THE ASSOCIATION BETWEEN HYPERTENSIVE DISORDERS IN PREGNANCY AND BREASTFEEDING INITIATION AND DURATION: RESULTS FROM 2007-2009 NORTH CAROLINA PREGNANCY RISK ASSESSMENT MONITORING SYSTEM

by

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ABSTRACT

SANGAMITHRA KRUPAKAR. The association between hypertensive disorders in pregnancy and breastfeeding initiation and duration: Results from the 2007-2009 North Carolina Pregnancy Risk Assessment Monitoring System. (Under the direction of DR. LARISSA R. BRUNNER HUBER)

Hypertensive disorders are the most commonly reported medical disorder among pregnant women, and an important cause of adverse birth outcomes as well as maternal and perinatal mortality and morbidity. One important step to reduce these adverse effects is to initiate breastfeeding early and continue exclusive breastfeeding for at least 6 months postpartum. Breastfeeding has immediate benefits and lowers blood pressure in mothers before, during, and after breastfeeding sessions. This study assessed the association between hypertensive disorders in pregnancy and breastfeeding initiation and duration. This study was a secondary data analysis of 3,826 women aged between 18-45 years who participated in the 2007-2009 North Carolina Pregnancy Risk Assessment and Monitoring System. Information on hypertensive disorders in pregnancy was obtained from birth certificate records, and breastfeeding initiation and duration were self-reported. Multivariate logistic regression was used to calculate odds ratios (OR) and 95% confidence intervals (CI) while controlling for confounders. Nearly 76% of women initiated breastfeeding and among those who initiated, 68% continued breastfeeding for ≥ 8 weeks. Women with hypertensive disorders in pregnancy had slightly increased odds of breastfeeding initiation (OR=1.15; 95% CI: 0.81, 1.62), however, this result was not statistically significant. After adjusting for race, pre-pregnancy BMI, and smoking, the magnitude of this association increased (OR=1.22; 95% CI: 0.84, 1.77), and remained statistically insignificant. Women with hypertensive disorders in pregnancy had

statistically significant decreased odds of breastfeeding for ≥8 weeks (OR=0.68; 95% CI: 0.49, 0.94). After adjusting for pre-pregnancy BMI, the association was no longer statistically significant (OR=0.75, 95% CI: 0.54, 1.05). Although women with hypertensive disorders in pregnancy are initiating breastfeeding successfully, they are unable to continue breastfeeding for a longer duration. Additional studies are required that examine breastfeeding patterns for a longer duration and explicitly categorize hypertensive disorders in pregnancy to confirm these findings.

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TABLE OF CONTENTS

CHAPTER 1: INTRODUCTION

Hypertensive disorders represent the most commonly reported medical disorder among pregnant women, complicating nearly 10% of all pregnancies.[1] Hypertensive disorders in pregnancy are an important cause of maternal and perinatal mortality and morbidity in the United States, accounting for 12% of maternal deaths.[2] In addition, hypertension during pregnancy contributes to various adverse pregnancy outcomes such as intrauterine growth restriction, preterm birth, and fetal death.[3]

According to the Hospital Cost Utilization Project (HCUP) Nationwide Inpatient Survey (NIS), spending on hypertension in pregnancy totaled nearly $2.3 billion in the United States in 2003. During that year, approximately 204,868 pregnant women were admitted to the hospital for hypertension, staying an average of 3.5 days. The average per-person charge for such hospital admissions totaled $11,208.[4] Appropriate management can help reduce the significant societal and cost burden of these conditions.

The term “hypertensive disorders in pregnancy” encompasses a spectrum of disease processes ranging from mild to severe, and even life-threatening. The National High Blood Pressure Education Program of the National Heart, Lung, and Blood Institute (NHLBI) classifies hypertensive disorders in pregnancy into the following categories: chronic hypertension, gestational hypertension, preeclampsia-eclampsia, and preeclampsia superimposed on chronic hypertension.[5] This classification differentiates

hypertensive disorders that occur before pregnancy, from preeclampsia which is a serious disease specific to pregnancy.

The exact pathogenesis of hypertensive disorders in pregnancy is not fully understood. However, recent studies have shown a higher risk of hypertensive disorders in pregnancy among women with a family history of hypertension, history of hypertension during a previous pregnancy, pre-existing diabetes mellitus, gestational diabetes, maternal age ≥35 years, nulliparity, multiple pregnancies, pre-pregnancy obesity, and excessive gestational weight gain.[6-9] Identification of these risk factors can help in the early diagnosis of hypertensive disorders in pregnancy, and facilitate appropriate management.

In addition to adverse pregnancy outcomes, hypertensive disorders in pregnancy are associated with long-term maternal effects such as an increased risk for hypertension and cardiovascular, cerebrovascular, arterial, renal, and metabolic diseases.[10,11] Thus, pregnancy may act as an early natural "stress test" unmasking underlying defects, and predicting a woman's health in later life.[12]

One important step in reducing the morbidity and mortality associated with hypertensive disorders in pregnancy is to initiate breastfeeding early and to continue exclusive breastfeeding for at least 6 months after delivery.[13] Breastfeeding has immediate benefits, such as lowering blood pressure in mothers before, during, and after breastfeeding sessions. Oxytocin release during breastfeeding is thought to be responsible for this effect.[14] Studies have found that mothers with high oxytocin levels have lower blood pressure and lower levels of stress, further highlighting the association between oxytocin and low blood pressure.[15] Breastfeeding is an important mediator of

oxytocin release, and breastfeeding mothers are more likely to have increased oxytocin levels compared to bottle feeding mothers.[16] Furthermore, studies have reported that mothers who breastfed exclusively for 3-6 months after delivery had significantly higher oxytocin levels than those who gave supplementary feeds.[17,18] Therefore, it is likely that women who breastfeed exclusively for 6 months are more likely to experience the blood pressure lowering effect of oxytocin. Lactation reduces blood pressure not only in the postpartum period but also diminishes the risk of future development of hypertension in the mother. Studies suggest that women who exclusively breastfed for ≥ 6 months are less likely to develop hypertension than women who did not breastfeed.[19] Therefore, breastfeeding may be especially beneficial to women with chronic illnesses such as hypertension , and can decrease the risk or prevent those illnesses from developing in their children.[20]

Breastfeeding is a cost-effective, health promoting, and disease-preventing activity that new mothers can perform. Human milk is a complex biological fluid which provides infants with nutrients for healthy growth and development, and enhances their immunity.[21] Breast milk is considered the gold standard for infant nutrition especially during the first 6 months. Breastfeeding initiation is an important attribute of breastfeeding. The World Health Organization (WHO) defines early initiation of breastfeeding as provision of mother's breast milk to infants within one hour of birth and exclusive breastfeeding as providing the infant only breast milk and no other liquids or solids with the exception of medications and vitamins.[22] The American Academy of Pediatrics recommends exclusive breastfeeding for about 6 months, followed by

continued breastfeeding as complementary foods are introduced, with continuation of breastfeeding for 1 year or longer as mutually desired by mother and infant.[23]

Duration and exclusivity are key measures of breastfeeding patterns. Ever breastfed is an indicator for assessing if breastfeeding was initiated.[24] According to the CDC's 2014 Breastfeeding Report Card, 79% of newborn infants started to breastfeed. However, breastfeeding did not continue for as long as recommended, with only 49% breastfeeding at 6 months and 27% at 12 months. The rate of exclusive breastfeeding at 3 months was 41% and 19% at 6 months.[25]

In North Carolina, in 2014, 77% of infants were ever breastfed, with 48% breastfeeding at 6 months and 25% at 12 months; rates slightly lower than the national average.[25] However, the rate of exclusive breastfeeding was 43% at 3 months and 21% at 6 months. Although these rates are higher than the national average, they continue to fall short of national goals set in initiatives such as Healthy People 2020. The Healthy People 2020 goals for breastfeeding are: 81.9% ever breastfed, 60.5% at 6 months, and 34.1% at 12 months with 46.2% exclusively breastfed at 3 months and 25.5% at 6 months.[26]

Breastfeeding has significant nutritional, psychological, immunological, social, economic, and environmental benefits. Breastfeeding decreases the incidence and severity of various conditions among children such as diarrhea,[27] respiratory infections,[28] asthma,[29] otitis media,[30] sudden infant death syndrome,[31] insulin-dependent diabetes mellitus,[32] various chronic diseases such as cancer and cardiovascular disease,[33] childhood obesity,[34] and neonatal mortality.[35] Breastfeeding is also positively associated with cognitive development in children.[36] These benefits are magnified with exclusive breastfeeding and breastfeeding beyond 6 months of age.[37]

Breastfeeding has several maternal health benefits such as decreased postpartum bleeding and rapid uterine involution,[38] an earlier return to pre-pregnancy weight,[39] and reduced risk of ovarian cancer,[40] breast cancer,[41] postpartum depression, type 2 diabetes, and coronary heart disease.[42] Exclusive breastfeeding also serves as natural contraceptive by suppressing ovulation, thus helping in family planning.[43]

The absence of breastfeeding not only affects short and long-term health outcomes but also exacts a financial toll on the United States economy. A detailed pediatric cost analysis based on the Agency for Healthcare Research and Quality report concluded that $13 billion per year could be saved if 90% of United States mothers would comply with the recommendation to breastfeed exclusively for 6 months.[44] Breastfeeding is an important public health strategy for improving infant and child morbidity and mortality and maternal morbidity. As a preventive measure, breastfeeding promotes improved health outcomes and is cost-effective.

Previous research on the possible association between hypertensive disorders in pregnancy and breastfeeding initiation and duration has been very sparse. At the time of this investigation, only one study specifically examined this association.[45] However, the study population in that study had a high rate of prematurity and the authors hypothesized that although women with hypertensive disorders in pregnancy breastfed significantly less often compared to normotensive women, this effect was at least partly due to the increased rate of prematurity. Also, the control group in this study included few infants with birth weight <2500g, compared to women with hypertensive disorders, and therefore the effect of low birth weight on breastfeeding initiation was hard to discern. Furthermore, the study was conducted in Germany and the results may not be

generalizable to the population in the United States.[45] Therefore, this study examined the association between hypertensive disorders in pregnancy and breastfeeding initiation and duration in a large sample of North Carolina women who had live births. The study's findings may help health care professionals to encourage women with hypertensive disorders in pregnancy to initiate breastfeeding.

CHAPTER 2: LITERATURE REVIEW

2.1 Background of Hypertensive Disorders in Pregnancy

Hypertensive disorders in pregnancy are a major health issue for women and their infants. During pregnancy, hypertension is classified as chronic hypertension, gestational hypertension, preeclampsia-eclampsia, and preeclampsia superimposed on chronic hypertension.[5]

Hypertension is defined as blood pressure ≥140 mm Hg systolic or ≥90 mm Hg diastolic. Chronic hypertension is defined as hypertension that is diagnosed before pregnancy or before 20 weeks of gestation. Hypertension that is first diagnosed during pregnancy and persists for more than 12 weeks postpartum also is considered chronic hypertension.[5] The prevalence of chronic hypertension in pregnancy, currently estimated to be 3%, has been increasing.[46] This increase can be attributed to an increase in the prevalence of obesity, a major risk factor for hypertension, and delaying childbearing to ages when chronic hypertension is more prevalent.[47]

Although most women with chronic hypertension have good pregnancy outcomes, these women are at an increased risk for pregnancy complications compared to the general population. In addition to an increased risk for superimposed preeclampsia (25% vs 3-5% in general population), women with chronic hypertension have higher rates of placental abruption, pulmonary edema, cerebral hemorrhage and acute renal failure. Fetal and neonatal complications such as preterm delivery, small for gestational age infants, and fetal death are also observed.[47] Therefore, counseling, evaluating, and

managing chronic hypertension in women of reproductive age either before conception or during regular prenatal visits is important.

Gestational hypertension is defined as hypertension that develops after 20 weeks of gestation and resolves before 12 weeks postpartum in the absence of proteinuria (<300 mg protein in urine/day). Gestational hypertension is the most common cause of hypertension during pregnancy with a rate of 2-4% among multiparous women and 6-17% among nulliparous women.[48] The majority of cases of mild gestational hypertension develop at or beyond 37 weeks of gestation and have good pregnancy outcomes. However, women with severe gestational hypertension have increased maternal and perinatal morbidities such as placental abruption, preterm delivery, and small for gestational age infants. These women are also more likely to have induced labor and cesarean delivery compared to normotensive women.[48]

Preeclampsia is a pregnancy-specific syndrome characterized by new-onset hypertension and proteinuria (>300 mg protein in urine/day) and usually occurs after 20 weeks of gestation. Preeclampsia can lead to various systemic complications affecting renal, hematological, hepatic, neurologic, and pulmonary functions such as oliguria (urine output <500 ml/day), elevated serum creatinine levels (>1.2 mg/dl), thrombocytopenia (platelets counts <100,000 cells/µl), elevated liver enzymes (serum transaminases), cerebral and visual disturbances, and pulmonary edema or cyanosis.[49] Pregnant women can sometimes present with a variant or complication of preeclampsia called the HELLP syndrome, which is characterized by hemolysis, elevated liver enzymes, and low platelets.[49] Eclampsia on the other hand, is the occurrence of seizures not attributable to any other cause, in a woman with preeclampsia.[5]

The incidence of preeclampsia has increased by 25% in the United States during the past two decades.[50] The rate of preeclampsia ranges from 2-7% among nulliparous women, with substantially higher rates in women with multiple gestations (14%) and those with previous preeclampsia (18%).[48] Preeclampsia is a significant public health threat contributing significantly to maternal and fetal morbidity and mortality. Women with preeclampsia are at an increased risk for placental abruption, acute renal failure, cerebrovascular and cardiovascular complications, and death. Preterm delivery, intra-uterine growth restriction, fetal distress, and fetal death are some of the fetal complications observed in preeclampsia.[48]

The etiology of preeclampsia is largely unknown although several risk factors have been identified. Preeclampsia is most common in first pregnancies and other risk factors include hypertensive disorder in previous pregnancy or chronic hypertension, diabetes mellitus, multiple gestation, vascular and connective tissue disorders, renal disease, obesity, maternal age ≥35 years, and being African American.[49]

Numerous clinical and bio-chemical tests have been proposed for the prediction or early detection of preeclampsia, but these tests have poor sensitivity and poor predictive values, and therefore are not reliable.[51] Early diagnosis, monitoring, and clinical management of hypertension are currently the only effective ways to manage preeclampsia, with delivery being the only effective cure. This fact underlines the importance of early and adequate prenatal care in reducing adverse maternal and fetal outcomes. From a public health perspective, this would imply increasing access to prenatal care and ensuring a continuum of care from pregnancy through delivery and postpartum.

Preeclampsia superimposed on chronic hypertension is defined as chronic hypertension with a new-onset of worsening blood pressure, proteinuria, or other systemic features of preeclampsia. Superimposed preeclampsia develops in 13-40% of women with chronic hypertension leading to higher rates of adverse maternal and fetal outcomes.[5] Hence, preconception counseling and antepartum management are crucial to avoid worsening of blood pressure during pregnancy and its associated complications.[5]

2.2 Background of Breastfeeding Initiation and Duration

Several factors influence initiation and duration of breastfeeding. Demographic factors that are associated with early initiation and continued breastfeeding include being white, well educated, married, older, a non-smoker, not employed outside the home, and of higher socioeconomic status.[52] Other factors associated with early initiation and continued breastfeeding include giving birth to a healthy full-term infant, increased parity, and previous successful breastfeeding experience.[52]

Attitudinal factors such as prenatal intention to breastfeed and positive attitude towards breastfeeding are associated with greater likelihood of initiation and longer duration. Informal sources of support such as the woman's partner, and friends and family members with breastfeeding experience positively influence breastfeeding initiation and duration.[52] Formal sources of support which include healthcare professionals and hospital practices can also positively influence breastfeeding women.[52]

2.3 Epidemiologic Studies on the Association between Hypertensive Disorders in Pregnancy and Breastfeeding Duration

Only one previous study examined the association between hypertensive disorders in pregnancy and breastfeeding initiation and duration. Leeners et al. (2005) conducted a case-control study to examine breastfeeding rates in women with and without

hypertensive disorders in pregnancy from the Hy-Di-Preg study, a research project on Hypertensive Disorders in Pregnancy (HDP) across Germany. A self-administered questionnaire was given to 2,600 women with a suspected history of hypertensive disorders in pregnancy and 1,233 controls. After matching and confirming hypertension diagnosis, 877 cases and 623 controls were included in the study. Women were asked whether they had had the wish to breast feed, whether they did breast feed, for how long they fed only maternal milk, as well as whether and for how long they combined breast and bottle feeding.

This study found that normotensive women initiated (48.9%, $p < 0.001$) and continued (42.2%, $p < 0.005$) breastfeeding significantly more often than women with hypertensive disorders (39.2% and 37.2%). Specifically, women who developed HELLP syndrome, a complication of preeclampsia, those who delivered infants before the 32nd gestational week, and those who delivered infants with a birth weight <1500 g were less likely to breastfeed, although the percentage of breastfeeding women with gestational hypertension or pre-eclampsia was not statistically significantly different compared to normotensive women. Although women with HELLP syndrome initiated breastfeeding less often than women developing pre-eclampsia or gestational hypertension, after 3 months following delivery, no statistical difference between women with gestational hypertension, preeclampsia and HELLP syndrome was found. This study has certain limitations. The authors speculated that the association between hypertensive disorders and a lower rate of breastfeeding was due at least in part to a high rate of prematurity.[45] The control group did not include enough infants with low birth weight (<2500g; only 13% of controls), whereas women with hypertensive disorders had high rates of low birth

weight among their infants (42% of gestational hypertension cases and 72% of preeclampsia cases). Therefore, the effect of birth weight on breastfeeding initiation cannot be fully evaluated. As data were collected retrospectively, there is a chance that information such as intention to breastfeed may have been over or under reported resulting in recall bias. Also, the study was conducted in Germany and the results may not be generalizable to the population in the United States.

One study examined various factors associated with breastfeeding initiation and duration among hypertensive women, and several other studies that incidentally found hypertensive disorders in pregnancy to be an important determinant of breastfeeding initiation. In a prospective cohort study that examined maternal and infant characteristics associated with human milk feeding in very low birth weight infants conducted in North Carolina, 184 mothers who participated in lactation counseling and initiated breastfeeding were enrolled. Women who delivered singleton or multiple infants between May 2001 and August 2003 with birth weight between 700g and 1500g were invited within 3 days of delivery to participate in a study which compared anxiety levels before and after lactation counseling.[53]

Data were collected by interviewing the mothers and reviewing medical records. Mothers' infant feeding plans were recorded at the time of admission into labor and delivery. Mothers were classified as intending to breastfeed if they stated that they planned to breastfeed or combine breastfeeding with formula feeding. Mothers were classified as formula feeding if they stated that they planned to formula feed or were unsure at the time of admission. Perinatal hypertensive disorder was defined as having any of the following: chronic hypertension, preeclampsia, eclampsia, and pregnancy-

induced hypertension or HELLP syndrome during pregnancy. The main outcomes of this study were receipt of ≥ 50% human milk proportion of enteral feeding to the infant during the first 2 weeks of life and receipt of human milk on the last day of hospitalization.

This study found that among various demographic and medical variables, intention to breastfeed was the strongest predictor of initiation and duration of human milk feeding. As far as hypertensive disorders in pregnancy was concerned, the study found that among infants born to mothers who chose to breastfeed, those born to mothers with hypertensive disorders were less likely (OR=0.48, 95% CI: 0.19,1.23; p=0.10) to receive at least 50% human milk proportion of enteral feedings during the first 2 weeks of life. However, despite lower human milk feeding early in life, infants born to mothers with hypertensive disorders were as likely to receive human milk until discharge from the hospital as those born to normotensive mothers.[53] Some limitations to this study such as a small sample size which limit the generalizability of the results. Selection bias is likely in this study because the study participants were recruited from a medical center which specializes in high risk obstetric care. These women may have been more likely to receive prenatal counseling on breastfeeding and its importance especially after a high risk pregnancy.

Cordero et al. conducted a retrospective cohort study in Ohio to examine clinical and demographic factors associated with breastfeeding initiation in women with severe preeclampsia who delivered late preterm and term infants.[54] The study population consisted of 281 women with severe preeclampsia, the diagnosis established according to clinical and laboratory criteria. On arrival to labor and delivery, women's feeding

preference for their infants was obtained (breastfeeding, formula feeding, or undecided). Successful breastfeeding initiation was defined as if at the time of discharge from the hospital ≥ 50% of the feedings were direct from the breast or by expressed breast milk.

All the mothers received magnesium sulfate treatment for 24 hours following delivery. Of 281 women, 144 (51%) successfully initiated breastfeeding by the time of discharge. The strongest predictor of breastfeeding initiation was the intention to breastfeed (OR=18.6, 95% CI: 9.45, 36.69, p<0.0001). Of the 149 women who intended to breastfeed, 76% were successful. Women of African American race (OR=0.39, 95% CI: 0.19, 0.61, p<0.0002), smokers (OR=0.19, 95% CI: 0.09, 0.40, p<0.0001), and obese women (OR=0.90, 95% CI: 0.93, 0.99, p<0.01) were less likely to initiate breastfeeding.[54] The small sample size of this study limits the generalizability of the study results. Also, the study included only women with severe preeclampsia making it difficult to compare the results with women without hypertensive disorders. The retrospective design of this study and lack of follow-up regarding breastfeeding after discharge are some other limitations of this study.

In a cross-sectional study examining breastfeeding outcomes and factors associated with breastfeeding <8 weeks among preterm infants, a population of 35,697 women were examined. Data from seven Pregnancy Risk Assessment Monitoring System (PRAMS) project sites (Colorado, Florida, Illinois, Louisiana, Maine, New York City, and Oregon) from 2004 to 2007 were included in this study.[55] In this study, breastfeeding initiation was defined as ever having breastfed or pumped breast milk, and breastfeeding duration as the number of completed weeks the mother reported feeding her infant any breast milk. Breastfeeding duration was defined as short if < 8 weeks and

longer if ≥ 8 weeks. Information on various socio-demographic variables, pregnancy characteristics, maternal and infant health characteristics, and institutional support for breastfeeding was obtained through self-report and from birth certificates. More specifically, information on hypertension (chronic/pregnancy-induced or no hypertension) and breastfeeding was self-reported.

This study found that among preterm infants, hypertension was a significant predictor (OR=1.34, 95% CI: 1.06, 1.69, p<0.10) of short breastfeeding duration (i.e. <8 weeks).[55] As data on breastfeeding were self-reported there may be a chance of recall bias, resulting in information bias. This study examined factors associated with breastfeeding in preterm infants only and therefore the results may not be generalizable to term infants.

2.4 Biological Mechanism and Conceptual Model

Women with hypertensive disorders in pregnancy initiate and continue breastfeeding for shorter durations compared to normotensive women. These women experience several obstacles or difficulties with breastfeeding, within the context of their medical condition. Maternal complications due to hypertension, such as HELLP syndrome, may require the mother to be treated in an intensive care unit or experience a prolonged recovery due to the effect of medications. All of these factors can adversely affect breastfeeding initiation.[45]

Intention to breastfeed is an important determinant of breastfeeding initiation and duration.[53] The decision to breastfeed can be affected by various factors especially medical issues during pregnancy and complications during labor and delivery. Women

with complex pregnancies, such as those complicated with hypertension, have lower odds of intending to breastfeed.[56]

Women with hypertensive disorders are more likely to have preterm delivery and low birth weight among their infants.[49] Both of these factors are associated with reduced rates of breastfeeding.[45,57] Women with hypertensive disorders in pregnancy are also likely to have high rates of cesarean section deliveries.[45] Cesarean section has been found to be a persistent barrier to early initiation of breastfeeding.[58]

Early mother-infant interaction is very important for the success of breastfeeding.[59] It is possible that hypertensive complications in the mother or the effect of medications may cause a delay in the interaction with the newborn.[45,54] If the newborn is premature or low birth weight a need for intensive care treatment may arise, further delaying the mother-infant interaction, and affecting breastfeeding initiation and duration.[60]

Lack of supportive health care professionals and hospital practices can negatively affect breastfeeding behavior especially in women with a complex pregnancy.[52] Supportive hospital practices such as the Baby Friendly Hospital Initiatives which help mothers to initiate breastfeeding early by encouraging “rooming in” and help sustain breastfeeding with the help of trained staff can play a very important role in early breastfeeding initiation especially after a complex pregnancy.[52,56] The conceptual model in Figure 1 developed on the basis of the literature review depicts some of the factors that influence breastfeeding initiation in women with hypertensive disorders in pregnancy.

Most women discontinue breastfeeding prematurely because of perceived difficulty with breastfeeding rather than choice.[61] Perceived insufficient milk supply,

latching difficulties, engorged breast, maternal fatigue and sleep deprivation, post-partum depression, lack of family or social support, employment or school, and medications are a few factors that can affect continuation or duration of breastfeeding.[61-64] Studies have reported that women with hypertensive disorders in pregnancy are at an increased risk for breastfeeding cessation within 10 days post-partum, indicating the success of breastfeeding is strongly associated with events in the first 2 weeks postpartum.[65] The conceptual model in Figure 2 developed on the basis of the literature review depicts some of the factors that influence breastfeeding duration. No factors specific to hypertenisve diosrders in pregnancy-breastfeeding duration association were found. However, it is possible that these factors are heightened in women with hypertensive disorders in pregnanccy affecting their duration of breastfeeding.

2.5 Summary and Implications

In summary, previous research on the possible association between hypertensive disorders in pregnancy and breastfeeding initiation and duration has been very sparse. Only one study examined this association but the study population had an increased rate of prematurity, thus possibly masking the true association. As the study was conducted in a European nation, the findings may not be generalizable to the United States.[45]

Breastfeeding is of particular importance for mothers and children born after experiencing hypertensive disorders in pregnancy. The long term health outcomes of breastfeeding include a decreased incidence of obesity, hypertension, and diabetes mellitus, not just for the mother but for the infant as well.[33,34,42,66] It is therefore imperative to examine if hypertensive disorders in pregnancy affect breastfeeding initiation and duration, so that appropriate support can be provided to these women to

encourage and sustain breastfeeding. This study examined the association between hypertensive disorders in pregnancy and breastfeeding initiation and duration in a large sample of North Carolina women who had live births.

CHAPTER 3: HYPOTHESES

This study examined whether an association exists between hypertensive disorders in pregnancy and breastfeeding initiation after delivery as well as breastfeeding duration.

The specific hypotheses were:

1. Women with hypertensive disorders in pregnancy have decreased odds of breastfeeding initiation after delivery as compared to normotensive women.
2. Women with hypertensive disorders in pregnancy have decreased odds of breastfeeding their babies for eight weeks or more after delivery as compared to normotensive women

CHAPTER 4: METHODS

4.1 Study Population and Design

This study was a retrospective cohort study that used data from the 2007-2009 North Carolina Pregnancy Risk Assessment Monitoring System (N.C. PRAMS). The N.C. PRAMS is a joint initiative between the North Carolina State Center for Health Statistics (NCHS) and the Centers for Disease Control and Prevention (CDC) to lower rates of low birth weight and infant mortality. It is an on-going surveillance system, which is conducted to provide data on selected self-reported maternal behaviors, conditions, and experiences that occur shortly before, during, and after pregnancy among women who deliver live-born infants.[67]

The N.C. PRAMS is a random, stratified, monthly mail and telephone survey of North Carolina women who recently (i.e., 2-6 months before participating in the survey) delivered a live-born infant. The sample is stratified based on birth weight, with oversampling occurring among low birth weight babies (1,500-2,499 grams) and very low birth weight babies (less than 1,500 grams).

Each month, a sample of approximately 200 women with recent live-born deliveries is drawn from the Provisional Birth File. Up to three self-administered surveys are mailed to mothers in the sample, with non-respondents followed up with a telephone interview. The first survey is mailed approximately 2-4 months after delivery. Nonresponse to the first mailing initiates a follow-up schedule that includes two

additional mailings. Follow-up by phone is employed in cases of non-response to the mail phase.[67]

Self-reported survey data are then linked to selected birth certificate data and weighted for sample design, non-response, and non-coverage to create the annual N.C. PRAMS analysis data sets. These weights make the data statistically representative of all North Carolina women with a live-born delivery. N.C. PRAMS data for the years 2007-2009 was used for this study since they had response rates (Year 2007: 71%, Year 2008: 72% and Year 2009: 63%) similar to the CDC's suggested threshold of 65%.[68] Approximately 4,400 women participated in N.C. PRAMS during these years. Only women between the ages of 18 to 45 years who provided complete information on the exposure, outcome, and key confounding variables was included in the analysis.

4.2 Exposure Assessment

For this study, the exposure was the diagnosis of hypertensive disorders in pregnancy, which includes chronic hypertension, pregnancy related hypertension, and eclampsia/toxemia. This information was determined primarily from birth certificate records. In the birth certificate records, hypertensive complications in pregnancy are labeled as "Hypertension?" This variable is a combination of three checkboxes: pre-pregnancy (chronic), gestational (i.e., pregnancy-induced hypertension, preeclampsia), and eclampsia. If any one of the boxes was checked on the birth certificate, PRAMS personnel further collapsed the information to just be a "Yes" for hypertension. The exposure variable was categorized as women with hypertensive disorders in pregnancy (i.e., exposed) and women with no hypertensive disorders in pregnancy/normotensive (i.e., unexposed).

4.3 Outcome Assessment

The first outcome of this study was breastfeeding initiation. Breastfeeding initiation was defined as any breastfeeding after delivery. This information was measured from the self-reported responses to the N.C. PRAMS survey. The question on the survey asks, "Did you ever breastfeed or pump breast milk to feed your new baby after delivery, even for a short period of time?" Women who initiated breastfeeding were considered to have the outcome.

The second outcome of this study was breastfeeding duration. Breastfeeding duration was defined as the length of time for any breastfeeding, whether or not the infant was exclusively breastfed during this period. This information was determined based on the responses to the following question: "How many weeks or months did you breastfeed or pump milk to feed your baby? Women who breastfed for eight weeks or more were considered to have the outcome. An eight week cut-off was used because the first N.C. PRAMS survey questionnaire could have been mailed as early as eight weeks after delivery; making it difficult to assess breastfeeding at a later time.[55,68]

4.4 Covariate Assessment

Demographic, maternal, and infant characteristics collected through N.C. PRAMS were evaluated as potential confounding factors. These confounders included demographic factors such as maternal age, maternal race/ethnicity, maternal education, marital status, and income; and maternal factors such as parity, pre-pregnancy body mass index, and weight gain during pregnancy, maternal smoking during pregnancy, alcohol consumption during pregnancy, gestational diabetes, participation in WIC, Medicaid, and receipt of prenatal care and prenatal counseling on breastfeeding.[45] The infant factors

that were considered as potential confounders were sex, gestational age, birth weight, mode of delivery, and the number of nights the infant spent in the hospital.[62]

4.5 Data Analysis

Univariate analysis: Frequencies and percentages describing the various demographic, lifestyle and pregnancy characteristics of the sample population were calculated.

Bivariate analysis: Logistic regression was used to calculate the odds ratios (ORs) and 95% confidence intervals (95% CIs) to obtain a crude association between hypertensive disorders in pregnancy and breastfeeding initiation and duration. Other factors associated with breastfeeding initiation and breastfeeding duration were identified.

Multivariate analysis: Adjusted ORs and 95% CIs were calculated using multivariate logistic regression to evaluate the hypertensive disorders-breastfeeding initiation and duration associations, while controlling for confounders. The adjusted models included variables that changed the magnitude of the exposure-outcome relationship by at least 5%.[69] All analyses were conducted using SAS-callable SUDAAN due to the complex sampling design employed by PRAMS.

4.6 Sample Size and Power

For this study, data from the years 2007 through 2009 were used, and 3,826 women were included. Setting alpha at 0.05, power at 80%, the ratio of unexposed (i.e. no hypertensive disorders in pregnancy) to exposed (i.e. with hypertensive disorders in pregnancy) at 8.6:1 and the frequency of breastfeeding initiation among the unexposed at 68.6%, the smallest detectable odds ratio is 0.74. Assuming the same settings, and with

61.3% of women breastfeeding at 8 weeks, the smallest detectable odds ratio for the hypertensive disorders-breastfeeding duration association is 0.75.

4.7 Human Subject Protection

No contact was made with participants of this study as this was a secondary data analysis. Individuals who agreed to participate in N.C. PRAMS were asked to sign an Informed Consent Form prior to filling out the self-administered questionnaire. All available data were stripped of personal identifiers, thus maintaining participant confidentiality. No communication was required with these individuals. Additionally, no follow up procedures were associated with this study.

4.8 Permission to Access Data

The N.C. PRAMS data set for the years 2007-2009 was obtained through a data sharing agreement signed on April 1st, 2014 with the North Carolina State Center for Health Statistics. A data security plan was established with the College of Health and Human Services' IT Data Security Office at UNC Charlotte. The de-identified data were housed on a private drive accessible only to Ms.Sangamithra Krupakar and Dr. Huber based on network id and password. Data were stored on the network server only. When the research team was not physically on campus, the directory containing the data and the software to analyze the data were accessed remotely through VMware Horizon Client software and analyzed leaving the data on the server. Once the thesis and subsequent publications are completed, the data will be returned to N.C. PRAMS and destroyed by them.

CHAPTER 5: RESULTS

5.1 Univariate Results

A total of 4,227 women participated in the 2007-2009 N.C PRAMS. Women were excluded from the study if they were not between the ages of 18-45 years (n=144) or if they did not answer the question on breastfeeding initiation (n=151). Women were further excluded from the study if they were missing information on any of the following variables: education (n=11), race (n=1), smoking status (n=4), previous live birth (n=45), participation in WIC (n=20), infant birth weight (n=3), or infant admission to intensive care (n=22). Thus, a total of 3,826 women were available for analysis.

Among these women, 6.23% were diagnosed with hypertensive disorders in pregnancy and more than three-fourths of women (76.30%) initiated breastfeeding. Among those women who initiated breastfeeding, 31.90% of women breastfed for less than 8 weeks and 68.10% breastfed for 8 weeks or more (Table 1).

Approximately half (52.02%) of the women were between the age of 25 to 34 years, and 14.19% of the women were 35 to 45 years of age. More than half the women were Non-Hispanic White (58.19%) and had a house-hold income between $20,000 and $49,999 (52.62%) and 30.51% had a college education or graduate education. Nearly 2 out of 5 women were overweight or obese (40.42%) or had a higher than recommended weight gain (39.87%) during pregnancy. Nearly 1 out of 10 infants was either born pre-term i.e. < 37 gestation weeks (9.47%) or was admitted to intensive care (11.00%) after birth.

5.2 Bivariate Results

Women who were 18 to 24 years of age had statistically significant decreased odds of breastfeeding initiation (OR=0.49; 95% CI: 0.41, 0.60; Table 2) and breastfeeding duration of ≥8 weeks (OR=0.49; 95% CI: 0.39, 0.60; Table 3) compared to women 25 to 34 years of age. Non-Hispanic Black women had statistically significant decreased odds of breastfeeding initiation (OR=0.47; 95% CI: 0.38, 0.58) and breastfeeding duration of ≥8 weeks (OR=0.65; 95% CI: 0.51, 0.83), whereas Hispanic women had increased odds of initiating breastfeeding (OR=3.32; 95% CI: 2.24, 4.92) and breastfeeding for longer (OR=1.58; 95% CI: 1.19, 2.10) compared to Non-Hispanic White women. Women with a college degree or higher had 5 times the odds of initiating breastfeeding (OR=5.21; 95% CI: 4.00, 6.80), and nearly 4 times the odds of continuing breastfeeding for ≥8 weeks (OR=3.57; 95% CI: 2.78, 4.59) as compared to women with a high school education.

Women who were not married were 60% less likely to initiate breastfeeding (OR=0.40; 95% CI: 0.34, 0.49) and 50% less likely to breastfeed for ≥ 8 weeks (OR=0.50; 95% CI: 0.41, 0.61) compared to married women. Women with a household income of ≤$19,999 had decreased odds of initiating breastfeeding (OR=0.39; 95% CI: 0.32, 0.48) and breastfeeding for ≥8 weeks (OR=0.54; 95% CI: 0.43, 0.66). In contrast, women with a household income of ≥$50,000 had increased odds of initiating breastfeeding (OR=1.64; 95% CI: 1.12, 2.40) and continuing breastfeeding for longer (OR=1.50; 95% CI: 1.08, 2.09) compared to women with a household income of $20,000-$49,999.

Women with no previous live births had statistically significant decreased odds of breastfeeding initiation (OR=0.66; 95% CI: 0.55, 0.79), however, they had increased odds of breastfeeding for a longer duration (OR=1.32, 95% CI: 1.09, 1.59) compared to women with previous live births. Women with fewer than 12 prenatal care visits were nearly 30% less likely to initiate breastfeeding (OR=0.72; 95% CI: 0.60, 0.87) compared to women with more than 12 prenatal care visits. Women who did not receive prenatal counseling on breastfeeding had increased odds of initiating breastfeeding (OR=1.16, 95% CI: 0.89, 1.51), and continuing breastfeeding for a longer duration (OR=1.74; 95% CI: 1.31, 2.31) compared to women who received prenatal counseling on breastfeeding.

Women with a pre-pregnancy BMI ≥30.0 were 25% less likely to initiate breastfeeding (OR=0.75; 95% CI: 0.59, 0.95) and 54% less likely to continue breastfeeding for ≥8 weeks (OR=0.46; 95% CI: 0.36, 0.59) compared to women with a normal pre-pregnancy BMI. These associations were statistically significant. Women with a higher than recommended weight gain during their pregnancy had decreased odds of breastfeeding initiation (OR=0.94, 95% CI: 0.76, 1.17), although not statistically significant, compared to women with a recommended weight gain. However, women with higher than recommended weight gain during their pregnancy had statistically significant decreased odds of breastfeeding for ≥8 weeks (OR=0.76, 95% CI: 0.61, 0.94).

Compared to non-smokers, women who smoked during pregnancy were less likely to initiate breastfeeding (OR=0.24; 95% CI: 0.18, 0.31) and continue breastfeeding for ≥8 weeks (OR=0.29; 95% CI: 0.20, 0.41). Women with gestational diabetes had decreased odds of breastfeeding initiation (OR=0.83; 95% CI: 0.51, 1.35) compared to non-diabetic women, but this association was not statistically significant. However,

women with gestational diabetes had statistically significant decreased odds of breastfeeding for ≥8 weeks (OR=0.60; 95% CI: 0.37, 0.99) compared to non-diabetic women.

Women who participated in the WIC program had a 64% reduction in the odds of breastfeeding initiation (OR=0.36; 95% CI: 0.30, 0.43) and a 56% reduction in the odds of breastfeeding for ≥8 weeks (OR=0.44; 95% CI: 0.36, 0.53) compared to non-participants. Both these associations were statistically significant. Women who participated in Medicaid had decreased odds of initiating breastfeeding (OR=0.30; 95% CI: 0.23, 0.38) and breastfeeding for a longer duration (OR=0.38; 95% CI: 0.27, 0.52) compared to non-participants.

Women who gave birth to infants with birth weights of ≤1499 grams were more likely (OR=1.73; 95% CI: 1.19, 2.52) to initiate breastfeeding. In contrast, women with infants weighing 1500-2499 grams had decreased odds of initiating breastfeeding (OR=0.75; 95% CI: 0.64, 0.89) and breastfeeding for a longer duration (OR=0.73; 95% CI: 0.61, 0.87) compared to women with infants weighing ≥2500 grams.

Women who had a cesarean birth had increased odds of breastfeeding initiation (OR=1.10; 95% CI: 0.91, 1.33) compared to women with a vaginal delivery, though this association was not statistically significant. However, women with a cesarean birth had statistically significant decreased odds of breastfeeding for ≥8 weeks (OR=0.80; 95% CI: 0.66, 0.97) compared to women with a vaginal delivery. With respect to the exposure of interest, women with hypertensive disorders in pregnancy had a slight increase in odds of breastfeeding initiation (OR=1.15; 95% CI: 0.81, 1.62) compared to normotensive women, however, this finding was not statistically significant. In spite of the increased

odds of initiating breastfeeding, women with hypertensive disorders in pregnancy had statistically significant decreased odds of breastfeeding for ≥8 weeks (OR=0.68; 95% CI: 0.49, 0.94) compared to normotensive women.

5.3 Multivariate Results

After adjusting for race, pre-pregnancy BMI, and smoking, the magnitude of the hypertensive disorders in pregnancy-breastfeeding initiation association increased slightly. Women with hypertensive disorders in pregnancy had 1.22 times the odds of initiating breastfeeding (95% CI: 0.84, 1.77) compared to women who did not have these disorders during pregnancy, however, the results were not statistically significant. After adjusting for pre-pregnancy BMI, the magnitude of the hypertensive disorders in pregnancy-breastfeeding duration association was attenuated and no longer statistically significant. Specifically, women with hypertensive disorders in pregnancy had a 25% decreased odds of breastfeeding for ≥8 weeks as compared to women without these disorders (OR=0.75, 95% CI: 0.54, 1.05).

CHAPTER 6: DISCUSSION

5.1 Summary of Main Findings

In the unadjusted model, women with hypertensive disorders in pregnancy had slight increased odds of breastfeeding initiation; however, the association was not statistically significant. After adjusting for race, pre-pregnancy BMI, and smoking status the magnitude of the association increased slightly and remained not statistically significant. Women with hypertensive disorders in pregnancy had statistically significant decreased odds of breastfeeding for ≥8 weeks in the unadjusted model. However, after adjustment for pre-pregnancy BMI this association was attenuated and no longer statistically significant.

5.2 Consistency with Previous Research

The prevalence of hypertensive disorders in pregnancy among the study population was 6.2%, a rate lower than the 10% found in the literature.[1,70] On average, 76.3% of women in the study population initiated breastfeeding, a rate comparable to the United States national trends.[71,72] Although breastfeeding initiation rates in the United States have been steadily increasing over the past two decades,[73,74] the rates are still below the Healthy People 2020 goal of 82% of women initiating breastfeeding.[75]

Odds of breastfeeding initiation and duration differed by demographic characteristics among the study population with Non-Hispanic Black women having lower rates of initiating and continuing breastfeeding compared to Non-Hispanic White

women. Similar results have been observed in various studies examining breastfeeding rates among the Non-Hispanic Black population.[76,77] A similar trend also is observed nationally, with 58.9% of Non-Hispanic Black women initiating breastfeeding in 2008, compared to 75.2.% of Non-Hispanic White who initiated breastfeeding.[78] These low odds are especially concerning as the Non-Hispanic Black population in North Carolina has an infant mortality rate that is more than twice that of the Non-Hispanic White population. Many infant deaths can be prevented by increasing breastfeeding initiation and duration.[79] This study also found that women with higher income and education are more likely to initiate and continue breastfeeding, similar to the results observed from national data.[80] Women who smoke were found to have lower odds of breastfeeding initiation and shorter breastfeeding duration, results consistent with those found in other national studies.[81] Breastfeeding can modify the effects of smoking during pregnancy and also protect the infant from conditions that can arise due to exposure to second-hand smoke, such as sudden infant death syndrome and asthma.[82] Therefore, encouraging women who smoke to initiate and continue breastfeeding for as long as possible is important.

Obese women were found to have lower odds of breastfeeding initiation and duration. This finding is consistent with studies that reported an association between high pre-pregnancy BMI and reduced initiation and early termination of breastfeeding.[83-85] Women with higher than recommended gestational weight gain had a shorter duration of breastfeeding, a finding similar to studies that reported that excessive gestational weight gain is associated with earlier discontinuation of breastfeeding.[86,87]

An interesting finding of this study was the higher odds of breastfeeding initiation among very low birth infants (birth weight ≤1499 grams) and a lower odds of initiation among low birth weight infants (birth weight 1500-2499 grams) compared to infants with a birth weight ≥2500 grams. The exact incidence rates of breastfeeding initiation among very low birth weight infants in unknown as usually the data on these infants is grouped into the low birth weight infant category, which is a healthier group.[88] It may be possible that women with very low birth weight infants may be encouraged by health care providers to provide breast milk to their newborns, and therefore have higher rates of breastfeeding initiation.

With respect to the association between hypertensive disorders in pregnancy and breastfeeding initiation, this study's findings are inconsistent with those of Leeners et al. who examined this association and reported that women with hypertensive disorders had a lower odds of breastfeeding initiation compared to the control group.[45] However, the study by Leeners et al. reported that the rate of breastfeeding initiation among women with gestational hypertension or pre-eclampsia did not differ significantly from normotensive women, and only women with HELPP syndrome were significantly less likely to initiate breastfeeding. These inconsistent findings could be due to a high rate of prematurity among the study population of Leeners et al., which could partly explain the association between hypertensive disorders in pregnancy and lower odds of breastfeeding initiation. Furthermore, this study was conducted in Germany and the overall study population had low rates of breastfeeding initiation (48.9%), even among the normotensive women. In contrast, the present study included a representative sample of

all live births in North Carolina, which included preterm and term infants, and very low birth weight, low birth weight, and normal birth weight infants.

As far as the association between hypertensive disorders in pregnancy and breastfeeding duration is concerned, the current study's findings are consistent with the results from Leeners et al. who found that women with hypertensive disorders in pregnancy continued breastfeeding for shorter durations (≤3 months) compared to the normotensive women.[45] Also consistent with the current study are the results from a cross-sectional study conducted by Mulready-Ward and Sackoff (2012) who concluded that women with hypertensive disorders in pregnancy had increased odds of short breastfeeding duration (<8 weeks).[55]

5.3 Strengths and Limitations

The present study had several strengths and limitations. Information on hypertensive disorders in pregnancy, the exposure variable, was obtained from birth certificate records, thus reducing the possibility of nondifferential misclassification of exposure. However, a possible source of nondifferential misclassification of the exposure was the collapsing of different types of hypertensive disorders in pregnancy into one variable in the birth certificate data. Hypertension in this source was defined as one or more of the following: high blood pressure, pregnancy induced hypertension, preeclampsia, eclampsia or toxemia. By collapsing these different diagnoses into one variable, it was impossible to investigate specific conditions like pregnancy induced hypertension or preeclampsia. Thus, nondifferential misclassification of the exposure is possible and would likely bias the results towards the null.

Information on the outcome variables, breastfeeding initiation and duration, was obtained from the N.C. PRAMS survey. This information was self-reported and there is a possibility that women may have over reported breastfeeding because it is a socially desirable practice, leading to a nondifferential misclassification of the outcome. If this type of misclassification occurred, it would likely bias the results towards the null.

The response rates for N.C. PRAMS for the years 2007-2009 ranged from 63% to 72%. These relatively high response rates make selection bias less likely. N.C. PRAMS uses a complex sampling method to select participants for the survey. However, it is possible that women who completed the survey differed from women who did not respond. For example, women who completed the survey may have been healthier or had different characteristics than the average individual in the target population. If participation is somehow related to both the exposure and outcome, the results may be biased away from the null.

Recall bias is unlikely in this study as information on the exposure was obtained from the birth certificate data. However, differential misclassification is possible as the information on outcomes, i.e., breastfeeding initiation and duration, was self-reported. A woman with hypertensive disorders may be more likely to accurately report that she did not initiate breastfeeding, if she believes that suffering from hypertensive disorders during her pregnancy may have been a reason for non-initiation or early termination. Conversely, a woman with hypertensive disorders may be more likely to report that she initiated breastfeeding, even if she did not, because she feels guilty and knows that breastfeeding would have been best for her baby. If this type of misclassification occurred, it would likely bias the results away from the null.

This study considered multiple potential confounders such as maternal age, maternal race/ethnicity, maternal education, marital status, income, previous live birth, pre-pregnancy body mass index, weight gain during pregnancy, maternal smoking during pregnancy, alcohol consumption during pregnancy, gestational diabetes, participation in WIC, Medicaid, prenatal care, prenatal counseling on breastfeeding, infant sex, gestational age, birth weight, and mode of delivery. The possible confounders that were assessed in this study were restricted to the variables available in the N.C. PRAMS data. Intention to breastfeed is an important factor that can confound the relationship between hypertensive disorders in pregnancy and breastfeeding initiation.[53] However, this information was not available in the N.C PRAMS data. It is possible that there are other unknown confounders of the hypertension-breastfeeding initiation and duration association. Failure to control for these missing and unknown confounders could result in an over or underestimate of the true association.

The N.C. PRAMS utilizes a complex, weighted sampling design to create a representative sample of the general population. Assuming internal validity, the results of this study could be generalized to women between the reproductive ages of 18 and 45 years residing in North Carolina and possibly the Southeast region. However, it is possible that regional differences may limit generalizing these results to all women in the United States.

5.4 Conclusion

This study examined the association between hypertensive disorders in pregnancy and breastfeeding initiation and duration after delivery in a large sample of North Carolina women who have recently had live births. Very few studies in the past have

examined this association. Breastfeeding has short and long-term effects on health outcomes in mothers and their children.[13] It is important for clinicians and public health professionals to encourage women with hypertensive disorders in pregnancy to continue to initiate breastfeeding. Based on the current study's results it is also important to encourage women with hypertensive disorders to continue breastfeeding for a longer duration, by providing adequate support and addressing the barriers to continued breastfeeding. It is possible that women receive assistance with breastfeeding in the hospital through nurses and lactation consultants, and are therefore able to initiate breastfeeding successfully. However, few women report assistance of any kind with breastfeeding while at home after being discharged from the hospital.[89] Support for sustaining breastfeeding while managing their blood pressure may be especially important to women with hypertensive disorders in pregnancy, and the lack thereof could explain the early termination of breastfeeding among these women.

Future research should focus on defining the exposure variable more explicitly so it would be possible to examine the association between specific types of hypertensive disorders in pregnancy and breastfeeding initiation and duration. A longitudinal cohort study would be helpful, especially to assess breastfeeding for a longer duration and at multiple time points. It would also be useful to examine the duration of exclusive breastfeeding among women with hypertensive disorders in pregnancy as this study examined any breastfeeding and not exclusive breastfeeding. Overall, more research among a diverse sample population is required to confirm or refute this study's findings.

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APPENDIX A: FIGURES

Figure 1: Conceptual model of the association between hypertensive disorders in pregnancy and breastfeeding initiation.

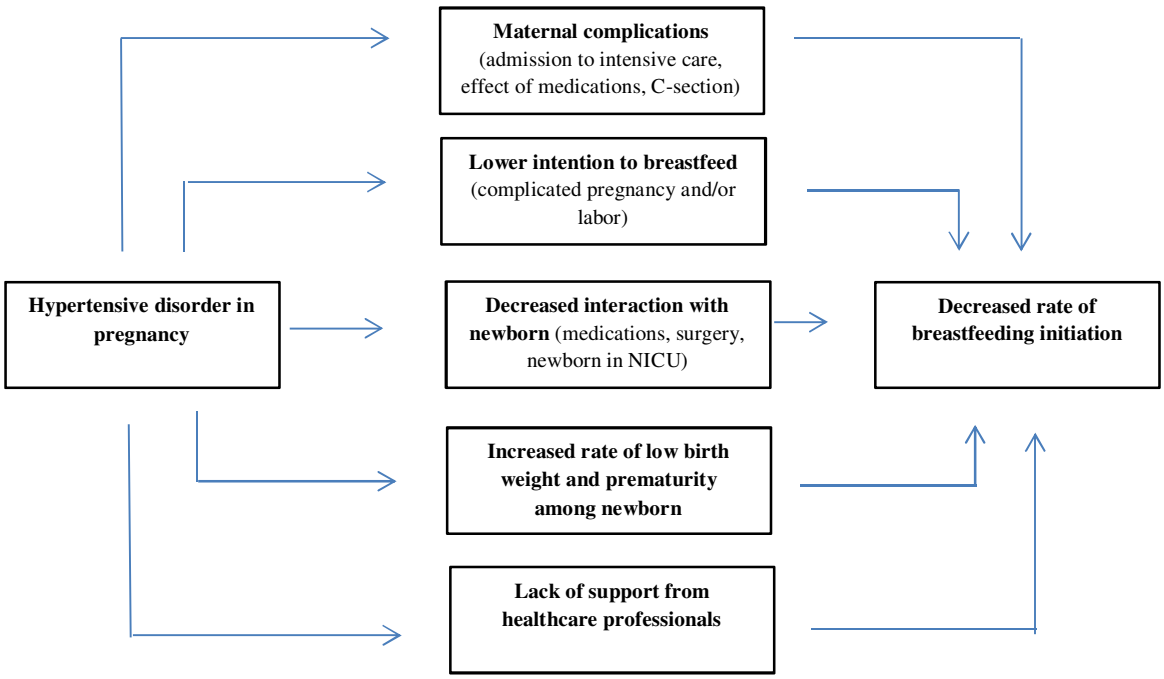
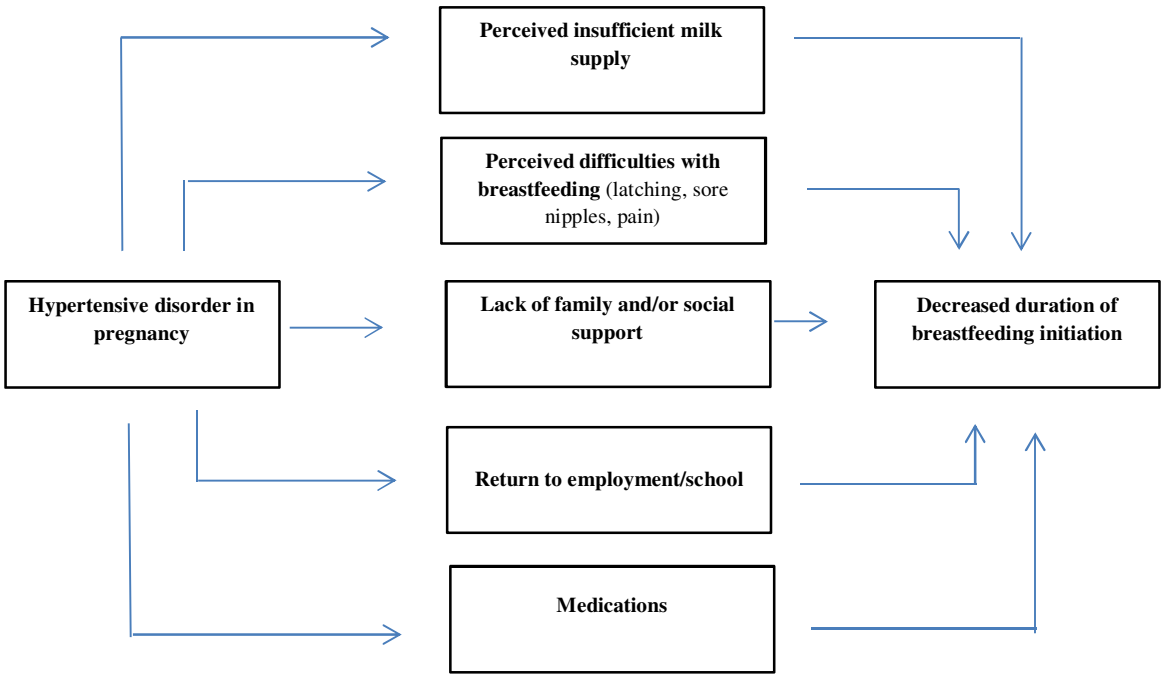


Figure 2: Conceptual model of the association between hypertensive disorders in pregnancy and breastfeeding duration.



APPENDIX B: TABLES

Table 1: Characteristics of the analytic sample

Variable	N	%
Maternal age		
18-24 years	1218	33.79
25-34 years	2022	52.02
35-45 years	586	14.19
Maternal race/ethnicity		
Non-Hispanic White	2253	58.19
Non-Hispanic Black	936	22.79
Hispanic	472	14.96
Other	165	4.07
Maternal education		
Less than High School	607	17.70
High School	1069	29.49
Some college	900	22.30
College graduate and above	1250	30.51
Marital status		
Married	2427	60.69
Other	1399	39.31
Income		
≤ $19,999	1256	36.57
$20,000-49,999	1998	52.62
≥ $ 50,000	367	10.82
Previous live birth		
Yes	2063	57.09
No	1763	42.91
Number of prenatal care visits		
<12	1566	36.96
≥12	2209	61.93
Missing	51	1.11
Prenatal counseling on breastfeeding		
Yes	3186	83.81
No	566	14.39
Missing	74	1.80
Pre-pregnancy BMI		
≤18.5	419	11.34
18.6-24.9	1885	48.24
25.0- 29.9	802	21.80
≥30.0	720	18.62

Table 1 continued

Maternal weight gain during pregnancy		
Low	1043	23.57
Normal	1265	33.64
High	1390	39.87
Missing	128	2.92
Maternal smoking during pregnancy		
Yes	434	10.71
No	3392	89.29
Maternal alcohol consumption during pregnancy		
Yes	21	0.41
No	3805	99.59
Gestational diabetes		
Yes	135	3.37
No	3691	96.63
Participation in WIC		
Yes	1645	45.80
No	2181	54.20
Participation in Medicaid		
Yes	481	13.14
No	3345	86.86
Infant sex		
Male	1899	49.91
Female	1927	50.09
Gestational age		
<37 weeks	1089	9.47
≥37 weeks	2737	90.53
Birth weight		
≤1499 grams	238	1.28
1500-2499 grams	1174	6.40
≥2500 grams	2414	92.32
Infant admitted to ICU		
Yes	976	11.00
No	2850	89.00
Mode of delivery		
Vaginal	2401	67.03
Cesarean	1425	32.97
Hypertension in pregnancy		
Yes	400	6.23
No	3426	91.91

Table 1 continued

Breastfeeding initiation		
Yes	2944	76.30
No	882	23.70
Breastfeeding duration*		
< 8 weeks	926	31.90
≥ 8 weeks	1977	68.10

Table 2: Unadjusted odds ratios (OR) and 95% confidence intervals (CI) of the association between selected demographic, lifestyle, and pregnancy characteristics and breastfeeding initiation; N.C. PRAMS 2007-2009.

Variable	**Breastfeeding initiation**	
	OR	**95% CI**
Maternal age		
18-24 years	0.49	0.41, 0.60
25-34 years	1.00	Referent
35-45 years	1.11	0.83, 1.47
Maternal race/ethnicity		
Non-Hispanic White	1.00	Referent
Non-Hispanic Black	0.47	0.38, 0.58
Hispanic	3.32	2.24, 4.92
Other	0.73	0.47, 1.12
Maternal education		
Less than High School	1.18	0.92, 1.53
High School	1.00	Referent
Some college	1.99	1.56, 2.54
College graduate and above	5.21	4.00, 6.80
Marital status		
Married	1.00	Referent
Other	0.40	0.34, 0.49
Income		
≤ $19,999	0.39	0.32, 0.48
$20,000-49,999	1.00	Referent
≥ $ 50,000	1.64	1.12, 2.40
Previous live birth		
Yes	1.00	Referent
No	0.66	0.55, 0.79
Number of prenatal care visits		
<12	0.72	0.60, 0.87
≥12	1.00	Referent
Missing	0.54	0.25, 1.17
Prenatal counseling on breastfeeding		
Yes	1.00	Referent
No	1.16	0.89, 1.51
Missing	0.84	0.45, 1.57

Table 2 continued

Pre-pregnancy BMI		
≤18.5	1.15	0.84, 1.58
18.6-24.9	1.00	Referent
25.0-29.9	0.84	0.66, 1.05
≥30.0	0.75	0.59, 0.95
Maternal weight gain during pregnancy		
Low	0.92	0.73, 1.17
Normal	1.00	Referent
High	0.94	0.76, 1.17
Missing	0.73	0.44, 1.22
Maternal smoking during pregnancy		
Yes	0.24	0.18, 0.31
No	1.00	Referent
Maternal alcohol consumption during pregnancy		
Yes	3.54	1.30, 9.67
No	1.00	Referent
Gestational diabetes		
Yes	0.83	0.51, 1.35
No	1.00	Referent
Participation in WIC		
Yes	0.36	0.30, 0.43
No	1.00	Referent
Participation in Medicaid		
Yes	0.30	0.23, 0.38
No	1.00	Referent
Infant sex		
Male	1.00	Referent
Female	0.86	0.72, 1.03
Gestational age		
<37 weeks	0.86	0.69, 1.09
≥37 weeks	1.00	Referent
Birth weight		
≤1499 grams	1.73	1.19, 2.52
1500-2499 grams	0.75	0.64, 0.89
≥2500 grams	1.00	Referent
Infant admitted to ICU		
Yes	0.91	0.71, 1.17
No	1.00	Referent

Table 2 continued

Mode of delivery		
Vaginal	1.00	Referent
Cesarean	1.10	0.91, 1.33
Hypertension in pregnancy		
Yes	1.15	0.81, 1.62
No	1.00	Referent

Table 3: Unadjusted odds ratios (OR) and 95% confidence intervals (CI) of the association between selected demographic, lifestyle, and pregnancy characteristics and breastfeeding duration ≥ 8 weeks; N.C. PRAMS 2007-2009.

Variable	**Breastfeeding duration ≥ 8 weeks**	
	OR	**95% CI**
Maternal age		
18-24 years	0.49	0.39, 0.60
25-34 years	1.00	Referent
35-45 years	1.27	0.96, 1.69
Maternal race/ethnicity		
Non-Hispanic White	1.00	Referent
Non-Hispanic Black	0.65	0.51, 0.83
Hispanic	1.58	1.19, 2.10
Other	1.45	0.87, 2.41
Maternal education		
Less than High School	1.78	1.30, 2.43
High School	1.00	Referent
Some college	1.41	1.09, 1.83
College graduate and above	3.57	2.78, 4.59
Marital status		
Married	1.00	Referent
Other	0.50	0.41, 0.61
Income		
≤ $19,999	0.54	0.43, 0.66
$20,000-49,999	1.00	Referent
≥ $ 50,000	1.50	1.08, 2.09
Previous live birth		
Yes	1.00	Referent
No	1.32	1.09, 1.59
Number of prenatal care visits		
<12	0.84	0.69, 1.03
≥12	1.00	Referent
Missing	0.75	0.30, 1.85
Prenatal counseling on breastfeeding		
Yes	1.00	Referent
No	1.74	1.31, 2.31
Missing	0.99	0.48, 2.03

Table 3 continued

Pre-pregnancy BMI		
≤18.5	1.35	0.96, 1.90
18.6-24.9	1.00	Referent
25.0-29.9	0.75	0.59, 0.96
≥30.0	0.46	0.36, 0.59
Maternal weight gain during pregnancy		
Low	0.79	0.61, 1.20
Normal	1.00	Referent
High	0.76	0.61, 0.94
Missing	0.71	0.40, 1.25
Maternal smoking during pregnancy		
Yes	0.29	0.20, 0.41
No	1.00	Referent
Maternal alcohol consumption during pregnancy		
Yes	0.87	0.24, 3.09
No	1.00	Referent
Gestational diabetes		
Yes	0.60	0.37, 0.99
No	1.00	Referent
Participation in WIC		
Yes	0.44	0.36, 0.53
No	1.00	Referent
Participation in Medicaid		
Yes	0.38	0.27, 0.52
No	1.00	Referent
Infant sex		
Male	1.00	Referent
Female	1.13	0.94, 1.36
Gestational age		
<37 weeks	0.85	0.67, 1.09
≥37 weeks	1.00	Referent
Birth weight		
≤1499 grams	0.85	0.62, 1.17
1500-2499 grams	0.73	0.61, 0.87
≥2500 grams	1.0	Referent

Table 3 continued

Infant admitted to ICU		
Yes	0.85	0.66, 1.09
No	1.00	Referent
Mode of delivery		
Vaginal	1.00	Referent
Cesarean	0.80	0.66, 0.97
Hypertension in pregnancy		
Yes	0.68	0.49, 0.94
No	1.00	Referent

Table 4: Adjusted odds ratios (OR) and 95% confidence intervals (CI) of the association between hypertensive disorders in pregnancy and breastfeeding initiation; N.C. PRAMS 2007-2009.

	Breastfeeding Initiation	
Hypertensive disorders in pregnancy	**OR**	**95% CI**
Yes	1.22	0.84, 1.77
No	1.00	Referent

*Adjusted for maternal race, pre-pregnancy BMI, and smoking

Table 5: Adjusted odds ratios (OR) and 95% confidence intervals (CI) of the association between hypertensive disorders in pregnancy and breastfeeding duration of 8 weeks or more; N.C. PRAMS 2007-2009**.**

	Breastfeeding Duration ≥ 8 weeks	
Hypertensive disorders in pregnancy	**OR**	**95% CI**
Yes	0.75	0.54, 1.05
No	1.00	Referent

*Adjusted for maternal pre-pregnancy BMI