billed to Medicaid such as condoms or withdrawal. Medicaid claims data only capture receipt of contraception not actual use. Thus there is a potential for women to be classified as receiving a contraceptive method but they may not be using it at the time indicated on the claim. Furthermore, we did not assess method discontinuation. Our analysis does not account for IUC expulsions, which may be between 2% and

10% during the first year after insertion.[127,128] Additionally, 0.25% of the sample had a removal claim for an implant or IUC in the 90-day period, and we continued to classify them as receiving contraception and receiving the most effective methods even if they had no other claims or claims for a less-effective method. We did not reclassify them because our question of interest was PTB in relation to the methods women received in the 90-day period. Thus we may be slightly overestimating contraceptive receipt and effectiveness for these methods. Finally, claims data may be subject to billing errors.

Considering these limitations, overall our contraceptive prevalence is likely underestimated and may overstate the level of risk for a short IPI or unintended pregnancy because a portion of women classified as not receiving contraception or less effective methods may be using methods not billed by Medicaid. This could lead to misclassification, such that women with a recent PTB may appear less likely to receive contraception, but it may not accurately reflect their actual use.

Additionally, obstetric estimate (OE) of gestation was used as our exposure measure. Several studies have examined the validity of obstetric estimate since its addition to the 2003 revision of the birth certificate and concluded that OE may undercount the rate of PTB.[76–80] We acknowledge that OE may underestimate PTB and make our estimate of PTB look better than the national prevalence based on last menstrual period (LMP) calculated by the National Center for Health Statistics (NCHS), but we use it because LMP was missing more observations in our sample and LMP has its own limitations.[78,79] We excluded 6% of women missing data,

mostly on pregnancy intentions, but sensitivity analysis generated effect measures similar to those of the main analysis.

Finally, our analysis was only conducted among pregnant women screened by the PMH program, which was just over half of the Medicaid deliveries that were matched to birth certificates during that time period. Excluding women not screened by the program limits our generalizability but allowed us to control for novel risk factors from the PMH risk screen and provide baseline information for the PMH program.

This research makes an important contribution in an understudied area of PTB prevention. We documented that women with a recent PTB were less likely to receive any contraception or the most effective methods than women with term infants, though differences were minimal and appeared to matter more for women who had more than two children. More importantly, we found that only half of women with a recent PTB received any contraception and one-quarter received the most effective methods. Even if this underestimates actual contraceptive use, it suggests that a sizeable proportion of low-income postpartum women at high risk for PTB in NC are at risk for unintended pregnancy and short interpregnancy intervals. Our study cannot determine the reasons for the low levels of contraceptive receipt (e.g., low patient demand or insufficiently trained providers), but it suggests that increased attention to the provision of effective methods of postpartum contraception in publicly funded programs is needed, particularly for women with a recent PTB, for further reductions in preterm birth to be realized.

FIGURES AND TABLES

Figure 3.1. Analysis sample.

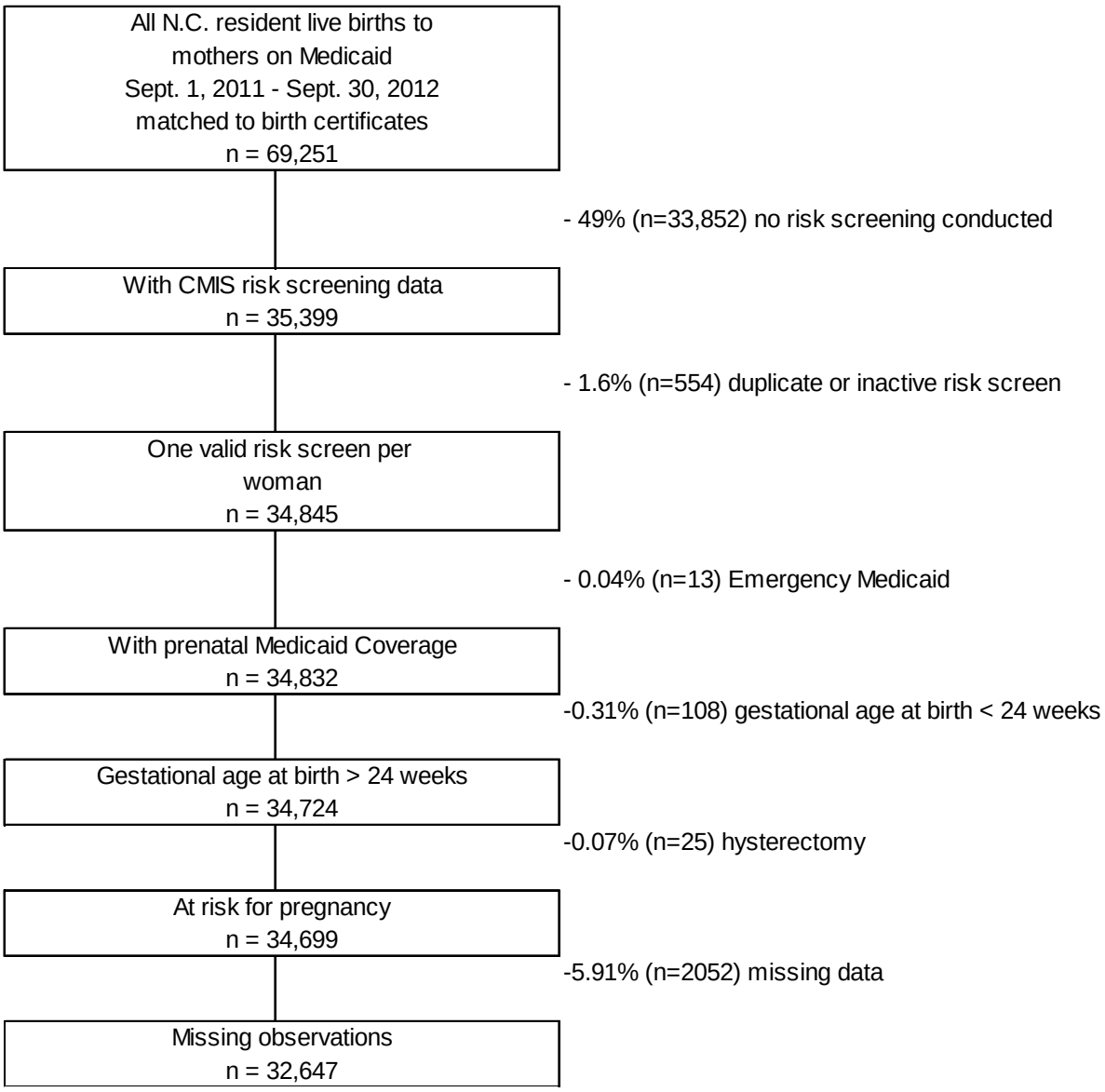


Figure 3.2. Conceptual model depicting hypothesized relationships among preterm birth, parity, and postpartum contraception.

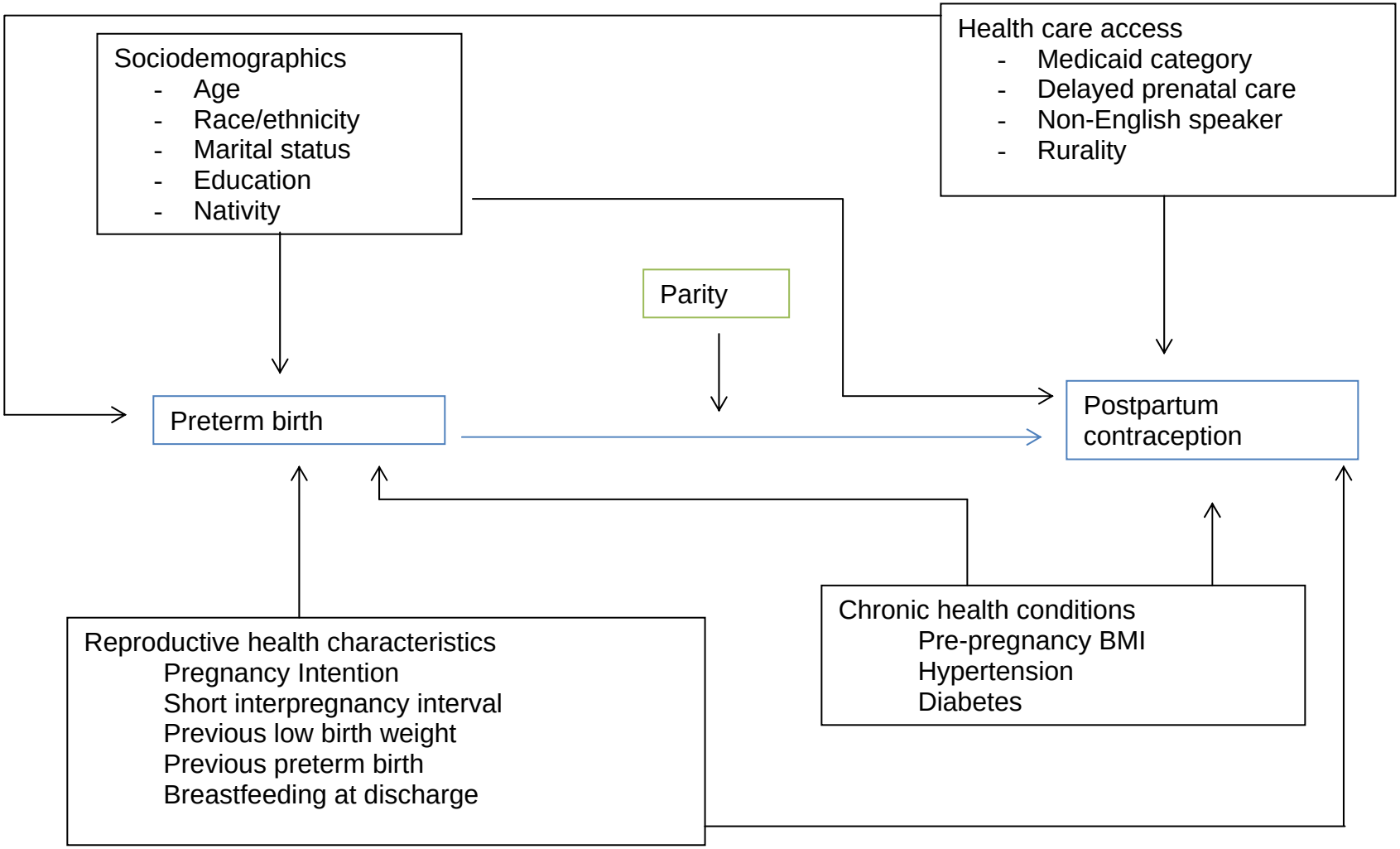


Table 3.1.

Sociodemographic, Health, and Access Characteristics of Women Screened by the Pregnancy Medical Home Program, Stratified by Preterm Birth (n=32,647)

	Term 37–42 weeks		Preterm 24–36 weeks		Total	
	N	%	N	%	N	p-value*
Sociodemographic Characteristics						
Age at Delivery						0.0001
≤18	3056	90.49	321	9.51	3377	
19-34	24729	89.99	2750	10.01	27479	
≥35	1557	86.93	234	13.07	1791	
Race/Ethnicity						0.0001
Non-Hispanic White	13807	91.02	1363	8.98	15170	
Non-Hispanic Black	11436	87.81	1587	12.19	13023	
Asian/Pacific Islander	687	91.97	60	8.03	747	
American Indian/Alaska Native	836	91.27	80	8.73	916	
Hispanic	2338	92.56	188	7.44	2526	
Other	238	89.81	27	10.19	265	
U.S. Born						0.0001
No	2015	92.81	156	7.19	2171	
Yes	27327	89.67	3149	10.33	30476	
Married at Conception or Birth						0.0001
No	20673	89.24	2492	10.76	23165	
Yes	8669	91.43	813	8.57	9482	
Education Level						0.355
Less than high school	7653	89.44	904	10.56	8557	
High school grad/GED	10214	90.12	1120	9.88	11334	
Some college/Assoc degree	10045	89.88	1131	10.12	11176	
College grad or higher	1430	90.51	150	9.49	1580	
Reproductive Health Characteristics						
Parity						0.0001
≤ 2 births	21211	90.58	2207	9.42	23418	
More than 2 births	8131	88.10	1098	11.90	9229	
Pregnancy Intention						0.0001
Intended (Now/Sooner)	7710	90.78	783	9.22	8493	
Mistimed (Later)	13095	90.58	1362	9.42	14457	
Unwanted (Never)	3132	88.03	426	11.97	3558	
Don't know	5405	88.04	734	11.96	6139	

Short Interpregnancy Interval (< 12 months)						0.001
No	27751	90.01	3079	9.99	30830	
Yes	1591	87.56	226	12.44	1817	
Preterm Birth History						0.0001
No	27504	91.07	2697	8.93	30201	
Yes	1838	75.14	608	24.86	2446	
Low Birth Weight History						0.0001
No	28878	90.17	3147	9.83	32025	
Yes	464	74.60	158	25.40	622	
Breastfeeding at Discharge						0.0001
No	11751	88.62	1509	11.38	13256	
Yes	17591	90.74	1795	9.26	19391	
Chronic Health Conditions						
Body Mass Index						0.0001
Underweight	1174	86.32	186	13.68	1360	
Normal	10852	89.83	1228	10.17	12080	
Overweight	7336	90.45	775	9.55	8111	
Obese	9980	89.94	1116	10.06	11096	
Diabetes						0.0001
No	28959	90.09	3187	9.91	32146	
Yes	383	76.45	118	23.55	501	
Hypertension						0.0001
No	28604	90.29	3077	9.71	31681	
Yes	738	76.40	228	23.60	966	
Access Characteristics						
Medicaid for Pregnant Women						0.0001
No	10164	88.40	1334	11.60	11498	
Yes	19178	90.68	1971	9.32	21149	
Delayed Prenatal Care						0.005
No	22392	89.61	2595	10.39	24987	
Yes	6950	90.73	710	9.27	7660	
Non-English Speaking						0.004
No	28802	89.81	3267	10.19	32069	
Yes	540	93.43	38	6.57	578	
Rurality						0.044
Metropolitan	19687	89.59	2288	10.41	21975	
Micropolitan	7390	90.52	774	9.48	8164	
Rural	2265	90.31	243	9.69	2508	
Sample size (n)	**29342**	**89.88**	**3305**	**10.12**	**32647**	

Source: Pregnancy Medical Home Case Management Information System, North Carolina Birth Records, and Medicaid Claims Data from September 1, 2011, to December 31, 2012
N = frequency; % = percent. *p-value from the Pearson chi-square test.

Table 3.2.

Sociodemographic, Health, and Access Characteristics of Women Screened by the Pregnancy Medical Home Program, Stratified by Receipt of Contraception 90 Days after Delivery (n=32,647)

	Receipt of Contraception				Total	
	No		Yes			
	N	%	N	%	N	p-value*
Sociodemographic Characteristics						
Age at Delivery						0.0001
≤18	1495	44.27	1882	55.73	3377	
19-34	13268	48.28	14211	51.72	27479	
≥35	939	52.43	852	47.57	1791	
Race/Ethnicity						0.0001
Non-Hispanic White	6878	45.34	8292	54.66	15170	
Non-Hispanic Black	6584	50.56	6439	49.44	13023	
Asian/Pacific Islander	430	57.56	317	42.44	747	
American Indian/Alaska Native	417	45.52	499	54.48	916	
Hispanic	1254	49.64	1272	50.36	2526	
Other	139	52.45	126	47.55	265	
U.S. Born						0.0001
No	1191	54.86	980	45.14	2171	
Yes	14511	47.61	15965	52.39	30476	
Married at Conception or Birth						0.373
No	11178	48.25	11987	51.75	23165	
Yes	4524	47.71	4958	52.29	9482	
Education Level						0.0001
Less than high school	4426	51.72	4131	48.28	8557	
High school grad/GED	5376	47.43	5958	52.57	11334	
Some college/Assoc degree	5097	45.61	6079	54.39	11176	
College grad or higher	803	50.82	777	49.18	1580	
Reproductive Health Characteristics						
Parity						0.0001
≤ 2 births	11023	47.07	12395	52.93	23415	
More than 2 births	4679	50.70	4550	49.30	9232	
Pregnancy Intention						0.0001
Intended (Now/Sooner)	4171	49.11	4322	50.89	8493	
Mistimed (Later)	6666	46.11	7791	53.89	14457	
Unwanted (Never)	1773	49.83	1785	50.17	3558	
Don't know	3092	50.37	3047	49.63	6139	

Short Interpregnancy Interval (< 12 months)						0.059
No	14789	47.97	16041	52.03	30830	
Yes	913	50.25	904	49.75	1817	
Preterm Birth History						0.001
No	14447	47.84	15754	52.16	30201	
Yes	1255	51.31	1191	48.69	2446	
Low Birth Weight History						0.0001
No	15355	47.95	16670	52.05	32025	
Yes	347	55.79	275	44.21	622	
Breastfeeding at Discharge						0.014
No	6487	48.92	6773	51.08	13260	
Yes	9215	47.53	10172	52.47	19387	
Chronic Health Conditions						
Body Mass Index						0.0001
Underweight	707	51.99	653	48.01	1360	
Normal	5959	49.33	6121	50.67	12080	
Overweight	3909	48.19	4202	51.81	8111	
Obese	5127	46.21	5969	53.79	11096	
Diabetes						0.469
No	15453	48.07	16693	51.93	32146	
Yes	249	49.70	252	50.30	501	
Hypertension						0.256
No	15220	48.04	16461	51.96	31681	
Yes	482	49.90	484	50.10	966	
Access Characteristics						
Medicaid for Pregnant Women						0.0001
No	5781	50.28	5717	49.72	11498	
Yes	9921	46.91	11228	53.09	21149	
Delayed Prenatal Care						0.0001
No	11519	46.10	13468	53.90	24987	
Yes	4183	54.61	3477	45.39	7660	
Non-English Speaking						0.0001
No	15362	47.90	16707	52.10	32069	
Yes	340	58.82	238	41.18	578	
Rurality						0.0001
Metropolitan	10877	49.50	11098	50.50	21975	
Micropolitan	3724	45.61	4440	54.39	8164	
Rural	1101	43.90	1407	56.10	2508	
Sample size (n)	**15702**	**48.10**	**16945**	**51.90**	**32647**	

Source: Pregnancy Medical Home Case Management Information System, North Carolina Birth Records, and Medicaid Claims Data from September 1, 2011, to December 31, 2012
N = frequency; % = percent. *p-value from the Pearson chi-square test.

Table 3.3.

Receipt of Contraception, Method Type, and Effectiveness 90 Days after Delivery of Women Screened by the Pregnancy Medical Home Program, Stratified by Preterm Birth (n=32,647)

	Term 37–42 weeks		Preterm 24–36 weeks		Total		
	N	**%**	**N**	**%**	**N**	**%**	**p-value***
Receipt of Contraception							0.018
No	14048	47.88	1654	50.05	15702	48.10	
Yes	15294	52.12	1651	49.95	16945	51.90	
Contraceptive Methods*							
Tubal Ligation/Essure Procedure							0.241
No	26855	91.52	3005	90.92	29860	91.46	
Yes	2487	8.48	300	9.08	2787	8.54	
Intrauterine contraception (IUC)							0.0001
No	25205	85.90	2932	88.71	28137	86.19	
Yes	4137	14.10	373	11.29	4510	13.81	
Implant							0.383
No	27781	94.68	3141	95.04	30922	94.72	
Yes	1561	5.32	164	4.96	1725	5.28	
Oral Contraceptive							0.142
No	24832	84.63	2829	85.60	27661	84.73	
Yes	4510	15.37	474	14.40	4988	15.28	
Injectable							0.002
No	26693	90.97	2953	89.35	29646	90.81	
Yes	2649	9.03	352	10.65	3001	9.19	
Patch							0.539
No	29052	99.01	3276	99.12	32328	99.02	
Yes	290	0.99	29	0.88	319	0.98	
Ring							0.184
No	29026	98.92	3261	98.67	32287	98.90	
Yes	316	1.08	44	1.33	360	1.10	
Diaphragm							0.288
No	29332	99.97	3305	100	32637	99.97	
Yes	10	0.03	0	0.00	10	0.03	
Long-acting Reversible† (LARC)							0.0001
No	23651	80.60	2769	83.78	26420	80.93	
Yes	5691	19.40	536	16.22	6227	19.07	

Effectiveness tier††							0.006
Less	14048	47.88	1654	50.05	15702	48.10	
Moderate	7123	24.27	814	24.66	7936	24.31	
Most	8173	27.85	836	25.30	9009	27.60	
Sample size (n)	**29342**	**89.88**	**3305**	**10.12**	**32647**	**100.00**	

Source: Pregnancy Medical Home Case Management Information System, North Carolina Birth Records, and Medicaid Claims Data from September 1, 2011, to December 31, 2012
N = frequency; % = percent. p-value from the Pearson chi-square test. *Women who received more than one method type were counted in each of the methods received.
†Long-acting reversible includes implant and intrauterine contraception.
††Less effective refers to no contraceptive Medicaid claim within 90 days of delivery. Moderate refers to injectable, patch, ring, oral contraceptive, and diaphragm. Most effective refers to tubal ligation, implant, intrauterine contraception. Women with more than one method were classified in the tier of the most effective method.

Table 3.4.

Crude and Adjusted Odds Ratios for Sociodemographic, Health, and Access Characteristics and Receipt of Contraception 90 Days after Delivery among Women Screened by the Pregnancy Medical Home Program (n=32,647)

	Contraception					
	Crude OR	(95% CI)	p	Adj. OR	(95% CI)	p
Preterm Birth most recent delivery						
No	---	---				
Yes	0.92	(0.85,0.99)	**			
Parity						
≤ 2 births	---	---		---	---	
More than 2 births	0.86	(0.82, 0.91)	***	---	---	
Interaction preterm birth*parity						
≤ 2 births & full term	---	---		---	---	
≤ 2 births & preterm	---	---		1.01	(0.92, 1.10)	
>2 births & full term	---	---		---	---	
> 2 births & preterm	---	---		0.84	(0.74, 0.96)	**
Sociodemographic Characteristics						
Age at Delivery						
≤18	1.18	(1.09, 1.26)	***	1.35	(1.25, 1.47)	***
19–34	---	---		---	---	
≥35	0.85	(0.77, 0.93)	***	0.88	(0.80, 0.98)	**
Race/Ethnicity						
Non-Hispanic White	---	---		---	---	
Non-Hispanic Black	0.81	(0.77, 0.85)	***	0.84	(0.80, 0.88)	***
Asian/Pacific Islander	0.61	(0.53, 0.71)	***	0.79	(0.67, 0.94)	***
American Indian/Alaska Native	0.99	(0.87, 1.13)		0.96	(0.83, 1.10)	
Hispanic	0.84	(0.77, 0.92)	***	0.91	(0.83, 1.00)	**
Other	0.75	(0.59, 0.96)	**	0.91	(0.71, 1.17)	
U.S. Born						
No	---	---		---	---	
Yes	1.34	(1.23, 1.46)	***	1.12	(1.00, 1.25)	*
Married at Conception or Birth						
No	---	---		---	---	
Yes	1.02	(0.97, 1.07)		1.01	(0.95, 1.06)	

Education Level						
Less than high school	---	---		---	---	
High school grad/GED	1.19	(1.12, 1.26)	***	1.18	(1.12, 1.26)	***
Some college/Assoc degree	1.28	(1.21, 1.35)	***	1.28	(1.20, 1.36)	***
College grad or higher	1.04	(0.93, 1.15)		1.06	(0.94, 1.19)	
Reproductive Health Characteristics						
Pregnancy Intention						
Intended (Now/Sooner)	---	---		---	---	
Mistimed (Later)	1.13	(1.07, 1.19)	***	1.16	(1.09, 1.23)	***
Unwanted (Never)	0.97	(0.90, 1.05)		1.10	(1.01, 1.20)	**
Don't know	0.95	(0.89, 1.02)		1.01	(0.95, 1.09)	
Short Interpregnancy Interval (< 12 months)						
No	---	---		---	---	
Yes	0.91	(0.83, 1.00)	*	0.98	(0.89, 1.08)	
Preterm Birth History						
No	---	---		---	---	
Yes	0.87	(0.80, 0.95)	***	0.99	(0.90, 1.08)	
Low Birth Weight History						
No	---	---		---	---	
Yes	0.73	(0.62, 0.86)	***	0.85	(0.71, 1.01)	*
Breastfeeding at Discharge						
No	---	---		---	---	
Yes	1.06	(1.01, 1.10)	**	1.01	(0.97, 1.06)	
Chronic Health Conditions						
Body Mass Index						
Underweight	0.90	(0.80, 1.01)	*	0.89	(0.80, 1.00)	**
Normal	---	---		---	---	
Overweight	1.05	(0.99, 1.11)		1.07	(1.01, 1.13)	**
Obese	1.13	(1.08, 1.19)	***	1.17	(1.11, 1.23)	***
Diabetes						
No	---	---		---	---	
Yes	0.94	(0.79, 1.12)		0.93	(0.77, 1.11)	
Hypertension						
No	---	---		---	---	
Yes	0.93	(0.82, 1.06)		0.94	(0.83, 1.08)	

Access Characteristics						
Medicaid for Pregnant Women						
No	---	---		---	---	
Yes	1.14	(1.09, 1.20)	***	1.11	(1.05, 1.16)	***
Delayed Prenatal Care						
No	---	---		---	---	
Yes	0.71	(0.68, 0.75)	***	0.75	(0.71, 0.79)	***
Non-English Speaking						
No	---	---		---	---	
Yes	0.64	(0.54, 0.76)	***	0.91	(0.75, 1.10)	
Rurality						
Metropolitan	---	---		---	---	
Micropolitan	1.17	(1.11, 1.23)	***	1.10	(1.04, 1.16)	***
Rural	1.25	(1.15, 1.36)	***	1.15	(1.05, 1.25)	***

Source: Pregnancy Medical Home Case Management Information System, North Carolina Birth Records, and Medicaid Claims Data from September 1, 2011 to December 31, 2012. *p<0.1, **p<0.05,***p<0.01, OR = odds ratio, CI = confidence interval, Adj. = Adjusted

Table 3.5. Crude and Adjusted Odds Ratios for Sociodemographic, Health, and Access Characteristics and Method Effectiveness Tier 90 Days after Delivery among Women Screened by the Pregnancy Medical Home Program (n=32,647)

	Moderately Effective				Most Effective				Moderately Effective				Most Effective			
	Crude OR	(95% CI)		p	Crude OR	(95% CI)		p	Adj. OR	(95% CI)		p	Adj. OR	(95% CI)		p
Preterm Birth most recent delivery																
No	---	---	---		---	---	---		---	---	---		---	---	---	
Yes	0.97	(0.89 ,	1.06)		0.87	(0.80 ,	0.95)	***	1.03	(0.94 ,	1.13)		0.89	(0.81 ,	0.97)	**
Sociodemographic Characteristics																
Age at Delivery																
≤18	1.48	(1.36 ,	1.61)	***	0.91	(0.83 ,	1.00)	**	1.45	(1.31 ,	1.59)	***	1.21	(1.09 ,	1.34)	***
19-34	---	---	---		---	---	---		---	---	---		---	---	---	
≥35	0.61	(0.53 ,	0.70)	***	1.05	(0.94 ,	1.17)		0.75	(0.65 ,	0.86)	***	0.97	(0.86 ,	1.09)	
Race/Ethnicity																
Non-Hispanic White	---	---	---		---	---	---		---	---	---		---	---	---	
Non-Hispanic Black	1.02	(0.96 ,	1.08)		0.66	(0.62 ,	0.69)	***	1.13	(1.06 ,	1.20)	***	0.64	(0.60 ,	0.68)	***
Asian/Pacific Islander	0.79	(0.66 ,	0.95)	**	0.48	(0.40 ,	0.58)	***	1.00	(0.81 ,	1.23)		0.64	(0.52 ,	0.79)	***
American Indian/Alaska Native	0.99	(0.83 ,	1.17)		1.00	(0.85 ,	1.16)		0.96	(0.81 ,	1.15)		0.95	(0.81 ,	1.11)	
Hispanic	0.87	(0.78 ,	0.97)	**	0.82	(0.74 ,	0.90)	***	0.94	(0.83 ,	1.05)		0.89	(0.80 ,	0.99)	**
Other	0.73	(0.53 ,	1.01)	*	0.77	(0.58 ,	1.02)	*	0.90	(0.65 ,	1.25)		0.92	(0.68 ,	1.23)	
U.S. Born																
No	---	---	---		---	---	---		---	---	---		---	---	---	
Yes	1.36	(1.22 ,	1.52)	***	1.32	(1.19 ,	1.47)	***	1.17	(1.02 ,	1.36)	**	1.08	(0.94 ,	1.23)	
Married at Conception or Birth																
No	---	---	---		---	---	---		---	---	---		---	---	---	
Yes	0.85	(0.80 ,	0.90)	***	1.19	(1.12 ,	1.26)	***	0.95	(0.89 ,	1.02)		1.05	(0.98 ,	1.12)	
Education Level																
Less than high school	---	---	---		---	---	---		---	---	---		---	---	---	
High school grad/GED	1.09	(1.01 ,	1.16)	**	1.29	(1.21 ,	1.38)	***	1.10	(1.02 ,	1.18)	**	1.27	(1.18 ,	1.37)	***
Some college/Assoc degree	1.14	(1.06 ,	1.22)	***	1.42	(1.32 ,	1.52)	***	1.17	(1.08 ,	1.26)	***	1.38	(1.28 ,	1.49)	***
College grad or higher	1.01	(0.88 ,	1.15)		1.07	(0.94 ,	1.22)		1.05	(0.91 ,	1.21)		1.07	(0.93 ,	1.23)	

Reproductive Health Characteristics				
Parity				
≤ 2 births	--- --- ---	--- --- ---	--- --- ---	--- --- ---
More than 2 births	0.55 (0.51 , 0.58) ***	1.21 (1.14 , 1.28) ***	0.66 (0.61 , 0.71) ***	1.26 (1.18 , 1.34) ***
Pregnancy Intention				
Intended (Now/Sooner)	--- --- ---	--- --- ---	--- --- ---	--- --- ---
Mistimed (Later)	1.07 (1.00 , 1.14) **	1.19 (1.11 , 1.26) ***	0.98 (0.91 , 1.05)	1.34 (1.25 , 1.44) ***
Unwanted (Never)	0.68 (0.61 , 0.75) ***	1.27 (1.16 , 1.39) ***	0.74 (0.67 , 0.83) ***	1.48 (1.35 , 1.63) ***
Don't know	0.88 (0.81 , 0.96) ***	1.02 (0.94 , 1.11)	0.88 (0.81 , 0.96) ***	1.14 (1.05 , 1.24) ***
Short Interpregnancy Interval (< 12 months)				
No	--- --- ---	--- --- ---	--- --- ---	--- --- ---
Yes	0.69 (0.61 , 0.79) ***	1.11 (1.00 , 1.24) *	0.83 (0.72 , 0.94) ***	1.10 (0.99 , 1.23) *
Preterm Birth History				
No	--- --- ---	--- --- ---	--- --- ---	--- --- ---
Yes	0.68 (0.61 , 0.76) ***	1.04 (0.95 , 1.14)	0.90 (0.79 , 1.01) *	1.05 (0.94 , 1.16)
Low Birth Weight History				
No	--- --- ---	--- --- ---	--- --- ---	--- --- ---
Yes	0.59 (0.47 , 0.73) ***	0.86 (0.71 , 1.03)	0.80 (0.63 , 1.01) *	0.88 (0.72 , 1.07)
Breastfeeding at Discharge				
No	--- --- ---	--- --- ---	--- --- ---	--- --- ---
Yes	1.07 (1.02 , 1.13) **	1.04 (0.99 , 1.10)	1.03 (0.97 , 1.09)	1.00 (0.95 , 1.06)
Chronic Health Conditions				
Body Mass Index				
Underweight	0.98 (0.86 , 1.12)	0.81 (0.70 , 0.94) ***	0.97 (0.85 , 1.11)	0.81 (0.70 , 0.94) ***
Normal	--- --- ---	--- --- ---	--- --- ---	--- --- ---
Overweight	0.94 (0.88 , 1.01)	1.16 (1.08 , 1.24) ***	0.98 (0.92 , 1.06)	1.16 (1.08 , 1.24) ***
Obese	0.92 (0.86 , 0.98) ***	1.36 (1.28 , 1.45) ***	0.98 (0.91 , 1.05)	1.36 (1.28 , 1.46) ***
Diabetes				
No	--- --- ---	--- --- ---	--- --- ---	--- --- ---
Yes	0.89 (0.71 , 1.11)	0.98 (0.80 , 1.21)	1.00 (0.80 , 1.26)	0.87 (0.70 , 1.08)
Hypertension				
No	--- --- ---	--- --- ---	--- --- ---	--- --- ---
Yes	0.68 (0.57 , 0.81) ***	1.15 (1.00 , 1.33) *	0.76 (0.63 , 0.91) ***	1.09 (0.93 , 1.26)

Access Characteristics												
Medicaid for Pregnant Women												
No	---	---	---		---	---	---		---	---	---		---	---	---	
Yes	1.10	(1.04 , | 1.17)	***	1.18	(1.12 , | 1.25)	***	1.10	(1.03 , | 1.17)	***	1.12	(1.05 , | 1.19)	***
Delayed Prenatal Care												
No	---	---	---		---	---	---		---	---	---		---	---	---	
Yes	0.74	(0.70 , | 0.79)	***	0.68	(0.64 , | 0.73)	***	0.78	(0.73 , | 0.84)	***	0.72	(0.67 , | 0.77)	***
Non-English Speaking												
No	---	---	---		---	---	---		---	---	---		---	---	---	
Yes	0.70	(0.57 , | 0.86)	***	0.59	(0.48 , | 0.73)	***	1.00	(0.78 , | 1.27)		0.83	(0.65 , | 1.06)	
Rurality												
Metropolitan	---	---	---		---	---	---		---	---	---		---	---	---	
Micropolitan	1.10	(1.03 , | 1.18)	***	1.23	(1.16 , | 1.30)	***	1.09	(1.02 , | 1.16)	**	1.10	(1.04 , | 1.18)	***
Rural	1.32	(1.19 , | 1.46)	***	1.19	(1.08 , | 1.32)	***	1.27	(1.15 , | 1.41)	***	1.04	(0.94 , | 1.15)	

Source: Pregnancy Medical Home Case Management Information System, North Carolina Birth Records, and Medicaid Claims Data from September 1, 2011 to December 31, 2012. Moderately effective includes diaphragm, injections, patch, ring and oral contraceptives. Most effective includes tubal ligation, implant, and IUD. Referent group is no contraceptive claim. *p<0.1, **p<0.05, ***p<0.01, OR = odds ratio, CI = confidence interval. Adj. = adjusted

Table 3.6.

Sociodemographic, Health, and Access Characteristics of Women Screened by the Pregnancy Medical Home Program, Stratified by Very Preterm Birth (n=32,647)

	Mod. PTB or Term 32–42 weeks		Very Preterm 24–31 weeks		Total	
	N	**%**	**N**	**%**	**N**	**p-value***
Sociodemographic Characteristics						
Age at Delivery						0.936
≤18	3316	98.19	61	1.81	3377	
19-34	26988	98.21	491	1.79	27479	
≥35	1761	98.32	30	1.68	1791	
Race/Ethnicity						0.0001
Non-Hispanic White	14964	98.64	206	1.36	15170	
Non-Hispanic Black	12701	97.53	322	2.47	13023	
Asian/Pacific Islander	740	99.06	7	0.94	747	
American Indian/Alaska Native	900	98.25	16	1.75	916	
Hispanic	2499	98.93	27	1.07	2526	
Other	261	98.49	4	1.51	265	
U.S. Born						0.005
No	2149	98.99	22	1.01	2171	
Yes	29916	98.16	560	1.84	30476	
Married at Conception or Birth						0.0001
No	22697	97.98	468	2.02	23165	
Yes	9368	98.80	114	1.20	9482	
Education Level						0.855
Less than high school	8411	98.29	146	1.71	8557	
High school grad/GED	11124	98.15	210	1.85	11334	
Some college/Assoc degree	10976	98.21	200	1.79	11176	
College grad or higher	1554	98.35	26	1.65	1580	
Reproductive Health Characteristics						
Parity						0.209
≤ 2 births	22987	98.16	431	1.84	23418	
More than 2 births	9078	98.36	151	1.64	9229	
Pregnancy Intention						0.193
Intended (Now/Sooner)	8359	98.42	134	1.58	8493	
Mistimed (Later)	14203	98.24	254	1.76	14457	
Unwanted (Never)	3487	98.00	71	2.00	3558	
Don't know	6016	98.00	123	2.00	6139	

Short Interpregnancy Interval (< 12 months)						0.165
No	30288	98.24	542	1.76	30830	
Yes	1777	97.80	40	2.20	1817	
Preterm Birth History						0.0001
No	29729	98.44	472	1.56	30201	
Yes	2336	95.50	110	4.50	2446	
Low Birth Weight History						0.0001
No	31475	98.28	550	1.72	32025	
Yes	590	94.86	32	5.14	622	
Breastfeeding at Discharge						0.646
No	13029	98.26	231	1.74	13260	
Yes	19036	98.19	351	1.81	19387	
Chronic Health Conditions						
Body Mass Index						0.416
Underweight	1332	97.94	28	2.06	1360	
Normal	11878	98.33	202	1.67	12080	
Overweight	7972	98.29	139	1.71	8111	
Obese	10883	98.08	213	1.92	11096	
Diabetes						0.0001
No	31585	98.25	561	1.75	32146	
Yes	480	95.81	21	4.19	501	
Hypertension						0.0001
No	31144	98.30	537	1.70	31681	
Yes	921	95.34	45	4.66	966	
Access Characteristics						
Medicaid for Pregnant Women						0.002
No	11257	97.90	241	2.10	11498	
Yes	20808	98.39	341	1.61	21149	
Delayed Prenatal Care						0.026
No	24519	98.13	468	1.87	24987	
Yes	7546	98.51	114	1.49	7660	
Non-English Speaking						0.046
No	31491	98.20	578	1.80	32069	
Yes	574	99.31	4	0.69	578	
Rurality						0.047
Metropolitan	21556	98.09	419	1.91	21975	
Micropolitan	8042	98.51	122	1.49	8164	
Rural	2467	98.37	41	1.63	2508	
Sample size (n)	**32065**	**98.22**	**582**	**1.78**	**32647**	

Source: Pregnancy Medical Home Case Management Information System, North Carolina Birth Records, and Medicaid Claims Data from September 1, 2011, to December 31, 2012
N = frequency; % = percent. *p-value from the Pearson chi-square test.

Table 3.7.

Receipt of Contraception, Method Type, and Effectiveness 90 Days after Delivery among Women Screened by the Pregnancy Medical Home Program, Stratified by Very Preterm Birth (n=32,647)

	Mod. PTB or Term 32–42 weeks		Very Preterm 24–31 weeks		Total		
	N	%	N	%	N	%	p-value*
Receipt of Contraception							0.009
No	15391	48.00	311	53.44	15702	48.10	
Yes	16674	52.00	271	46.56	16945	51.90	
Contraceptive Methods*							
Tubal Ligation/Essure Procedure							0.001
No	29306	91.40	554	95.19	29860	91.46	
Yes	2759	8.60	28	4.81	2787	8.54	
Intrauterine contraception (IUC)							0.001
No	27609	86.10	528	90.72	28137	86.19	
Yes	4456	13.90	54	9.28	4510	13.81	
Implant							0.010
No	30357	94.67	565	97.08	30922	94.72	
Yes	1708	5.33	17	2.92	1725	5.28	
Oral Contraceptive							0.035
No	27186	84.78	475	81.62	27661	84.73	
Yes	4879	15.22	107	18.38	4986	15.27	
Injectable							0.051
No	29131	90.85	515	88.49	29646	90.81	
Yes	2934	9.15	67	11.51	3001	9.19	
Patch							0.067
No	31756	99.04	572	98.28	32328	99.02	
Yes	309	0.96	10	1.72	319	0.98	
Ring							0.867
No	31711	98.90	576	98.97	32287	98.90	
Yes	354	1.10	6	1.03	360	1.10	
Diaphragm							0.670
No	32055	99.97	582	100	32637	99.97	
Yes	10	0.03	0	0.00	10	0.03	

Long-acting Reversible† (LARC)							0.0001
No	25908	80.80	512	87.97	26420	80.93	
Yes	6157	19.20	70	12.03	6227	19.07	
Effectiveness tier††							0.0001
Less	15391	48.00	311	53.44	15702	48.10	
Moderate	7763	24.21	173	29.73	7936	24.31	
Most	8911	27.79	98	16.84	9009	27.60	
Sample size (n)	**32065**	**98.22**	**582**	**1.78**	**32647**	**100.00**	

Source: Pregnancy Medical Home Case Management Information System, North Carolina Birth Records, and Medicaid Claims Data from September 1, 2011, to December 31, 2012.
N = frequency; % = percent. p-value from the Pearson chi-square test.
*Women who received more than one method type were counted in all of the methods received.
†Long-acting reversible includes implant and intrauterine contraception.
††Less effective refers to no contraceptive Medicaid claim within 90 days of delivery. Moderate refers to injectable, patch, ring, oral contraceptive, and diaphragm. Most effective refers to tubal ligation, implant, intrauterine contraception. Women with more than one method were classified in the tier of the most effective method.

Table 3.8.

Crude and Adjusted Odds Ratios for Sociodemographic, Health, and Access Characteristics and Receipt of Contraception 90 Days after Delivery among Women Screened by the Pregnancy Medical Home Program (n=32,647)

	Contraception					
	Crude OR	**(95% CI)**	**p**	**Adj. OR**	**(95% CI)**	**p**
Very Preterm Birth Most Recent Delivery						
No	---	---				
Yes	0.80	(0.68, 0.95)	***			
Parity						
≤ 2 births	---	---		---	---	
More than 2 births	0.86	(0.82, 0.91)	***	---	---	
Interaction very preterm birth*parity						
≤ 2 births & >= 32 weeks	---	---		---	---	
≤ 2 births & very preterm	---	---		0.89	(0.73, 1.08)	
>2 births & >=32 weeks	---	---		---	---	
> 2 births & very preterm	---	---		0.64	(0.46, 0.90)	**
Sociodemographic Characteristics						
Age at Delivery						
≤18	1.18	(1.09, 1.26)	***	1.35	(1.25, 1.47)	***
19-34	---	---		---	---	
≥35	0.85	(0.77, 0.93)	***	0.88	(0.80, 0.97)	***
Race/Ethnicity						
Non-Hispanic White	---	---		---	---	
Non-Hispanic Black	0.81	(0.77, 0.85)	***	0.84	(0.79, 0.88)	***
Asian/Pacific Islander	0.61	(0.53, 0.71)	***	0.79	(0.67, 0.94)	***
American Indian/Alaska Native	0.99	(0.87, 1.13)		0.96	(0.84, 1.10)	
Hispanic	0.84	(0.77, 0.92)	***	0.91	(0.83, 1.00)	**
Other	0.75	(0.59, 0.96)	**	0.91	(0.71, 1.17)	
U.S. Born						
No	---	---		---	---	
Yes	1.34	(1.23, 1.46)	***	1.12	(1.00, 1.25)	*
Married at Conception or Birth						
No	---	---		---	---	
Yes	1.02	(0.97, 1.07)		1.01	(0.95, 1.06)	

Education Level						
Less than high school	---	---		---	---	
High school grad/GED	1.19	(1.12, 1.26)	***	1.19	(1.12, 1.26)	***
Some college/Assoc degree	1.28	(1.21, 1.35)	***	1.27	(1.20, 1.36)	***
College grad or higher	1.04	(0.93, 1.15)		1.06	(0.94, 1.19)	
Reproductive Health Characteristics						
Pregnancy Intention						
Intended (Now/Sooner)	---	---		---	---	
Mistimed (Later)	1.13	(1.07, 1.19)	***	1.16	(1.09, 1.23)	***
Unwanted (Never)	0.97	(0.90, 1.05)		1.10	(1.01, 1.20)	**
Don't know	0.95	(0.89, 1.02)		1.01	(0.95, 1.09)	
Short Interpregnancy Interval (< 12 months)						
No	---	---		---	---	
Yes	0.91	(0.83, 1.00)	*	0.98	(0.89, 1.08)	
Preterm Birth History						
No	---	---		---	---	
Yes	0.87	(0.80, 0.95)	***	0.98	(0.90, 1.07)	
Low Birth Weight History						
No	---	---		---	---	
Yes	0.73	(0.62, 0.86)	***	0.84	(0.71, 1.00)	**
Breastfeeding at Discharge						
No	---	---		---	---	
Yes	1.06	(1.01, 1.10)	**	1.02	(0.97, 1.06)	
Chronic Health Conditions						
Body Mass Index						
Underweight	0.90	(0.80, 1.01)	*	0.89	(0.80, 1.00)	**
Normal	---	---		---	---	
Overweight	1.05	(0.99, 1.11)		1.07	(1.01, 1.13)	**
Obese	1.13	(1.08, 1.19)	***	1.17	(1.11, 1.23)	***
Diabetes						
No	---	---		---	---	
Yes	0.94	(0.79, 1.12)		0.93	(0.77, 1.11)	
Hypertension						
No	---	---		---	---	
Yes	0.93	(0.82, 1.06)		0.94	(0.82, 1.08)	

Access Characteristics						
Medicaid for Pregnant Women						
No	---	---		---	---	
Yes	1.14	(1.09, 1.20)	***	1.11	(1.05, 1.16)	***
Delayed Prenatal Care						
No	---	---		---	---	
Yes	0.71	(0.68, 0.75)	***	0.75	(0.71, 0.79)	***
Non-English Speaking						
No	---	---		---	---	
Yes	0.64	(0.54, 0.76)	***	0.91	(0.75, 1.10)	
Rurality						
Metropolitan	---	---		---	---	
Micropolitan	1.17	(1.11, 1.23)	***	1.10	(1.04, 1.16)	***
Rural	1.25	(1.15, 1.36)	***	1.15	(1.05, 1.25)	***

Source: Pregnancy Medical Home Case Management Information System, North Carolina Birth Records, and Medicaid Claims Data from September 1, 2011 to December 31, 2012. *p<0.1, **p<0.05, ***p<0.01, OR = odds ratio, CI = confidence interval, Adj. = Adjusted

Table 3.9. Crude and Adjusted Odds Ratios for Sociodemographic, Health, and Access Characteristics and Method Effectiveness Tier 90 Days after Delivery among Women Screened by the Pregnancy Medical Home Program (n=32,647)

	Moderately Effective			Most Effective			Moderately Effective			Most Effective		
	Crude OR	(95% CI)	p	Crude OR	(95% CI)	p	Adj. OR	(95% CI)	p	Adj. OR	(95% CI)	p
Very Preterm Birth Most Recent Delivery												
No	---	---		---	---		---	---		---	---	
Yes	1.10	(0.91 , 1.33)		0.54	(0.43 , 0.68)	***	1.11	(0.92 , 1.34)		0.57	(0.45 , 0.71)	***
Sociodemographic Characteristics												
Age at Delivery												
≤18	1.48	(1.36 , 1.61)	***	0.91	(0.83 , 1.00)	**	1.45	(1.31 , 1.59)	***	1.21	(1.09 , 1.34)	***
19-34	---	---		---	---		---	---		---	---	
≥35	0.61	(0.53 , 0.70)	***	1.05	(0.94 , 1.17)		0.75	(0.65 , 0.86)	***	0.97	(0.86 , 1.08)	
Race/Ethnicity												
Non-Hispanic White	---	---		---	---		---	---		---	---	
Non-Hispanic Black	1.02	(0.96 , 1.08)		0.66	(0.62 , 0.69)	***	1.13	(1.06 , 1.20)	***	0.64	(0.60 , 0.68)	***
Asian/Pacific Islander	0.79	(0.66 , 0.95)	**	0.48	(0.40 , 0.58)	***	1.00	(0.81 , 1.23)		0.64	(0.52 , 0.79)	***
American Indian/Alaska Native	0.99	(0.83 , 1.17)		1.00	(0.85 , 1.16)		0.96	(0.81 , 1.15)		0.95	(0.81 , 1.12)	
Hispanic	0.87	(0.78 , 0.97)	**	0.82	(0.74 , 0.90)	***	0.94	(0.83 , 1.05)		0.89	(0.80 , 0.99)	**
Other	0.73	(0.53 , 1.01)	*	0.77	(0.58 , 1.02)	*	0.90	(0.65 , 1.25)		0.92	(0.68 , 1.23)	
U.S. Born												
No	---	---		---	---		---	---		---	---	
Yes	1.36	(1.22 , 1.52)	***	1.32	(1.19 , 1.47)	***	1.17	(1.02 , 1.36)	**	1.07	(0.94 , 1.23)	
Married at Conception or Birth												
No	---	---		---	---		---	---		---	---	
Yes	0.85	(0.80 , 0.90)	***	1.19	(1.12 , 1.26)	***	0.95	(0.89 , 1.02)		1.05	(0.98 , 1.12)	
Education Level												
Less than high school	---	---		---	---		---	---		---	---	
High school grad/GED	1.09	(1.01 , 1.16)	**	1.29	(1.21 , 1.38)	***	1.10	(1.02 , 1.18)	**	1.27	(1.18 , 1.37)	***
Some college/Assoc degree	1.14	(1.06 , 1.22)	***	1.42	(1.32 , 1.52)	***	1.17	(1.08 , 1.26)	***	1.38	(1.28 , 1.49)	***
College grad or higher	1.01	(0.88 , 1.15)		1.07	(0.94 , 1.22)		1.05	(0.91 , 1.21)		1.08	(0.93 , 1.23)	

Reproductive Health Characteristics				
Parity				
≤ 2 births	--- --- ---	--- --- ---	--- --- ---	--- --- ---
More than 2 births	0.55 (0.51 , 0.58) ***	1.21 (1.14 , 1.28) ***	0.66 (0.61 , 0.71) ***	1.25 (1.18 , 1.33) ***
Pregnancy Intention				
Intended (Now/Sooner)	--- --- ---	--- --- ---	--- --- ---	--- --- ---
Mistimed (Later)	1.07 (1.00 , 1.14) **	1.19 (1.11 , 1.26) ***	0.98 (0.91 , 1.05)	1.34 (1.25 , 1.44) ***
Unwanted (Never)	0.68 (0.61 , 0.75) ***	1.27 (1.16 , 1.39) ***	0.74 (0.67 , 0.83) ***	1.48 (1.35 , 1.63) ***
Don't know	0.88 (0.81 , 0.96) ***	1.02 (0.94 , 1.11)	0.88 (0.81 , 0.96) ***	1.14 (1.05 , 1.24) ***
Short Interpregnancy Interval (< 12 months)				
No	--- --- ---	--- --- ---	--- --- ---	--- --- ---
Yes	0.69 (0.61 , 0.79) ***	1.11 (1.00 , 1.24) *	0.83 (0.72 , 0.94) ***	1.10 (0.99 , 1.23) *
Preterm Birth History				
No			--- --- ---	--- --- ---
Yes	0.68 (0.61 , 0.76) ***	1.03 (0.95 , 1.14)	0.90 (0.80 , 1.01) *	1.04 (0.94 , 1.16)
Low Birth Weight History				
No			--- --- ---	--- --- ---
Yes	0.59 (0.47 , 0.73) ***	0.86 (0.71 , 1.03)	0.80 (0.63 , 1.01) *	0.88 (0.72 , 1.07)
Breastfeeding at Discharge				
No	--- --- ---	--- --- ---	--- --- ---	--- --- ---
Yes	1.07 (1.02 , 1.13) **	1.04 (0.99 , 1.10)	1.03 (0.97 , 1.09)	1.00 (0.95 , 1.06)
Chronic Health Conditions				
Body Mass Index				
Underweight	0.98 (0.86 , 1.12)	0.81 (0.70 , 0.94) ***	0.97 (0.85 , 1.11)	0.81 (0.70 , 0.93) ***
Normal	--- --- ---	--- --- ---	--- --- ---	--- --- ---
Overweight	0.94 (0.88 , 1.01)	1.16 (1.08 , 1.24) ***	0.98 (0.92 , 1.05)	1.16 (1.08 , 1.24) ***
Obese	0.92 (0.86 , 0.98) ***	1.36 (1.28 , 1.45) ***	0.98 (0.91 , 1.04)	1.37 (1.28 , 1.46) ***
Diabetes				
No	--- --- ---	--- --- ---	--- --- ---	--- --- ---
Yes	0.89 (0.71 , 1.11)	0.98 (0.80 , 1.21)	1.00 (0.80 , 1.27)	0.87 (0.70 , 1.08)
Hypertension				
No	--- --- ---	--- --- ---	--- --- ---	--- --- ---
Yes	0.68 (0.57 , 0.81) ***	1.15 (1.00 , 1.33) *	0.76 (0.63 , 0.91) ***	1.09 (0.93 , 1.26)

Access Characteristics								
Medicaid for Pregnant Women								
No	--- --- ---		--- --- ---		--- --- ---		--- --- ---	
Yes	1.10 (1.04 , 1.17)	***	1.18 (1.12 , 1.25)	***	1.10 (1.03 , 1.17)	***	1.12 (1.05 , 1.19)	***
Delayed Prenatal Care								
No	--- --- ---		--- --- ---		--- --- ---		--- --- ---	
Yes	0.74 (0.70 , 0.79)	***	0.68 (0.64 , 0.73)	***	0.78 (0.73 , 0.84)	***	0.72 (0.67 , 0.77)	***
Non-English Speaking								
No	--- --- ---		--- --- ---		--- --- ---		--- --- ---	
Yes	0.70 (0.57 , 0.86)	***	0.59 (0.48 , 0.73)	***	1.00 (0.78 , 1.27)		0.83 (0.65 , 1.06)	
Rurality								
Metropolitan	--- --- ---		--- --- ---		--- --- ---		--- --- ---	
Micropolitan	1.10 (1.03 , 1.18)	***	1.23 (1.16 , 1.30)	***	1.09 (1.02 , 1.16)	**	1.10 (1.04 , 1.18)	***
Rural	1.32 (1.19 , 1.46)	***	1.19 (1.08 , 1.32)	***	1.27 (1.15 , 1.41)	***	1.04 (0.94 , 1.15)	

Source: Pregnancy Medical Home Case Management Information System, North Carolina Birth Records, and Medicaid Claims Data from September 1, 2011 to December 31, 2012. Moderately effective includes diaphragm, injections, patch, ring and oral contraceptives. Most effective includes tubal ligation, implant, and IUD. Referent group is no contraceptive claim. *p<0.1, **p<0.05, ***p<0.01, OR = odds ratio, CI = confidence interval. Adj. = adjusted

CHAPTER 4. CONCLUSIONS

OVERVIEW OF FINDINGS

This dissertation evaluated Community Care of North Carolina's Pregnancy Medical Home risk screening tool to determine which combination of risk factors was most predictive of preterm birth by parity and race/ethnicity (Chapter 2). The risk factors that were most predictive of PTB in this sample of Medicaid beneficiaries screened early in pregnancy include non-Hispanic black race, smoking during pregnancy, underweight, multi-fetal gestation, chronic disease (diabetes, hypertension, asthma, renal disease, and other chronic conditions), cervical insufficiency, nulliparity, and previous adverse reproductive outcomes (history of PTB, LBW baby, fetal death, and second trimester loss).

Furthermore, several risk factors differed in relation to PTB based on parity and race/ethnicity. Obesity was associated with an increased risk of PTB among nulliparous women only, while food insecurity was associated with an increased risk of PTB among parous women only. A short IPI was associated with an increased risk of PTB for black women only; unsafe or unstable housing was associated with increased odds of PTB among white women only.

This dissertation also compared receipt of postpartum contraception and method effectiveness among women with and without a recent preterm birth who were screened by the PMH program (Chapter 3). Women with a recent PTB who had more than two children had a lower likelihood of receiving any contraception,

particularly the most effective methods, compared to equal parity women who delivered at term. Among women who recently delivered preterm, contraceptive receipt was only 50% (and 25% for the most effective methods) at 90 days postpartum when two-thirds of the sample loses Medicaid coverage.

Use of the Pregnancy Medical Home Risk Screen, Birth Certificates, and Medicaid Claims Data

This dissertation takes advantage of extensive risk screening data from a novel program in North Carolina that has not been examined previously. Furthermore, it links this rich source of risk factor data to birth certificates and Medicaid claims. CCNC's risk screen includes several psychosocial risk factors that have not been assessed before in relation to PTB while including important sociodemographic, current pregnancy, and obstetric history variables in the model. Although few of these psychosocial factors were significant in the final predictive model of PTB, they did show evidence of being important predictors of PTB among certain subpopulations. This level of detail of clinical risk factor data is not typically available on such a large and diverse sample of women on Medicaid identified early in pregnancy. Thus findings reported in Chapter 2 are more generalizable than the bulk of research on risk scoring systems for PTB that are based on smaller, clinic-based convenience samples. Finally, prospective assessment of risk factors on the screening tool early in pregnancy, prior to the occurrence of the outcomes, provides for a stronger design compared to cross-sectional and retrospective studies.

The analysis in Chapter 3 provides the first estimate of the relationship between PTB and postpartum contraceptive receipt. Linkage of risk factor data to birth certificates and Medicaid claims enabled inclusion of a wealth of control

variables to calculate the least biased estimate of contraceptive receipt by PTB status. The lower likelihood of receiving contraception among women who recently had a PTB remained significant even when adjusting for several sociodemographic, reproductive, and chronic health conditions and healthcare access variables.

There are several limitations of these data. Because this was the first analysis to use the PMH risk screening form, the quality of the data was unknown and has not been validated. Several important variables were missing a substantial amount of data on the risk screening form and required substitution from the birth certificate. Numbers for current pregnancy characteristics were low for conditions that are often not detected until later in the pregnancy, such as hypertensive disorders of pregnancy, likely due to the screening cutoff prior to 24 weeks. The lower prevalence of these factors could lead to an underestimation of their effects, which could lead to the erroneous conclusion that these risk factors should not be prioritized even though they may be important contributors to PTB risk.

Using Medicaid claims to assess contraception avoids the limitations of self-reported data, which are the most common sources of contraceptive data in the United States from the NSFG and PRAMS. However, contraceptive claims data have several pitfalls, as were discussed in Chapter 3. Namely, Medicaid claims data only capture receipt of contraception, not actual use, and miss methods that cannot be billed such as condoms and withdrawal. It is not possible to determine whether women without a contraceptive claim are trying to get pregnant or not sexually active and therefore not in need of contraception. Furthermore, it remains unknown whether women obtain methods after 90 days. However given that 65% may lose

Medicaid coverage then, it is unlikely they would wait if they wanted it in the near future. Thus there may be misclassification bias due to women being classified as not receiving contraception when in reality they are using a less effective method that is not billable to Medicaid. Finally, though the risk screen provides a wealth of control variables to provide the least biased estimate of PTB and contraceptive receipt, it does not allow a test of the mechanisms through which PTB is inversely related to contraceptive receipt, which is important to inform intervention strategies.

Contribution to the Literature on Risk Screening and Preterm Birth, Disparities in Birth Outcomes, and Interconception Health

Risk assessment in PTB prevention has been hindered because many women who give birth preterm have no major risk factors.[3] Also, a number of risk factors that are predictive of PTB, such as black race, are highly prevalent with a low relative risk.[8] As such, previous risk scoring systems have only been able to identify a small proportion of women who have a PTB as high risk (low sensitivity), while a large proportion who have a PTB have been labeled as low risk (high false negative rate).[21] Although the predictive model designed and internally validated from the PMH risk screening in this dissertation appears to perform slightly better than previous tools in terms of sensitivity, it still misses a large proportion of women who were identified as low risk by the model yet who go on to have a PTB (false negatives).

These limitations suggest that different research methods are needed that better reflect the complexity of PTB parturition. One potential method is latent class analysis (LCA), which is a person-centered approach used to identify unobservable subgroups in a population.[129] LCA could be used to identify groups of women

clustered by certain behaviors or co-occurring risk factors rather than individual risk factors. Results from LCA could translate more easily into the provision of more nuanced and holistic women's health care, rather than current approaches of highly targeted programs for small groups of high-risk women that have evolved from research largely focused on parsing out individual risk factors.[130]

Given the striking disparities in birth outcomes between NHB and NHW women, this analysis sought to identify risk factors that could be targeted specifically for care management among non-Hispanic black women. A short interpregnancy interval was the only risk factor that was associated with an increased PTB risk among black women but not white women. More research on obstacles to achieving healthy pregnancy spacing among black women is needed to inform interconception care strategies.

The analysis in Chapter 3 is the first to compare contraceptive receipt by PTB status. Women with a recent PTB were less likely to receive any contraception, particularly the most effective methods, which suggests that they are at increased risk for a short IPI, unintended pregnancy, and recurrent PTB. These findings support the call to prioritize interconception care provision to women with prior adverse pregnancy outcomes.[31,32] The findings in Chapter 3 also support previous qualitative data on the difficulties low-income women face who may require multiple services in the postpartum period while trying to care for a preterm infant.[31,68,99] More research is needed to understand the mechanisms through which a recent PTB may hinder receipt of contraception to better understand how to help women access it and achieve their reproductive plans.

Implications

This study has several implications for practice and policy. Evaluation of risk factors from the PMH screening tool in Chapter 2 provides the evidence base to guide PMH program decision-making about which patients are most likely to deliver preterm and thus particularly warrant care management. The women who should be prioritized according to the final predictive model include those with the following risk factors: non-Hispanic black race, smoking during pregnancy, underweight, multi-fetal gestation, chronic disease (diabetes, hypertension, asthma, renal disease, and other chronic conditions), cervical insufficiency, nulliparity, and a history of PTB, low birth weight baby, fetal death, or second trimester loss.

Additionally, salient risk factors for PTB were identified for certain subgroups that will guide prevention approaches for vulnerable populations and could promote equity in birth outcomes. These include a short IPI, food insecurity, obesity, and unsafe or unstable housing. For example, black women had a higher prevalence of both a history of PTB and a recent PTB, a higher risk of PTB associated with a short IPI, and a lower likelihood of receiving contraception or the most effective methods. Taken together, these findings highlight the need for care management for non-Hispanic black women, particularly in the interconception period, to help optimize IPIs, avoid unintended pregnancy, and reduce the risk of recurrent PTB.

This dissertation provides insight into how the PMH program can increase the sensitivity and specificity of their tool to reduce preterm births and associated costs by revising the list of currently prioritized risk factors based on variables in the final predictive model. Under the current prioritization scheme, each priority risk factor is

weighted the same such that a woman is referred for a care management assessment if she has any one of the priority risk factors. Weighting each risk factor according to its strength of association with PTB will reduce the number of women with a positive test so that resources can be funneled to those most in need of care management.

It is also important to consider attributable risk rather than just relative risk.[130] For example, though multi-fetal gestations had the highest odds ratio for PTB in the final model, they were a relatively small proportion of the sample. Meanwhile, non-Hispanic black race had a lower odds ratio, yet 40% of the sample is black. To impact PTB rates in the Medicaid population, resources will need to be directed to those risk factors with a larger attributable risk. This is tricky, however, because these risk factors make up a larger share of the population, which will result in more women being care managed. One solution is that the PMH program could adopt an algorithm to weight risk factors differently for certain subgroups by parity and race/ethnicity to reflect the higher risk of some factors for vulnerable subgroups.

Before revisions to the risk screening tool are made, which would require amendment to Medicaid policy, similar analyses should be conducted using other important maternal and child health outcomes. Although the main objective of the PMH program is to reduce PTB, there are a host of outcomes (e.g., LBW) included in the larger program goal to improve birth outcomes and maternity care. Before changes in policy are made to adjust the composition of the priority population, other key outcomes should be examined.

For reductions in PTB to be realized, increased attention to the provision of effective methods of postpartum contraception in the PMH program is needed, particularly among women who recently had a PTB and have more than two children. Though this group of women is particularly in need of postpartum/interconception services given their increased vulnerability for a recurrent PTB, our findings in Chapter 3 suggest that they are less likely to receive any contraception within 90 days of delivery. Previous research documents that there may be missed opportunities for contraception dispensing in the postpartum period.[83,97] In a recent study of women who received publicly funded healthcare services in California within 18 months of delivery, researchers calculated that there were 68,869 missed opportunities to dispense contraception; 59% of women did not obtain contraception despite accessing postpartum care.[83]

In this dissertation it is not possible to determine the reasons why women with a recent PTB were less likely to receive contraception. Some literature suggests that women facing multiple burdens caring for a preterm infant may be less able to follow through on reproductive plans or attend postpartum visits.[68,99,105] Or perhaps family planning is less of a priority for their providers who are busy addressing other health needs for these women and infants given their more complicated postnatal situation.

Regardless, contraceptive counseling and method dispensing should be prioritized and extended for these women once they get past the initial demands of the early postpartum period. PMH care management is especially warranted for women with a recent PTB to assist in scheduling and attending the postpartum visit and connecting women who lose Medicaid coverage to the Family Planning Waiver.

This dissertation also provides evidence to support ongoing healthcare coverage for women who experience a preterm birth, such as through an Interconception Care Waiver that provides Medicaid coverage for an extended period of time beyond pregnancy to women with an adverse birth outcome. Most of the risk factors in the predictive model of PTB require monitoring and would benefit from follow-up beyond the prenatal period, such as smoking cessation, chronic disease management, and nutrition education. Furthermore, counseling about the need to prolong the IPI and supporting women to maintain continuous contraceptive coverage is especially needed in the interconception period for women with a recent PTB, LBW baby, fetal death, or second trimester loss.

Though the main focus of this dissertation was on PTB prevention, it is important to acknowledge that poor birth outcomes and disparities in NC and the United States are largely a legacy of poor women's health.[130] All the women in this sample were living in poverty. The relationship between poverty, both at the individual and neighborhood level, and poor birth outcomes has been well established.[75,131–134] In conclusion, the PMH program's goal to improve maternity care and birth outcomes by intervening in the prenatal and postpartum/interconception period is just one aspect of a larger effort that is needed to improve women's health and reduce health disparities over the life course. More comprehensive efforts that take into account the social context of women's lives, including poverty, are needed for further reductions in PTB and disparities to be realized.

APPENDIX. PREGNANCY MEDICAL HOME RISK SCREENING FORM

CCNC Pregnancy Home Risk Screening Form – 1st OB visit

Practice Name: _____

First name: _____ MI___ Last name:_____ Medicaid ID#:_____

Today's date: __/__/____

EDC: __/__/____ By what criteria: ❑ LMP ❑ 1st trimester U/S ❑ 2nd trimester U/S ❑ Other:_____

Height: _____ Pre-pregnancy weight: _____Gravidity: _____ Parity: ___ ___ ___

Insurance type: ❑ Medicaid ❑ None ❑ Other: _____

CURRENT PREGNANCY (check all that apply)

- ❑ *Multifetal gestation
- ❑ *Fetal complications:
  - ❑ Fetal anomaly
  - ❑ Fetal chromosomal abnormality
  - ❑ Intrauterine growth restriction (IUGR)
  - ❑ Oligohydramnios
  - ❑ Polyhydramnios
  - ❑ Other: _____
- ❑ *Chronic condition which may complicate pregnancy:
  - ❑ Diabetes
  - ❑ Hypertension
  - ❑ Asthma
  - ❑ Mental illness
  - ❑ HIV
  - ❑ Seizure disorder
  - ❑ Renal disease
  - ❑ Systemic lupus erythematosus
  - ❑ Other(s): _____
- ❑ *Current use of drugs or alcohol/recent drug use or heavy alcohol use (month prior to learning of pregnancy)
- ❑ *Late entry into prenatal care (>14 weeks)
- ❑ Cervical insufficiency
- ❑ Gestational diabetes
- ❑ Vaginal bleeding in 2nd trimester
- ❑ Hypertensive disorders of pregnancy (eclampsia, preeclampsia, gestational hypertension, HELLP syndrome)
- ❑ Short interpregnancy interval (<12 months between last live birth and current pregnancy)
- ❑ Current sexually transmitted infection
- ❑ Recurrent urinary tract infections (>2 in past 6 months, >5 in past 2 years)
- ❑ Communication barriers:
  - ❑ Literacy
  - ❑ Disability

  Explain: _____
  - ❑ Non-English speaking

  Primary language: _____

OBSTETRIC HISTORY (check all that apply)

- ❑ *Preterm birth (<37 completed weeks)

Gestational age(s) of previous preterm birth(s): _____

  - ❑ Were any a result of spontaneous preterm labor and/or preterm rupture of the membranes?
  - ❑ Is this a singleton pregnancy?

If yes to both questions, this patient is eligible for 17P treatment.

- ❑ *Low birth weight (<2500g)
- ❑ *Very low birth weight (<1500g)
- ❑ Fetal death >20 weeks
- ❑ Neonatal death (within first 28 days of life)
- ❑ Second trimester pregnancy loss
- ❑ Three or more first trimester pregnancy losses
- ❑ Cervical insufficiency
- ❑ Gestational diabetes
- ❑ Postpartum depression
- ❑ Hypertensive disorders of pregnancy
  - ❑ Eclampsia
  - ❑ Preeclampsia
  - ❑ Gestational hypertension
  - ❑ HELLP syndrome

❑ Provider requests pregnancy care management assessment

Reason(s)/Comments:_____

Items marked with a * will trigger automatic follow-up by a pregnancy care manager. If you would like a care manager to assess this patient, and none of the * conditions are marked, check the box above.

Name of person completing form: _____

Signature: _____

CCNC Pregnancy Home Risk Screening Form – 1st OB visit

Complete this side of the form and give it to the nurse or doctor. Please answer as honestly as possible so we can provide the best care for you and your baby. The care team will keep this information private.

Name: _____Date of birth: _____
Today's date: _____
Address: _____
County: _____ Home phone number: _____
Work/other phone number: _____
Cell phone number: _____ Social security number: _____
Race: ❑American-Indian or Alaska Native ❑Asian ❑Black/African-American
❑Pacific Islander/Native Hawaiian ❑White ❑Other (specify):_____
Ethnicity: ❑Not Hispanic ❑Cuban ❑Mexican American ❑Puerto Rican ❑Other Hispanic

1. Thinking back to <u>just before you got pregnant</u>, how did you feel about becoming pregnant?

- ❑ I wanted to be pregnant sooner.
- ❑ I wanted to be pregnant now.
- ❑ I wanted to be pregnant later.
- ❑ I did not want to be pregnant then or any time in the future.
- ❑ I don't know.

2. *Within the last year, have you been hit, slapped, kicked or otherwise physically hurt by someone? ❑ Yes ❑ No
3. *Are you in a relationship with a person who threatens or physically hurts you?
❑ Yes ❑ No
4. *Has anyone forced you to have sexual activities that made you feel uncomfortable?
❑ Yes ❑ No
5. In the last 12 months were you ever hungry but didn't eat because you couldn't afford enough food? ❑ Yes ❑ No
6. *Do you have a safe and stable place to live? ❑ Yes ❑ No
7. *Which statement best describes your smoking status? Check one answer.

- ❑ A. I have never smoked, or have smoked less than 100 cigarettes in my lifetime.
- ❑ B. I stopped smoking BEFORE I found out I was pregnant and am not smoking now.
- ❑ C. I stopped smoking AFTER I found out I was pregnant and am not smoking now.
- ❑ D. I smoke now but have cut down some since I found out I was pregnant.
- ❑ E. I smoke about the same amount now as I did before I found out I was pregnant.

8. Did any of your parents have a problem with alcohol or other drug use?
❑ Yes ❑ No
9. Do any of your friends have a problem with alcohol or other drug use?
❑ Yes ❑ No
10. Does your partner have a problem with alcohol or other drug use?
❑ Yes ❑ No

11. In the past, have you had difficulties in your life due to alcohol or other drugs, including prescription medications?

❑ Yes ❑ No

12. Before you knew you were pregnant, how often did you drink any alcohol, including beer or wine, or use other drugs? ❑Not at all ❑Rarely ❑Sometimes ❑Frequently

13. In the past month, how often did you drink any alcohol, including beer or wine, or use other drugs?

❑Not at all ❑Rarely ❑Sometimes ❑Frequently

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