THE ASSOCIATION BETWEEN HAVING A PRETERM INFANT AND LATER MENTAL AND PHYSICAL HEALTH OUTCOMES AMONG PARENTS

by

Kenesha F. Smith, MSPH

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Approved by:

_____
Dr. Larissa Brunner Huber

_____
Dr. Suzanne Boyd

_____
Dr. Sharon Portwood

_____
Dr. JaneDiane Smith

_____
Dr. Lisa Walker

ABSTRACT

KENESHA F. SMITH, MSPH. The association between having a preterm infant and later mental and physical health outcomes among parents. (Under the direction of DR. LARISSA BRUNNER HUBER)

In 2017, 10% of babies were born preterm, accounting for one out of every ten infants born in the US. Previous research suggests that the birth of a preterm infant may lead to substantial challenges among parents, and may eventually lead to psychological distress and ill mental health. In addition, the psychological stress of having a preterm infant may lead to a decline in physical health, including sleep disturbances, fatigue, and poor overall well-being compared to parents of full term infants. Thus, the purpose of this study was to examine the association between having a preterm infant and physical health among US parents. Ebaugh's Role Exit Theory guided this study; the researcher argues that the process of role exit may place many new parents in the "vacuum experience," causing them to be unable to swiftly move from one identity into the next, leading to ill mental health. Various data sets were needed to examine the research aims. Specifically, the US Pregnancy Risk Assessment Monitoring System (PRAMS), the North Carolina Behavioral Risk Factor Surveillance Survey (BRFSS), and primary data collection were used to examine the potential relationship. The primary data collection was a web-based survey of women in two Facebook support groups for mothers in the Charlotte, NC area, as well as mothers in the University of North Carolina at Charlotte community. Summary statistics of demographic and lifestyle factors were calculated. Logistic regression and multivariate logistic regression were used to calculate unadjusted and adjusted odds ratios

and 95% confidence intervals. SAS-callable SUDAAN were used in BRFSS and PRAMS analyses and SAS was used to analyze the web-based survey data.

Although not all results were statistically significant, these studies consistently revealed increased odds of adverse health outcomes for parents who had preterm infants compared to those who had full term infants. Findings of the population-based study of North Carolina mothers and fathers using BRFSS data revealed that parents of preterm infants have increased odds of several chronic diseases (diabetes OR=1.83; 95% CI: 0.54, 6.23; hypertension OR=1.12; 95% CI: 0.43, 2.92; cholesterol OR=1.30; 95% CI: 0.61, 3.23) A population-based study of US women using PRAMS data posited that preterm birth was associated with a statistically significant increased odds of feeling hopeless, but not loss of interest (OR=1.24; 95% CI: 1.08, 1.43; OR=0.96; 95% CI: 0.85, 1.09, respectively). In addition, findings of the cross-sectional, web-based survey of maternal health among North Carolina mothers revealed increased odds of postpartum depression (OR=1.27; 95% CI: 0.28, 5.80), anxiety (OR=2.04; 95% CI: 0.49, 8.56), and poor physical health (OR=1.60; 95% CI: 0.29, 8.82) among women who had a preterm birth. Findings of this dissertation add significant information to the current body of literature on preterm birth and later maternal health outcomes. This dissertation was the first to examine parent health outcomes among those individuals who have experienced a preterm birth using large, population-based datasets. In addition, the dissertation partially focused on health outcomes among fathers who have a child who was born preterm, an issue that has rarely been addressed in the scientific literature. Since the current dissertation suggests a relationship between preterm birth and parent health, there are important public health implications. Health care providers may need additional training

regarding how to identify health problems for parents following preterm birth. In addition, comprehensive screening of physical and mental health problems following the birth of a preterm infant may be warranted if the preterm birth-parent health association is confirmed in future studies.

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A debt of gratitude is owed to my parents Mr. Albert Smith and Mrs. Janice Shearin-Smith, who instilled in me the importance of education and pushed me to be the best I could be regardless of how hard it can get. Their sacrifices to better my life and that of my brother do not go unnoticed.

I would also like to thank my fiancé, Jarred Barber, who encouraged me to continue when I felt like giving up; for giving me inspiration to just keep writing, and for inspiring me to be passionate in everything that I do.

Finally, this dissertation is dedicated not only to all of my family and friends, but also to all youth: to our future. In addition, I hope that my accomplishments will one day inspire little ones who look like me to know that anything is possible. Despite the fact that we may sometimes have to work twice as hard to get half of what others have, the hard work will soon pay off.

“Hey Black Child. Do you know who your really are?” –Useni Eugene Perkins

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LIST OF ABBREVIATIONS

BRFSS	Behavioral Risk Factor Surveillance System
CDC	Centers for Disease Control and Prevention
DHHS	Department of Health and Human Services
IOM	Institute of Medicine
LBW	low birth weight
MHS	Maternal Health Survey
NAMI	National Alliance of Mental Illnes
NBW	normal birth weight
NC	North Carolina
NICU	neonatal intensive care unit
NIMH	National Institute of Mental Health
PRAMS	Pregnancy Risk Assessment Monitoring System
PTB	preterm birth
UNCC	University of North Carolina at Charlotte
US	United States of America
WHO	World Health Association

CHAPTER 1: INTRODUCTION

The World Health Organization (WHO) defines preterm birth as infants born alive before the mother has completed a full 37 weeks of pregnancy (WHO, 2016a). In 2017, 10% of babies were born preterm, accounting for one out of every ten infants born in the US (CDC, 2018). The US is listed as one of the ten countries with the highest prevalence of preterm births (Blencowe, Cousens, Oestergaard, Chou, Moller, Narwal et al., 2012). This is particularly alarming since the US is the only country on the list that is not categorized as a developing country.

Measurement

Preterm birth is usually measured using gestational age, with 37 weeks used as the upper cut-off for defining a preterm birth. In addition, infants born at 28-32 weeks' gestation are considered very preterm and those born at less than 28 weeks' gestation are considered extremely preterm (WHO, 2012). Ways to measure gestational age include using the date of the mother's last menstrual period and using an ultrasound to examine fetal length, fetus flexes, and fetus head circumference (Behrman & Butler, 2007). More specifically, to calculate gestational age, health practitioners use the interval between the first day of the mothers last normal menstrual period and the date of birth described in weeks (Martin, Osterman, Kimeyer, & Gregory, 2015).

Risk factors and treatment

The risk of prematurity increases with decreasing prenatal care utilization (Partridge, Balayla, Holcroft, & Abenhaim, 2012). Pregnant women who receive little to no prenatal care are approximately three times more likely to deliver preterm (Vintzileos, Ananth, Smulian, Scorza, & Knuppel, 2002), and their baby is five times more likely to die (Child Trends, 2014). In addition, infants born to Non-Hispanic Black women have the highest rates of preterm birth (16.53%), compared to Non-Hispanic Whites (10.29%) and Hispanic women (11.58%) (U.S. Department of Health and Human Services [DHHS], 2013). Other risk factors for preterm birth include smoking, alcohol use or illicit drug use during pregnancy, younger or older maternal age, maternal chronic health problems, gestational diabetes, pregnancy-induced hypertension, carrying more than one baby, and having certain infections during pregnancy (Centers for Disease Control & Prevention [CDC], 2013a).

Although there is no specific treatment for preterm birth, there are ways to prevent it. Many of the risk factors for prematurity listed above are preventable and/or treatable health behaviors and conditions. In addition, use of midwifery-led care has been shown to reduce prematurity by approximately 24% (WHO, 2016a). This reduction in prematurity risk may be attributable to the fact that one-on-one care with a midwife reduces stress and anxiety for the pregnant mother, two risk factors for preterm birth (Sandall, Soltani, Gates, Shennan, Devane, 2013).

There are also ways to lessen the adverse effects of preterm birth. For example, health care professionals may administer antenatal steroid injections to mothers at risk for preterm delivery in order to strengthen the lungs of the infant, and antibiotics to preterm

newborns in order to treat infections (WHO, 2016a). Health care professionals also recommend skin-to-skin contact with the mother and infant and essential care during child birth and immediately following childbirth to reduce other potential health issues following preterm birth (i.e., lack of infant attachment to mother) (WHO, 2016a).

Consequences

More babies die from premature birth than any other cause; however, it is believed that three-quarters of these deaths from prematurity could be prevented if cost-effective treatments were given to pregnant mothers (WHO, 2016a). Specifically, providing mothers with information on healthy pregnancy practices during prenatal care appointments may decrease the risk of preterm birth and prevent deaths from prematurity. Preterm babies who do survive often have poor health, low quality of life, and generate high health care expenses (Blencowe, Cousens, Oestergaard, Chou, Moller, Narwal et al., 2012). Preterm babies face an increased risk of cerebral palsy, hearing loss, respiratory problems, and intellectual/neurological disabilities (Howson, Kinney, &Lawn, 2012). Mothers of preterm infants are at higher risk for depression, less positive feelings towards their baby, lower ratings of perceived health, and lower quality of life compared to mothers of full term infants (Henderson, Carson, & Redshaw, 2016; Davis, Edwards, Mohay, & Wollin, 2003; Haas & McCormick, 1997; Eiser, Eiser, Mayhew, & Gibson, 2005).

Many babies born preterm or with other adverse birth outcomes are admitted to the Neonatal Intensive Care Unit (NICU) upon birth for weeks or even months (CDC, 2013a). These admissions can lead to an economic burden on mothers, families, and society. In 2005, the total medical care costs associated with preterm birth in the US was

16.1 billion dollars; these costs decline with increasing gestational age (i.e., $6.1 billion for infants born less than 28 weeks, $5.1 billion for infants born between 28 and 31 weeks, and $4.9 billion for infants born between 32 and 36 weeks) (Urban Child Institute, 2006). According to the Institute of Medicine (IOM), the total annual economic burden of preterm birth on society is approximately $26.2 billion or $51,600 per infant (IOM, 2006). Due to the economic and social burden of this health issue, Healthy People 2020 seeks to reduce total preterm births by 10 percent (DHHS, 2012a).

Previous research suggests that the birth of a preterm infant may lead to substantial challenges among parents, and may eventually lead to psychological distress and ill mental health (Singer, Salvator, Guo, Collin, Lililien, & Baley, 1999; Davis et al., 2003; Blom et al., 2010; Vigod, Villegas, Dennis, & Ross, 2010; Moore, Taylor, Klein, Minich, & Hack, 2006; Taylor, Klein, Minich, & Hack, 2001). Mothers of preterm infants have higher levels of psychological distress (i.e., depression and anxiety) compared to mothers of full term infants. Parents of preterm infants also experience increased stressors when parenting and providing care for their preterm infants compared to those parents who have normal birth weight infants; daily parenting tasks are more time-consuming and many times, call for more financial resources (Singer et al., 1999). Psychological distress, in turn, may have a negative effect on maternal coping ability and parenting style, because preterm infants may have poorer cognitive skills than their full term peers and are thus, harder to parent (Brecht, Shaw, St. John, & Horwitz, 2012). In addition, the psychological stress of having a preterm infant may cause parents to have a decline in physical health, such as sleep disturbances, fatigue, and poor overall well-being compared to parents of full term infants (Lee & Kimble, 2009).

Although there have been studies examining the relationship between preterm birth and mental/physical health of mothers, very few have examined its effect on fathers or male caregivers (Moore et al., 2006; Taylor et al., 2001; Donohue, Maurin, Kimzey, Allen, & Strobino, 2008), and most have examined symptoms of poor mental/physical health as opposed to diagnoses (Davis et al., 2003; Blom et al., 2010; Vigod et al., 2010; Moore et al., 2006; Taylor et al., 2001; Donohue et al., 2008; Haas & McCormick, 1997; Eiser, Eiser, Mayhew, & Gibson, 2005). As preterm birth is a major public health problem in the US, this study will seek to identify if preterm birth increases the odds of ill physical and/or mental health among parents, using population-based data from North Carolina (NC) and the US. Because psychological distress and ill physical health can lead to a decreased quality of life, it is important to identify and counsel parents who have had a preterm birth, even before signs and symptoms of disease begin to appear among parents. Findings from this study highlight the importance of early identification and counseling for parents of preterm infants to ensure that this population receives the treatment they need following the event of preterm birth.

Increasing scientific knowledge and improving clinical practice

By addressing the issue of mental and physical health among parents who have an infant born preterm, scientific knowledge and clinical practice may be improved. Further research in this area may aid in determining some of the unknown confounders in the relationship between previous preterm birth and parent. Furthermore, clinical practice may change by standardizing methods used to care for parents of preterm infants, so that all parents have the same positive clinical experiences. Addressing this issue may also increase consistency in how physicians identify adverse health outcomes that may

occur among parents of preterm infants. Finally, understanding the issues that influence health outcomes of all parents may be useful for health care providers and aid in minimizing or eliminating factors that increase risk for adverse health outcomes.

Addressing the problem to change the concepts and interventions that drive the field

Parent health outcomes are important to the fields of maternal and child health and public health. Parents may have different experiences from those individuals who do not have children, causing different health outcomes. In addition, parents who have dealt with the experience of having birth complications may have different health problems compared to parents who have had a normal live birth. Addressing the issue of mental and physical health disorders among parents who have had a preterm infant could change preventative interventions that drive the field. For example, if an association between preterm birth and parent health is found, health care professionals and public health practitioners may find it useful to provide comprehensive care and education to this target population on ways to prevent and treat mental and physical health disorders. Supportive nursing and educational interventions to reduce parental stress and emotional support have been found to reduce the risk of poor health outcomes (Abdeyazdan, Shahkolahi, Mehrabi, & Hajiheidari, 2014). Additionally, future interventions may address views and barriers that may be specific to parents who have had a preterm infant on the concept of self-care. Paternal and maternal knowledge and beliefs regarding the importance of self-care can affect health outcomes. Parents of preterm infants may be more likely to disregard self-care under the belief that self-sacrifice is more important in order to care for their child. Barriers to self-care among parents include time, access to resources, and social support (Mayer, 1997). Therefore, it is imperative that interventions address these

barriers and provide information on the importance of self-care so parents practice it adequately (Barkin & Wisner, 2013).

Addressing this issue may also inform future interventions to emphasize the importance of postpartum care among mothers who have had a preterm birth. Postpartum or postnatal care, which is medical care of women and infants following the child's birth, has a significant influence on maternal and infant health (WHO, 2017). The World Health Organization has reiterated the importance of postnatal care in improving maternal and infant health outcomes and assert that care immediately following the birth of an infant helps to detect, manage, modify, and control maternal behaviors, health conditions, and risk factors that contribute to adverse maternal and infant outcomes (Chalmers, Mangiaterra, & Porter, 2001).

Adverse health outcomes among parents of preterm infants is a significant problem in the field of public health. The issue leads to an economic burden on society and significant health problems that affect quality of life and mortality. Further research in this field can increase scientific knowledge, improve clinical practices, and make future interventions more effective.

Aims and Hypotheses

Overall Aim: The purpose of this study was to examine the relationship between preterm birth and ill physical and/or mental health among parents. Specifically, this study examined whether parents who have had a preterm infant are at increased odds of having physical health problems (i.e., diabetes, hypertension, and coronary heart disease) and/or mental health problems (i.e., depression and postpartum depression), using both state and national, population-based datasets (Table 1). To my knowledge, there have not been any previous studies to address all of the parent health outcomes mentioned; therefore, data sources on these variables are limited. In order to address these outcomes, three different studies were conducted. The use of different data sources allowed for the examination of the preterm birth-later parent health relationship among different populations including mothers and fathers in North Carolina, and mothers across the US.

Study 1 Aim: The purpose of study 1 was to examine the association between having a preterm infant and physical health (i.e., type II diabetes, hypertension, and cholesterol) among parents (mothers and fathers) who had a child when they were between the age of 18-45 in the state of NC using the 2013-2014 NC Behavioral Risk Factor Surveillance System (BRFSS) data. The intended journal for this manuscript is the Journal of Midwifery and Women's Health due to its interest in primary care for women and newborns and the healthcare of women throughout the lifespan.

Study 2 Aim: The purpose of study 2 was to examine the association between having a preterm infant and mental health (i.e., postpartum depression) among mothers age 18-40 in the United States using the 2012-2014 US Pregnancy Risk

Assessment Monitoring System (PRAMS) data. The intended journal for this manuscript is Women's Health Issues due to its interest in improving the health and health care of all women throughout the lifespan.

Study 3 Aim: The purpose of study 3 was to examine the relationship between preterm birth and physical (type II diabetes, hypertension, or cardiovascular disease) and mental health (i.e., depression, postpartum depression, and anxiety) among North Carolina (NC) mothers who have had a child in the past 5 years using a self-administered online survey (i.e., primary data collection). The intended journal for this manuscript is the NC Medical Journal due to its interest in the health care challenges facing North Carolina residents.

Table 1: Exposures and Outcomes for Each Study

Study	**Data Source**	**Exposure**	**Outcomes**
One	BRFSS	Preterm birth (self-report)	1. Type II diabetes 2. Hypertension 3. Cholesterol
Two	PRAMS	Preterm birth (birth certificate)	1. Postpartum depression
Three	Primary data collection	Preterm birth (self-report)	1. Depression 2. Postpartum depression 3. Anxiety 4. Type II diabetes, Hypertension, or Coronary Heart Disease

Theoretical Framework

The current study was guided by Helen Rose Fuchs Ebaugh's (1988) role exit theory. The theory posits that a role is central to one's self-identity and the process of leaving one role and establishing a new one is referred to as role exit. Ebaugh argues that role exit is a basic social process experienced by all humans, and allows researchers to further understand human social behavior, social interaction, and role conflict. The role exit process has four stages: first doubts, seeking alternatives, the turning point, and creating the ex-role (Ebaugh, 1988). It is possible that parents of preterm infants may have difficulty with role exit due to the fact that they are suddenly parents, before they have had time to grasp that identity, as the infant did not develop for the full 37 weeks. To further explain how each stage may align with the study, examples of the current population (parents of preterm infants) will be used.

In the first doubts stage, the individual begins to question his/her role commitment. New parents may have to reinterpret role requirements needed to meet the demands of the parent role. In some cases, the exit process may halt at this stage and never progress to further stages. In other cases, the stage may last over a long period of time; and for some, the stage may progress quickly and lead to seeking alternatives. Alternative seeking is a process that requires individuals to evaluate alternative roles in comparison to the costs and benefits of their current role. This process may leave parents with "what-if" feelings, and wondering what they may have done differently to prevent the unexpected birth and role exit. After weighing alternatives, the individual moves to a turning point, where he/she makes a firm and final decision to exit his/her role. This decision may be difficult for parents of preterm infants, or may take them longer because

they are leaving their "expected parent" role so quickly, and usually without warning, to become parents. Until the exiter makes a decision and reaches the final turning point, he/she is in what is known as a "vacuum experience" until a new identity is formed; this suspension may cause feelings of fear, anxiety, and 'being neither here nor there.' Similarly, parents of preterm infants may undergo the "vacuum experience" since the mother/father identity did not immediately replace the pregnant woman/expectant father identity. The final stage of this process is creating the ex-role and adapting to it. This role stems from expectations, social obligations, and norms relative to one's previous role (Ebaugh, 1988). For example, an exiter's previous role as a pregnant woman must be incorporated in her future identity as a mother. It may be hard for parents to become emotionally disentangled from the norms associated with their previous role, while trying to adhere to norms associated with being a parent.

The current researcher argues that the process of role exit may place many new parents in the "vacuum experience," causing them to be unable to swiftly move from one identity into the next. Thus, parents of preterm birth infants may have feelings of fear and anxiety because their new role as parent came sooner than they expected. These feelings may lead to poor mental health, poor physical health or both. Specifically, there is a plausible biological mechanism concerning how feelings of fear and anxiety can take a toll on physical and/or mental health (Harvard Medical School, 2008). The feeling of anxiety as a reaction to stress begins in the amygdala, where many strong emotional responses are managed. The impulse is carried via neurotransmitters to the sympathetic nervous system; in turn, heart and breathing rates increase, muscles become tense, and blood flow is averted from the abdominal organs to the brain. In addition, physical

symptoms of this diversion include light-headedness, nausea, diarrhea, and frequent urination. When these symptoms persist, anxiety can begin to affect one's mental and physical health. Therefore; the researcher argues the following framework for the current study based on this theory (Figure 1).

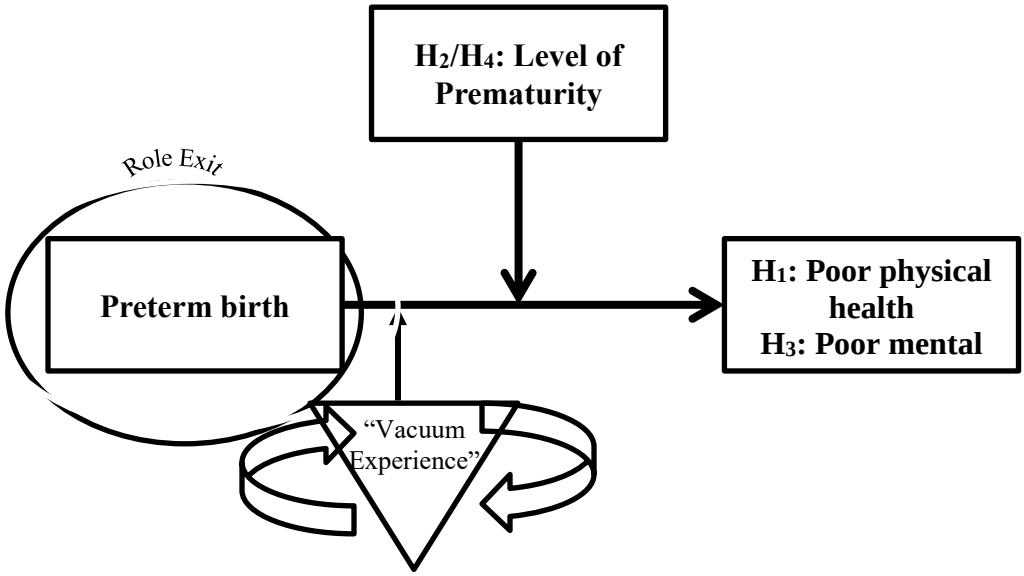

Figure 1: Theoretical Framework for the relationship between preterm birth and physical/mental health using the Role exit theory; H=Hypothesis

Few researchers have used role exit theory to examine the issue of preterm birth and poor parent health outcomes. Researchers Baum, Wiedberg, Osher, and Kohelet (2012) viewed their qualitative findings of 30 mothers of very low birth weight babies in terms of the role exit theory. The researchers conducted interviews with the mothers while their infants were still in the neonatal care unit. Mothers who participated in the study described their deliveries as traumatic experiences. Many women also referred to their labor as a nonevent because they felt as though they barely participated. In addition, women in this study reported difficulty grasping the fact that they were mothers, noting that mothers were left in "suspension" when the identity of motherhood did not

immediately replace the role of pregnant woman. However, as this was a qualitative study, researchers did not discuss the potential for role exit theory to guide their study, but rather to explain their findings. A strength of role exit theory in Baum et al.'s study as well as the current study is its ability to explain the potential reasoning behind a woman's inability to take on the role of mother. The "vacuum experience" helps researchers to understand the suspension that women may become stuck in if they do not immediately replace one social role with another.

Although few studies have used role-exit theory specifically, many have used the concept of role identity to guide their work concerning parent health outcomes. As stated earlier, the concept of role commitment (or role identity) is important in the first stage of role-exit. Because the role identity theory seeks to understand the self as a reflection of change in roles/statuses, it is very closely related to the first stage of exit theory. Researchers Jeffcoate, Humphrey, and Lloyd (1979) used role perception to guide their study which found more increased stress levels (which may lead to poor mental health outcomes) for mothers and fathers who had a preterm delivery, compared to the mothers and fathers who had their infants full-term. Researchers suggest that stress associated with the transition to parenthood may develop into a "crisis" under particular circumstances, including preterm birth. In addition, failure of role expectations involving the birth timing and possibly the appearance of the infant may affect parental role performance, thus affecting parent mental health status (Jeffcoate et al., 1979). Although role identity is a viable explanation for the findings of this study, researchers did not go beyond role identity and into other stages of the role-exit process. The "vacuum

experience" could have further explained the reason why parents of preterm infants experience more stress than parents of full-term infants.

Additional studies examining preterm birth and parent health using role or role-exit theory include Davis et al.'s (2003) study on factors associated with maternal depressive symptomology 1-month post preterm birth and Reid's (2000) study on the development of maternal identity of mothers in the Neonatal Intensive Care Unit (NICU). An obvious gap in the role-exit theory literature is its lack of use to guide studies examining parent health outcomes. Some studies use only the concept of role identity, without further exploring the process of premature role-exiting due to preterm birth, and the consequences of the "vacuum experience." Other studies examining this relationship do not use theory at all (Catov et al., 2010; Vigod, et al.2010; Moore et al., 2006; Treyvaud, 2014).

Literature Review

Mental Health

Mental illness is defined as a condition impacting mood, feelings, or thinking, thus affecting a person's ability to care for him/herself or others on a daily basis (National Alliance of Mental Illness [NAMI], 2016). The most commonly studied mental illnesses are depression, anxiety, bipolar disorder, and schizophrenia (CDC, 2013b). The studies in this dissertation specifically examined depression, defined as an overwhelming, sometimes reoccurring sadness which interferes with a person's daily life; anxiety, defined as feelings of intense fear and distress interfering with daily activities (NAMI, 2016); and postpartum depression, which is the same as depression but only occurs in women following childbirth (National Institute of Mental Health [NIMH], 2014). In America, approximately 61.5 million adults (1 in 4) are affected by some form of mental illness (NAMI, 2013). Approximately $193.2 billion in earnings lost each year is due to serious mental illnesses (NAMI, 2013). Recovery from mental illness is possible; however, individuals who are diagnosed are at higher risk for chronic diseases compared to those who have not suffered with mental illness. According to the National Alliance of Mental Illness, those with mental illness should begin treatment by actively participating in an individual treatment plan (Ko, et al., 2012). However, since there is stigma associated with mental illness, many may be discouraged from seeking treatment (NIMH, 2008). Although Healthy People 2020 does not have a goal for all mental illnesses, the initiative does have a goal to reduce the percentage of adults who experience a major depressive episode by 10% (DHHS, 2012). An additional Healthy People 2020 goal is to

decrease the proportion of women delivering a live birth who experience postpartum depressive symptoms (DHHS, 2014).

Studies examining preterm birth and maternal depression

Previous research has demonstrated that mothers of preterm and very preterm infants are more likely to report depressive symptomology compared to women who have had a full-term infant (Davis et al., 2003). One retrospective cohort study examined factors associated with maternal depressive symptomology 1-month post preterm birth in 62 mothers of very preterm infants. Approximately 40% of mothers who had preterm births reported depressive symptomology compared to the 10-15% of women who had a full-term birth (Davis et al., 2003). One strength of this study was the use of multiple valid instruments to assess depressive symptoms; however, this study was limited by its small sample size (n=62), and the fact that it measured maternal depressive symptoms, and not diagnoses. In addition, only mothers were examined in this study.

A recent study investigated depression and anxiety symptoms among 75 mothers of preterm infants and 125 mothers of term-born infants using a Greek sample (Bouras, Thepfanopoulou, Mex-Bourna, Poulios, Michopoulos, Tassipoulou, et al., 2015). Using the State-Trait Anxiety Inventory Form Y and the Beck Depression Inventory (BDI), researchers found that mothers of preterm infants had higher BDI scores compared to mothers of tem infants (mean= 10.26 v 7.06; p= 0.001); mothers of preterm infants also had higher state anxiety scale scores (mean= 41.56 v 33.62; $p<0.001$). Potential limitations of this study include reliance on self-reported data and use of one ethnicity (i.e., Greek), limiting generalizability to other populations (Bouras et al., 2015). Again, only mothers, not fathers, were examined in this study.

A cross-sectional survey of 1,420 predominantly Hispanic Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) participants was used to describe the postpartum health of mothers who delivered preterm and full-term infants (Leonard, Gee, Zhu, Crespi, & Whaley, 2014). While only 26.3% of mothers of full term infants displayed depressive symptoms, 30.2% of mothers of preterm infants displayed depressive symptoms, assessed by two questions adopted from the Patient-Health Questionnaire-2; however, these findings were not statistically significant ($p=0.56$). Because this study was conducted among primarily Hispanic women, findings may not be generalizable to the national WIC-population, and the population of pregnant women in general (Leonard, et al; 2014). In addition, this study did not investigate paternal depression status. Thus, studies examining preterm birth and maternal depression have consistently found a relationship, although not all have been statistically significant. Future studies may benefit from using a larger, more diverse sample.

Studies examining preterm birth and postpartum depression

Sustained or ongoing depression is significantly associated with preterm birth as well as other complications such as earlier gestational age, lower birth weight, and ongoing infant illness or disability (Vigod et al., 2010). In a systematic review of 26 peer-reviewed articles, researchers observed the prevalence and risk factors for postpartum depression among women who had a preterm birth (Vigod et al., 2010). Findings of Vigod et al.'s study revealed postpartum depression rates as high as 40% among women with premature infants. In addition, sustained depression was associated with multiple birth complications including earlier gestational age, lower birth weight, ongoing infant illness/disability and perceived lack of social support. It is also important

to note that of the six studies that included comparison groups, four reported a significant increased prevalence of depression in mothers who had a preterm birth compared to mothers who had a full-term birth. Furthermore, of the four studies without comparison groups, three demonstrated high levels of depressive symptomology among mothers of preterm infants (i.e., CESD-mean score of 24.88). Although this was a strong systematic review with 26 peer-reviewed articles, most articles in the study did not consider depression during pregnancy as a confounding variable and gave very broad and differing definitions of postpartum depression.

Another study conducted by Blom and colleagues (2010) utilized a prospective longitudinal design to examine whether pregnancy complications (i.e., preterm birth, pre-eclampsia, and hospitalization during pregnancy) among 4,941 pregnant women in Rotterdam, Netherlands increased the risk for postpartum depression. The researchers found that preterm birth, as well as other birth complications, were significantly associated with increased risk of postpartum depression. While 4.6% of women who had a preterm birth scored normal on the Edinburgh postnatal depression scale, 6.1% of these women scored clinically high; however, these findings were not statistically significant (Blom et al., 2010). While strengths of this study include its large sample size and complex study design, there is a lack of generalizability for Blom et al.'s study since the majority of participants were highly educated, Western women. This study also examined depressive symptoms, not diagnoses, of mothers.

Another study utilizing a prospective, longitudinal design, investigated hypertension, gestational diabetes, and preterm birth as risk factors for health outcomes (i.e., health-related quality of life and postpartum depression) (Mautner, Greimel,

Trutnovosky, Daghoferm Egger, & Lang, 2009). Using the Edinburgh Postnatal Depression Scale, researchers found that women who had a preterm birth had statistically significant higher scores 3-4 months postpartum compared to women who did not have a preterm birth or any other birth complications (mean=6.53 v 5.48; $p<0.05$). This study may have been limited by its small sample size (90 cases and 29 controls), as well the researchers' lack of control for potential confounders (Mautner, et al., 2009). In summary, previous studies have found statistically significant associations between having a preterm birth and postpartum depression; however, findings may have been limited by small sample size (Mautner, et al., 2009) and inability to control for potential confounders (Vigod et al., 2010; Blom et al., 2010).

Studies examining preterm birth and parent/family mental health outcomes

In addition to depression symptoms and postpartum depression among mothers, birth complications have a significant effect on families. There are few studies which examine the effects of preterm birth on families; however, researchers have studied the relationship between family mental health outcomes and low birth weight, an extremely common outcome of preterm birth (March of Dimes, 2014). In one longitudinal study, researchers examined long-term family outcomes among families of very low birth weight infants. Participants were the family members of 64 children with a birth weight of less than 750 grams, 54 family members of children with a birth weight of 750-1,499 grams, and 66 family members of term-born controls. Family burden (OR=4.28; CI: 1.84–9.91) and parental distress (OR=4.93; CI: 1.56–15.59) were found to be increased among families with low birth weight infants compared to those of normal birth weight infants (Moore et al., 2006). While this study is novel in investigating family outcomes

as opposed to maternal outcomes only, it may have been limited by its small sample size (n=184) and the fact that the researchers noted that follow-up rates of low socioeconomic families were low; however, specific follow-up rates were not provided. In addition, researchers did not properly define the control group (i.e., term-born infants), so any weight restrictions on controls in this study is unclear (Moore et al., 2006).

Another prospective cohort study that explored long-term outcomes of families of very low birth weight children (n=49) compared to full-term controls (n=115) found that families of low birth weight children experienced greater stress (OR=3.35; CI: 1.47-7.63) and psychological symptoms compared to families of normal birth weight (NBW) children (Brief Symptom Inventory mean of LBW families= 57.11, compared to mean of NBW families=50.79; $p<0.05$) (Taylor et al., 2001). Again, this study may have been limited by its relatively small sample size (n=164) and the fact that follow-up rates of low socioeconomic families were below average.

Studies examining the relationship between preterm birth and parent/family mental health have also identified moderators and mediators of the relationship. One potential moderator is physical and hormonal changes experienced by the mother (Blom et al., 2010). Potential mediators include education level, social support, child age, family environment, degree of low birth weight, and problems in child functioning (Davis et al., 2003; Moore et al., 2006; Taylor et al., 2001). Also, researchers suggest that because preterm birth is a sudden life event, this may lead to maternal complications, such as depression or depressive symptomology (Davis et al., 2003; Blom et al., 2010).

In addition, Treyvaud's (2014) literature review investigated the relationship between preterm birth and parent and family outcomes over time. Findings of this study revealed that parents of very preterm infants reported an increased negative impact on family systems and parental stress within 2 years of the preterm birth compared to families of full term infants. Treyvaud's (2014) review may have been limited by differing outcomes and measurements of outcomes across studies. In addition, the studies included in this review took place across multiple locations including the US, Malaysia, Switzerland, Australia, Finland, and the United Kingdom. Furthermore, the researcher did not provide clear details of the methods used to conduct the literature review (i.e., inclusion/exclusion criteria and number of studies selected). Ultimately, Treyvaud suggests that future studies include fathers, and evaluate stress and family functioning outcomes. Although not all statistically significant, previous studies have found increased odds of poor parent/family mental health outcomes among those who have experienced a preterm birth; however, findings may have been limited by the studies' small sample sizes (Moore et al., 2006; Taylor et al., 2001).

Physical Health

The World Health Organization defines good health as a state of complete physical, social and mental well-being, and not merely the absence of disease, meaning all of these aspects are important to overall health (WHO, 2016b). While health is not merely the absence of disease, it is still important that chronic diseases, such as heart disease, diabetes, and hypertension are examined and monitored closely to increase quality of life. Cardiovascular disease, also known as heart disease, refers to several different heart conditions which lead to plaque build-up in the walls of the arteries. This

plaque makes it harder for blood to flow through, sometimes causing blood clots or even a heart attack or stroke (American Heart Association, 2016a). Heart disease is the leading cause of death for men and women in the US (CDC, 2015). Each year, approximately 370,000 people die from heart disease. It is estimated that someone has a heart attack every 43 seconds in the US. The US spends approximately $108.9 billion per year in health care services, medications, and lost productivity due to heart disease (CDC, 2015).

Two common risk factors for heart disease are type II diabetes, a condition causing blood sugar to rise to life-threatening levels; and hypertension (i.e., high blood pressure), a condition causing the force of blood flow to be too high, leading to an unhealthy stretching of tissues in the walls of the arteries (American Heart Association, 2016b). Type II diabetes may occur when the body develops a resistance to insulin and the pancreas begins to lose capacity to make its own insulin (American Heart Association, 2015). Risk factors for this disease are obesity, lack of physical activity, high cholesterol, and hypertension. If diabetes is left untreated, it may lead to serious health issues including stroke (American Heart Association, 2015). Often called the "silent killer," people with hypertension display no obvious signs or symptoms of the condition; however, measuring blood pressure is a relatively easy task performed by health care providers during emergency room or primary care visits (American Heart Association, 2016c). Hypertension is classified by two numbers read as mm Hg (millimeters of mercury); if a participant's blood pressure is more than $\frac{139}{89}$ mm Hg, he/she would be considered to have hypertension (American Heart Association, 2016c). Risk factors for hypertension include lack of physical activity, race, age, family history,

diet, and stress. Potential consequences of untreated hypertension include stroke, heart failure, vision loss, and kidney disease/failure (American Heart Association, 2017).

Studies examining preterm birth and physical health outcomes

Few studies have examined the relationship between preterm birth and parent physical health, but researchers who have examined this relationship have found that parents of preterm infants rate their well-being as less satisfactory compared to mothers of full term infants (Eiser et al., 2005). In one cross-sectional study, researchers explored child quality of life, maternal well-being, and parenting among 126 mothers of full-term infants, and 91 mothers of preterm infants two years post birth (Eiser et al., 2005). After controlling for level of education, mothers of preterm infants rated their own well-being as less satisfactory compared to mothers of full term infants (survey score mean full term= 79.73 v. PTB= 76.70 ; $p<0.1$). Researchers also found that the preterm birth-maternal health relationship may be mediated by mothers' perceptions of their child's difficulties following birth. Simultaneously, associations with child difficulties are partly mediated by mothers' well-being (Eiser et al., 2005). Eiser et al.'s study may have been limited by the relatively small sample size (n=217) and the use of the SF-36 survey as opposed to actual diagnoses.

As opposed to well-being or physical health, some researchers have chosen to examine quality of life and its relationship with preterm birth, but have found no significant relationship (Donohue et al., 2008; Haas & McCormick, 1997). Donohue et al. examined the quality of life among caregivers of very low birth weight infants (n=83) and that of normal birth weight infant caregivers (n=84) in a cross sectional study and found that quality of life differed slightly among the two groups (VLBW Quality of Life

scale mean=3.58 v. NBW mean=3.19); however, these findings were not significant. This finding may have been due to a relatively small sample size (n=167) and non-response bias in Donohue et al.'s study. However, this study was strengthened by its ability to control for many potential confounders.

Researchers Haas & McCormick utilized a longitudinal study design to observe the health status and hospital use of women after delivering a premature, low birth weight infant. A total of 985 study participants from the Infant Health and Development Program, a randomized trial of an intervention addressing health problems for premature, low birth weight infants, were included. Mothers were examined nine times over a period of 5 years following delivery of their preterm infant. Findings of this study indicated that mothers/caregivers of both preterm and term infants report higher percentages of physical health problems and have higher percentages of hospitalization for non-pregnancy related conditions compared to women who have not given birth in the US (29.7% compared to 6.9%) (Haas & McCormick, 1997). Haas and McCormick's study only included women who gave birth to high-risk infants as this was an exploratory study of women who had given birth to preterm, low birth weight infants. Hence, there was no comparison group to verify findings. While previous studies examining preterm birth and physical health outcomes have all found an association, not all have been statistically significant. Future studies should seek to observe the relationship with a larger sample size of diverse, US participants.

Studies examining preterm birth and cardiovascular disease, hypertension, and diabetes

Few studies have examined the preterm birth-cardiovascular disease relationship. Three studies have found that women who have had a preterm birth have approximately two to three times the normal risk of cardiovascular disease (Smith, Pell, & Walsh, 2001; Bhasin & Kapoor, 2014; Smith, Whitley, Gissler, & Himmenki, 2000). Smith et al. (2000) conducted a cohort study of 3,706 Finnish women, examining the relationship between offspring birth dimensions and later maternal mortality (i.e., cardiovascular disease). Information on birth dimensions and cardiovascular disease were obtained from patient records in maternity centers in Helsinki. These researchers found that women who gave birth prematurely had increased risk of cardiovascular disease (Hazard Ratio [HR]= 2.06; 95% CI: 1.22, 3.47) (Smith, Whitley, Gissler, & Himmenki, 2000). Researchers in another study examined the relationship between low birth weight and maternal ischemic heart disease among 129,920 women from Scotland using the Scottish Morbidity Record (SMR) and routine discharge data (Smith, Pell, & Walsh, 2001). In this retrospective cohort study, women who delivered preterm had statistically significant increased risk of being admitted to the hospital for ischemic heart disease compared to women who had a full term infant (HR=1.8; 95% CI: 1.3, 2.5) (Smith, Pell, & Walsh, 2001). Although both of these studies were large in size, increasing generalizability, findings may have been limited by researchers' lack of control for potential confounders (i.e., smoking) (Smith, Pell, & Walsh, 2001; Smith, Whitley, Gissler, & Himmenki, 2000).

Recently, Bhasin and Kapoor (2014) conducted a cross-sectional study of 631 Punjabi Khatri urban women, investigating obesity markers (cardiovascular risk factors)

and pregnancy complications. Researchers conducted an epidemiological survey in households and collected medical records and anthropometric measurements to compile data on the exposures and outcomes. Findings demonstrated that having a preterm birth was associated with nearly a two-fold risk of entering high levels of systolic blood pressure (OR=1.58; 95% CI: 1.23, 2.41), diastolic blood pressure (OR=2.12; 95% CI: 1.62, 3.09), and glucose (OR=2.58; 95% CI: 1.23, 2.61) compared to women without birth complications. While this study's use of complex multistage cluster sampling increases generalizability, findings may have been limited by the study's relatively small sample size (n=631) and lack of racial/ethnic diversity (Bhasin & Kapoor 2014).

In one retrospective cohort study of 427,765 women who gave birth in Denmark between 1973 and 1983, researchers linked birth data to cardiovascular disease-related hospitalizations and deaths as indicated on national registers (Catov, Wu, Olsen, Sutton-Tyrrell, Li, & Nohr, 2010). Findings revealed that women who had a previous preterm birth had higher cardiovascular disease morbidity (HR=1.98; 95% CI: 1.73, 2.26) and mortality (i.e., ischemic events; HR=1.78; 95% CI: 1.40, 2.27). It should be noted, however, that this study was unable to control for lifestyle factors that may have confounded the associations. Catov et al. conducted a similar study of 487 women, again using data from national registers in 2013 (Catov, Dodge, Barinas-Mitchell, Sutton-Tyrrell, Yamal, Piller, & Ness, 2013). This study explored the relationship between preterm birth and hypertension and found that women with a prior preterm birth had higher blood pressure readings compared to mothers of full term infants (109.1/71.6 mmHg v. 106.7/69.7 mmHg; p=0.03) (Catov et al., 2013). Since this study was conducted among a relatively small group of women, findings may not be generalizable.

Additionally, since these studies were conducted among Danish women, it is possible that the findings do not apply to US women.

A review of studies examining pregnancy complications in relation to later maternal vascular and metabolic disease suggests that women with a history of adverse pregnancy outcomes are at increased risk of these diseases later in life compared to those who did not have pregnancy complications during delivery (Sattar & Greer, 2002). Specifically, women who had a preterm birth had over two times the odds of having diabetes compared to women who had a full-term birth (OR=2.1; 95% CI: 1.2, 3.5). Most of the studies in this review were observational with relatively small samples, potentially decreasing generalizability (Sattar & Greer, 2002). In addition, researchers did not explain details of the methods used to conduct this summary of literature, nor did they provide the number of studies included in this review. In summary, previous studies have found 1.5-2 times the odds of cardiovascular disease, hypertension, and diabetes among mothers who have had a preterm birth; however, none examined the potential association among fathers, and most studies were conducted outside of the US.

Summary

Although previous findings regarding the relationship between having a preterm birth and parent mental health have been consistent, those regarding the relationship between preterm birth and physical health vary. Many of the studies described have limitations that would affect generalizing the findings to a broader population. These limitations include a lack of racial/ethnic diversity (Davis et al., 2003; Blom et al., 2010; Bouras et al., 2015; Leonard, et al; 2014; Bhasin & Kapoor 2014), mostly higher socioeconomic participants (Taylor et al., 2001), inability to control for

known confounders (Smith, Pell, & Walsh, 2001; Smith, Whitley, Gissler, & Himmenki, 2000; Mautner, et al., 2009), and relatively small sample sizes (Davis et al., 2003; Moore et al., 2006; Taylor et al., 2001; Donohue et al., 2008; Eiser et al., 2005; Bhasin & Kapoor, 2014; Catov, et al., 2010; Catov, et al., 2013; Sattar & Greer, 2002; Bouras et al., 2015; Mautner, et al., 2009). Also, all studies examined participants' symptoms of poor mental or physical health (i.e., Brief symptom inventory or quality of life scale) as opposed to diagnoses (Davis et al., 2003; Blom et al., 2010; Vigod et al., 2010; Moore et al., 2006; Taylor et al., 2001; Donohue et al., 2008; Haas & McCormick, 1997; Eiser et al., 2005). In addition, most studies only observed the effect preterm birth has on the mother, and not the father or male caregiver (Davis et al., 2003; Blom et al., 2010; Vigod et al., 2010; Haas & McCormick, 1997; Eiser et al., 2005; Bhasin & Kapoor, 2014; Catov, et al., 2010; Catov, et al., 2013; Smith, Pell, & Walsh, 2001; Smith, Whitley, Gissler, & Himmenki, 2000; Bouras et al., 2015; Mautner, et al., 2009; Leonard, et al; 2014). Thus, the purpose of this dissertation was to evaluate the relationship between having a preterm birth and parent physical health (i.e., diabetes, hypertension, and coronary heart disease) and mental health (i.e., depression, postpartum depression, and anxiety).

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CHAPTER 2: THE ASSOCIATION BETWEEN HAVING A PRETERM INFANT AND LATER PARENT HEALTH: A POPULATION-BASED STUDY OF NC BRFSS

Introduction

The World Health Organization defines good health as a state of complete physical, social and mental well-being, and not merely the absence of disease, meaning all of these aspects are important to overall health (WHO, 2016). While health is not merely the absence of disease, it is still important that chronic diseases, such as heart disease, diabetes, and hypertension are examined and monitored closely to increase quality of life. Each year, approximately 370,000 people die from heart disease, the leading cause of adult death in the US. The US spends approximately $108.9 billion per year in health care services, medications, and lost productivity due to heart disease (CDC, 2015a). While there are a number of known risk factors related to the development of diabetes, hypertension, and high cholesterol, research on how having a preterm birth may impact the later development of these conditions is sparse(American Heart Association, 2016). It is possible that stress associated with the transition to parenthood may develop into a "crisis" under particular circumstances, including preterm birth (Doss, Rhoades, Stanley, Markman, 2009). This stress may be due to issues with parenting and thus may not only affect biological parents, but also step and/or adoptive parents. In addition, failure of role expectations involving the birth timing and possibly the appearance of the infant may affect parental role performance, thus affecting parent mental health status (Jeffcoate Humphrey, & Lloyd, 1979). Consequently, preterm birth may lead to parents' poor mental health, which in turn may affect physical health status.

A few previous studies have examined the effect of preterm birth on cardiovascular-related chronic conditions (Smith, Pell, & Walsh, 2001; Bhasin & Kapoor, 2014; Smith, Whitley, Gissler, & Himmenki, 2000; Catov, Wu, Olsen, Sutton-Tyrrell, Li, & Nohr, 2010; Catov, Dodge, Barina Mitchell, Sutton Tyrrell, Yamal, Piller, & Ness, 2013; Sattar & Greer). Most of these studies found that women who have had a preterm birth have approximately two to three times the normal risk of cardiovascular disease (Smith, Pell, & Walsh, 2001; Bhasin & Kapoor, 2014; Smith, Whitley, Gissler, & Himmenki, 2000; Catov, et al., 2010; Sattar & Greer). One study found that women with a prior preterm birth had significantly higher blood pressure readings compared to mothers of full term infants (Catov, Dodge, Barina Mitchell, Sutton Tyrrell, Yamal, Piller, & Ness, 2013).

Although some of these studies had large sample sizes sizes, ranging from 3,706 to 129,920 (Smith, Pell, & Walsh, 2001;Catov, Wu, Olsen, Sutton-Tyrrell, Li, & Nohr, 2010), a number of studies have been limited by lack of racial/ethnic diversity (Bhasin & Kapoor 2014; Catov, Wu, Olsen, Sutton-Tyrrell, Li, & Nohr, 2010) and inability to control for known confounders (Smith, Pell, & Walsh, 2001; Smith, Whitley, Gissler, & Himmenki, 2000). In addition, many of these studies have been conducted internationally and it is possible that there may be cultural differences affecting the relationship between preterm birth, stress, and cardiovascular disease (Bhasin & Kapoor, 2014; Catov, et al., 2010; Catov, et al., 2013; Sattar & Greer, 2002; Smith, Pell, & Walsh, 2001; Smith, Pell, & Walsh, 2001). Finally, all studies observed the effect preterm birth has on the mother only, and not the father or male caregiver (Bhasin & Kapoor, 2014; Catov, et al., 2010; Catov, et al., 2013; Smith, Pell, & Walsh, 2001; Smith, Whitley,

Gissler, & Himmenki, 2000; Sattar & Greer, 2002). Thus, the purpose of this study is to examine the association between having a preterm infant and physical health among parents (mothers and fathers) who had a child when they were between the ages of 18-45.

Methods

This secondary data analysis used 2013-2014 NC Behavioral Risk Factor Surveillance System (BRFSS) data, and was approved by UNC Charlotte's Institutional Review Board. The state of NC was chosen for analyses because the exposure variable, having a preterm infant, is only found in Child Health Assessment Monitoring Program (CHAMP) data, a supplementary set of data only collected in NC.

BRFSS is a program funded by the CDC, with the goal of collecting state data about health-related risk behaviors, chronic diseases, and use of prevention services among US adults age 18 and older (CDC, 2014). The system collects data from 50 states, the District of Columbia, and three US territories, totaling over 400,000 interviews each year. BRFSS is a cross-sectional telephone survey in which respondent data are sent to the CDC, aggregated for each state, and then returned with standard tabulations.

To conduct the BRFSS survey, states collect telephone numbers from the CDC. State personnel use disproportionate stratified sampling (DSS) for the landline sample, drawing numbers from two strata based on high or medium density of known telephone household numbers. Random sampling is conducted for the cellphone sample of BRFSS, using a sampling frame of confirmed cellular numbers; each number has an equal probability of being selected (CDC, 2014). In NC, the BRFSS collected 3,790 landline surveys and 3,292 cell phone surveys for a weighted percentage of 62.6% and 75.9%

respectively (CDC, 2015c). Interviews are conducted over the phone by state-health personnel or contractors.

In NC, BRFSS is supplemented by the CHAMP data. BRFSS respondents with children age 0-17 living in their household are invited to participate in the CHAMP survey. One child is selected at random from the household and the most knowledgeable adult is asked questions about the child's health. Every year since 2005, NC CHAMP personnel have collected data on child birth characteristics, child development, mental health, physical health, and other health information (NC Department of Health and Human Services, 2016). Because CHAMPS collects data on children age 0-17, parents who are over 60 were excluded from the current study to eliminate parents who had their child after age 45. This exclusion aided in reducing the risk of bias due to the fact that older parents are at higher risk for pregnancy complications (Elina Hemminki Affilation, 1996). Participants with incomplete information on the exposure (i.e., preterm birth) and outcomes (i.e., diabetes, hypertension, and coronary heart disease) were also excluded from this study.

Exposure Assessment

The exposure for this study was preterm birth. The questions CHAMP uses to assess the exposure are "Was [CHILD] born before his/her due date?" and "How many weeks or months was he/she born early?" If the participant answers "yes" and reports that the child was born 3 full weeks early or more, then the participant was considered to be exposed. If the participant answered "no" or reported that the child was born less than 3 full weeks early, he/she was considered to be unexposed. Thus, participants with

children born at less than 37 full weeks gestation were considered preterm, and those born at 37 weeks gestation or more were not considered preterm.

Outcome Assessment

The outcome of interest was physical health. The BRFSS questions that were used to assess physical health are “Have you ever been told by a doctor that you have diabetes?” “Have you ever been told by a doctor, nurse, or other health professional that your blood cholesterol is high?” and “Have you ever been told by a doctor that you had high blood pressure?” Response choices are ‘yes’ or ‘no.’ If the participant answered ‘yes,’ the person was considered to have that particular outcome (i.e., diabetes, high cholesterol, and/or high blood pressure) and an answer of ‘no’ meant he/she did not have the outcome.

Measurement of confounders

Possible confounders of the preterm birth-parent physical health outcome association are race/ethnicity, sex, age at child’s birth, education level, income, health insurance, marital status, body mass index (BMI), excessive alcohol consumption, currently smoking, and mental health status (Eiser et al., 2005; Donohue et al., 2008; Haas & McCormick, 1997; Smith, Pell, & Walsh, 2001; Bhasin & Kapoor, 2014; Smith, Whitley, Gissler, & Himmenki, 2000; Catov, et al., 2013; Sattar & Greer, 2002). Information on age at child’s birth was collected from the CHAMP survey. All other variables were gathered from BRFSS data.

Data Analysis

Summary statistics were calculated. Specifically, demographic and lifestyle factors of the participants were described using frequencies and percentages. To

obtain a crude association between having a preterm birth and physical health (i.e., diabetes, high cholesterol, and hypertension), logistic regression was used to calculate crude ORs and 95% confidence intervals. In addition, other risk factors for poor physical health were identified.

Multivariate logistic regression was used to calculate adjusted ORs and 95% confidence intervals of the association between having a preterm birth and poor health (i.e., having diabetes, high cholesterol, or hypertension), while controlling for potential confounders. If the potential confounder changed the OR estimate by at least 10% when added to the model, it was considered to be a confounder of the relationship between preterm birth and poor physical health outcomes (Maldonado & Greenland, 1993). Due to the complex sampling design used by BRFSS, SAS-callable SUDAAN was used in all analyses.

Results

A total of 1,101 parents participated in the 2013/2014 BRFSS CHAMP survey. Participants were excluded if there was missing information on preterm birth (n=135), or chronic health conditions (i.e., cholesterol, hypertension, or diabetes; n=54) or if they were not the biological or adoptive/step parent (i.e., grandparents, aunts, or uncles; n=70). Elimination of step and adoptive parents was considered in analyses; however, because findings were similar with and without these caregivers, they remained in the study due to sample size concerns. Questions about cholesterol and hypertension were only asked in the 2014 BRFSS survey; thus, 477 participants were eligible for analyses regarding those outcomes. However, the question about diabetes was asked in both years; thus, 842 participants remained eligible for the analyses regarding diabetes.

Almost 10% (n=73) of participants had a child who was born preterm (Table 1). Approximately 20% of participants had hypertension, 19.51% had high cholesterol, and 3.94% had diabetes. Over half of the participants were non-Hispanic White (54.16%) and most were female (68.73) and the biological mother of the child reference in the CHAMP survey (78.92%). Almost half of the participants were 18-29 years of age when their child was born (49.09%), and the majority had some college education (34.40%) and were married (63.25%).

Parents who had a child who was born preterm had increased odds of diabetes (OR=2.89; 95% CI: 0.60, 14.05; Table 2), hypertension (OR=1.12; 95% CI: 0.43, 2.92), and high cholesterol (OR=2.31; 95% CI: 0.83, 6.44); however, none of these findings were statistically significant in the unadjusted model. Women had increased odds of diabetes (OR=1.11; 95% CI: 0.46, 2.68) and decreased odds of hypertension (OR=0.61; 95% CI: 0.32, 1.18) and cholesterol (OR=0.55; 95% CI: 0.30, 1.04) compared to men; however, these findings were not statistically significant. In general, there was a dose-response relationship between age and the diseases examined; specifically, as age increased so did the odds of disease. For example, parents who were 50-60 years of age had a five-fold increased odds of high cholesterol (OR=5.04; 95% CI: 1.96, 12.91), parents who were 40-49 years had two times the odds of high cholesterol (OR=2.42; 95% CI: 1.12, 5.23), and those who were age 18-29 had statistically significant decreased odds of high cholesterol (OR=0.03; 95% CI: 0.01, 0.13) as compared to parents who were age 30-39.

Following adjustment for education, income, BMI, and currently smoking, the relationship between preterm birth and diabetes was attenuated and remained

statistically insignificant (OR=1.83; 95% CI: 0.54, 6.23; Table 3). Since no confounders were identified for the relationship between preterm birth and hypertension, the model was not adjusted. Following adjustment for parent's age at birth, sex, marital status, and BMI, the relationship between preterm birth and high cholesterol was also attenuated and remained statistically insignificant (OR=1.30; 95% CI: 0.61, 3.23).

Discussion

Findings of this population-based study revealed that parents of preterm infants have increased odds of several chronic diseases; however, these findings were not statistically significant. The findings of the current study are similar in magnitude to that of three previous studies which revealed that women who have had a preterm birth have approximately two to three times the normal risk of cardiovascular disease; however findings of these prior studies were statistically significant (Smith, Pell, & Walsh, 2001; Bhasin & Kapoor, 2014; Smith, Whitley, Gissler, & Himmenki, 2000). Findings of the current study are also similar to that of Sattar & Greer (2002) who found that women who had a preterm birth had over twice the odds of having diabetes compared to women who had a full-term birth. However, the findings of Sattar et al. were statistically significant unlike the current study. Sample sizes of most of the previous studies were larger than the current study (range: 3,706 to 427,765) which may explain the lack of statistical significance in the current study (Smith, Pell, & Walsh, 2001; Catov, Wu, Olsen, Sutton-Tyrrell, Li, & Nohr, 2010).

Strengths and Limitations

Interpretation of these findings may be affected by limitations of the study; however, there are also many strengths. Because BRFSS data on preterm birth are self-reported, it is possible that there was nondifferential misclassification of the exposure. Participants may not have remembered or incorrectly reported the number of weeks early their infant was born. However, previous research has found that the self-report of preterm birth and other perinatal factors tends to be valid and in agreement with birth records (Sanderson, Williams, White, Daling, Holt, Malone, et al., 1998).

Nondifferential misclassification of the outcome was also possible in the current study. Participants were asked whether they have been diagnosed by a health care worker for all outcomes; however, answers were not confirmed by medical records. Nevertheless, self-report of these physical health outcomes tend to be valid; thus, the potential for nondifferential misclassification of the outcome is limited (Martin, Leff, Calonge, Garrett, & Nelson, 2000).

There may be potential for selection bias in NC BRFSS. While response rates in 2014 were acceptable (62.6% landline; 75.9% cell phones), response rates for 2013 were somewhat lower (61.7% landline; 70.0% cell phones) (NC DHHS, 2014; NC DHHS, 2015; CDC, 2015c). Previous research has also shown that certain populations are under-represented in BRFSS results (i.e., minorities, women, and younger individuals) (Schneider, Clark, Rakowski, & Lapane, 2012). Furthermore, it is possible that parents who participated may not have been the child's primary caregiver. Step and adoptive parents were eliminated in initial analyses; however, since findings were similar regardless of whether these caregivers were included, we ultimately included them in the

study sample due to sample size concerns. In addition, the biological mechanism proposed may be applied to both biological and adoptive parents.

Since the analyses were limited to variables available in NC BRFSS, other known or unknown confounders of the preterm birth-parent physical health outcomes association could not be analyzed. For example, illicit drug use may be associated with preterm birth as well as physical health outcomes; however, this information is not available in BRFSS data (Hass &McCormick, 1997). Failure to control for confounders could result in an over- or under-estimation of the true association.

Unlike previous studies, the current study included both mothers and fathers when examining the association between having a preterm birth and later cardiovascular disease. This is a strength of the current study given the fact that, as previously mentioned, the proposed biological mechanism could affect both mothers and fathers. The complex sampling design of NC BRFSS increased the generalizability of the study; however, it is important to note that the relatively small sample size may affect external validity. Assuming internal validity, the results of this study may be generalized to mothers and fathers who had a child when they were between the ages of 18-45 and reside in NC or other similar geographic areas.

Conclusion

Few previous studies have investigated both maternal and paternal health as it relates to having a preterm birth, and none have examined these associations using NC BRFSS. While some previous studies have used hospital records and screening tools, few have used diagnoses to evaluate the association between having a preterm birth and

parent health outcomes. The focus on health outcomes among fathers who have a child who was born preterm is an issue that is rarely addressed in the scientific literature.

Although not statistically significant, the current study did find increased odds of diabetes, hypertension, and high cholesterol among parents who had a preterm infant, compared to parents who had a term infant. Due to limited research on the association examined, additional studies are needed. If confirmed in other large, diverse studies, comprehensive screening of physical health problems for parents who have had a preterm infant may be warranted. Understanding the relationship between preterm birth and parent health may allow health care providers to improve postpartum care of parents.

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Table 1a: Characteristics of NC BRFSS Participants (N=842)

Variables	Number	Weighted Percent
	N	(%)
Preterm Birth		
Yes	73	9.93
No	769	90.07
Cholesterol[1]		
Yes	111	19.51
No	366	80.49
Hypertension/High blood pressure[1]		
Yes	113	19.71
No	364	80.29
Diabetes		
Yes	39	3.94
No	803	96.06
Race/ethnicity		
Non-Hispanic White	503	54.16
Non-Hispanic Black	129	18.43
Non-Hispanic Other	61	8.40
Hispanic, any race	149	19.01
Gender		
Male	263	31.27
Female	579	68.73
Relationship to child		
Biological Mother	671	78.92
Step, Adoptive, or Foster Mother	20	1.77
Biological Father	141	18.45
Step, Adoptive, or Foster Father	10	0.87
Age		
18-29	72	12.81
30-39	304	41.87
40-49	348	36.87
50-60	117	8.45
Age at birth		
18-29	339	49.09
30-39	438	45.66
≥40	65	5.26
Education		
Less than high school graduate	114	14.66
High school graduate	151	21.80
Some college	236	34.40
Bachelor’s degree or above	341	29.14
Income		
<$20,000	140	19.41

$20,000-49,999	238	32.92
≥$50,000	396	38.16
Missing	68	9.51
Health Insurance		
Yes	644	71.97
No	198	28.03
Marital Status		
Married	595	63.25
Other	247	36.75
Body Mass Index (BMI)		
<25.0	246	28.66
25.0-29.9	262	29.44
>30.0	273	34.21
Missing	61	7.69
Excessive Alcohol Consumption		
Yes	22	2.51
No	800	95.11
Missing	20	2.37
Currently Smoking		
Yes	152	18.01
No	690	81.99

[1]Questions about hypertension and cholesterol were only asked in the year 2013. Thus, the *n* for these variables is 477.

Table 1a: Unadjusted Odds Ratios and 95% Confidence Intervals for the Association between Demographic and Lifestyle Characteristics and Diabetes, Hypertension, and Cholesterol, NC BRFSS Participants

Variables	Diabetes		Hypertension		Cholesterol	
		N=842		N=477		N=477
	OR	95% CI	OR	95% CI	OR	95% CI
Preterm birth						
Yes	2.89	0.60, 14.05	1.12	0.43, 2.92	2.31	0.83, 6.44
No	1.00	Referent	1.00	Referent	1.00	Referent
Race/ethnicity						
Non-Hispanic White	1.00	Referent	1.00	Referent	1.00	Referent
Non-Hispanic Black	3.55	1.30, 9.66	1.73	0.71, 4.24	0.47	0.18, 1.24
Non-Hispanic Other	4.03	1.41, 11.47	0.63	0.18, 2.19	1.85	0.56, 6.15
Hispanic, any race	5.91	0.90, 38.82	0.41	0.15, 1.15	0.52	0.23, 1.15
Gender						
Male	1.00	Referent	1.00	Referent	1.00	Referent
Female	1.11	0.46, 2.68	0.61	0.32, 1.18	0.55	0.30, 1.04
Relationship to child						
Biological Mother	1.00	Referent	1.00	Referent	1.00	Referent
Step, Adoptive, or Foster Mother	0.11	0.01, 0.94	0.46	0.07, 2.94	0.94	0.13, 7.14
Biological Father	0.65	0.22, 1.97	1.27	0.61, 2.62	1.10	0.54, 2.27
Step, Adoptive, or Foster Father	5.97	1.11, 32.05	2.69	0.31, 23.17	1.32	0.20, 8.77
Age						
18-29	-	--	1.98	0.52, 7.44	0.03	0.01, 0.13
30-39	1.00	Referent	1.00	Referent	1.00	Referent
40-49	1.67	0.57, 4.91	1.36	0.63, 2.91	2.42	1.12, 5.23
50-60	2.13	0.71, 6.39	4.16	1.67, 10.36	5.04	1.96, 12.91
Age at birth						
18-29	1.00	Referent	1.00	Referent	1.00	Referent
30-39	0.82	0.30, 2.23	1.42	0.69, 2.95	2.20	1.06, 4.59
≥40	1.62	0.44, 5.92	2.37	0.84, 6.70	7.74	2.82, 21.21
Education						
Less than high school graduate	5.34	1.92, 14.80	1.09	0.39, 3.07	0.76	0.30, 1.92
High school graduate	1.06	0.31. 3.66	3.93	1.58, 9.75	1.83	0.76, 4.39

Some college	2.52	0.77, 8.20	2.01	0.93, 4.34	1.62	0.78, 3.36
Bachelor's degree or above	1.00	Referent	1.00	Referent	1.00	Referent
Income						
<$20,000	2.84	0.98, 8.29	1.75	0.65, 4.71	0.81	0.35, 1.90
$20,000-49,999	3.34	1.16, 9.66	1.29	0.61. 2.71	0.43	0.21, 0.90
≥$50,000	1.00	Referent	1.00	Referent	1.00	Referent
Missing	1.12	0.22, 5.67	0.45	0.09, 2.12	0.25	0.07, 0.93
Health Insurance						
Yes	1.00	Referent	1.00	Referent	1.00	Referent
No	1.39	0.51, 3.78	0.63	0.29, 1.37	0.60	0.27, 1.32
Marital Status						
Married	1.00	Referent	1.00	Referent	1.00	Referent
Other	1.31	0.45, 3.78	0.82	0.37, 1.83	0.46	0.22, 0.97
Body Mass Index (BMI)						
<25.0	1.00	Referent	1.00	Referent	1.00	Referent
25.0-29.9	4.68	0.90, 24.36	1.82	0.63, 5.32	2.85	1.22, 6.68
>30.0	14.78	3.23, 67.59	6.46	2.29, 18.25	4.02	1.74, 9.28
Missing	24.32	2.76, 214.48	1.29	0.20, 8.26	0.77	0.19, 3.12
Excessive Alcohol Consumption						
Yes	-	--	0.55	0.14, 2.19	0.64	0.15, 2.67
No	1.00	Referent	1.00	Referent	1.00	Referent
Missing	-	--	0.12	0.02, 0.63	3.98	0.72, 22.06
Currently Smoking						
Yes	2.31	0.66, 8.04	1.52	0.70, 3.29	0.55	0.26, 1.15
No	1.00	Referent	1.00	Referent	1.00	Referent

Table 3a: Adjusted Odds Ratios and 95% Confidence Intervals for the Association between Demographic and Lifestyle Characteristics and Diabetes, Hypertension, and Cholesterol, NC BRFSS Participants

Variables	Diabetes[a]		Hypertension[b]		Cholesterol[c]	
	OR	95% CI	OR	95% CI	OR	95% CI
Preterm birth						
Yes	1.83	0.54, 6.23	1.12	0.43, 2.92	1.30	0.61, 3.23
No	1.00	Referent	1.00	Referent	1.00	Referent

[a]Model adjusted for education, income, body mass index, and smoking
[b]Model unadjusted. No confounders identified.
[c]Model adjusted for parent's age at birth, sex, marital status, and BMI

CHAPTER 3: THE ASSOCIATION BETWEEN HAVING A PRETERM BIRTH AND LATER MATERNAL MENTAL HEALTH: AN ANALYSIS OF US PRAMS DATA

Introduction

Mental illness is defined as a condition impacting mood, feelings, or thinking, thus affecting a person's ability to care for him/herself or others on a daily basis (National Alliance of Mental Illness [NAMI], 2016). In America, approximately 61.5 million adults (1 in 4) are affected by some form of mental illness (NAMI, 2013). Approximately $193.2 billion in earnings lost each year is due to serious mental illnesses (NAMI, 2013). Although Healthy People 2020 does not have a goal for all mental illnesses, the initiative does have a goal to reduce the percentage of adults who experience a major depressive episode by 10% (DHHS, 2012a). An additional Healthy People 2020 goal is to decrease the proportion of women delivering a live birth who experience postpartum depressive symptoms (DHHS, 2014).

Previous research suggests that the birth of a preterm infant leads to substantial challenges among parents, and may eventually lead to psychological distress and ill mental health (Singer, Salvator, Guo, Collin, Lilien, & Baley, 1999; Treyvaud, 2014). Mothers of preterm infants have higher levels of psychological distress (i.e., depression and anxiety) compared to mothers of full term infants. Mothers of preterm infants also experience increased stressors when parenting and providing care for their preterm infants compared to those who have term infants; daily parenting tasks are more time-consuming and many times, call for more financial resources (Singer et al., 1999). Thus,

the examination of the relationship between having a preterm birth and postpartum depression may provide valuable insight for the field of maternal and child health.

Although previous studies found a relationship between having a preterm birth and maternal depression (Vigod et al., 2010; Mautner et al., 2009; Blom), various methodological issues and limitations may have limited the generalizability of results. These limitations include a lack of racial/ethnic diversity (Blom et al., 2010), inability to control for known confounders (Vigod et al., 2010; Mautner, et al., 2009), and the use of international populations (Blom et al., 2010; Mautner, et al., 2009). Thus, the purpose of this study was to evaluate the relationship between having a preterm birth and postpartum depression using a large, population-based sample of US women.

Materials and Methods

This secondary data analysis used 2012-2014 (Phase VII) US Pregnancy Risk Assessment Monitoring System (PRAMS) data to examine the association between having a preterm infant and postpartum depression among mothers age 18-40 in the US. The study protocol was approved by UNC Charlotte's Institutional Review Board.

The CDC initiated PRAMS to decrease infant mortality and morbidity. With 47 US states, New York City, Puerto Rico, the District of Columbia and the Great Planes Tribal Chairmen's Health Board participating, it is estimated that PRAMS represents 83% of all US live births (CDC, 2017a). Each participating state conducts stratified random sampling to select women from birth certificates 2-4 months after the infant is born. PRAMS personnel administer a survey via mail, and if mothers do not respond, they are contacted by telephone (CDC, 2016). PRAMS questionnaire data on maternal behavior before, during, and after pregnancy are linked to birth certificate data, providing

additional information on demographics and medical records of the mother and infant (CDC, 2017a). All states use the same set of core questions; however, they are also able to add state-specific questions based on their needs. Participants are weighted to be representative of all mothers giving birth in the respective state (CDC, 2016). As of 2012, the minimum overall response rate for threshold is 60%; this is the minimum response rate necessary for PRAMS to release data to researchers (CDC, 2017b). Thirty-three states met the response rate threshold in Phase VII PRAMS and were available for analyses.

Because PRAMS collects data on new mothers age 12 and older, mothers younger than 18 and older than 45 were excluded from the study due to the fact that older and younger mothers are at higher risk for pregnancy complications (Elina Hemminki Affilation, 1996; Fraser, Brockert, & Ward, 1995). Participants with incomplete information on the exposure (i.e., preterm birth) and outcome (i.e., postpartum depression) were excluded from this study. Furthermore, women with a previous diagnosis of depression (i.e., depression before pregnancy and depression during pregnancy) and those who lost their infant after giving birth were excluded from the analysis.

Exposure Assessment

The main exposure in this study was preterm birth. Information on the exposure was extracted from birth certificate data. If a participant's infant was born at less than 37 full weeks' gestation, she was considered to have the exposure (preterm birth).

Outcome Assessment

The outcome of interest was postpartum depression. To assess the outcome, the following PRAMS questions were used: "Since your new baby was born, how often have you felt down, depressed, or hopeless?" and "Since your new baby was born, how often have you had little interest or little pleasure in doing things?" These two questions have been shown to be appropriate measures of postpartum depression since a major depressive episode may be defined as an experience of depressed mood or the loss of interest or pleasure in activities (Whooley, Alvins, Miranda, & Browner, 1997). In addition, the PRAMS depression questions are slightly modified from the Patient Health Questionnaire-2 (PHQ-2), which has previously demonstrated adequate sensitivity and specificity when measuring depression (Kroenke, Spitzer, & Williams, 2003). Response choices for both questions are "never," "rarely," "sometimes," "often," and always. An answer of "often" or "always" meant the participant had the outcome, and an answer of "never," "rarely," or "sometimes," meant the participant did not have the outcome. Several other studies have previously used these categories to classify participants as having or not having postpartum depression (Whooley, Alvins, Miranda, & Browner, 1997; Khan, Arif, Laditka, & Racine, 2015; CDC, 2008).

Measurement of Confounders

Possible confounders of the preterm birth-mental health outcome association are race/ethnicity, age, education level, income, health insurance, marital status, gestational diabetes, gestational hypertension, parity, receipt of postpartum check-up(s), infant placed in neonatal intensive care unit (NICU) after birth, infant currently alive, child currently living with participant, and presence of stressful life events (Davis et al., 2003; Bouras et al., 2015; Leonard et al., 2014; Vigod et al., 2010; Blom et al., 2010; Mautner,

et al., 2009; Moore et al., 2006; Taylor et al., 2001; Treyvaud, 2014). Race/ethnicity, education level, marital status, age, health insurance, marital status, gestational diabetes, and gestational hypertension were obtained from birth certificates linked to the PRAMS data set. All other variables were obtained from the PRAMS survey.

Data Analysis Plan

Frequencies and percentages were used to describe demographic and lifestyle characteristics of the study population. Logistic regression was used obtain a crude association between having a preterm birth and mental health (i.e., depression) and to identify other risk factors for poor mental health. Multivariate logistic regression was used to calculate adjusted odds ratios and 95% confidence intervals. A multivariable model was created by first including all potential confounders in the model. Then, the backward elimination procedure was used to retain only those variables with $p<0.20$ (Budtz-Jorgensen, Keiding, Grandjean, & Weihe, 2007). Since PRAMS utilizes a complex sampling design, SAS-callable SUDAAN was used in all analyses.

Results

A total of 106,290 women participated in the 2012-2014 US PRAMS. Those mothers who were diagnosed with depression before their most recent pregnancy (n=11,308), those who were under the age of 18 (n=1,957) and those whose infants died before the time of survey (n=1,076) were excluded from the study. Participants were also excluded if they were missing information on preterm birth (n=261) or depression (n=2,322). Therefore, 89,366 participants remained for analysis. Approximately 8% (n=15,932) of participants had a preterm birth and 9.64% (n=9,697) reported having symptoms of depression (hopelessness and/or loss of interest) (Table 1). Among the

participants whose most recent live birth was preterm, 11.26% (n=2,052) reported having symptoms of depression since delivery. The majority of women were non-Hispanic White (61.41%), between the ages of 25-34 (58.81%), had private health insurance (57.16%), and were married (64.01%; Table 1).

In the unadjusted model, women who had a preterm birth had increased odds of feeling hopeless (OR=1.40; 95% CI: 1.23, 1.60; Table 2) and loss of interest (OR=1.11; 95% CI: 0.99, 1.25) compared to women who did not have a preterm; however, only findings on hopelessness were statistically significant. There was a dose-response relationship between level of prematurity and hopelessness; as the level of prematurity increased, the odds of feeling hopeless increased. Mothers who had extremely premature infants had over twice the odds of reporting hopelessness (OR=2.36; 95% CI: 1.75, 3.17), those with a very preterm infant had 1.46 times the odds of feeling hopeless (95% CI: 1.19, 1.78), and mothers who had a preterm infant had 1.33 times the odds of feeling hopeless (95% CI: 1.13, 1.57) compared to mothers who did not have a preterm birth; all of these findings were statistically significant.

Non-Hispanic Black mothers also had statistically significant increased odds of both hopelessness and loss of interest (OR=1.50; 95% CI: 1.32, 1.72; OR=2.12; 95% CI: 1.91, 2.37) compared to non-Hispanic White mothers. Mixed race/other and Hispanic mothers also had statistically increased odds of loss of interest (OR=2.27; 95% CI: 2.05, 2.51; OR=1.18; 95% CI: 1.05, 1.33, respectively), but did not have statistically significant increased odds of hopelessness (OR=1.11; 95% CI: 0.97, 1.27; OR=1.01; 95% CI: 0.88, 1.15). Younger women (18-24 years) had statistically significant increased odds of both outcomes (hopelessness OR= 1.75; 95% CI: 1.58, 1.94; loss of interest OR= 1.63;

95% CI: 1.50, 1.78) while older women (35-45 years) had statistically significant decreased odds of both outcomes (hopelessness OR= 0.83; 95% CI: 0.72, 0.96; loss of interest OR= 0.88; 95% CI: 0.78, 0.98) compared to women age 25-34.

Following adjustment for race/ethnicity, age, income, marital status, BMI, drinking during pregnancy, breastfeeding, plurality, postpartum checkup, infant currently living with mother, and stress, the relationship between having a preterm birth and maternal hopelessness was attenuated and remained statistically significant for all levels of prematurity, except those born at 32-37 weeks' gestation (preterm OR=1.19; 95% CI: 1.00-1.42; very preterm OR=1.28; 95% CI: 1.04, 1.58; extremely preterm OR=1.81; 95% CI: 1.31, 2.49; Table 3). In addition, after adjustment for race/ethnicity, education, income, insurance, previous preterm birth, gestational diabetes, breastfeeding, postpartum checkup, child currently living with mother, and stress, all findings, regardless of level of prematurity, indicated no association (extremely preterm OR=0.85 95% CI: 0.60, 1.19; very preterm OR=1.04; 95% CI: 0.86, 1.26; preterm OR=0.95; 95% CI: 0.82, 1.10).

Discussion

In this population-based study of US women, preterm birth was associated with a statistically significant increased odds of feeling hopeless; however, there was no association between preterm birth and loss of interest. Findings of the current study regarding hopelessness are similar to that of previous studies that found statistically significant associations between having a preterm birth and postpartum depression (Vigod et al., 2010; Blom et al., 2010; Mautner et al., 2009; Barroso et al., 2015). The current study's results are also similar to smaller (n=90; n=102) studies examining postpartum depression among mothers who had a preterm birth (Mautner et al., 2009;

Barroso et al., 2015). Both studies found that preterm birth significantly predicted postpartum depressive symptoms on the Edinburgh postpartum depression scale. In addition, participants in the Mautner et al. study were similar to that of the current study in that most mothers were age 25-34, and of those who had a preterm birth, the majority had a late preterm birth (32-less than 37 weeks gestation). Also similar to the current study, results of Barroso et al. revealed a dose-response relationship. Researchers found that for every one unit decrease in the latent variable, preterm birth, there was a .91 unit increase on the Edinburg postpartum depression scale (EPDS) Barroso et al., 2015).

Previous research has shown that one question on depressed mood may be sensitive enough to screen for depression; however, the use of two questions increases sensitivity and specificity (Kroenke, Spitzer & Williams, 2003). It is possible that women who have preterm babies may feel depressed mood, but not loss of interest due to the fact that premature babies may require more care. Thus, findings on the lack of relationship between having a premature birth and loss of interest are plausible.

Results of the current study are also consistent with the theorized biological mechanism, suggesting that feelings of fear and anxiety that may often accompany having a preterm birth can affect maternal mental health (Harvard Medical School, 2008). According to Ebaugh's (1988) role exit theory, the process of role exit (from expectant mother to mother) may place many new parents in the "vacuum experience," causing them to be unable to swiftly move from one identity into the next. Thus, parents of preterm birth infants may have feelings of fear and anxiety because their new role as parent came sooner than they expected.

Potential Strengths & Limitations

The exposure variable, preterm birth, was obtained directly from birth certificates; therefore, nondifferential misclassification of the exposure was limited. However, it is possible that clerical errors in recording information on birth certificates may have occurred. Due to self-reporting of the outcome variables, there was also potential for nondifferential misclassification of the outcome. For example, mothers may be embarrassed to disclose if they have been having mental health problems, as there is a stigma associated with poor mental health. Any resulting nondifferential misclassification may have biased results towards the null.

Due to the high response rates for US PRAMS, there is limited potential for selection bias. In addition, the current study only includes states that reached the minimum threshold response rate for PRAMS data to be released (60%). However, there may be differences between parents who decided to participate and those who did not. Previous research suggests that PRAMS response rates tend to be higher for mothers who are older, White, married, and have a normal birth weight infant (Shulman, Gilbert, & Lansky, 2006). In addition, there may be potential for recall bias (i.e., differential misclassification) because mothers of preterm infants may be less likely to remember having feelings of depression or hopelessness, potentially due to avoidance or numbing (Holditch-Davis, Santos, Levy, White-Traut, O'Shea, Geraldo, & Davis, 2015).

Analyses of this study were dependent upon variables available in US PRAMS; therefore, some potential confounders of the preterm birth-parent mental health outcomes association may not be included. For example, immigration status may affect one's risk of preterm birth as well as postpartum depression; however, this information is

not available in PRAMS data (Mautner et al., 2009). An over- or under-estimation of the true association could occur as a result of failure to control for known or unknown confounders.

Generalizability of the study is increased due to the complex sampling design of US PRAMS and the large sample size of the study. In addition, the current study was diverse in terms of race/ethnicity and socioeconomic status, and researchers examined specific symptoms of postpartum depression, as opposed to a scale or single diagnosis. While it is possible to screen for postpartum depression using scales, only health care providers can provide diagnoses, the gold standard for determining if women's symptoms are due to postpartum depression or something else (NIMH, 2014). However, understanding the specificity of symptoms related to having a preterm birth may allow healthcare providers to better serve this subpopulation of mothers. Therefore, assuming internal validity, results may be generalized to women 18-40, residing in the US.

Implications for Practice and Policy

Given the statistically significant increased association between having a preterm birth and maternal depression, health professionals should consider implementation of comprehensive screening for depression and other mental illnesses among all mothers who give birth prematurely. Findings may also inform future interventions to emphasize the importance of postpartum care among mothers who have had a preterm birth. In addition, future interventions may address views and barriers that may be specific to mothers who have had a preterm infant on the concept of self-care, as this may decrease the risk for worsened adverse mental health outcomes.

Conclusions

Mental health is not only an important issue for mothers; depression may also affect child development. Mental health issues, such as postpartum depression, in parents (both pregnant and postpartum) often lead to attachment disorders for infants. In fact, many studies have shown an average of 17-28% lower rates of secure attachment among infants of depressed parents compared to infants of parents without depression (Ko, Farr, Dietz, & Robbins, 2012). Other studies have found parent depression to increase difficult behavior and dysregulation of emotions and attention in children. In addition, infants of mothers who experience depression during pregnancy and postpartum may have higher cortisol and norepinephrine levels at birth, along with lower levels of dopamine, all of which could negatively affect neuroendocrine and psychological functioning. Infants of depressed mothers have also been found to have decreased cognitive-intellectual functioning and increased chances of developing psychopathology (Goodman & Brand, 2009).

Future studies should examine specific symptoms of postpartum depression, as opposed to a scale to determine why mothers of preterm infants may be more at risk for some symptoms and not others. Future studies should also seek to examine why mothers of extremely preterm infants may have different or worse health outcomes than that of mothers of preterm and very preterm infants.

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Table 1b: Characteristics of 2012-2014 US PRAMS Participants (N=89,366)

Variables	Unweighted Number N	Weighted Percent (%)
Preterm Birth		
Yes	15,891	7.91
No	73,475	92.09
Prematurity Level		
Not preterm	73,475	92.09
Preterm (32- <37 weeks)	9,685	5.89
Very preterm (28- <32 weeks)	4,979	1.66
Extremely preterm (<28 weeks)	1,227	0.36
Depression (Hopelessness)		
Yes	4,952	4.90
No	84,414	95.10
Depression (Loss of interest)		
Yes	6,997	6.95
No	82,369	93.05
Race/ethnicity		
Non-Hispanic White	43,829	61.41
Non-Hispanic Black	13,571	13.14
Mixed Race/Other	15,173	10.43
Hispanic	13,388	14.70
Age		
18-24	23,679	24.96
25-34	51,354	58.81
≥35	14,333	16.23
Education		
Less than high school graduate	11,973	12.53
High school graduate	21,968	23.41
Some college	25,310	27.56
Bachelor's degree or above	30,115	36.49
Income		
≤$22,000	32,910	36.46
$22,001-52,000	19,291	22.22
>$52,000	28,389	37.52
Missing	8,776	3.80
Health Insurance		
Private	48,297	57.16
Medicaid	17,483	17.38
Other	3,944	4.05
None	16,238	18.33
Missing	3,404	2.92
Marital Status		
Married	55,490	64.01

Other	33,814	35.95
Missing	62	0.03
Body Mass Index (BMI)		
<18.5	7,602	8.41
18.5-24.9	42,076	48.11
25.0-29.9	20,838	23.49
>30.0	18,850	19.99
Previous Preterm Birth		
Yes	7,235	6.41
No	43,556	51.67
Missing	38,575	41.92
Drank during pregnancy		
Yes	6,372	7.74
No	82,994	92.26
Smoked during pregnancy		
Yes	8,615	8.30
No	80,751	91.70
Gestational diabetes		
Yes	8,877	9.05
No	79,647	90.01
Missing	842	0.94
Weeks Breastfed		
Did not breastfeed	11,551	14.06
Less than 1 week	2,539	2.90
1-10 weeks	24,381	25.49
11-20 weeks	5,641	6.13
More than 20 weeks	703	0.85
Breastfeeding currently	44,551	49.64
Plurality		
1	83,501	97.90
$\geq$2	5,865	2.10
Receipt of postpartum check-ups		
Yes	80,187	90.95
No	8,908	8.46
Missing	271	0.32
Infant placed in NICU after birth		
Yes	16,968	11.21
No	71,378	87.73
Missing	1,020	1.06
Child currently living with participant		
Yes	86,658	97.44
No	422	0.36
Missing	2,286	2.20
Stressful life events		
0	27,056	32.05

1-2	37,349	41.54
3-5	20,327	21.58
6-18	4,634	4.83

Table 2b: Unadjusted Odds Ratios and 95% Confidence Intervals for the Association between Demographic and Lifestyle Characteristics and Depression, 2012-2014 US PRAMS Participants

Variables	**Depression (Hopelessness)**		**Depression (Loss of Interest)**	
	OR	95% CI	OR	95% CI
Preterm birth				
Yes	1.40	1.23, 1.60	1.11	0.99, 1.25
No	1.00	Referent	1.00	Referent
Prematurity Level				
Not preterm	1.00	Referent	1.00	Referent
Preterm (32-<37 weeks)	1.33	1.13, 1.57	1.07	0.93, 1.23
Very preterm (28- <32 weeks)	1.46	1.19, 1.78	1.24	1.03, 1.49
Extremely preterm (<28 weeks)	2.36	1.75, 3.17	1.27	0.93, 1.74
Race/ethnicity				
Non-Hispanic White	1.00	Referent	1.00	Referent
Non-Hispanic Black	1.50	1.32, 1.72	2.12	1.91, 2.37
Mixed Race/Other	1.11	0.97, 1.27	2.27	2.05, 2.51
Hispanic	1.01	0.88, 1.15	1.18	1.05, 1.33
Age				
18-24	1.75	1.58, 1.94	1.63	1.50, 1.78
25-34	1.00	Referent	1.00	Referent
35-45	0.83	0.72, 0.96	0.88	0.78, 0.98
Education				
Less than high school graduate	1.95	1.67, 2.28	2.28	2.02, 2.59
High school graduate	2.16	1.90, 2.45	2.23	2.01, 2.48
Some college	1.81	1.60, 2.05	1.77	1.59, 1.96
Bachelor's degree or above	1.00	Referent	1.00	Referent
Income				
≤$22,000	2.38	2.12, 2.68	2.46	2.23, 2.72
$22,001-52,000	1.81	1.58, 2.07	1.93	1.72, 2.12
>$52,000	1.00	Referent	1.00	Referent
Health Insurance				
Private	1.00	Referent	1.00	Referent
Medicaid	1.99	1.77, 2.24	2.20	2.00, 2.43
Other	1.56	1.23, 1.97	1.84	1.53, 2.23
None	1.69	1.50, 1.90	1.72	1.55, 1.91
Missing	1.84	1.45, 2.35	1.69	1.36, 2.09
Marital Status				
Married	1.00	Referent	1.00	Referent
Other	2.01	1.83, 2.20	1.70	1.57, 1.84
Missing	0.48	0.12, 1.83	2.84	0.89, 9.11

Body Mass Index (BMI)				
<18.5	1.25	1.05, 1.48	1.33	1.17, 1.52
18.5-24.9	1.00	Referent	1.00	Referent
25.0-29.9	1.24	1.10, 1.40	1.02	0.92, 1.13
>30.0	1.58	1.40, 1.77	1.21	1.10, 1.35
Previous Preterm Birth				
Yes	1.29	1.09, 1.53	1.28	1.10, 1.48
No	1.00	Referent	1.00	Referent
Missing	1.07	0.97, 1.17	1.13	1.04, 1.23
Drank during pregnancy				
Yes	0.98	0.82, 1.16	0.79	0.68, 0.93
No	1.00	Referent	1.00	Referent
Smoked during pregnancy				
Yes	2.31	2.02, 2.63	1.58	1.39, 1.79
No	1.00	Referent	1.00	Referent
Gestational diabetes				
Yes	1.10	0.94, 1.29	1.24	1.10, 1.41
No	1.00	Referent	1.00	Referent
Missing	1.49	0.94, 2.36	1.42	0.98, 2.05
Weeks Breastfed				
Did not breastfeed	1.95	1.69, 2.25	1.44	1.28, 1.62
Less than 1 week	2.83	2.21, 3.62	1.75	1.40, 2.18
1-10 weeks	2.41	2.16, 2.68	1.55	1.42, 1.70
11-20 weeks	1.69	1.39, 2.05	1.27	1.07, 1.50
More than 20 weeks	0.82	0.42, 1.60	1.05	0.68, 1.63
Breastfeeding currently	1.00	Referent	1.00	Referent
Plurality				
1	1.00	Referent	1.00	Referent
≥2	0.90	0.78, 1.59	1.01	0.75, 1.97
Receipt of postpartum check-ups				
Yes	1.00	Referent	1.00	Referent
No	1.88	1.64, 2.15	1.76	1.56, 1.98
Missing	2.65	1.39, 5.03	1.71	0.93, 3.14
Infant placed in NICU after birth				
Yes	1.50	1.33, 1.69	1.37	1.24, 1.53
No	1.00	Referent	1.00	Referent
Missing	1.33	0.86, 2.05	2.74	2.10, 3.57
Child currently living with participant				
Yes	1.00	Referent	1.00	Referent
No	5.48	3.56, 8.41	3.33	2.13, 5.21
Missing	1.63	1.27, 2.09	1.79	1.44, 2.23
Stressful life events				
0	1.00	Referent	1.00	Referent
1-2	1.84	1.59, 2.13	1.17	1.06, 1.29

3-5	4.78	4.13, 11.62	1.95	1.76, 2.18
6-18	9.72	8.14, 11.62	3.30	2.83, 3.85

Table 3b: Adjusted Odds Ratios and 95% Confidence Intervals for the Association between Demographic and Lifestyle Characteristics and Depression, 2012-2014 US PRAMS Participants

Variables	**Depression (Hopelessness)[a]**		**Depression (Loss of Interest)[b]**	
	OR	95% CI		
Preterm birth				
Yes	1.24	1.08, 1.43	0.96	0.85, 1.09
No	1.00	Referent	1.00	Referent
Prematurity Level				
Not preterm	1.00	Referent	1.00	Referent
Preterm (32-37 weeks)	1.19	1.00, 1.42	0.95	0.82, 1.10
Very preterm (28-<32 weeks)	1.28	1.04, 1.58	1.04	0.86, 1.26
Extremely preterm (<28 weeks)	1.81	1.31, 2.49	0.85	0.60, 1.19

[a]Model adjusted for race, age, income, marital status, BMI, drinking during pregnancy, breastfeeding, plurality, postpartum checkup, infant currently living with mother, and stress.

[b] Model adjusted for race, education, income, insurance, previous preterm birth, gestational diabetes, breastfeeding, postpartum checkup, child currently living with mother, and stress.

CHAPTER 4: THE ASSOCIATION BETWEEN HAVING A PRETERM BIRTH AND LATER MATERNAL HEALTH: A SURVEY OF MATERNAL MENTAL AND PHYSICAL HEALTH OUTCOMES

Introduction

The World Health Organization (WHO) defines preterm birth as infants born alive before the mother has completed a full 37 weeks of pregnancy (WHO, 2016a). In 2016, 9.6% of babies were born preterm (approximately 380,000 infants), accounting for one out of every ten infants born in the US (March of Dimes, 2016). The US is listed as one of the ten countries with the highest prevalence of preterm births (Blencowe, Cousens, Oestergaard, Chou, Moller, Narwal et al., 2012). This is particularly alarming since the US is the only country on the list that is not categorized as a developing country. In the state of North Carolina, rates of preterm birth are higher than the national prevalence at 10.2%, ranking the state number 44 in the US (March of Dimes, 2016).

Previous research suggests that women who experience a preterm birth may be more likely to have poor mental and physical health outcomes (Lee & Kimble, 2009). Researchers who have examined this relationship have found that parents of preterm infants rate their well-being as less satisfactory compared to mothers of full term infants (Eiser et al., 2005; Treyvaud, 2014). In addition, some studies have specifically examined the preterm birth-cardiovascular disease relationship. Three studies found that women who have had a preterm birth have approximately two-three times the normal risk of cardiovascular disease (Smith, Pell, & Walsh, 2001; Bhasin & Kapoor, 2014; Smith, Whitley, Gissler, & Himmenki, 2000; Sattar & Greer, 2002).

Findings regarding the preterm birth-maternal health association are consistent; however, multiple factors may have limited the external validity of many of these studies. These factors include lack of racial/ethnic diversity (Bhasin & Kapoor 2014; Catov, Wu, Olsen, Sutton-Tyrrell, Li, & Nohr, 2010), inability to control for known confounders (Eiser et al., 2005; Donohue et al., 2008; Smith, Pell, & Walsh, 2001; Smith, Whitley, Gissler, & Himmenki, 2000), and relatively small sample sizes (Eiser et al., 2005; Donohue et al., 2008). In addition, many of these studies have been conducted outside of the US (Bhasin & Kapoor, 2014; Sattar & Greer, 2002; Smith, Pell, & Walsh, 2001; Smith, Pell, & Walsh, 2001; Eiser et al., 2005; Treyvaud, 2014), and many measured quality of life and well-being as opposed to specific diagnoses (Eiser et al., 2005; Treyvaud, 2014; Donohue et al., 2008; Haas & McCormick, 1997).

A review of studies examining pregnancy complications in relation to later maternal vascular and metabolic disease suggests a biological mechanism for the relationship of interest (Sattar & Greer, 2002). Preterm birth exposes women to inflammatory markers, which leads to leukocyte (white blood cells) infiltration in the cervical and uterine tissues. In turn, women who have a preterm birth develop greater upregulation of the chronic inflammatory pathways compared to women who have full term births. Inflammation is an independent predictor of cardiovascular disease; thus, it is plausible that preterm birth is along the pathway leading to cardiovascular disease (Sattar & Greer, 2002).

In addition, due to the birth timing and possibly the appearance of the infant, mothers may have trouble exiting the expectant parent role, and entering the new mother role, thus affecting parent mental health status (Ebaugh, 1988; Jeffcoate Humphrey, &

Lloyd, 1979). Thus, preterm birth may lead to parents' poor mental health, which in turn may affect physical health status. Therefore, the purpose of this study is to examine the relationship between preterm birth and physical (i.e., diabetes, hypertension, and coronary heart disease) and mental health (i.e., depression, postpartum depression, and anxiety) among North Carolina mothers.

Methods

This study surveyed women in two Facebook support groups for mothers in the Charlotte, NC area, as well as mothers at a local university. The "Charlotte Moms" group and the "New to Charlotte Moms" group are closed online Facebook support groups with 5,428 and 577 members, respectively (Facebook, 2017). The goal of both social media groups are to provide a safe space for mothers who want to ask questions, share stories, and meet other mothers in the Charlotte area. The study was also open to mothers who were students, faculty, and/or staff at a local university during the time of the study (n=30,860).

The Facebook group managers were identified by searching the following terms in the Facebook group search tool: "Charlotte Moms" and "Charlotte Mothers." Group manager names are listed and publicly available to all Facebook users. After requesting a partnership with the Facebook group manager, a link to the "Survey of Maternal Mental and Physical Health Outcomes" was sent to the group managers. The group manager posted the link to their Facebook group 4 times over the course of one month (i.e., once per week). For the UNC Charlotte community, participants were sent an e-mail informing them of their invitation to participate in an online survey.

Participants completed an online survey using a web-based survey software tool. Mothers who were interested in participating first completed a short screening survey to determine eligibility. If women responded that they had not had a child in the last 5 years, they were under the age of 18 or over the age of 50, or they had been hospitalized for specific mental and physical health problems in the past, they were thanked for their time but were ineligible to continue with the study. Eligible mothers completed an electronic informed consent and then, the final survey. The survey was 31 questions and took approximately 15-20 minutes to complete. Upon completion of the study, participants were offered an opportunity to be entered into a drawing to win a $100 gift card.

Exposure Assessment

To assess the main exposure, preterm birth, participants were asked, "The following questions are about your most recent child and his/her health. When was your baby due?" and "When was your baby born?" If the calculated time between the two dates given was more than 3 full weeks, the participant was considered to be exposed.

Outcome Assessment

The outcomes of interest were mental health (depression, postpartum depression, and anxiety) as well as physical health problems (diabetes, hypertension, and coronary heart disease). Participants were asked if a doctor, nurse, or healthcare worker told them they had depression, postpartum depression, anxiety, diabetes, angina or coronary heart disease, or high blood pressure since their most recent live birth. An answer of 'yes' meant the participant did have the outcome (poor mental or physical

health) and an answer of ‘no’ meant she did not have the outcome. Due to the fact that so few participants reported having diabetes (n=3), hypertension (n=24), and coronary heart disease (n=2), if mothers responded ‘yes’ to any of these questions, they were considered to have the poor physical health outcome.

Measurement of Confounders

Possible confounders of the preterm birth-maternal health outcome association are race/ethnicity, age at time of childbirth, education level, income, health insurance, marital status, family history of chronic disease, gestational diabetes, gestational hypertension, family history of mental health problems, depression during pregnancy, smoking and drinking during pregnancy, history of postpartum depression (following a previous pregnancy), receipt of postpartum check-up(s), taking prescription medicine for depression/anxiety, seeing a counselor for depression/anxiety, history of preterm birth or other birth complications, parity, infant placed in ICU after birth, infant currently alive, child currently living with participant, stressful life events, current parental stress, and social support (Treyvaud, 2014; Sattar & Greer, 2002). Information on these variables were self-reported by the participants.

Data Analysis

Summary statistics (i.e., frequencies and percentages) were used to describe participants’ demographic and lifestyle characteristics. Logistic regression was used to determine the unadjusted association between having a preterm birth and poor mental health (i.e., depression, postpartum depression, and anxiety) and physical health (i.e., diabetes, hypertension, and coronary heart disease). In addition, other risk factors for poor mental and physical health were identified. Adjusted ORs and 95% confidence

intervals of the association between preterm birth and poor health outcomes were calculated using multivariate logistic regression. Confounders of the preterm birth-poor health outcomes relationship were identified as a variable that changed the OR estimate by at least 10% when added to the model (Maldonado & Greenland, 1993). SAS was used in all analyses.

Results

A total of 424 mothers participated in the Maternal Health Survey. Participants were excluded if they did not complete the survey (n=31) or if they were missing information on the exposure or outcomes (n=12); therefore 381 mothers remained for analyses. Approximately 10% of mothers had a preterm birth within the last 5 years (Table 1). Of those who had a preterm birth, only 1.6-2.6% reported having the individual physical and mental health outcomes. The majority of participants were non-Hispanic White (66.93%), had an annual income above $50,000 (65.09%), and were married (72.44%).

Mental Health Outcomes

Mothers who had a preterm birth in the last 5 years had slightly decreased odds of later having depression (OR=0.90; 95% CI: 0.19, 4.27; Table 2), and increased odds of having postpartum depression (OR=2.03; 95% CI: 0.60, 6.91) and anxiety (OR=1.94; 95% CI: 0.57, 6.56) compared to mothers who had a full term birth; however, none of these findings were statistically significant. Participants who had an annual income of less than $50,000 had over twice the odds of depression (OR=2.27; 95% CI: 0.95, 5.44), postpartum depression (OR=2.19; 95% CI: 0.95, 5.05), and anxiety (OR=2.44; 95% CI: 1.07, 5.55) compared to those with an annual income of $50,000 or more; however, only

findings regarding anxiety were statistically significant. Mothers who reported that they never, rarely, or sometimes receive the emotional support they need had statistically significant increased odds of depression (OR=6.38; 95% CI: 2.42, 16.85), postpartum depression (OR=5.20; 95% CI: 2.01, 13.43), and anxiety (OR=6.16; 95% CI: 2.40, 15.80) compared to mothers who reported they often or always receive the emotional support they need.

Following adjustment the relationship between having a preterm birth and later depression (OR=0.19; 95% CI: 0.02, 1.71) as well as that of preterm birth and later postpartum depression (OR=1.27; 95% CI: 0.28, 5.80) was attenuated and remained statistically insignificant. Following adjustment for smoking or drinking during pregnancy, emotional support, and current child health, the relationship between preterm birth and later anxiety was slightly strengthened; however, findings remained not statistically significant (OR=2.04; 95% CI: 0.49, 8.56).

Physical Health Outcomes

Participants who had a preterm birth in the last 5 years had over twice the odds of poor physical health (OR=2.06; 95% CI: 0.41, 10.28) compared to those who had a full term infant in the last 5 years; however, these findings were not statistically significant. In addition, the more children mothers had, the higher their odds for poor physical health (2 children: OR=1.18; 95% CI: 0.47, 2.97 and 3 or more children: OR=1.67; 95% CI: 0.56, 4.95) compared to mothers with only one child; however, these findings were not statistically significant. Following adjustment for gestational diabetes or hypertension, the preterm birth-poor physical health association was still increased but attenuated.

Specifically, women who had a preterm birth had over 1.5 times the odds of poor physical health (OR=1.60; 95% CI: 0.29, 8.82) compared to women who had a term birth; however, findings remained not statistically significant.

Discussion

Findings of this cross-sectional survey revealed increased odds of postpartum depression, anxiety, and poor physical health among women who had a preterm birth; however, findings were not statistically significant. The current study's findings are similar to that of previous studies, which found significant associations between having a preterm birth and poor mental and physical health outcomes (Vigod et al., 2010; Blom et al., 2010; Lee & Kimble, 2009; Bhasin & Kapoor, 2014; Sattar & Greer, 2002; Smith, Pell, & Walsh, 2001; Smith, Pell, & Walsh, 2001; Eiser et al., 2005; Treyvaud, 2014). Sample sizes of these studies ranged from 217-4,941; these larger sample sizes may have contributed to the statistically significant findings in these studies. It is also important to note that the majority of prior studies were conducted outside of the US (Bhasin & Kapoor, 2014; Sattar & Greer, 2002; Smith, Pell, & Walsh, 2001; Smith, Pell, & Walsh, 2001; Eiser et al., 2005; Treyvaud, 2014); thus, the lack of statistical significance in the current study may also reflect cultural differences.

Results of the current study, although not statistically significant, show increased odds of poor health outcomes among mothers who have had a preterm birth. These findings are consistent with the proposed biological mechanism for the relationship of interest (Sattar & Greer, 2002). Greater upregulation and inflammation are predictors of cardiovascular disease; thus, it is plausible that preterm birth is along the pathway leading to cardiovascular disease (Sattar & Greer, 2002). In addition, poor physical

health may increase stress levels, thus leading to poor mental health (Jeffcoate et al., 1979).

Strengths and Limitations

Due to the fact that data on the exposure, preterm birth, was self-reported, there is potential for nondifferential misclassification of the exposure. However, mothers tend to remember and accurately report perinatal factors, especially preterm birth (Sanderson, Williams, White, Daling, Holt, Malone, et al., 1998). The questionnaire was pre-tested to reduce the risk of nondifferential misclassification. However, because the outcome variables were self-reported, nondifferential misclassification of the outcome is possible. To assess all outcomes, mothers were asked whether they had been diagnosed by a health care worker; nonetheless, answers are not confirmed by medical records. Another potential issue is the stigma associated with mental health diagnoses; thus, participants may be embarrassed or unwilling to disclose depression or anxiety diagnoses. However, self-report measures of the outcomes tend to be valid, reducing potential for this type of bias (Martin, Leff, Calonge, Garrett, & Nelson, 2000).

There may be potential for selection bias in the current study. Convenience sampling may exclude some women from the study; specifically, those women who do not use the internet, Facebook, or join Facebook groups after giving birth, as well as those who were not students, faculty, or staff at the University. The use of multiple attempts to contact potential participants (i.e., 4 attempts in one month) may have reduced the potential for selection bias. The current study controlled for all known confounders of the proposed associations; therefore, providing the ability to control for potential confounders. However, some unknown confounders may not have been

included in the survey.

Despite these limitations, this study did have a number of strengths. This was the first study, to our knowledge, to examine the association between having a preterm birth and later mental and physical health outcomes among mothers in North Carolina using a web-based survey. While some previous studies have used hospital records and/or screening tools (Vigod et al., 2010; Blom et al., 2010; Lee & Kimble, 2009; Bhasin & Kapoor, 2014; Sattar & Greer, 2002; Smith, Pell, & Walsh, 2001; Smith, Pell, & Walsh, 2001; Eiser et al., 2005), few have used original survey data to evaluate the association between having a preterm birth and parent health outcomes. In addition, the current study was able to control for many known confounders of the preterm birth-maternal health outcome relationship, thus reducing the potential for bias. While convenience sampling may decrease the overall generalizability of the current study, findings of this study may be generalized to women age 18-50 in North Carolina and similar regions who have given birth in the past 5 years.

Conclusion

This study adds to the current body of literature on preterm birth and maternal health outcomes. Since mothers of preterm birth infants may be more at risk for adverse birth outcomes, comprehensive screening of this subpopulation is warranted. Although not statistically significant, there were increased odds of postpartum depression, anxiety, and chronic disease among mothers who had a preterm birth. Therefore, findings of the current study emphasize the importance of postpartum care. All mothers should be screened for mental and physical health conditions during their postpartum visit to a health care provider, and those who have had a preterm birth may

need to be screened beyond their postpartum visit (i.e., annual exams). As findings were not statistically significant, future studies should seek to examine this relationship using a large and diverse, population-based sample of mothers. In addition, future studies may seek to include fathers to determine if those who have a preterm infant also had increased odds of poor health outcomes.

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Table 1c: Characteristics of Maternal Health Survey Participants (N=381)

Variables	Number	Percent
	N	(%)
Preterm Birth		
Yes	41	10.76
No	340	89.24
Depression		
Yes	71	18.64
No	310	81.36
Postpartum Depression		
Yes	74	19.42
No	307	80.58
Anxiety		
Yes	72	18.90
No	309	81.10
CVD, Diabetes, or Hypertension		
Yes	25	6.56
No	356	93.44
Race/ethnicity		
Non-Hispanic White	255	66.93
Other	126	33.07
Current Age		
<30	138	36.22
30-35	137	35.96
>35	106	27.82
Education		
Some college or less	103	27.03
Bachelor's degree or above	278	72.97
Income		
≤$50,000	133	34.91
≥$50,000	248	65.09
Health Insurance		
Private	279	73.23
Medicaid/ Other	102	26.77
Marital Status		
Married	276	72.44
Other	105	27.56
Previous Preterm Birth		
Yes	25	6.56
No	356	93.44
Smoked or drank during pregnancy		
Yes	28	7.35
No	353	92.65
Gestational diabetes or hypertension		
Yes	51	13.39

No/ Don't know	330	86.61
Frequency of Emotional support		
Never/Rarely/Sometimes	47	12.34
Often/Always	334	87.66
Receipt of postpartum check-ups		
Yes	369	96.85
No	12	3.15
Infant placed in NICU		
Yes	42	11.02
No	339	88.98
Stressful life events		
0	102	25.50
1-2	213	53.25
3 or more	73	18.25
Missing/ Unknown	7	1.75
Total Number of Children		
1	208	54.59
2	119	31.23
3 or more	54	14.17
Child health currently		
Excellent	254	66.67
Very good	94	24.67
Poor/Fair/Neutral	33	8.66

Table 2: Unadjusted Odds Ratios and 95% Confidence Intervals for the Association between Demographic and Lifestyle Characteristics and Mental Health, MHS Participants (N=381)

Variables		**Depression**		**Postpartum Depression**		**Anxiety**
	OR	95% CI	OR	95% CI	OR	95% CI
Preterm birth						
Yes	0.90	0.19, 4.27	2.03	0.60, 6.91	1.94	0.57, 6.56
No	1.00	Referent	1.00	Referent	1.00	Referent
Race/ethnicity						
Non-Hispanic White	1.00	Referent	1.00	Referent	1.00	Referent
Other	1.29	0.53, 3.13	1.28	0.55, 2.98	1.71	0.75, 3.90
Age						
<30	1.00	Referent	1.00	Referent	1.00	Referent
30-35	0.40	0.21, 0.76	0.48	0.26, 0.89	0.49	0.27, 0.92
>35	0.58	0.31, 1.09	0.58	0.31, 1.09	0.67	0.36, 1.25
Education						
Some college or less	0.94	0.30, 2.97	1.10	0.38, 3.17	0.76	0.24, 2.38
Bachelor's degree or above	1.00	Referent	1.00	Referent	1.00	Referent
Income						
≤$50,000	2.27	0.95, 5.44	2.19	0.95, 5.05	2.44	1.07, 5.55
≥$50,000	1.00	Referent	1.00	Referent	1.00	Referent
Health Insurance						
Private	1.00	Referent	1.00	Referent	1.00	Referent
Medicaid/ Other	1.60	0.54, 4.75	1.09	0.43, 2.78	1.58	0.65, 3.80
Marital Status						
Married	1.00	Referent	1.00	Referent	1.00	Referent
Other	0.16	0.02, 1.34	1.36	0.46, 3.99	1.72	0.62, 4.76
Previous Preterm Birth						
Yes	0.47	0.10, 2.14	0.67	0.19, 2.42	1.29	0.44, 3.78
No	1.00	Referent	1.00	Referent	1.00	Referent
Smoked or drank during pregnancy						
Yes	0.90	0.19, 4.27	2.03	0.60, 6.91	1.94	0.57, 6.56
No	1.00	Referent	1.00	Referent	1.00	Referent
Gestational diabetes or hypertension						
Yes	0.99	0.27, 3.63	3.12	1.12, 8.63	1.20	0.37, 3.85
No/ Don't know	1.00	Referent	1.00	Referent	1.00	Referent
Frequency of Emotional support						
Never/Rarely/Sometime	6.38	2.42, 16.85	5.20	2.01, 13.43	6.16	2.40, 15.80
Often/Always	1.00	Referent	1.00	Referent	1.00	Referent
Infant placed in NICU						
Yes	<0.001	<0.001, >1000	0.38	0.05, 3.00	0.82	0.17, 3.85
No	1.00	Referent	1.00	Referent	1.00	Referent
Stressful life events						
0	1.00	Referent	1.00	Referent	1.00	Referent
1-2	2.35	0.73, 7.54	2.00	0.68, 5.85	4.33	1.21, 15.48
3 or more	4.25	1.13, 16.06	4.00	1.17, 13.71	6.93	1.67, 28.79

Total number of children						
1	1.00	Referent	1.00	Referent	1.00	Referent
2	0.63	0.35, 1.14	0.76	0.43, 1.34	0.82	0.46, 1.47
3 or more	0.53	0.22, 1.24	0.53	0.22, 1.24	0.67	0.29, 1.52
Child health currently						
Excellent	1.00	Referent	1.00	Referent	1.00	Referent
Very good	0.39	0.11, 1.40	0.59	0.21, 1.68	4.43	1.33, 14.73
Poor/Fair/Neutral	5.09	1.51, 17.11	3.23	0.95, 11.00	0.59	0.21, 1.68

Table 3c: Unadjusted Odds Ratios and 95% Confidence Intervals for the Association between Demographic and Lifestyle Characteristics and Physical Health, MHS Participants (N=381)

Variables	**Diabetes, Hypertension, or Cardiovascular disease**	
	OR	95% CI
Preterm birth		
Yes	2.06	0.41, 10.28
No	1.00	Referent
Race/ethnicity		
Non-Hispanic White	1.00	Referent
Other	2.00	0.64, 6.26
Age		
<30	1.00	Referent
30-35	1.32	0.48, 3.64
>35	1.74	0.63, 4.83
Education		
Some college or less	0.90	0.19, 4.27
Bachelor's degree or above	1.00	Referent
Income		
≤$50,000	1.65	0.51, 5.31
≥$50,000	1.00	Referent
Health Insurance		
Private	1.00	Referent
Medicaid/ Other	0.56	0.12, 2.66
Marital Status		
Married	1.00	Referent
Other	0.47	0.06, 3.80
Previous Preterm Birth		
Yes	1.08	0.23, 5.21
No	1.00	Referent
Smoked or drank during pregnancy		
Yes	<0.001	<0.001, >1000
No	1.00	Referent
Gestational diabetes or hypertension		
Yes	2.37	0.60, 9.41
No/ Don't know	1.00	Referent
Frequency of Emotional support		
Never/Rarely/Sometimes	1.99	0.51, 7.81
Often/Always	1.00	Referent
Infant placed in NICU		
Yes	2.24	0.45, 11.30
No	1.00	Referent
Stressful life events		
0	1.00	Referent

1-2	1.93	0.50, 7.45
3 or more	0.64	0.06, 6.47
Total number of children		
1	1.00	Referent
2	1.18	0.47, 2.97
3 or more	1.67	0.56, 4.95
Child health currently		
Excellent	1.00	Referent
Very good	0.64	0.06, 6.47
Poor/Fair/Neutral	1.93	0.50, 7.45

Table 4c: Adjusted Odds Ratios and 95% Confidence Intervals for the Association between Having a Preterm Birth and Mental and Physical Health, MHS Participants (N=381)

Variables	**Depression[a]**		**Postpartum Depression[b]**		**Anxiety[c]**		**Diabetes, Hypertension, or CVD[d]**	
	OR	95% CI						
Preterm birth								
Yes	0.19	0.02, 1.71	1.27	0.28, 5.80	2.04	0.49, 8.56	1.60	0.29, 8.82
No	1.00	Referent	1.00	Referent	1.00	Referent	1.00	Referent

[a]Model adjusted for plurality, emotional support, and current child health

[b]Model adjusted for income, marital status, plurality, smoking or drinking during pregnancy, gestational diabetes or hypertension, emotional support, and current child health

[c]Model adjusted for smoking or drinking during pregnancy, emotional support, and current child health

[d]Model adjusted for gestational diabetes or hypertension

CHAPTER 5: DISCUSSION

Review of Major Findings

Findings of this dissertation add potentially important information to the current body of literature on preterm birth and later maternal health outcomes. Although not all findings were statistically significant, these studies consistently revealed increased odds of adverse health outcomes for parents who had preterm infants compared to those who had full term infants. Findings align with the theory used to guide the study, as well as theorized biological mechanisms. The current researcher argued that the process of role exit may place many new parents in the "vacuum experience," causing them to be unable to move swiftly from one identity into the next (Ebaugh 1988). Thus, parents of preterm birth infants may have feelings of fear and anxiety because their new role as parent came sooner than they expected. These feelings may lead to poor mental health, poor physical health or both.

In Manuscript 1, findings of the population-based study of North Carolina mothers and fathers revealed that parents of preterm infants had increased odds of several chronic diseases (i.e., diabetes, hypertension, and cholesterol); however, these findings were not statistically significant. The lack of statistical significance may have been due to the small rates of the outcome in the sample, compared to the general US population (Benjamin et al., 2018). A population-based study of US women, Manuscript 2, posited that preterm birth was associated with statistically significant increased odds of feeling hopeless; however, there was no association between preterm birth and loss of interest. Previous research has shown that one question on depressed mood may be sensitive enough to screen for depression; however, the use of two questions increases sensitivity

and specificity (Kroenke, Spitzer & Williams, 2003). It is possible that women who have preterm babies may feel depressed, but not loss of interest due to the fact that premature babies may require more care. Thus, these findings are plausible.

Finally, findings of the cross-sectional survey discussed in Manuscript 3 revealed increased odds of postpartum depression, anxiety, and poor physical health among women who had a preterm birth; however, findings were not statistically significant. Insignificant findings may have been due to the small sample size of this study (N=381). It is important to note that smoking and drinking during pregnancy, stress, social support, and child health were reoccurring confounders in these analyses. Future studies should seek to determine how these factors affect the preterm birth-parent health outcome relationship.

Overall Novelty

The purpose of this dissertation was to examine the relationship between having a preterm birth and poor physical and mental health among parents. Few studies have observed the association between preterm birth and parent mental health, and even fewer have studied potential relationships between preterm birth and parent physical health. In addition, very few studies have investigated paternal health as it relates to having a preterm birth, and none have examined these associations using US PRAMS or NC BRFSS. While some previous studies have used hospital records and screening tools, few have used original survey data to evaluate the association between having a preterm birth and parent health outcomes.

This dissertation was the first to examine parent health outcomes among those individuals who have experienced a preterm birth using large, population-based datasets.

In addition, the dissertation (Manuscript 1) partially focused on health outcomes among fathers with a child who was born preterm, an issue that is rarely addressed in the scientific literature. This study was also the first study of parent health guided by Ebaugh's (1988) role exit theory. According to the role exit theory, the process of role exit (from expectant mother to mother) may place many new parents in the "vacuum experience," causing them to be unable to swiftly move from one identity into the next. Thus, parents of preterm birth infants may have feelings of fear and anxiety because their new role as parent came sooner than they expected. This theoretical framework was demonstrated to align closely with the current study, since findings postulate that parents of preterm infants have increased odds of poor health outcomes (specifically anxiety) compared to parents of term born infants. Furthermore, the primary data collection for this dissertation allowed for control of confounders that have not been considered in previous studies (i.e., social support and current child health).

Public Health Implications

Findings on the relationship between preterm birth and parent health should inform future interventions to emphasize the importance of postpartum care among mothers and fathers who have experienced a preterm birth. Postpartum or postnatal care, which is medical care of women and infants following the child's birth, has a significant influence on maternal and infant health (World Health Organization, 2017). The World Health Organization has reiterated the importance of postnatal care in improving maternal and infant health outcomes and asserts that care immediately following the birth of an infant helps to detect, manage, modify, and control maternal behaviors, health

conditions, and risk factors that contribute to adverse maternal and infant outcomes (Chalmers, Mangiaterra, & Porter, 2001).

Since the current dissertation suggests a relationship between preterm birth and parent health, there are important public health implications for parents in the postpartum period. Health care providers may need additional training regarding how to identify health problems for parents immediately following preterm birth. In addition, mothers and fathers who have recently experienced preterm birth may need to be targeted for more in-depth health screenings. One potential issue that may arise for parents in need of screening is their ability to access healthcare. In the US, approximately 40% of mothers do not attend their postpartum visit (American College of Obstetricians & Gynecologists, 2018). Thus, the opportunity to assist parents during the postpartum period may be missed if mothers do not attend this visit. One way this issue may be addressed is by increasing the number of opportunities for parents to receive screening. For example, the opportunity for additional screenings for this at-risk population should be more abundant at more diverse locations including WIC (Women, Infants, and Children) offices, health clinics, and pediatrician offices. In addition, mothers and fathers of both preterm and term born infants could receive more information on their health risks during home visiting sessions, within support groups (including those on social media platforms), and at pregnancy classes, such as Lamaze.

Because a relationship between preterm birth and poor parent health outcomes was found, health care professionals and public health practitioners may find it useful to provide comprehensive care and education to this target population on ways to prevent and treat mental and physical health disorders immediately following the birth of a

preterm infant. In addition, supportive nursing and educational interventions to reduce parental stress and emotional support may be employed to help reduce the risk of poor health outcomes (Abdeyazdan, Shahkolahi, Mehrabi, & Hajiheidari, 2014). Additionally, interventions should address views and barriers that may be specific to parents who have recently had a preterm infant on the concept of self-care.

In addition to the potential health risks faced by parents immediately following a preterm birth, there are also multiple issues that could occur beyond the postpartum period. In fact, studies suggest that mothers of both preterm and term infants are at a high risk for depression even at four years postpartum (Woolhouse, Gartland, Mensah, & Brown, 2015). In addition, various lifestyle factors and experiences that may take place years after pregnancy are predictors for maternal depression (i.e.,. exposure to multiple stressful life events and intimate partner violence); these predictors may also be related to having preterm birth. Therefore, parents of preterm and term born infants should be comprehensively screened for physical and mental health problems beyond the postpartum period (i.e., during regular annual exams). In addition, information on screenings may need to be distributed at places frequented by parents including daycares, health clinics, and support/social groups.

Implications for Families

Health problems are not only a problem for parents; they may also affect child development. Specifically, mental health issues, such as depression, in parents (both pregnant and postpartum) often lead to attachment disorders for infants. In fact, many studies have shown an average of 17-28% lower rates of secure attachment among infants of depressed parents compared to infants of parents without depression (Ko, Farr, Dietz,

& Robbins, 2012). Other studies have found parent depression to increase difficult behavior and dysregulation of emotions and attention in children (Goodman & Brand, 2009). In addition, infants of mothers who experience depression during pregnancy and postpartum may have higher cortisol and norepinephrine levels at birth, along with lower levels of dopamine, all of which could negatively affect neuroendocrine and psychological functioning. Infants of depressed mothers have also been found to have decreased cognitive-intellectual functioning and increased chances of developing psychopathology (Goodman & Brand, 2009). Thus, interventions targeting families are warranted to prevent health issues for the parents as well as their children.

Future Research

Future studies should seek to examine and further understand the relationship between having a preterm birth and later health outcomes among fathers. This may be of importance not only to paternal health, but also maternal and child health, as fathers often act as the support system for mothers and aid in child development. Healthcare providers should also be aware of paternal mental and physical health issues, as the inclusion of fathers in child rearing has been shown to increase family cohesion and reduce maternal distress (Treyvaud, 2014). This may be particularly important for those fathers with a preterm infant.

The current dissertation revealed that mothers who reported that they do not get the emotional support they need have 5-6 times the odds of depression, postpartum, depression, and anxiety. In addition, emotional support was found to be a confounder of the preterm birth-postpartum depression relationship. More studies are needed to understand the role emotional support may play in the relationship between having a

preterm birth and parent outcomes. In addition, these findings suggest that healthcare providers speak with expecting and postpartum mothers about the importance of emotional support to potentially decrease the risk of poor mental health outcomes. In addition, given the increased risk for poor mental health following the birth of a preterm infant, these particular parents may benefit from support groups and additional health resources (i.e., counseling).

Future research should also seek to address access and barriers to healthcare among the population examined. Parents of preterm infants may benefit significantly from evidence-based interventions to reduce the risk of poor health outcomes. The increased workload of having a preterm infant or an infant with complications may be a barrier to receiving the health care that parents need. Finally, findings of the current dissertation suggest that there are many risk (i.e., smoking and drinking during pregnancy and stress) and resilience factors (i.e., social support, and child health) associated with the relationship between preterm birth and later parent health. Future studies should further examine these factors to inform health care providers of practices that may decrease parents' risk for poor mental and physical health (i.e., smoking/drinking interventions, social support groups).

Finally, future research should seek to examine the relationship between having a preterm birth and the health of adoptive parents. Findings of study 2 were similar with and without including adoptive parents; thus, adoptive parents may experience some of the same health issues as biological parents following the birth/adoption of a preterm infant. Future studies should examine this relationship in regards to timing with respect to when the child was adopted or placed in foster care. The current study could not identify

those adoptive parents who were aware of when they would obtain custody of their child and those who were not aware; therefore, findings on adoptive parents may or may not align with the proposed theoretical framework. It is possible that experiences and health outcomes among adoptive parents may vary; however, further research is needed.

Understanding the relationship between preterm birth and parent health may allow health care providers to improve postpartum care of both parents and infants. Since the current dissertation suggests a relationship between preterm birth and parent health, there are important public health implications. Health care providers may need additional training regarding how to identify health problems for parents following preterm birth. In addition, comprehensive screening of physical and mental health problems following the birth of a preterm infant may be warranted, and those who have had a preterm birth may need to be screened beyond their postpartum visit (i.e., annual exams).

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