COLEY, SHERYL L., DrPH, Race, Place, and Age: An Intersectional Multilevel Investigation of Birth Outcome Disparities among North Carolina Teen Mothers. (2014). Directed by Dr. Tracy R. Nichols. 173 pp.

Previous research illustrates the persistence of racial disparities in adverse birth outcomes across all age groups, including teen mothers. However, limited literature exists that examined contributors of these disparities specifically between racial groups of teen mothers. This study extended previous research with the examination and comparison of individual and structural factors between non-Hispanic African-American and white teen mothers as potential contributors to racial disparities in adverse birth outcomes. Birth record data for a cross-sectional sample of North Carolina teen mothers (n=16,472) were examined through multilevel models, and an intersectional conceptual framework served as a theoretical foundation for this examination to determine how race, socioeconomic status as defined by neighborhood factors, and age intersect in impacting birth outcomes and explaining racial disparities.

This study focused on infant birth weight in grams, gestational age in weeks, low birth weight and preterm birth as birth outcome variables, whereas secondary focus was placed on pregnancy health status and health behaviors (prenatal care use and smoking). Neighborhood socioeconomic status was operationalized by neighborhood risk and census-tract median household income. The two papers included in this dissertation address the following questions: 1) Are there racial differences in birth weight outcomes between African-American and White teen mothers after controlling for neighborhood risk? 2) Does neighborhood income moderate racial differences in gestational age and preterm birth outcomes of infants born to teen mothers? 3) Does neighborhood income

moderate racial differences in gestational age and preterm birth outcomes differently between younger and older teen mothers?

In this sample, African-American teens gave birth to infants of significantly lower birth weights and gestational ages and had higher odds of low birth weight and preterm birth outcomes in comparison to White teens across all census-tracts. Neighborhood risk had a significant negative association with infant birth weight; however racial differences remained significant after controlling for neighborhood risk. Racial differences in gestational age and preterm birth outcomes varied significantly by neighborhood income. With birth weight and gestational age, the greatest disparities were identified between African-American and White teens living in neighborhoods of lower neighborhood risk and higher income levels. Significant differences were not found in birth weight and gestational age outcomes based on maternal age.

Overall, findings from this study suggest that racial factors intersect with socioeconomic circumstances to subsequently impact birth weight outcomes and racial disparities for teen populations. Future examinations need to explore these intersectional influences in context of other individual and interpersonal factors, community and social context to enhance understanding on birth outcome disparities among teen mothers.

RACE, PLACE, AND AGE: AN INTERSECTIONAL MULTILEVEL INVESTIGATION OF BIRTH OUTCOME DISPARITIES AMONG NORTH CAROLINA TEEN MOTHERS

by

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A Dissertation Submitted to
the Faculty of The Graduate School at
The University of North Carolina at Greensboro
in Partial Fulfillment
of the Requirements for the Degree
Doctor of Public Health

Greensboro
2014

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ACKNOWLEDGEMENTS

Praise and thanksgiving goes first and foremost to God Almighty. I could not have made it without His unfailing grace and strength for nothing is impossible with God (Luke 1:37).

Thank you, Basil and Daphne Coley, my parents who instilled in me the value of education and never ceased to support me in my academic endeavors. I love you and I hope that I am making you proud.

The next set of thanks goes to several people from UNC Greensboro. First, many thanks goes to Dr. Tracy Nichols who patiently introduced me to intersectionality through her Gender and Health class and had endured my countless emails and questions during the past four years as my committee chair and mentor. To my other committee members – Drs. Robert Aronson, Sharon Morrison, Kelly Rulison, and Shelly Brown-Jeffy – thank you for your guidance and support. Thanks goes to Dr. Paige Hall Smith for introducing me to health research with teen mothers through my graduate assistantship, and Dr. Robert Henson and Prof. Thomas McCoy for their statistical instruction. To my cohort (Dr. D. Dingman, E. Eifert, and M. Gringle-Risk) – thanks for your support. To all other PHE doctoral students and faculty that I've had the opportunity to encounter over the years, I wish you all the best.

A shout-out goes to Dr. L. F. Graham as the "trailblazer" – thank you for exemplifying excellence as a doctoral student for our department. As for the "ones" who will be next (A. Johnson, W. Jenkins, and B. Chambers) and the “ones” to come – I am expecting greater things from you and for you. Grace and peace till we meet again.

I am thankful to the North Carolina State Center for Health Statistics for the use of these birth record data for this research.

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LIST OF ABBREVIATIONS

HPSA	Health professional shortage area
HRSA	US Health Resources and Services Administration
LBW	Low birth weight
NC	North Carolina
NCSCHS	North Carolina State Center for Health Statistics
PNC	Prenatal care
PRAMS	Pregnancy Risk Assessment Monitoring System
PTB	Preterm birth
SES	Socioeconomic status
US	United States
VLBW	Very low birth weight

CHAPTER I

INTRODUCTION

Statement of the Problem

Health disparities in adverse birth outcomes continue to persist in the US despite recent gains between age groups and racial populations. A substantial number of previous studies demonstrated greater levels of low birth weight (LBW), preterm birth (PTB), and neonatal mortality outcomes among teen mothers in comparison to mothers of older age groups (Chen et al., 2007; Eure, Lindsay, & Graves, 2002; Gilbert et al., 2004; Markovitz, Cook, Flick, & Leet, 2005). Research conducted with mothers in North Carolina yielded similar findings as higher rates of preterm births and LBW births were found among random samples of teen mothers in comparison to older mothers (NC State Center for Health Statistics, 2012). Meanwhile, health disparities in birth outcomes between African-American and white women continue in the US despite over 30 years of efforts to reduce health disparities. Previous research illustrates the persistence of these disparities across all age groups, including teen mothers.

This combined body of literature suggests that African-American teen mothers experience greater risk of adverse birth outcomes than white teen mothers and mothers of older age groups due to their younger age and racial status. However, limited literature exists that examined these issues specifically between African-American and white teen mothers. Moreover, the bulk of literature assumed atheoretical approaches in examining individual-level factors of mothers with limited consideration to structural factors. The call for further research that investigates potential structural influences of health outcomes had come forth on numerous occasions, but this research still comprises a small proportion of literature that investigated birth outcome disparities.

As teen motherhood persists in the US, research is still needed to examine pathways by which structural factors contribute to birth outcome disparities between populations of teen mothers. Furthermore, more research needs to expand the examination of these disparities through theoretical frameworks.

Study Purpose and Specific Aims

The purpose of this dissertation was to examine and compare individual and structural factors between non-Hispanic African-American and white teen mothers as potential contributors to racial disparities in adverse birth outcomes for teen mothers. Birth record data of North Carolina teen mothers were examined through this dissertation, and an intersectional conceptual framework served as a theoretical foundation for this examination. This dissertation had the following aims:

Aim 1: Assess racial differences in individual-level maternal characteristics (demographics, health conditions, health behaviors) and birth outcome disparities between African-American and white teen mothers.

Aim 2: Examine neighborhood characteristics and associations with health conditions, health behaviors and subsequent birth outcomes for African-American and white teen mothers.

Aim 3: Identify and examine the intersections between race, socioeconomic status, and maternal age on the health conditions, health behaviors and subsequent birth outcomes among African-American and white teen mothers.

Findings from this study contribute to the limited literature that specifically assesses racial disparities in birth outcomes for teen mothers. This study also contributes to the limited quantitative analyses that incorporated intersectional theoretical frameworks in investigating health disparities.

The next chapter (Chapter 2) will present a review of available literature and a theoretical framework of racial disparities of birth outcomes between African-American and white women in the US. Intersectionality will be explained as a theoretical lens to frame the study. Strengths and gaps in literature will be addressed in relation to research for teen mother populations. Chapter 3 will describe the study's design and the incorporation of the framework into this study. Multilevel approaches will be proposed to investigate these research aims. Chapters 4 and 5 will present two initial papers based off of findings for the birth weight and gestational age outcomes. This dissertation will conclude with discussion of implications of findings, strengths, limitations, and future directions for research and practice in Chapter 6.

CHAPTER II

REVIEW OF LITERATURE

Adverse Birth Outcomes

Numerous studies have investigated three types of adverse outcomes: low birth weight (birth weights under 2,500 grams), preterm birth (births that occur prior to 37 weeks gestation) and infant deaths that occur before babies turn one year old. Low birth weight (LBW) has been traditionally defined as birth weight below 2,500 grams or 5 pounds 8 ounces, and the sub-designation very low birth weight (VLBW) is defined as birth weight below 1500 grams (Vahratian et al., 2012). Two known causes of LBW and VLBW are 1) intrauterine growth restriction when babies are born small for gestational age and 2) premature or preterm births (when births occur prior to 37 weeks) (Vahratian et al., 2012). Preterm birth (PTB) outcomes have also been separated in subclasses according to gestational age: less than 28 weeks, 28-31 weeks, 32-33 weeks and 34-36 weeks (Goldenberg and McClure 2010), and these outcomes can stem from a myriad of factors.

The importance in examining LBW and PTB rests on the increased risk of infant mortality for LBW infants before they reach age 1. Data from the 2006 US infant mortality statistics convey that LBW, congenital malformations, and SIDS account for 46% of all infant deaths in the country, and LBW and preterm birth comprise the second leading cause of infant death overall (Mathews & MacDorman, 2010). Because of the strong association of preterm birth with low birth weight, these outcomes are often studied concurrently. Epidemiological approaches examining birth records data and survey research have typically been used to examine birth outcomes and associated health disparities.

Most research about these adverse birth outcomes focuses on the mothers' individual characteristics. Table 1 provides the LBW and PTB risk factors that the Institute of Medicine outlined in their historic 1985 report and the more recent 2006 report, and most risk factors stem from the mothers' individual characteristics. Overall, demographic characteristics associated with both PTB and LBW births include young and older maternal age (less than 17 years or older than 34 years old), racial status as Black or African American, and socioeconomic status. Mothers' pre-pregnancy health status, current pregnancy health risks (including multiple pregnancies – twins, triplets, etc.) and behaviors such as smoking, nutrition, and substance use impact birth outcomes regardless of race. Other pre-pregnancy factors associated with adverse birth outcomes include poor obstetric history among women with previous pregnancies (i.e. previous PTB, LBW, infant deaths, abortions), and issues with cervical disorders (Collins & David, 2009; Lhila & Long, 2012; Institute of Medicine, 1985, 2007; Rowley et al., 2012). Interconception factors such as birth spacing intervals less than 24 months has also been associated with adverse birth outcomes among women with previous children (Institute of Medicine, 1985; Institute of Medicine, 2006). Even though environmental toxins and neighborhood factors have previously been associated with adverse birth outcomes, less research on these factors exists in comparison to research examining individual level factors.

Table 1. Risk Factors for Preterm Birth and Low Birth Weight (IOM 1985, 2007)

Factor Type	Risk factors	Preterm Birth	Low Birth Weight
Demographic	Age (less than 17 years or greater than 34 years old)	X	X
	Single marital status	X	X
	Black / African-American racial status	X	X
	Low socioeconomic status	X	X
	Poor level of education (≤ 11 years)	X	X
Risks/ Conditions Pre-Existing Current Pregnancy	Low maternal pre-pregnancy weight	X	X
	Small stature	X	X
	Genital anomalies	X	
	Maternal diseases / disorders, not pregnancy related	X	X
	• Diabetes	X	
	• Chronic hypertension	X	
	• Heart / cardiovascular disease	X	
	Obstetric History		
	• Previous LBW baby	X	
	• Previous IUGR baby		X
	(intrauterine growth		
	restriction)	X	
	• Previous preterm delivery	X	X
	• Previous abortions		
	(spontaneous and	X	X
	induced)	X	X
	• Previous fetal / neonatal deaths		
	• Incompetent cervix		
	History of infertility	X	

Factor Type	Risk factors	Preterm Birth	Low Birth Weight
Medical risks of current pregnancy	Parity (previous children)	X	X
	Short interpregnancy interval		X
	Multiple pregnancy (twins or more)	X	X
	Genital / vaginal infections	X	X
	Anemia	X	X
	Fetal anomalies	X	X
	Placenta disorders	X	X
	Preeclampsia / Toxemia	X	X
	Spontaneous rupture of membranes & gestational bleeding	X	
	Familial / intergenerational factors	X	
Behavioral / Environmental Risks	Smoking	X	X
	Nutritional deprivation / poor weight gain	X	X
	Heavy alcohol use	X	X
	Marijuana / substance use	X	X
	Caffeine intake	X	
Health Care Risk Factors	Introgenic prematurity induction of labor / cesarean section	X	
	Absent / inadequate prenatal care	X	X
	Evolving Concepts of Risk		
	Stress (physical and psychosocial / emotional)	X	
	Uterine irritability	X	
	Events triggering premature uterine contractions (ex. Hard physical work and general physical stress)	X	
	Cervical changes detected before onset of labor	X	
	Progesterone deficiency	X	
	Environmental toxins / occupational exposure (i.e. air pollution, pesticides, radiation, lead, gases)	X	X
	Genitourinary infections	X	X

Previously Examined Factors for Disparities in Birth Outcomes

Race

Previous US studies have substantially contributed to research in birth disparities where higher rates of adverse birth outcomes existed among African Americans in comparison to white mothers (Collins & David, 2009; Collins, David, Simon, & Prachand, 2007; Spong, Iams, Goldenberg, Hauck, & Willinger, 2011). North Carolina populations parallel the same disparate patterns as previous studies found that NC African-American women in all age groups have higher levels of adverse birth outcomes than white mothers (Buescher & Mittal, 2006; Messer, Kaufman, Dole, Savitz, & Laraia, 2006) and Hispanics (Leslie, Galvin, Diehl, Bennett, & Buescher, 2003). Health organizations continue to focus on LBW and PTB as contributors of racial disparities in infant mortality because LBW and preterm births comprise the leading cause of infant mortality specifically for non-Hispanic African-American babies (Mathews & MacDorman, 2010).

The operationalization of race persists as an enigmatic undertaking across decades of health disparity research. Research on individual-level factors (mostly demographic and health behaviors) comprise the bulk of literature that examines health disparities between African-American and white women as disparities persist between these women consistently across state and local populations in the US. Despite the substantial knowledge that this previous research provides in examining birth outcomes, it is important to note that this research still predominantly focuses on individual level factors which subsequently contributes to convoluted understanding of health disparities based on race. Behavioral and demographic factors only had modest associations with the prevalence of racial disparities when examined in context with race despite the capacity to partially explain the prevalence of LBW. Smoking consistently exemplifies such a behavioral factor as African-American women are less likely to smoke than white women but still experience higher rates of LBW births (Buescher & Mittal, 2006).

Critics assert that the dominant focus on individual factors hinders the exploration of health disparities overall among racial groups and that race has been inappropriately used as a proxy for class and socioeconomic factors (Weber & Parra-Medina, 2003). Previous critics have also pointed out that studies have not taken into account the ways that racism can impact socioeconomic status, and researchers should further explore interactions between race and SES due to the strong association that race and SES have in impacting health outcomes (Wilson & Williams, 1998). This previous exhortation to examine the interplay of race and socioeconomic factors remains critical for the investigation of health disparities.

Researchers are shifting the examination of race from a strictly biological construct to a social construct that impacts biological processes (Krieger, 2003), and advocacy is growing for examining contextual factors that impact individual health outcomes (Moss, 2002; Weber & Parra-Medina, 2003). More research incorporates ecological & life course approaches in the examination of birth outcomes and disparities in recent years (Alio et al., 2010; Lu, 2010). These approaches account for contextual factors of the social and economic environments of study populations instead of sole reliance on individual characteristics. The following sections will summarize literature on these approaches.

Ecological Factors

Social ecological perspectives posit that health is affected at multiple levels within a population instead of just at the individual level (i.e. interpersonal, institutional, community, policy) (Glanz & Bishop, 2010). Research has increased that examined social and structural inequalities as main contributors to disparities, and advocacy grew for multiple strategies to address social and environmental circumstances and subsequently improve birth outcomes (Alio et al., 2010; Ferre, Handler, Hsia, Barfield, & Collins, 2011; Rowley, Chapple-McGruder, Mendez, & Browne, 2012).

Despite the progress made in research, complications still continue in examining racial disparities that lead to mixed findings as the following discussion at each of these ecological levels suggests. This next part of this literature review covers previous examination of these ecological factors. However, readers should note that these factors have primarily been examined with adult populations or overall populations of women at childbearing age with little focus on teen mother populations.

<u>Interpersonal</u>: Factors at this level remain sparsely examined in literature. Despite this limitation in research, recent investigation of paternal support indicates that this type of support may modify the influence of chronic stress, resulting in lesser likelihood of preterm birth among mothers of color (Ghosh et al., 2010). Marital status continues to be used as the main variable to explore interpersonal associations with birth outcomes. This

variable is used either as a proxy measure for support or a subvariable for economic status. However, the use of this variable alone is problematic since marital status is not indicative of presence nor absence of support for the mother during pregnancy, and it does not account for other support sources for the mother. Furthermore this variable does not carry strong associations to account for birth outcome disparities. While unmarried women were identified as more likely to experience LBW and preterm births (Institute of Medicine, 1985; Institute of Medicine 2006), only modest associations were found to explain differences between racial groups (Sullivan, Raley, Hummer, & Schiefelbein, 2012).

Sparse literature examines the associations between interpersonal support and births to teen mothers. While marital status is considered the most common variable for older mothers, the use of this variable has limited relevance to teen populations since the vast majority of teen mothers are unmarried. Support from the babies' fathers still remains underexplored in research, however the scant research available conveys that the presence of paternal support can contribute to favorable birth outcomes among teen parents (Alio et al., 2011). Further exploration is needed for investigating social support from immediate family members. It is generally assumed that teen mothers get the bulk of support from their mothers but scarce literature covers support from other family members (i.e. teens' fathers, grandmothers, extended kin). Therefore the breadth of support needs further investigation.

<u>Structural</u>: More attention has been given to structural factors related to health disparities in recent years. The continued advocacy for examining these structural factors

stems from the assertion that disparities in social and economic conditions can carry on throughout generations (Rowley et al., 2012). Structural variables include aspects related to socioeconomic status, community, and neighborhood characteristics.

Socioeconomic status (SES) functions as a complex variable to portray the location of individuals or population groups in a societal structure, and this location translates to deferential access to resources and overall power and privilege (Jackson & Williams, 2006; Krieger, Williams, & Moss, 1997). Typically SES has been operationalized in research with the use of education, occupational status, and the most commonly used variable of income (Cummings & Jackson, 2008; Jackson & Williams, 2006). Access and utilization of prenatal care has also been noted as a class indicator associated with birth outcomes (Markovitz, Cook, Flick, & Leet, 2005).

However, the use of socioeconomic variables carries substantial limitations which affect the application of research findings across populations of mothers. Previous literature explained how SES is often confounded by racial and ethnic factors and a lack of systematic measurement of SES does not exist (Doucette-Gates, Brooks-Gunn, & Chase-Lindale, 1998). The use of these variables to operationalize SES results subsequently yielded inconclusive findings to explain birth outcome disparities. Previous research found that SES variables were not enough to explain racial or ethnic disparities in birth outcomes (Culhane & Elo, 2005; Krieger, Williams, & Moss, 1997; Lu & Halfon, 2003). Multiple studies have demonstrated persistent gaps between LBW rates of African-American and white women regardless of age and income (Collins, Wall, & David, 1997). Generally, increased education levels have been associated with decreased infant mortality rates overall (Mathews & MacDorman, 2010); however previous literature suggested that education might not carry the same level of protection for non-Hispanic African-American women against adverse birth outcomes in comparison to non-Hispanic white women (Schoendorf, Hogue, Kleinman, & Rowley, 1992). This research suggests the need for further investigation of how these variables account for birth outcome disparities.

Neighborhood characteristics generally function as the main variables used to ascertain community level associations with birth outcomes. Census tract and block group variables used to operationalize neighborhood health include proportion of residents in poverty, median household income level, unemployment percentages, and education levels (Culhane & Elo, 2005; Wight, Botticello, and Aneshensel, 2006). More research concentrates on urban areas rather than rural since the urban status of neighborhoods have previously been associated with higher prevalence of adverse health conditions. Previous research found associations of poor neighborhoods and greater LBW rates among African-American women even when they receive adequate prenatal care (Collins, Wall, & David, 1997). Findings have stayed consistent throughout recent years in conveying that women residing in deprived neighborhoods have higher LBW and preterm birth rates than women in more affluent neighborhoods (Janevic et al., 2010).

Despite previous research findings that incorporate the use of these variables with older populations, complications can arise in applying these variables for teen populations. Previous literature explained how the gain of high school degrees should be incorporated rather than using continuous variables of grade levels (Krieger, Williams, &

Moss, 1997); however this standard has little application to teen mothers under 18 years old. Income variables are also problematic to assess the social class of teens as they are in assessing older populations (Doucette-Gates, Brooks-Gunn, & Chase-Lindale, 1998). More research is needed on investigating either new variables or more sensitive ways of clarifying existing variables that have greater relevance for teen populations as recommended in previous literature (Doucette-Gates, Brooks-Gunn, & Chase-Lindale, 1998). Future research could also continue to delve further in these neighborhood factors and their associations with birth outcome disparities, especially with teen populations. Only a few studies examined neighborhood variables and their associations with birth outcomes to teen mothers (ex. Partington et al., 2009). More studies are therefore warranted that examines relationships of other neighborhood and structural factors and birth outcomes among teen populations, as the main neighborhood variables are still operationalized by education and income factors.

Institutional and policy: Prenatal care (PNC) has functioned as a long-advocated strategy for reducing adverse birth outcomes through health care providers' detection of pregnancy complications, referrals to health services, education about health needs, and support during pregnancy (Alexander & Kotelchuck, 2001; Kirkham, Harris, & Grzybowski, 2005; NC State Center for Health Statistics, 2005; Vahratian, Hicken, Schwalberg, & Kotelchuck, 2012). Research indicates that mothers that received inadequate prenatal care had a higher likelihood of adverse birth outcomes in preterm births, LBW births and neonatal mortality (Cox, Zhang, Zotti, & Graham, 2011;

Kitsantas & Gaffney, 2010; Krueger & Scholl, 2000; Sparks, 2009; US Department of Health and Human Services, 2009).

Disparities in prenatal care utilization still continue nationwide as demonstrated by current research findings that women in minority groups were twice as likely to receive inadequate prenatal care in comparison to white women (Ruwe, Capitman, Bengiamin, & Soto, 2010). Commonly-cited structural barriers include limited transportation options, long wait periods, location and hours of operation, cost of services and offices that reject Medicaid payments (Baffour & Chonody, 2009; Phillippi, 2009). Previous studies have also conveyed African-American women's experiences with discrimination and stereotyping with health care providers (Novick, 2009), which constitutes another form of interpersonal racism among women across all socioeconomic levels.

Studies found conflicting findings in determining effectiveness of prenatal care for reducing disparities. Multiple literature reviews highlighted the concern about the lack of evidence that links the impact of prenatal care on reducing birth disparities (Fiscella, 1995; Lu, Tache, et al., 2003; Walford et al., 2011). Some studies found that racial factors contribute to birth outcome disparities despite increased levels of prenatal care utilization (Collins, Wall, & David, 1997). Other studies pointed to the effectiveness of PNC, as one study among African American and white mothers in Mississippi found that "inadequate" prenatal care and "no prenatal care" functioned as significant risk factors for low birth weight, preterm birth and infant death (Cox, Zhang, Zotti, & Graham, 2011). Meanwhile, Collins (2007) found an association between inadequate prenatal care utilization and VLBW outcomes among African-American women in Chicago, although the association was minimal. Since recent literature has given less attention to the effectiveness of prenatal care, these findings remain inconclusive in determining the impact of the use of prenatal care on birth outcome disparities. Overall consensus is building that focus on prenatal care alone as an intervention is not sufficient to reduce racial disparities in adverse birth outcomes (Collins & David, 2009).

Access to other resources and indirect associations of policy implementation with birth outcome disparities has been sparsely examined. Recent research suggests that supplemental programs might carry more protection for African-American women than white women in reducing infant mortality (Khanani et al., 2010). Previous research suggests that increased access to prenatal care through Medicaid expansion led to improvements in prenatal care utilization for low SES African-American and white women but no significant improvement in LBW rates (Dubay, Joyce, Kaestner, & Kenney, 2001). While other research has found that Medicaid enrollees' risk of adverse birth outcomes did not differ significantly from mothers with private insurance (Anum, Retchin, & Strauss, 2010), this research could suggest that Medicaid still offers some protection among low SES mothers in birth outcomes in comparison to those without insurance. Yet research on these associations of other resources and policy implementation is limited by the inadequacies of current research methods to examine and quantify these indirect associations.

Most existing research that examines institutional level factors for populations of teen mothers focuses on access to prenatal care. Generally prenatal care appears to carry some degree of protection for teens against infant mortality and adverse birth outcomes (Malabarey, Balayla, Klam, Shrim, & Abenhaim, 2012; Wallace & Harville, 2012). Research has identified gaps in prenatal care access between African-American and white teen mothers. While teen mothers are generally less likely to receive prenatal care than mothers in older age groups, national statistics also convey that African-American teen mothers are also more likely to delay seeking prenatal care than white teen mothers (Hueston, Geesey, & Diaz, 2008). PRAMS statistics specific to North Carolina convey that 35.1% of teen mothers did not receive prenatal care as early as they desired, and African-American teens were more likely to enter prenatal care late after the first trimester than white teens (NC State Center for Health Statistics, 2012). Despite the existence of studies like these, literature remains sparse that examines the role in prenatal care in reducing disparities between populations of teen mothers, and research that explores potential relationships with access to other institutional resources is even more limited among teen populations.

Life Course Perspective

More research takes the life course of the mother in consideration, particularly previous life events and generational disparities. Life course perspective focuses on broad social and structural factors that act as indirect causal factors of health disparities among disadvantaged populations (Fine & Kotelchuck, 2010). This perspective also incorporates the notion of cumulative impact in proposing that biological and social risk transmits through generations and not limited to a single generation (Ben-Shlomo & Kuh, 2002; Rowley et al., 2012). The “weathering hypothesis” first coined by Geronimus

(1992) proposed that cumulative impact of social inequalities contribute to increased likelihood of LBW births among African-American women as maternal age increases. Geronimus found in a later landmark study with urban Michigan populations that African-American mothers' likelihood of LBW deliveries increased with higher maternal age in comparison to white mothers, and this influence subsequently appears to contribute to the racial disparities in birth outcomes between African-American and white women (Geronimus, 1996).

Research that occurred after Geronimus' studies found similar results that associate life course factors to adverse birth outcomes. Recent research of Chicago birth files found that poor African-American women that consistently grew up in poor neighborhoods showed significant weathering associations with LBW outcomes in comparison to the white women in their sample (Love, David, Rankin, & Collins, 2010). Meanwhile, previous generational studies convey that LBW gaps between high SES African-Americans and whites persist even to the third generation (Foster et al., 2000). This literature also suggests that even recent SES gains by higher level African-Americans insufficiently compensates for SES associations of prior generations and mothers' childhood (Dominguez, 2011; Lu & Halfon, 2003). Other previous literature suggests that adverse past life events can set negative trajectories in mothers' health that affect health of infants (Lu & Halfon, 2003).

While the contributions that life course studies are noteworthy, they still have the following limitations that potentially hinder investigation of birth outcomes to teen mothers. Based on her research, Geronimus proposed that African-American women deal with structural factors that result in shorter life expectancies, and early fertility practices may serve as “adaptive practices” for African-American residents living in poverty-stricken areas (Geronimus, 2003). However, Geronimus’ research and other studies predominantly focus on populations in urban, high poverty areas with scarce attention to populations of higher SES levels. Another limitation relates to the type of data required to carry out studies rooted in life course approaches. While life course approaches are gaining momentum in investigating birth outcomes, incorporating these approaches carry the main disadvantage of the need for longitudinal data that is scarce for investigating birth outcome disparities. Due to the emphasis on time trajectories, life course approaches generally necessitate the use of longitudinal studies. The scarcity of available longitudinal datasets hinders the incorporation of these approaches in examining health disparities, although the body of research in increasing that uses such datasets as the National Longitudinal Study for Adolescent Health.

In the meantime, current neighborhood conditions of study populations were previously utilized as proxy measures for past conditions (Culhane & Elo, 2005). With regards to examining birth outcomes among teen populations, neighborhood variables could be used in conjunction with available vital records datasets to examine associations between birth outcomes and neighborhood factors among teen populations. Examining these neighborhood variables could shed light on stressful conditions that teen mother populations could face as factors of potential “weathering” on teens’ pregnancy health status, as Geronimus found in her research that women of low SES status face environmental exposures that diminish their health status (Geronimus, 1992). Therefore examining neighborhood conditions and associations with teen mothers' birth outcomes could add to the explanations of birth outcome disparities among teen populations.

Intersectionality

Research has recently expanded on the examination of health disparities and associated factors using intersectional lenses (Bengiamin, Capitman, & Ruwe, 2010; Cummings & Jackson, 2008; Jackson & Williams, 2006; Notaro, 2012). Intersectionality is based on several principle tenets (Bowleg, 2012): 1) multiple social identities intersect and are interdependent of each other, 2) research focuses on the viewpoints of historically oppressed or marginalized groups, 3) multiple social identities at the individual level intersect with multiple level structural factors to contribute to disparities in health outcomes and 4) social categories do not outweigh one another in their influence. Intersectional frameworks can therefore complement ecological frameworks due to the focus on societal and structural factors associated with health outcomes.

Overall, intersectional approaches provide a way to look at the contributions of race and class to the social operation of gender and how social relationships of power transpire (Berger & Guidroz, 2009; Shields, 2008). Weber (2004) equates race, class, gender, and sexuality to "systems of oppression" which carry the following characteristics in each system: 1) context, 2) social construction, 3) illustrative of power dynamics, 4) social in the structural sense and social in the psychological sense, and 5) expressed simultaneously. Using intersectional frameworks can allow researchers to explore health disparities through examining relationships between race, class and gender as "historically created relationships of differential distribution of resources, privilege, and power, of advantage and disadvantage" (Mullings, 2005, p.79-80). Advocacy in exploring intersectional relationships among black women and birth outcomes stems from the position that black women experience unique discrimination based on the intersection of race and gender, and impact of this discrimination can carry on through pregnancy (Rosenthal & Lobel, 2011).

Despite the increasing momentum, literature that uses intersectionality as a theoretical lens to examine health disparities is more prevalent in qualitative than quantitative studies. The Harlem Birth Right Project (Mullings et al., 2001) exemplifies a previous qualitative study that investigated social and economic conditions leading to adverse outcomes among African-Americans in Central Harlem. Complications of employing intersectional approaches in quantitative studies appear to stem from the lack of clarity in the process. Shields (2008) commented that quantitative studies incorporate intersectionality as a perspective on research rather than using intersectionality to formulate and drive the research design. Shields further asserts that quantitative studies subsequently do not assume the principle of "mutually constituted categories" when intersectionality resembles "independent factors within a conventional research design" (p.304). These complications in employing intersectional approaches in quantitative studies subsequently limit the number of studies that use these approaches to investigate health disparities.

While some may view intersectional approaches as unfeasible to implement in quantitative research, other theorists refute that claim. Some intersectional theorists propose that quantitative research can even contribute to better feminist theoretical frameworks for the improvement of social science research (Berger & Guidroz, 2009; Harnois, 2009). Several recent quantitative studies utilized intersectional approaches to explore health outcome disparities among older populations (Hinze, Lin, & Andersson, 2012; Mair, 2010; Seng et al., 2012). These studies give justification for examining health disparities among teen populations through intersectional approaches. Even though no published literature was found that uses intersectional approaches to examine quantitative data in maternal and infant health studies, research studies can potentially use intersectionality to investigate potential factors associated with health outcomes among teen mother populations.

Adverse Birth Outcomes and Disparities among Teen Populations

The bulk of current studies in birth outcome disparities focus on older populations of mothers with much less focus on younger populations. This inadequacy in focus stems from the “trickle down” approach which posits that research conducted with older populations of mothers translates to younger populations, which subsequently undermines the influence of the adolescent development period in health outcomes (Guthrie & Low, 2006). Because younger maternal age is recognized as a risk factor of adverse birth outcomes, it is assumed that the maternal age mostly explains the adverse birth outcomes among teens. This assumption subsequently limits investigation of other factors. Limited research exists overall that examines the interplay of race, socioeconomic status, and age in birth outcomes among teen populations.

Most existing research on birth outcomes for teen populations focuses on demographic factors and access to prenatal care. Within this literature, the limited investigation of birth outcome disparities among teen mother populations yielded contrasting results to the consistent literature of birth outcome disparities among older mothers. Some studies convey that teen pregnancy could bring increased risk of adverse birth outcomes even after adjusting for other factors such as race (Chen et al., 2007a; DuPlessis, Bell, & Richards, 1997; Hediger, Scholl, Schall, & Krueger, 1997). Little research examines interpersonal and structural factors that lead to birth outcome disparities in teen populations, especially in recent years.

This limited research appears to perpetuate the notion that factors that attribute to birth outcome disparities remain solely at the individual level, and that improving access to prenatal care would sufficiently reduce disparities at this age group. Subsequently attention to greater structural factors remains overlooked and underexplored in research for teen mother populations.

Strengths and Limitations of Current Literature

Previous literature on birth outcome disparities continues to yield valuable information. Research had consistently documented racial disparities in birth outcomes between African-American and white mothers in the US across all age groups, including teen mothers. The further examination of ecological factors and the incorporation of life course and other newer theoretical approaches illuminate more holistic views of investigating explanatory pathways for adverse birth outcomes and associated disparities.

Despite this progress, this literature carries the following gaps for consideration regarding research with teen mother populations. While disparities in adverse birth outcomes are present between African-American and white teen mothers in the US, factors that contribute to these disparities are still sparsely examined in recent research on teen populations. Therefore this dearth of literature warrants further investigation on these associations. Also, further research is needed that examines birth outcomes through theoretical approaches. While the previously discussed literature and other studies cover ecological and life course perspectives, these studies remain the minority and the progress of increasing literature is slow. Other theoretical frameworks have been incorporated even less.

Overall, a scarcity of analytic literature exists that examines broader structural factors related to disparities specifically within teen populations. This study will contribute to this dearth in literature in investigating this query in a statewide sample of teen mothers. Furthermore, further research could incorporate intersectional approaches from a stronger theoretical lens to examine quantitative data beyond the mathematical consideration of multiplicative interactions to improve the examination of health disparities. Proponents of intersectionality encourage 1) the comparison of individual identities relative to each other and 2) the contextual aspects of these categories (Shields, 2008). This study therefore proposes the examination of individual and structural factors that impact the multiple social identities that these teen mothers operate in with regards to racial status and SES status.

Study Theoretical Framework

The conceptualization for this study stems from the aforementioned available literature and from a recent quantitative study that investigated self-reported health status through an intersectional lens. Hinze, Lin, & Andersson (2012) promoted an intersectional conceptual framework for examining differences in self-reported health outcomes between Black and White elders in their study. The authors assert through their framework that the intersection of race, gender, and education interact to uniquely shape individuals' life experiences and subsequently influences their health outcomes through pathways in relationships and behaviors, along with physiological and psychological pathways.

While the framework's contribution does have significance in employing an intersectional approach to health outcomes, it does not appear to adequately address the socioeconomic factors that can lead to pathways to health outcomes for teen populations. Education does not account for socioeconomic status fully as a variable at the individual or neighborhood level. Due to the study's focus on older populations, this framework does not relate to younger age groups and the physiological factors that stem from their developmental processes.

Figure 1 illustrates a theoretical framework as future research might relate intersectionality within an ecological context to teen mother populations. In combining both theoretical perspectives, this study would investigate how race as an individual level construct interplays with structural factors at the community level to affect physiological and behavioral pathways and subsequently affect birth outcomes. Therefore, this study proposes that African-American adolescent mothers' social identities based on race and age (within gender roles as mothers) uniquely intersect with multiple structural/SES factors that contribute to birth outcome disparities in comparison to white adolescent mothers.

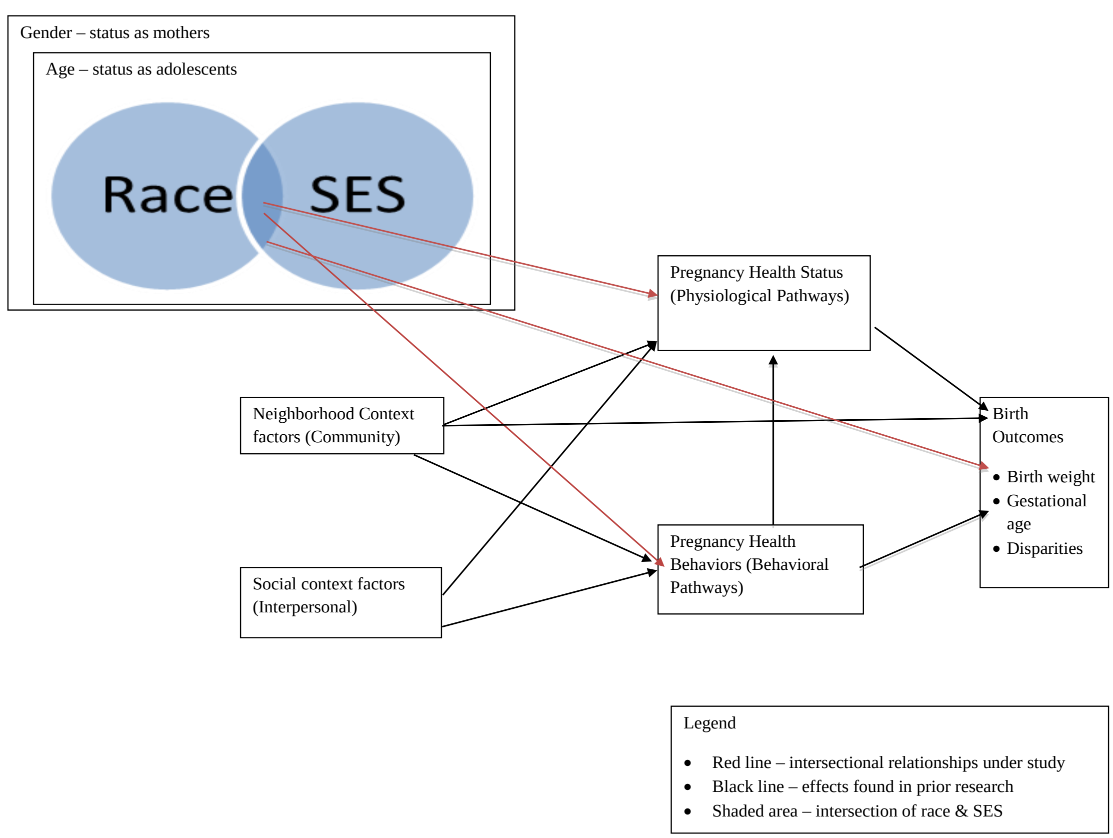
Adapting from Hinze, Lin, & Andersson's framework, this current framework first illustrates how health of adolescent mothers and birth outcomes of babies can stem from these factors in conjunction with individual health factors: race and associated social factors, age, and SES status. An intersectionality perspective recognizes teens' operation in multiple roles at the same time: 1) gender roles as mothers (and wives for those that are married), 2) identities as adolescent females, 3) social status attributed by race, and 4) social roles within their SES level. The intersection depicted in the model represents the points where each of these roles meet in acknowledgement that these entities are not mutually exclusive. This framework therefore proposes that teens' racial status and SES levels intersect to cause additional influence on health behaviors, health outcomes, and subsequently birth outcomes for their infants.

The SES construct reflects the variables of education, household income, employment and health insurance previously explored in adult mothers. This study will examine the associations of education and household income as SES variables. Education might play a greater role in affecting birth outcomes for teens than previous literature suggests. For adult mothers, research shows that educational levels do not carry the same protective factor for African-Americans and whites for birth outcomes (Schoendorf, Hogue, Kleinman, & Rowley, 1992). This pattern might be the same for teens, but we do not know based on the lack of investigation in current literature for teen mothers. Therefore, variations of the education variable were explored in this study.

Within an ecological context, factors at the individual, interpersonal, and community levels interact to impact populations of mothers, birth outcomes, and associated health disparities. *Individual* impact comprises of mothers' demographics (including race & age), individual-level SES factors (education and household income), pregnancy health status (combination of pre-pregnancy health conditions, pregnancy complications, and prior pregnancies), and pregnancy health behaviors (prenatal care utilization, tobacco use, alcohol use, and diet/physical activity). *Interpersonal* impact comprises of relationships with the babies' fathers, family members, and immediate social circles. *Community* impact comprises of local neighborhood conditions (census tract household income, poverty rates, unemployment rates, inequality, segregation, high school graduation rates, and teen pregnancy incidence rates), environmental factors (housing conditions, crime), and access to community resources related to health.

The inclusion of the neighborhood constructs for this study stem from the rationale that theoretically race and SES can intertwine to influence inequality of resources, segregated neighborhoods, income, access to health resources, unemployment and education. Reasons for including these factors in the intersection: 1) structural racism causes African-Americans to live in segregated neighborhoods and perpetuates inequality in overall resources, 2) African-Americans historically make lower wages and live in neighborhoods with lower median incomes than whites, 3) quality and accessibility of resources differing based on location, feasibility, insurance status, and private vs. public health care facilities, 4) unemployment disproportionately affects African-Americans more than whites, 5) neighborhood segregation can lead to increased rates of teen pregnancy within areas of high minority percentages. Racial and structural factors would influence school conditions within neighborhoods / census tracts, subsequently affecting the high school graduation rates. Schools conditions vary depending on the structural factors of the community as research conveyed that school conditions reflect the community around them. Depending on the level of support (or interference), school environments may cause additional stress for teen mother populations. School conditions could impact teen mother populations in affecting educational levels and support to teens during pregnancy periods.

Figure 1. Conceptual Model for Study



CHAPTER III

METHODS

Study Design

This dissertation centered on African-American teen mothers to investigate the associations that race, SES, and neighborhood factors had with health outcomes and subsequent birth outcomes of their infants within the context of their age status as adolescents. As mentioned in Chapter 2, advocates of intersectional approaches encourage 1) comparison of individual identities relative to each other and 2) investigation of the contextual aspects of these categories (Shields, 2008). This study therefore compared and examined individual and structural factors related to the teen mothers' multiple social identities of racial and SES status that could have associations with birth outcomes.

Research Aims and Questions

Aim 1: Assess racial differences in individual-level maternal characteristics (demographics, health conditions, health behaviors) and birth outcome disparities between African-American and white teen mothers

Rationale for this aim: Answering the questions for this aim identified which demographic and health risk factors had associations with birth outcomes to teen mothers. These variables had associations to birth outcomes and racial disparities identified in prior research among older populations, but associations could have been different with teen mothers in this sample. In response to the previously stated recommendation of exploring new ways of examining SES variables, the additional exploration of a new "education sufficiency" variable in reference to teens was included in this aim as a demographic SES variable. Figures 2a, 2b, and 2c show the simplified conceptual models for this aim; these figures are located at the end of this chapter.

Questions:

1. Do the individual-level characteristics significantly differ between African-American and white teen mothers in this study?
    a. Demographic hypotheses
        i. African-American teen mothers will be significantly younger than white teen mothers.
        ii. A smaller proportion of African-American teen mothers will have sufficient education than white teens for their age.
        iii. Interpersonal: African-American teen mothers will be more likely to be single than white teen mothers.

b. Medical risk hypotheses

   i. The prevalence of pre-existing risk factors will be greater among African-American mothers than white mothers.

   ii. The prevalence of pregnancy risk factors will be greater among African-American mothers than white mothers.

   iii. The prevalence of prior pregnancies, births, and terminations will be greater among African-American mothers than white mothers.

   iv. African-American mothers will report a higher number of medical risk factors that white mothers.

c. Behavioral risk hypotheses

   i. African-American teen mothers will be less likely to smoke than white teen mothers.

   ii. African-American mothers will have lower PNC adequacy levels than white mothers.

2. Do the gestational ages and birth weights significantly differ among infants born to African-American and white teen mothers in this study?

   a. Infants born to African American teens will have significantly lower mean gestational ages and birth weights than white teens.

   b. Infants born to African American teens will have significantly greater rates of PTB and LBW than white teens.

3. What other individual-level characteristics are associated with adverse birth outcomes among the overall sample of teen mothers in this study?

a. Significant associations will exist between positive birth outcomes (higher gestational age, higher birth weights) and the following demographic factors: higher age and higher educational levels.
b. Significant associations will exist between positive birth outcomes (higher gestational age, higher birth weights) and marital status as married.
c. Significant associations will exist between negative birth outcomes (lower gestational age, lower birth weights) and the presence of medical risk factors: pre-existing medical risk factors, current pregnancy risk factors, and prior pregnancies.
d. Significant associations will exist between negative birth outcomes (lower gestational age, lower birth weights) and tobacco use.
e. Significant associations will exist between positive birth outcomes (lower gestational age, lower birth weights) and higher levels of PNC adequacy.

4. Are there racial differences in birth outcomes between African-American and white teen mothers after controlling for demographic, medical risk, and behavioral factors?
   a. Racial differences will exist in birth outcomes between African-American and white teen mothers after controlling for demographic, medical risk, and behavioral factors.

Aim 2: Examine neighborhood characteristics and associations with health conditions, health behaviors and subsequent birth outcomes for African-American and white teen mothers

Rationale for this aim: Multilevel modeling is encouraged by intersectionality advocates to examine the context of marginalized populations. This aim focused on identifying potential neighborhood factors that had associations in birth outcomes to teen mothers. Development of a "neighborhood risk" index allowed for the examination of how neighborhood factors interacted with each other in their association with birth outcomes. Figures 3a & 3b show the simplified conceptual models for this aim; these figures are located at the end of this chapter.

Questions:

1. Do the neighborhood-level characteristics significantly differ between African-American and white teen mothers in this study?
    a. African-American teen mothers will live in areas with worse social environment factors (higher neighborhood segregation, lower high school graduation rates, higher rates of people age 25 and older with no high school diploma, higher teen pregnancy incidence rates, higher proportions of households headed by single mothers) than white teen mothers.
    b. African-American teen mothers will live in areas with worse economic factors (lower household income; higher poverty, unemployment, and inequality rates; higher proportions of households receiving public assistance) than white teen mothers.

c. African-American teen mothers will live in areas with worse housing conditions (more household crowding, higher proportions of households in rental housing) than white teen mothers.

d. More African-American teen mothers will live in health professional shortage areas than white teen mothers.

2. What neighborhood-level characteristics are associated with health status, health behaviors, and birth outcomes among the overall sample of teen mothers in this study?

   a. Significant associations will exist between teens that live in worse social environment factors (higher neighborhood segregation, lower high school graduation rates, higher rates of people age 25 and older with no high school diploma, higher teen pregnancy incidence rates, higher proportions of households headed by single mothers) and worse health status, health behaviors, and birth outcomes among teen mothers.

   b. Significant associations will exist between teens that live in worse economic factors (lower household income; higher poverty, unemployment, and inequality rates; higher proportions of households receiving public assistance) and worse health status, health behaviors, and birth outcomes among teen mothers.

   c. Significant associations will exist between teens that live in areas with worse housing conditions (more household crowding, higher proportions of households in rental housing) than white teen mothers.

d. Significant associations will exist between teens that live in health professional shortage areas and worse health status, health behaviors, and birth outcomes among teen mothers.

3. Are there racial differences in birth outcomes between African-American and white teen mothers after controlling for demographic, medical risk, behavioral and neighborhood factors?

   a. Racial differences will exist in birth outcomes between African-American and white teen mothers after controlling for demographic, medical risk, behavioral and neighborhood factors.

Aim 3: Identify and examine the intersections between race, socioeconomic status, and maternal age on the health conditions, health behaviors and subsequent birth outcomes among African-American and white teen mothers

Rationale for this aim: This aim focused on associations of SES factors in differences in health status, health behaviors, and birth outcomes within the context of race and age. Investigating these intersections accounted for combined influence within teen mothers' identities related to race, SES level, and age group.

This aim also introduced the utilization of 2-way and 3-way interaction terms in examining relationships between race, class, and age and the combined influence on birth outcomes. Taking intersectional theoretical approaches to quantitative analysis have previously been completed through examining interactions between variables as previous advocates suggest (Cummings & Jackson, 2008; Hinze, 2012; McCall, 2005).

Researchers posit that the examination of health disparities necessitates the analysis of interactions of multiple health determinants (Bilheimer & Klein, 2010). Figures 4a & 4b show the simplified conceptual models for this aim; these figures are located at the end of this chapter.

Questions:

1. Intersection of race and SES: How does SES moderate associations between race and pregnancy status, health behaviors, and birth outcomes?
    a. How does SES moderate associations between race and pregnancy health status?
        i. SES will significantly moderate associations between race and pregnancy health status.
    b. How does SES moderate associations between race and health behaviors?
        i. SES will significantly moderate associations between race and PNC utilization.
        ii. SES will significantly moderate associations between race and smoking.
    c. How does SES moderate associations between race and birth outcomes?
        i. SES will significantly moderate associations between race and infant birth weight.
        ii. SES will significantly moderate associations between race and LBW outcomes.

iii. SES will significantly moderate associations between race and infant gestational age.

iv. SES will significantly moderate associations between race and PTB outcomes.

2. Intersection of race, SES, and age: How is the intersection among race, SES, and age associated with pregnancy health status, health behaviors, and birth outcomes?

   a. How is the intersection among race, SES, and age associated with pregnancy health status?

      i. The intersection of age and SES will significantly moderate associations between race and pregnancy health status.

   b. How is the intersection among race, SES, and age associated with health behaviors?

      i. The intersection of age and SES will significantly moderate associations between race and PNC utilization.

      ii. The intersection of age and SES will significantly moderate associations between race and smoking.

   c. How is the intersection among race, SES, and age associated with birth outcomes?

      i. The intersection of age and SES will significantly moderate associations between race and infant birth weight.

ii. The intersection of age and SES will significantly moderate associations between race and LBW outcomes.

iii. The intersection of age and SES will significantly moderate associations between race and infant gestational age.

iv. The intersection of age and SES will significantly moderate associations between race and PTB outcomes.

Data Sources

Researchers continue to assert the importance of utilizing large and/or national birth record datasets for the purpose of examining health disparities due to the availability of information on multilevel factors and ability to test hypotheses in the context of multiple variables (Griffith, Neighbors, and Johnson, 2009). This study incorporated a cross-sectional design to examine birth record data from the North Carolina State Center of Health Statistics for the years 2010-2011. The cross-sectional nature of this study came from the collection of data from each mother at one time point during this time frame.

One advantage of this study rests on the use of accurate data. The data collection for this dataset is based off of 2003 U.S. birth certificate standards which provide accuracy in reporting data (Jones-Vessey, 2012). These data are routinely collected from each mother at hospitals and birth centers across the state and entered into the state database for the NCSCHS according to these uniform birth certificate standards. Validity of these standards for collecting NC data was first examined through a validation study where information from random samples of birth certificate records was compared to corresponding maternal medical records to determine accuracy levels of reporting (Buescher, Taylor, Davis, & Bowling, 1993). NC birth record data were also deemed reliable through a recent study that compared birth record data with maternal information received from a large prospective cohort of participants from the NC Pregnancy Infection and Nutrition Study (Vinikoor, Messer, Laraia, & Kaufman, 2010).

De-identified street addresses for the mothers were geocoded through ArcGIS and the FFIEC geocoder in order to link cases to 2010 U.S. Census Data. Linking the census data with birth records data allowed for a broader ecological lens with the opportunity to examine neighborhood / structural characteristics as contextual factors for these mothers and possible associations with birth outcomes.

Study Sample

This study focused on teen mothers that have the following characteristics:

- Racial status as African-American or white
- Non-Hispanic ethnic status
- Born in the United States (foreign-born teens were excluded due to ethnic considerations that might confound the comparison of racial groups)
- Residents of North Carolina
- Age under the age of 20 at the time of childbirth

- Mothers of single parity (i.e. single fetal live births rather than twins, triplets, etc.) because mothers that deliver multiple births automatically have greater risk of preterm birth and low birth weights than singleton births
- Mothers that had live births at a gestational age of 20 weeks or more – This inclusion criterion stemmed from certain geographic areas' definition of the lower gestational age limit at 20 weeks to separate preterm births from spontaneous abortions. Setting lower gestational age limits was recommended in literature for consistency in comparisons between geographic areas (Goldenberg & McClure, 2010), and this limit had been used as exclusion criteria in other recent studies(Haeri, Guichard, & Saddlemire, 2009; Partington et al., 2009).

Study Measures

Independent Variables

Individual-level factors: Demographic variables were assessed in relationship to birth outcomes. Race served as a key individual independent variable under study as teens will be identified as non-Hispanic African-American or non-Hispanic white; this variable is dichotomous. Other variables included age and marital status. Age was assessed both as a continuous variable and a dichotomous variable (less than 17 years old, 17-19 years old). Marital status was assessed as a dichotomous variable (married/single).

Due to the recent change in data reporting for education, education was assessed as a categorical variable (less than 9th grade, 9-11th grade, high school graduate) and as dichotomous "yes/no" variables for high school graduation and education sufficiency.

The “education sufficiency” variable accounted for the grade level and age of the teens at the time of childbirth. Teens that had insufficient education levels had an approximated 2-year difference between their age and education level (i.e. teens age 15-19 having less than 9^{th} grade education; teens age 19 having 9-11 grade education). This variable impacted older teens rather than teens younger than 15 years old. However, it was expected that the distribution of teens younger than 15 years old will be much lower than teens in higher age groups (~5% based on 2009 data).

Health conditions (prior pregnancies, pre-existing and pregnancy related health conditions) were examined as individual medical risk variables of adverse birth outcomes. These health conditions included prior live births, preterm / small for gestational age (SGA) births, or abortions; pre-existing and gestational diabetes, chronic and pregnancy-related hypertension (pre-eclampsia). These variables were measured as dichotomous “yes/no” variables in birth records data, and associations between these variables and birth outcomes were assessed individually and collectively as a total “medical risk” index variable. Physiological pathways were represented by presence / absence of these health conditions and any significant relationships found between these variables and birth outcomes.

Two main health behaviors were assessed for relationships with birth outcomes: PNC utilization and tobacco use. Tobacco use (smoking prior to pregnancy, smoking during pregnancy) was also measured as dichotomous “yes/no” variables. PNC utilization was operationalized by PNC adequacy as measured by the Kotelchuck

Adequacy of Prenatal Care Utilization Index (1994). This index is one of the most commonly used measures of PNC adequacy. The adequacy of received services takes into account the following information: 1) the month of the first PNC visit, 2) the actual number of PNC visits received, and 3) the expected number of visits which is calculated according to PNC standards of the American College of Obstetrics and Gynecology. Researchers use these numbers to classify PNC adequacy in four ordinal levels: inadequate, intermediate, adequate, and adequate plus.

- Inadequate – PNC initiation after 4th month of pregnancy or receipt of less than 50% of recommended visits
- Intermediate - PNC initiation in the 1st- 4th month and receipt of 50%-79% of recommended visits
- Adequate - PNC initiation in the 1st- 4th month and receipt of 80%-109% of recommended visits
- Adequate Plus - PNC initiation in the 1st- 4th month and receipt of 110% of recommended visits or more

<u>SES and Neighborhood Factors</u>: Due to the low numbers of teen mothers in majority of these census tracts (some tracts have less than 10), the smallest level of neighborhood analysis remained at the census tract level rather than the census-block level. The following variables were included for analyzing neighborhood contribution to adverse birth outcomes in Aim 2: census tract median household income, census-tract proportion of residents in poverty, census-tract unemployment rates, Gini inequality index, census-

tract percentage of African-American residents, percentages of urban and rural residency, proportion of people age 25 years and older without a high school degree, proportion of people age 25 years and older having a high school degree or more, teen pregnancy incidence rate, proportion of households headed by single females with children under 18 years old, proportion of households receiving public assistance (i.e. SNAP/food stamp benefits), household crowding (occupants per room ≥ 1.51), and proportion of households residing in rental properties. HRSA designation as a health professional shortage area (HPSA) was also included as a neighborhood indicator. This designation served as a proxy variable to determine accessibility to health resources due to teens having barriers to accessing PNC, such as transportation barriers (NC State Center for Health Statistics, 2012). Census tract median household income also functioned as the SES variable for Aim 3 because information on the teens' household income was not available in the birth records data.

Outcome Variables

Per prior research (Wier, Pearl, & Kharrazi, 2007), gestational age was used for operationalizing infants' timing of birth. The mother's last menstrual period date and infant birth date serves as primary sources of birth certificate data to estimate gestational age, and health care providers calculate the age based on 28-day menstrual cycles. Gestational age is universally used for reporting infants' timing of birth due to the ease in getting the information from the mothers. As previously stated, infants are considered preterm if births occur prior to 37 weeks. Gestational age was assessed in this study as a continuous variable measured in number of gestational weeks at the time of birth. Birth term status was also examined as a dichotomous variable (normal if born at 37 weeks or more / preterm if born earlier than 37 weeks).

Birth weight in grams is another commonly used variable for determining infant birth weight status. This variable was examined as a continuous variable. Birth weight status was also examined as a dichotomous variable (normal if greater than / equal to 2500 grams; low birth weight if below 2500 grams).

Analysis Plan

As a background for all aims, descriptive analyses were used to examine univariate characteristics of this teen mother sample. Table 2 outlines the characteristics of each demographic and health status variables, neighborhood and SES variables, and birth outcome variables. Frequencies were computed for teens based on demographics, pre-pregnancy and pregnancy health status, and health behaviors. Measures of central tendency and variability were provided for each continuous variable, and normality and linearity assumptions were tested for each continuous variable before confirming the types of bivariate analyses to use. The following section expands on the analysis plan for each research aim.

Table 2. Characteristics of Study Variables

Study variable	**Type of variable**	**Levels (if dichotomous / categorical)**
Demographic		
Age	Continuous and dichotomous	less than 17 years / 17-19

Study variable	Type of variable	Levels (if dichotomous / categorical)
Marital status	Dichotomous	Married / single
Race	Dichotomous	African-American / white
Education	Categorical and dichotomous	Less than 9th grade, 9th-11th grade, high school graduate High school graduate – Yes/No Education sufficiency – Yes/No
Risks/ Conditions Pre-Existing Current Pregnancy		
Diabetes	Dichotomous	Yes/No
Chronic hypertension	Dichotomous	Yes/No
Heart / cardiovascular disease	Dichotomous	Yes/No
Previous preterm / small-for-gestational age delivery	Dichotomous	Yes/No
Previous abortions (spontaneous and induced)	Dichotomous	Yes/No
Parity (previous children)	Dichotomous	Yes/No
Medical risks of Current Pregnancy		
Gestational diabetes	Dichotomous	Yes/No
Preeclampsia	Dichotomous	Yes/No
Behavioral Risk Factors		
Smoking	Dichotomous	Yes/No
Prenatal care	Categorical	Inadequate, Intermediate, Adequate, Adequate Plus
SES/Neighborhood variables		
Census-tract median household income	Continuous	n/a
Poverty proportion of census-tract residents	Continuous	n/a
Census-tract unemployment rates	Continuous	n/a
Gini inequality index	Continuous	n/a
Census-tract percentage of African-American residents	Continuous	n/a

Study variable	Type of variable	Levels (if dichotomous / categorical)
High-school graduation rates	Continuous	n/a
Health professional shortage area (HPSA) status	Dichotomous	Yes/No
Teen pregnancy incidence rate	Continuous	n/a
Proportion of households headed by single females with children under 18 years old	Continuous	n/a
Proportion of households receiving public assistance	Continuous	n/a
Household crowding	Continuous	n/a
Proportion of households residing in rental properties	Continuous	n/a
Birth outcome variables		
Gestational age	Continuous and dichotomous	Normal / PTB
Birth weight in grams	Continuous and dichotomous	Normal / LBW

Aim 1: Assess racial differences in individual-level maternal characteristics (demographics, health conditions, health behaviors) and birth outcome disparities between African-American and white teen mothers

Question 1: Do the individual-level characteristics significantly differ between African-American and white teen mothers in this study?

Chi-Square tests were used to identify significant differences in the categorical variables (age, education, marital status, health status and behavioral risk variables) between the two racial groups of teens. The maternal age variable was analyzed as a dichotomous variable (less than 17 years old, 17-19 years old). Independent t-tests and Mann-Whitney U tests were used to identify differences in mean age between the two racial groups of teens.

A "medical risk index" was designed for operationalizing overall health status for teen mothers. This variable was used for assessing associations between SES, neighborhood associations, and health status for Aims 2 & 3. This medical risk index was computed as a sum of medical risks; therefore Mann-Whitney U tests were used to identify significant differences in mean medical risk status between the two racial groups of teens.

Question 2: Do the gestational ages and birth weights significantly differ among infants born to African-American and white teen mothers in this study?

Race was examined as a dichotomous variable (African-American / white non-Hispanic). Birth weight in grams and gestational age functioned as the dependent variables. Independent t-tests or Mann-Whitney U tests were used to identify significant differences in continuous variables (gestational age & infant birth weights) between the two racial groups of teens.

Question 3: What other individual-level characteristics are associated with adverse birth outcomes among the overall sample of teen mothers in this study?

Relationships between individual-level characteristics and gestational age and birth weights were assessed through independent-sample t-tests and Mann-Whitney U tests for all variables except PNC utilization. One-way ANOVAs and Kruskal-Willis tests were used to determine associations between PNC utilization and gestational age and birth weights due to PNC utilization being a categorical variable.

Question 4: Are there racial differences in birth outcomes between African-American and white teen mothers after controlling for demographic, medical risk, and behavioral factors?

Race functioned as a dichotomous variable (African-American/ white non-Hispanic). Birth weight in grams and gestational age functioned as the dependent variables. Sequential multiple regression models were completed for each birth outcome (gestational age, birth weight in grams) for identifying significant associations between race and birth outcomes and any continuation of the association that occurs with the addition of other variables related to demographics, health status and behavioral risk factors. The simplest model (Model 1) included race and demographic characteristics only. Model 2 added the medical risk factors (using the medical risk index) to test the additive contribution of these factors while holding everything else constant. Model 3 added the behavioral factors to test the additive contribution of PNC utilization and tobacco use while holding everything else constant. The existence of racial differences after controlling for risk and behavior factors were assessed by looking at the significance level for beta weights for race in the final model. (See Appendix A for results for this question.)

Aim 2: Examine neighborhood characteristics and associations with health conditions, health behaviors and subsequent birth outcomes for African-American and white teen mothers

Question 1: Do the neighborhood-level characteristics significantly differ between African-American and white teen mothers in this study?

As with the first aim, Question 1 assessed differences between racial groups for neighborhood variables. T-tests and Mann-Whitney tests were used to determine differences in all neighborhood variables except health professional shortage area (HPSA) status for which chi-square tests were used.

Question 2: What neighborhood-level characteristics are associated with health status, health behaviors, and birth outcomes among the overall sample of teen mothers in this study?

Question 2 assessed relationships between health status, health behavior, and birth outcome variables with neighborhood variables separately. Multilevel means-as-outcomes models were run for this question in order to recognize the nesting of teens within census tracts. SAS PROCMIXED procedures and HLM 7.01 were used to run these models. Teens that did not have geocodible addresses at the street address level were excluded from analyses. Separate descriptive analyses were run for the excluded teen cases to ensure that these teens were not statistically different from the overall study sample.

Question 3: Are there racial differences in birth outcomes between African-American and white teen mothers after controlling for demographic, medical risk, behavioral and neighborhood factors?

Neighborhood context was operationalized by a “neighborhood risk” index. The neighborhood risk index consisted of a computation of these neighborhood variables of interest into a single variable to represent neighborhood context. Principal component analysis (PCA) was used to compute this index because this method had been used to compute neighborhood deprivation indices in previous research (Messer et al., 2006; O’Campo et al, 2008; O’Campo, Caughy, Aronson, & Xue, 1997). In order to identify associations that neighborhood context may have in explaining disparities, this study assessed neighborhood risk as a moderator variable to see whether or not the relationship between racial status and birth outcomes changed when accounting for neighborhood factors. Significant interactions between race and neighborhood risk that remained significant in the final models were tested through simple slope tests, omnibus interaction tests, and examination of 95% confidence intervals (Dawson, 2013; Jaccard, 2001; Preacher, Curran, & Bauer, 2006).

Multilevel modeling was used for answering Question 3 in accordance with procedures outlined in Raudenbush & Bryk (2002). This type of modeling accounts for the clustering of individuals in groups such as neighborhoods that are not independent of each other, and these methods have been recommended in previous literature (Leventhal & Brooks-Gunn, 2000). The medical risk presence variable functioned as the dependent health status variable, PNC and tobacco use functioned as the dependent health behavior variables, and birth weight in grams and gestational age functioned as the dependent birth outcome variables as with previous analyses. Significant racial differences were assessed in looking at changes in the beta weights for race across all models and the p-values (significance level at $p<.05$).

The following types of multilevel models were used:

- One-way ANOVA w/random effects (no predictors) to determine neighborhood variance for outcomes
- One-way ANCOVA w/random effects (one individual-level predictor, no neighborhood-level predictors) to assess racial differences across census tracts
- Means as outcomes (one neighborhood-level predictor, no individual-level predictors) to test the association of neighborhood risk with outcomes
- Intercepts & Slopes as Outcomes (both neighborhood & individual level predictors) to determine 1) whether racial disparities persisted in context of neighborhood risk, 2) moderating effects of neighborhood risk on the association between racial status and outcomes, and 3) whether any significant associations and moderating effects of neighborhood risk persisted when controlling for mothers' demographics, health status, and health behaviors. (Note that the prenatal care and smoking variables were not included as independent variables in the models when assessed as outcomes.)

Aim 3: Identify and examine the intersections between race, socioeconomic status, and maternal age on the health conditions, health behaviors and subsequent birth outcomes among African-American and white teen mothers

As with the previously mentioned tests, race functioned as a dichotomous independent variable. Socioeconomic status was operationalized by census-tract median household income for this aim. The census-tract median household income variable were used to separate the teens into three income groups (low, middle, high) as recommended in prior research guidelines for teen populations (Leventhal & Brooks-Gunn, 2000). Therefore the income variable was assessed in this aim as a categorical variable. The low income group consisted of teens that fall in the low 25th quartile of the income distribution and the middle income group consisted of the middle 50% of this distribution. The high income group consisted of teens that fall in the upper 25th quartile of the income distribution; this group was the referent category for all analyses due to the expectation that teens in the high SES group will have more opportunity for resources and subsequently have better health statuses, behaviors, and birth outcomes. This separation of the census-tract median household income variable into quartiles replicated methodological procedures in previous research on birth outcome disparities (ex. Collins, David, Simon, and Prachand, 2007). The medical risk variable functioned as the dependent health status variable, PNC and tobacco use functioned as the dependent health behavior variables, and birth weight in grams and gestational age functioned as the dependent birth outcome variables as with previous analyses.

Examinations of intersections were completed through examining 2-way and 3-way interactions. Interactions are generally seen in statistics as multiplicative because they represent contributions above each variable's separate effect (Polit & Lake, 2010, p. 239), and these interactions are generally examined through regression techniques (Bengiamin, Capitman, & Ruwe, 2010). These intersections were examined through sequential multilevel models as described for both questions below; these models were also completed in accordance with Raudenbush and Bryk (2002). SAS PROCMIXED procedures and HLM 7.01 were used to run these models. Any significant 2-way and 3-way interactions were tested through simple slope tests, omnibus interaction tests, and examination of 95% confidence intervals (Dawson, 2013; Jaccard, 2001; Preacher, Curran, & Bauer, 2006).

Question 1: How does SES moderate the associations between race and pregnancy health status, health behaviors, and birth outcomes?

Sequential models were used for answering this question with the addition of the 2-way interaction term of race x income level. In adapting Hinze, Lin, & Andersson's analytic strategy (refer to Hinze, Lin, & Andersson, 2012, e94), identified 2-way interactions between race as African-American and income level represented the contribution of being an African-American teen mother in a specific income level on health status, health behaviors, and birth outcomes beyond the separate contributions already accounted for by race and income. Types of models including the following:

- The first model was a “One-way ANCOVA w/random effects” in having one predictor at the individual level; this model tells us if the strength of the associations between racial status and outcomes was the same across census tracts or if it varies.

- The second model was a “means as outcomes” model for low and middle income levels to determine if the outcomes varied by the income level of the census tract.

- The final model 3 was an “intercepts and slopes as outcomes” model with the 2-way interaction terms to determine whether a unique contribution exists between the cross-level interaction of census tract income level x racial status to outcomes.

Question 2: How is the intersection among race, SES, and age associated with pregnancy health status, health behaviors, and birth outcomes?

Sequential multiple regression models were used for answering this question with the addition of the 3-way interaction term of race x income level x age group. The 17-19 year old age group functioned as the referent category for these analyses in addition to the white and high- income groups. The 3-way interactions between racial status as African-American, income level, and age represented the association of being an African-American teen mother in a specific income level and age group on health status, health behaviors, and birth outcomes beyond the separate contributions already accounted for by race, income, and age. Types of models used included the following:

- The first model was a “One-way ANCOVA w/random effects” in having all predictors at the individual level (race, age, and the race x age interaction term). This model tells us if the strength of the associations between racial status and outcomes was the same across census tracts or if it varies.

- The second model was an "intercepts and slopes as outcomes" model with the 2-way interaction terms to determine whether a unique contribution exists between the cross-level interaction of census tract income level x maternal age to outcomes.

- The final model was an "intercepts and slopes as outcomes" model with 1) the 2-way interaction terms to determine whether a unique contribution exists between the cross-level interaction of census tract income level x racial status to birth weight, gestational age, and weight gain, 2) the 2-way interaction terms to determine if unique contributions exists between the cross-level interaction of census tract income level x age less than 17 to these outcomes, and 3) the 3-way interaction terms to determine whether a unique contribution exists between the cross-level interaction of census tract income level x racial status x age to these outcomes.

Overall, this exploratory study just scratches the surface on determining how intersectionality can be used to investigate contextual factors on birth outcomes. Nevertheless, this study can propel discussion on how to develop and execute future theoretically based examinations of contextual factors and their associations on birth outcomes and health disparities.

Figure 2a. Simplified Model – Aim 1 (question 1-2)

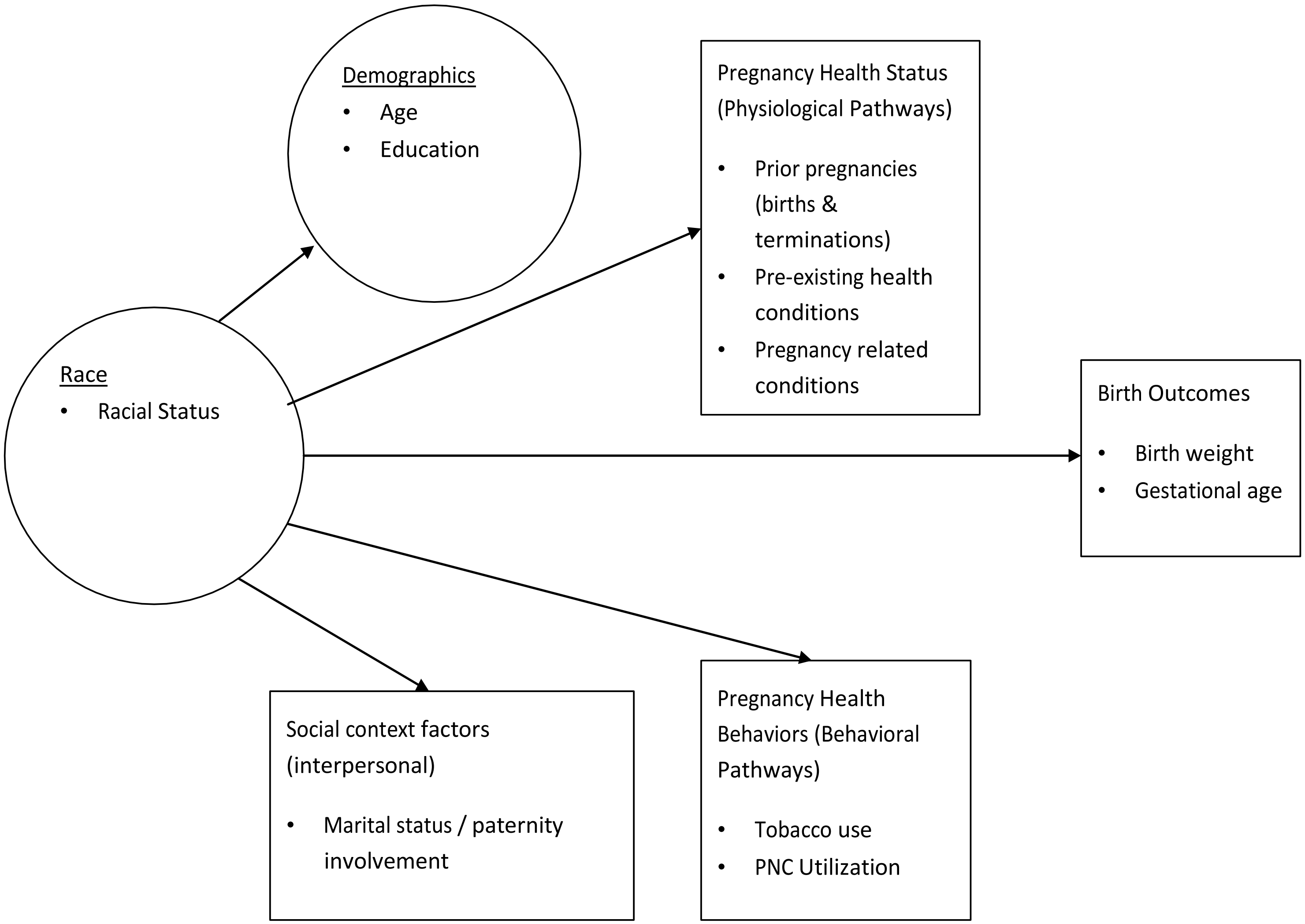


Figure 2b. Simplified Model – Aim 1 (question 3)

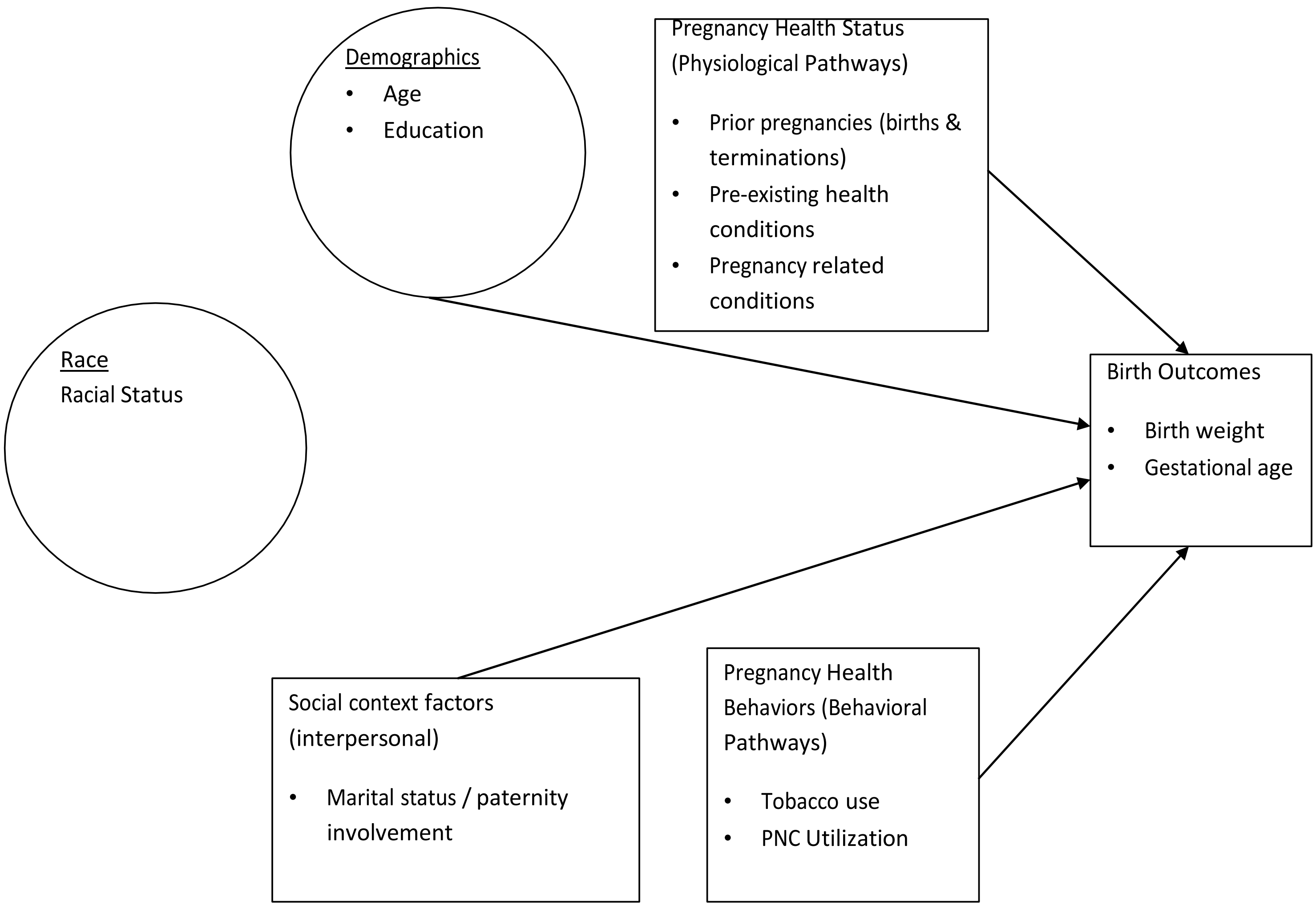


Figure 2c. Simplified Model – Aim 1 (question 4)

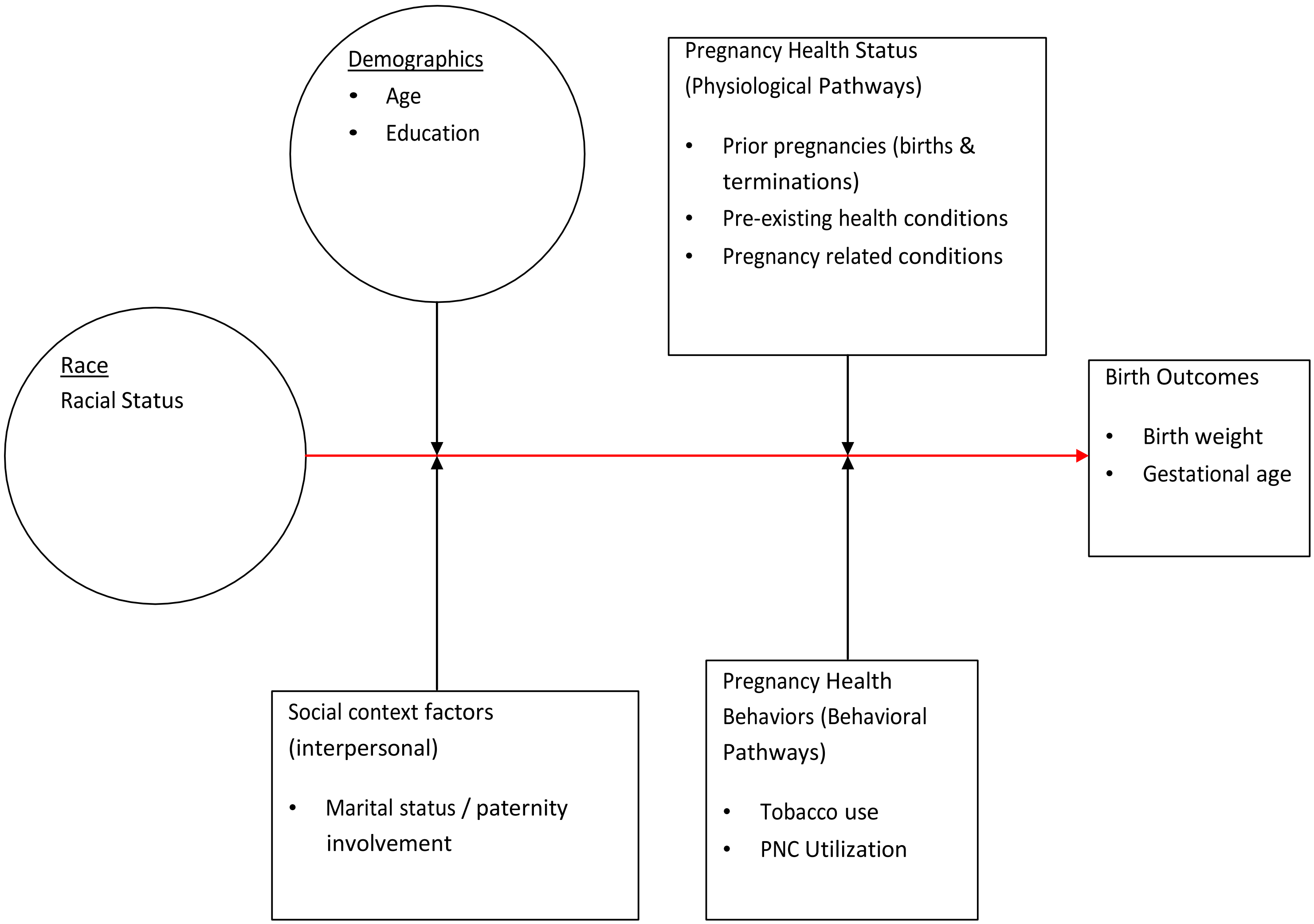


Figure 3a. Simplified Model – Aim 2 (question 1 & 2)

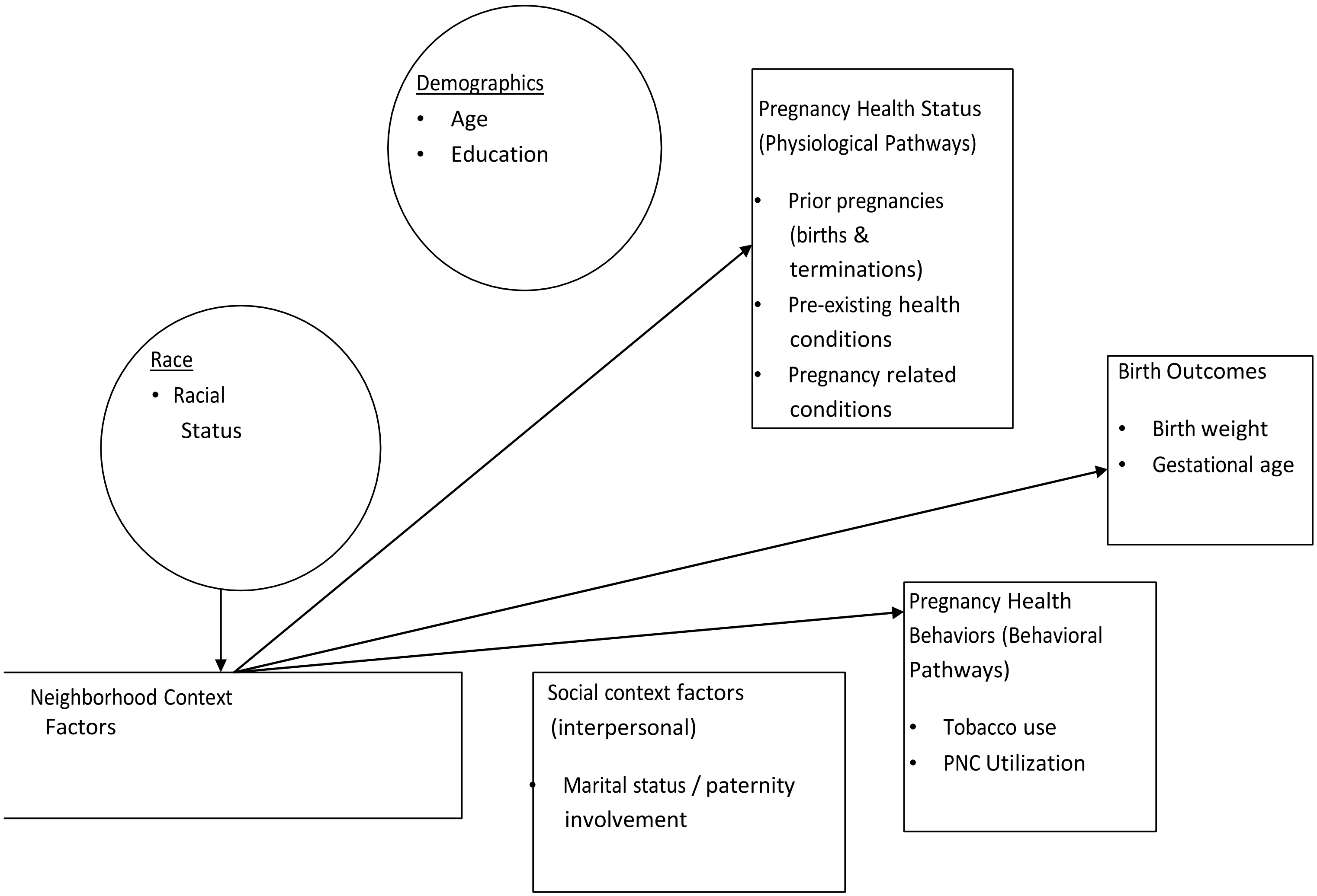


Figure 3b. Simplified Model – Aim 2 (question 3)

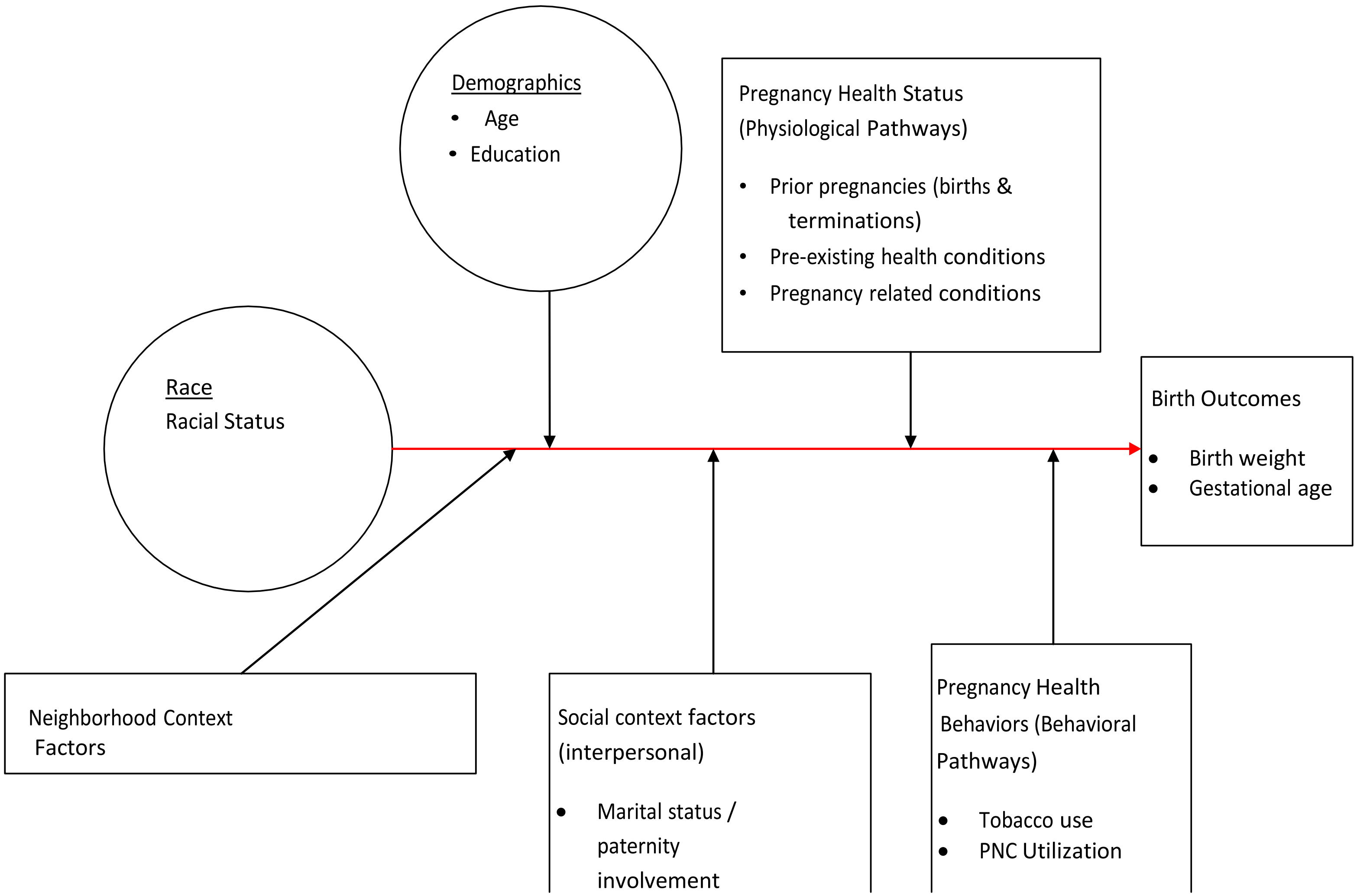


Figure 4a. Simplified Model – Aim 3 (question 1)

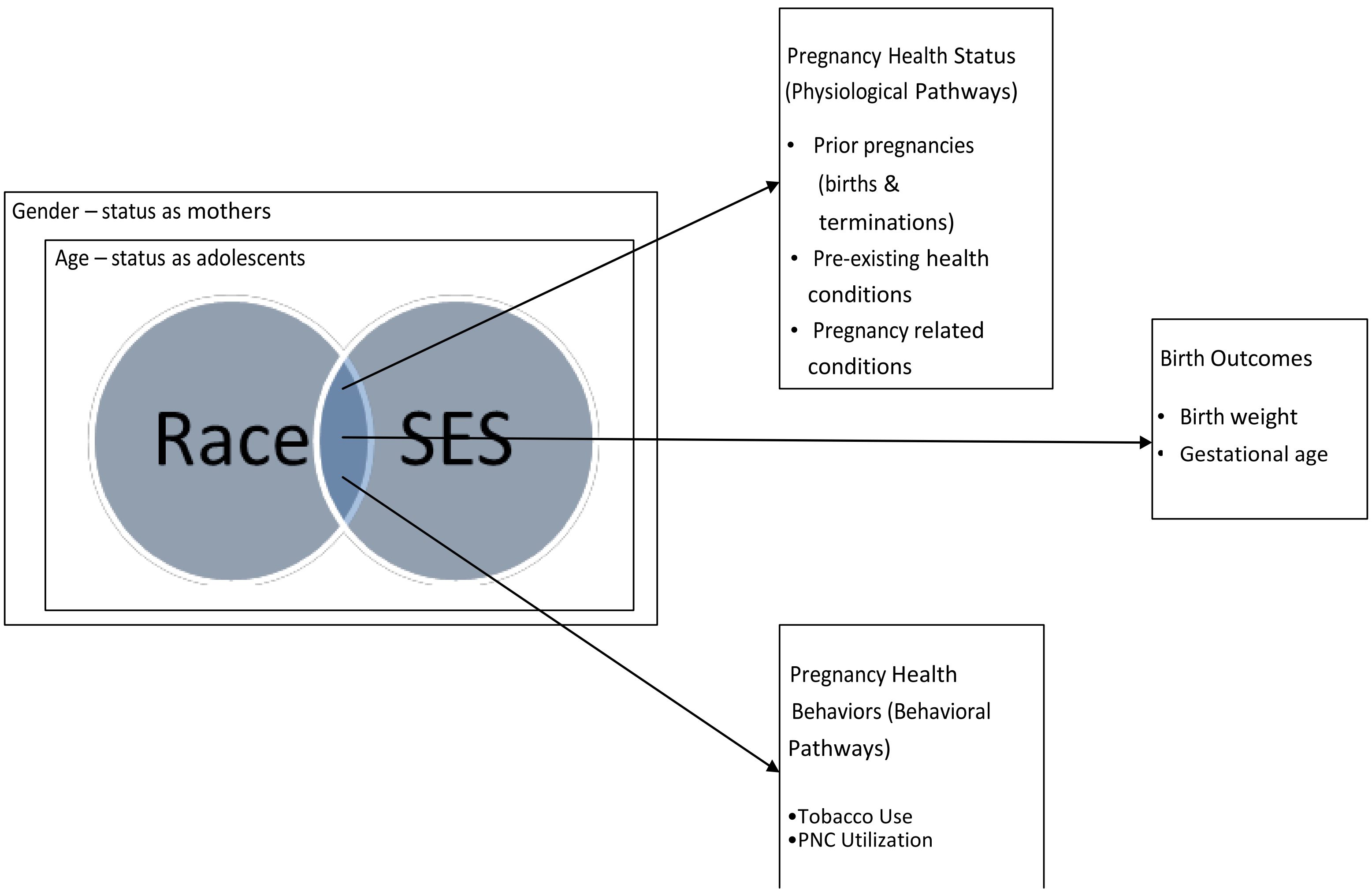
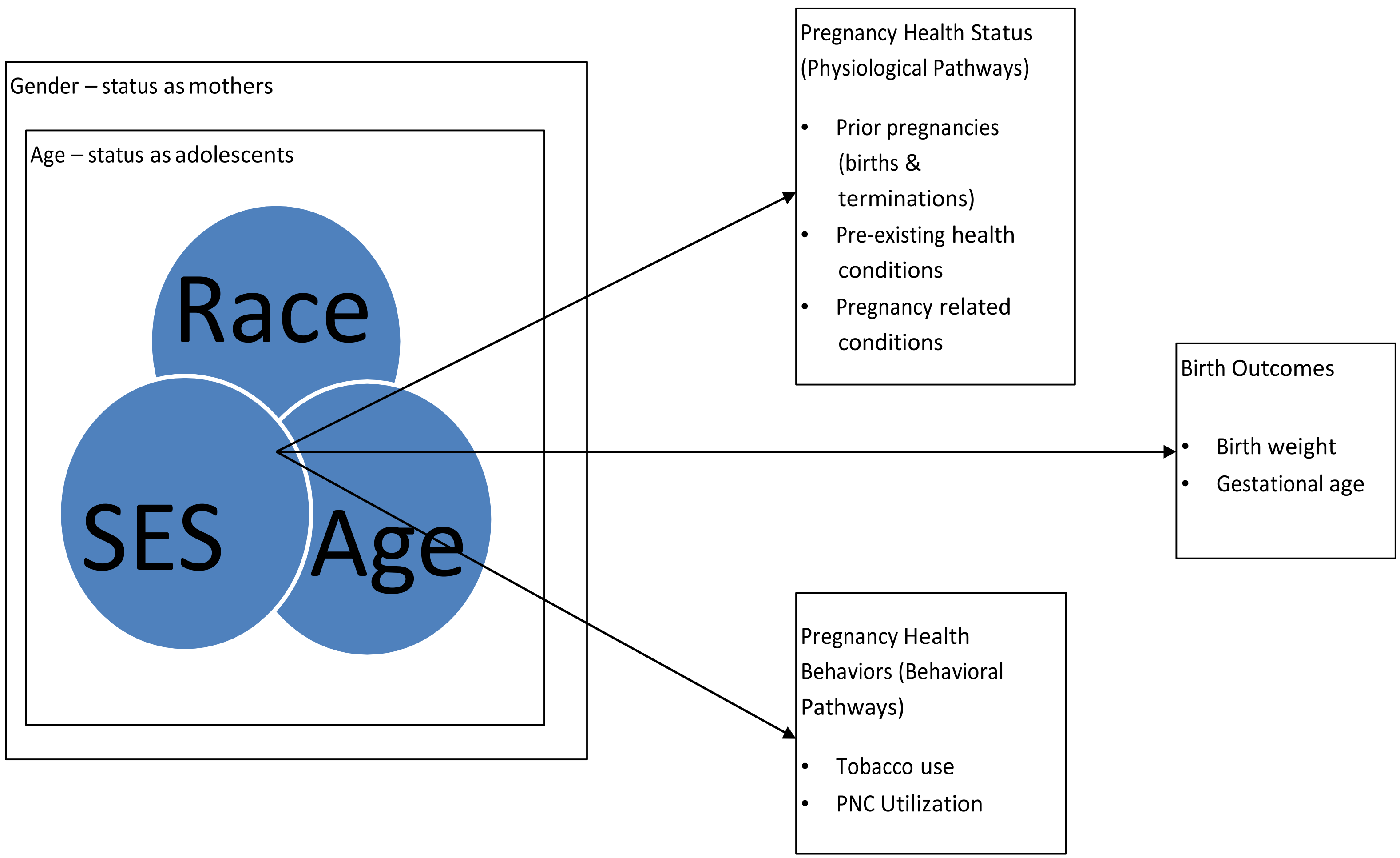


Figure 4b. Simplified Model – Aim 3 (question 2)



CHAPTER IV

NEIGHBORHOOD RISK AND BIRTH WEIGHT DISPARITIES AMONG INFANTS BORN TO TEEN MOTHERS: A MULTILEVEL APPROACH

Abstract

This multilevel cross-sectional study tested associations between racial status, neighborhood risk, and infant birth weight disparities between African-American and white teen mothers in North Carolina (n=7,923). Neighborhood risk was significantly associated with differences in mean infant birth weight and low birth weight odds when controlling for racial status, maternal characteristics, and pregnancy behaviors. However, neighborhood risk did not explain racial disparities in lower infant birth weight among African-American teens. These results highlight the need for further investigations of neighborhood characteristics and their associations with adverse birth outcomes and racial disparities among teen mother populations.

Key Words: adolescent mother, birth weight, race, birth outcomes, neighborhood, socioeconomic factors

Introduction

Disparities in adverse birth outcomes continue among teen populations as demonstrated in numerous studies that identified greater levels of low birth weight (LBW), preterm birth, and neonatal mortality outcomes among teen mothers in comparison to mothers of older age groups (Chen et al., 2007; Markovitz, Cook, Flick, & Leet, 2005). Previous research also identified racial disparities in adverse birth outcomes across all age groups, including populations of teen mothers (Buescher & Mittal, 2006). Despite the wealth of knowledge that these previous studies provide, most studies examined individual characteristics of mothers with limited consideration to neighborhood and structural factors. Moreover, the limited research that investigated neighborhood and socioeconomic associations focused on adult populations or overall populations of women at childbearing age with scarce focus on teen mother populations. This dearth in research justifies further examination of relationships between neighborhood factors and birth outcomes among teen populations.

Advocacy for the use of multiple strategies to address social and environmental circumstances related to birth outcomes grew in recent years (Alio et al., 2010; Rowley, Chapple-McGruder, Mendez, & Browne, 2012). Consequently census-tract and block-group variables have been used to operationalize neighborhood context and socioeconomic circumstances, including proportion of residents in poverty, median household income level, unemployment percentages, and education levels (Culhane & Elo, 2005; Schempf, Kaufman, Messer, & Mendola, 2011). Findings from these studies consistently demonstrated that women residing in deprived neighborhoods had higher rates of adverse birth outcomes than women in more affluent neighborhoods (Collins, David, Rankin, & Desireddi, 2009; Collins, Wambach, David, & Rankin, 2009; Love, David, Rankin, & Collins, 2010). Although these studies provided valuable findings for further understanding birth outcome disparities, the neighborhood factors under examination concentrated on income and educational demographics which have previously been deemed more problematic for assessing social class among teen populations in comparison to adult populations (Doucette-Gates, Brooks-Gunn, & Chase-Lindale, 1998). Further examinations of new neighborhood variables or more sensitive ways of clarifying existing variables are needed that have greater relevance for teen populations as recommended in previous literature (Doucette-Gates, Brooks-Gunn, & Chase-Lindale, 1998).

Given these limitations, this study examined neighborhood risk as a potential contributor to racial disparities in infant birth weight outcomes between African-American and white teen mothers. Through incorporating intersectional and socio-ecological frameworks in a multilevel approach, this study addressed the question: Do racial differences in birth weight outcomes between African-American and white teen mothers persist after controlling for neighborhood risk? This study mirrored previous studies with the theoretical assertion that multiple factors intersect at the individual, interpersonal, community, institutional, and policy levels to impact maternal and infant health outcomes (Alio et al., 2010; Seng et al., 2012). This examination of neighborhood risk stemmed from the rationale that individual and neighborhood factors can intersect to influence distribution of resources, household income, access to health resources, employment, and education, and subsequently affect birth weight outcomes and disparities between racial groups of teen mother populations.

Multilevel models were used to determine if 1) associations existed between neighborhood risk and birth weight outcomes in context of racial status, 2) neighborhood risk moderated the relationship between racial status and birth outcome differences, and 3) any moderation remained when controlling for demographic characteristics, health status characteristics, and health behaviors. With the examination of these questions, this study contributes to the scarce research that explored characteristics of neighborhood context and associations with birth outcome disparities between populations of teen mothers. Few previous studies examined neighborhood variables and their associations with birth outcomes among infants born to teen mothers (Madkour, Harville, & Xie, 2013; Partington et al., 2009). Results from these analyses can inform program planning for community-based and social service initiatives that serve teen mothers, and these findings can also inform future research on neighborhood contextual influences on birth outcome disparities in teen populations.

Methods

Data Sources

This study used a cross-sectional design to examine birth record data from the North Carolina State Center of Health Statistics for 2011. "Neighborhood" was defined as census-tracts delineated by 2010 U.S. Census boundaries. Mothers' street addresses were geocoded to census-tract identification numbers using ArcGIS 10.0 (Redlands, CA: Environmental Systems Research Institute) and the Federal Financial Institutions

Examination Council geocoder. Geocoded teen birth cases were subsequently linked to census-tract statistics from the 2010 US Census and the 2007-2011 American Community Survey. This research was approved by the authors' institutional review board.

Study Sample

This study focused on 8,302 teen mothers who matched the following criteria: African-American or white racial status, Non-Hispanic ethnic status, born in the United States, age under 20 years, North Carolina residency, and delivery of single live births at gestational ages of 20 weeks or more. Cases that could not be geocoded at the street address level were excluded from analyses, resulting in a final study sample of 7,923 teen mothers (95.4% of all eligible cases) who resided in 1,803 census-tracts. Descriptive analyses for the ~5% of excluded cases indicated that these mothers were not significantly different in maternal characteristics or infant birth outcomes in comparison to the study sample.

Study Measures

Birth outcomes. Birth weight in grams and LBW (infant birth weight under 2,500 grams) were the dependent variables for this study. Birth weight was examined in both dichotomous and continuous forms because of the extensive literature of LBW as an adverse birth outcome. Birth weight in grams was a continuous variable, whereas LBW was a dichotomous variable.

Maternal characteristics. This study focused on racial disparities in these birth outcomes. The racial status variable was dichotomized (African-American / white) with the exclusion of other racial categories for these analyses.

Most studies that investigated adverse birth outcomes and associated disparities examined demographic characteristics of mothers; therefore these characteristics were included in these analyses. Given this previous research (Institute of Medicine, 1985 & 2007), demographic variables included age (younger than 17 years old / 17-19 years old), marital status (single / married), and education (less than 9th grade, 9th-12th grade with no high school diploma, and high school graduate). Because this study assessed teen mothers exclusively, differences between school levels were assessed instead of computing a high-school graduate / non high-school graduate dichotomous variable commonly used with adult populations.

Mothers' pre-pregnancy health status (presence of chronic diseases before pregnancy), current pregnancy health risks (ex. Gestational hypertension), and poor obstetric history for mothers with previous pregnancies (ex. Preterm births, previous LBW outcomes) have been identified as risk factors of adverse birth outcomes (Collins & David, 2009; Lhila & Long, 2012; Institute of Medicine, 1985 & 2007; Rowley et al., 2012). Therefore, maternal health status was operationalized by a "medical risk presence" variable and a "prior pregnancy status" variable. Eight medical risk variables were combined into a dichotomous medical risk presence variable (0 = no medical risks, 1 = one or more medical risks) because of the small proportion of teens that had more than one medical risk factor (n=71, <1% of the study sample). Prior pregnancy status was computed as a dichotomous variable to account for prior history of live births, terminations, and neonatal deaths (0 = no prior pregnancies, 1 = one or more prior pregnancies).

Behaviors such as inadequate prenatal care utilization, poor nutrition, smoking, and other substance use have also been associated with increased risk in adverse birth outcomes (Institute of Medicine, 1985 & 2007). Therefore, analyses controlled for prenatal care utilization and tobacco use history; data were unavailable for other prenatal behaviors. Prenatal care utilization was measured with the Kotelchuck Adequacy of Prenatal Care Utilization Index (1994). Dummy variables for inadequate, intermediate, and adequate-plus prenatal care categories were included (adequate prenatal care was used as the reference category). Because of the greater risk associated with smoking during pregnancy in comparison to smoking before pregnancy, tobacco use was assessed as two dichotomous variables to identify any differences in birth weight outcomes among teens that 1) smoked at any point three months before pregnancy and 2) smoked at any point during pregnancy.

Development of neighborhood risk index and census-tract characteristics. Principal component analysis was used to create a "neighborhood risk index" based on neighborhood context variables used in previous research (Madkour, Harville, & Xie, 2013; Messer et al., 2006; O'Campo et al., 2008). This index included the following census-tract variables: median household income, poverty proportion, unemployment rate, percentage of people 25 years old and older with a high school diploma or more, percentage of households headed by single females with children younger than age 18, percentage of households that received public assistance, the Gini inequality index (a standardized measure for income inequality provided by the US Census), and percentage of households residing in rental housing. These variables were chosen based on prior research (Janevic et al., 2010; Krieger et al., 2003; Madkour et al., 2013; Messer et al., 2008; Nkansah-Amankra, Dhawain, Hussey, & Luchok, 2010; O'Campo et al., 2008; Schempf, Kaufman, Messer, & Mendola, 2011) to assess how multiple characteristics could explain the impact of socioeconomic status rather than sole reliance on income and educational factors. Higher values of this index indicate more neighborhood risk, whereas lower values of this index indicate less neighborhood risk.

Multilevel Analyses

Multilevel modeling was used to account for the nesting of teen mothers (Level 1) within census-tracts (Level 2). Multilevel modeling was beneficial for this study because of the ability to answer questions about associations between neighborhood factors and individual outcomes. This study assessed neighborhood risk as a continuous moderator variable in these models to test whether racial disparities in birth outcomes varied across different levels of neighborhood risk. Moderator variables influence the direction or strength of relationships between study variables (Baron & Kenny, 1986). HLM 7.01 (Lincolnwood IL: Scientific Software International, Inc.) was used for all multilevel analyses.

Hierarchical linear modeling was first used to assess if neighborhood risk was significantly associated with birth weight in grams. Binomial hierarchical generalized linear modeling was then used to assess if neighborhood risk was significantly associated with LBW odds. For greater precision of associations and interactions, neighborhood risk was centered at the grand mean whereas racial status and all other maternal variables were centered at the group mean. Assumptions for homogeneity of variance, normality, and independence of errors were checked for these variables.

Both sets of analyses were completed in the following sequence. One-way ANOVA models with random effects (Model 0) identified the overall neighborhood variance in birth weight with no covariates included. To establish racial differences in birth weight, Model 1 only included racial status as the Level 1 covariate. Model 2 added neighborhood risk as a Level 2 covariate to assess if racial differences persisted when controlling for neighborhood risk. Model 3 tested whether neighborhood risk moderated the relationship between racial status and birth weight with the addition of the racial status x neighborhood risk cross-level interaction term. Model 4 assessed if any associations or moderating effects of neighborhood risk remained significant when controlling for age, marital status, education, medical risk presence, and prior pregnancy status as Level 1 covariates. Given previous advocacy for prenatal care and smoking abstinence as protective behaviors in reducing risk of adverse birth outcomes, Model 5 added the prenatal care and smoking variables as Level 1 covariates to determine if associations or moderating effects of neighborhood risk remained significant when controlling for health behaviors. Two-sided $p < .05$ determined significance for all analyses.

Results

Table 3 provides descriptive statistics for the maternal characteristics of this sample and birth outcomes. Table 4 provides the descriptive characteristics of census-tract variables and differences by racial group. Results from bivariate analyses indicated that infant birth weights and census-tract characteristics significantly differed between the two racial groups ($p<.001$) with African-American teens more likely to have infants of lower birth weights and to reside in areas of higher neighborhood risk than white teens.

Birth Weight in Grams

Table 5 summarizes the results for birth weight in grams. Model 0 for birth weight in grams (results not shown) identified significant variance in birth weight outcomes across census-tracts ($p<.001$). The intraclass correlation for birth weight was approximately .03, which means that 3% of variance in birth weight among infants born to this teen sample was explained by between-census-tract variation. Therefore most variation in birth weight outcomes (~97%) stemmed from between-person differences. Despite the small proportion of variation across neighborhoods for birth weight, the significance of this variation justified multilevel modeling to examine these research questions.

When racial status was added in Model 1, racial disparities in infant birth weight were identified in which African-American teens had infants of significantly lower birth weights than white teens. When neighborhood risk was added in Model 2, there was a significant negative association between neighborhood risk and birth weight in which the average infant birth weight was lower in more deprived neighborhoods than in less deprived neighborhoods. The racial disparities remained significant and unchanged. When the racial status x neighborhood risk interaction term was added in Model 3, the negative associations with racial status and neighborhood risk and birth weight remained statistically significant with birth weight. However, the racial status x neighborhood risk interaction term was not significant ($p>.05$), indicating that racial differences in infant birth weight did not significantly vary by the level of risk in teens' neighborhoods. When all other demographic and behavioral variables were added in Models 4 & 5, the racial status and neighborhood risk associations remained significant although the interaction term remained non-significant.

In looking at all models, neighborhood risk had a significant negative association with infant birth weight after controlling for maternal characteristics and pregnancy behaviors. However, racial disparities in birth weight did not vary by neighborhood risk. Overall, racial disparities were present and remained significant when controlling for individual characteristics, pregnancy behaviors, and neighborhood risk.

Low Birth Weight

Table 6 summarizes the results for LBW. In Model 0 (results not shown), significant variance in LBW odds were identified across census-tracts ($p<.001$). The average odds of LBW across this sample is 0.10 (95% CI 0.10, 0.11; $p<.001$).

The LBW results replicated the results for birth weight in grams with the exception of Models 3 and 4. In Model 1, African-American teens had significantly higher odds of LBW than white teens across all census-tracts. In Model 2, teens that lived in more deprived neighborhoods had higher odds of LBW than teens in less deprived neighborhoods. Racial disparities in LBW odds remained significant and unchanged. In Model 3, the racial status x neighborhood risk interaction was significant, indicating that racial disparities in LBW odds varied by the level of neighborhood risk. This significant interaction indicates that the greatest racial disparities in LBW odds were found among African-American and white teens residing in areas of lower neighborhood risk. Although white teens in areas of higher neighborhood risk had higher odds of LBW than white teens in lower risk neighborhoods, African-Americans in areas of higher neighborhood risk had lower odds of LBW outcomes than African-Americans in areas of lower risk. (See Figure 5 for an illustration of these results.) In Model 4, this interaction still remained significant when controlling for other demographic variables. In Model 5, the main effects of racial status and neighborhood risk remained significantly associated with LBW odds whereas the racial status x neighborhood risk interaction was no longer statistically significant ($p>.05$).

Taking all models into account, racial differences in odds of LBW persisted regardless of neighborhood risk as shown by the higher LBW odds among African-American teens in all models. Neighborhood risk was also significantly associated with differences in LBW odds when controlling for maternal characteristics and behaviors, although the racial disparities in LBW outcomes did not significantly vary by levels of neighborhood risk when controlling for maternal behaviors. Therefore, racial disparities remained in LBW odds when controlling for individual characteristics, pregnancy behaviors, and neighborhood risk.

Discussion

Overall, these results indicate the persistence of racial disparities in birth weight outcomes across all levels of neighborhood risk. These results are consistent with previous findings for adult African American mothers who have been found to experience higher levels of adverse birth outcomes than white mothers across all levels of socioeconomic status (Collins, David, Simon, & Prachand, 2007). Therefore, these results show that African-American teens experience unique health burdens based on racial status that consequentially contribute to health disparities across all types of neighborhood environments.

These analyses also indicate that neighborhood context could potentially impact birth weight outcomes and racial disparities for teen samples. According to these results, neighborhood risk was related to average infant birth weights even when controlling for racial status, which contrasts Madkour and colleagues' (2013) findings that showed neighborhood disadvantage was no longer significantly associated with infant birth weight in context of racial status. Differences between these study results could stem from Madkour and colleagues' use of a nationwide sample of teens instead of the state sample used for this study. Although the use of national datasets can yield valuable information in health trends, trends found in national data can overshadow differences in local and state populations. These results illuminate that the association between neighborhood risk and birth outcomes could vary depending on geographic region, and that further exploration requires tailoring of multilevel analyses of neighborhood risk according to the geographic region of each study sample.

Given that neighborhood risk was previously associated with higher levels of adverse birth outcomes in adult populations, the finding that African-American teens in areas of higher neighborhood risk had lower odds of LBW outcomes was unexpected. Furthermore, the biggest disparity in LBW outcomes was identified between African-American and white teens who lived in neighborhoods with the lowest amount of neighborhood risk. One potential explanation is that fewer African-American residents may live in affluent neighborhoods of lower risk. Although areas of lower neighborhood risk have greater access to resources, African-American teen mothers residing in these areas might have experienced less social support, greater stigmatization, and consequently higher levels of chronic stress as previously hypothesized for adult African-American mothers (Pickett, Collins, Masi, & Wilkinson, 2005). These results also revealed that neighborhood risk was no longer a significant moderator of the association between racial status and LBW outcomes when maternal behaviors were controlled. Although racial disparities remained significant in context of maternal behaviors, this change in significance for the interaction may suggest that behavioral factors such as prenatal care utilization and smoking abstinence might reduce differences in LBW odds between African-American teens across different levels of neighborhood risk. For further clarification and potential areas of intervention, future analyses could further examine associations of maternal behaviors on birth outcomes in context of neighborhood risk with other samples of teen mothers.

Although neighborhood risk had a significant relationship with birth weight, significant variability in birth weight persisted across census-tracts ($p<.05$) which indicates the presence of other unidentified factors that significantly account for the variance (refer to Table 3 results for birth weight in grams). The variables used for this neighborhood risk index were grounded in previous literature for adult populations, but other characteristics might better explain neighborhood risk for teen populations and should be explored. The moderate association between the neighborhood risk variable and birth weight outcomes might also indicate that neighborhood characteristics as defined by census-tract characteristics may not be proximal enough to affect teen mothers' health during pregnancy. Future attention can focus on teens' immediate social and neighborhood environments, including block-group characteristics and school environments.

This study had several limitations. One limitation stems from the study's cross-sectional nature and the lack of information of the length of time that these mothers lived in their neighborhoods. Variations in these mothers' residential tenure might have explained variations in neighborhood influence on these teens' maternal health and subsequent outcomes in infant birth weights. A second limitation came from having only one demographic self-reported variable available to operationalize the concept of race. Examining maternal stressors related to racial status such as racial discrimination and inequity could help to explain these disparities in birth weight outcomes and should be considered for future research. Third, the lack of socioeconomic information at the individual level prohibited the examination of the influence of the teens' household environments in these analyses. The socioeconomic environment of teens' households could have deviated from the census-tract characteristics; therefore these results should be interpreted with the recognition that census-tract information is limited in accurately representing these mothers' households. Another limitation stemmed from the lack of data on social support variables; marital status was the only variable available for operationalizing social support. Although previous research consistently documented teen mothers' receipt of social support from their mothers (Logsdon et al., 2002), current research identified associations between the presence of paternal support and favorable birth outcomes among teen parents (Alio, Mbah, Grunsten, & Salihu, 2011; Shah, Gee, & Theall, 2013). Given this previous research, racial differences in paternal support could have influenced the racial differences in birth weight outcomes. Finally, the proportion of LBW births in this sample included full-term and preterm LBW births, and differences in outcomes related to neighborhood risk could have occurred between full-term and preterm LBW births. Given the higher likelihood of teen mothers having preterm infants than adult mothers, the benefits of looking at neighborhood risk associations for all LBW births among teen populations outweigh potential confounding of preterm birth effects. Overall, more exploration is needed in these areas for investigating racial disparities in teen populations.

Despite these limitations, this study has several noteworthy contributions. This study's main advantage is the examination of neighborhood risk in explaining racial disparities within a teen mother sample. Previous research has demonstrated that birth outcome disparities between African-American and white teen mothers persist after controlling for demographic, health status, and health behaviors (Coley & Aronson, 2013; Harville, Madkour, & Xie, 2012). This study expands this research by demonstrating that these disparities also persist when controlling for neighborhood factors. This study also provides an example on how birth records data can be used to examine birth outcome disparities across a teen sample. To our knowledge, this study is among the first to examine these neighborhood associations across a statewide sample of infants born to teen mothers. Therefore this study shows the utility that can come from using state birth records data to examine racial disparities in birth outcomes and the influence of neighborhood risk. Finally, the study's use of census-tract data for operationalizing neighborhood characteristics builds on existing literature that found significant associations between characteristics of neighborhood context and health outcomes (Messer, Vinikoor-Imler, & Laraia, 2012; Nkansah-Amankra, Dhawain, et al., 2010; Nkansah-Amankra, Luchok, Hussey, Watkins, & Liu, 2010).

Overall, these results show that racial disparities between African-American and white teen mothers can remain in birth weight outcomes in context of demographic, medical risk, prenatal behaviors, and neighborhood factors. More research is needed regarding these racial disparities given these results. Future studies can incorporate analyses of neighborhood factors with other teen populations, and these future analyses could provide more information to explain differences in birth outcomes and associated disparities.

Table 3. Demographic Characteristics (Paper 1)

	African-American (n=3782)	White (n=4141)	Total (n=7923)
Birth weight (grams)[a]	3034.44 ± 577.49	3261.85 ± 554.47	3153.88 ± 575.06***
Birth weight status[a]			
Normal	3296 (87.2%)	3851 (93.0%)	7147 (90.2%)***
LBW	483 (12.8%)	289 (7.0%)	772 (9.7%)***
Mother's age	17.89 ± 1.27	18.11 ± 1.08	18.01 ± 1.18***
<17	546 (14.4%)	384 (9.3%)	930 (11.7%)***
17-19	3236 (85.6%)	3757 (90.7%)	6993 (11.7%)***
Mother's education[a]			
8th grade or less	142 (3.8%)	174 (4.2%)	316 (4.0%)
9-12th grade; no diploma	1889 (49.9%)	1757 (42.4%)	3646 (46.0%)***
High school graduate or more	1751 (46.3%)	2209 (53.4%)	3960 (50.0%)***
Marital status[a]			
Married	78 (2.1%)	853 (20.6%)	931 (11.8%)***
Single	3703 (97.9%)	3286 (79.4%)	6989 (88.2%)***
Medical Risk Factor Presence			
None	3314 (87.6%)	3653 (88.2%)	6967 (87.9%)
1+ medical risks	468 (12.4%)	488 (11.8%)	956 (12.1%)
Prior pregnancies[a]			
None	2806 (74.2%)	3297 (79.6%)	6103 (77.0%)***
1+ prior pregnancies	976 (25.8%)	873 (20.4%)	1819 (23.0%)***
APNCU index[a]			
Inadequate	1156 (31.4%)	730 (18.0%)	1886 (24.4%)***
Intermediate	288 (7.8%)	289 (7.1%)	577 (7.5%)
Adequate	1020 (27.7%)	1368 (33.8%)	2388 (30.9%)***
Adequate plus	1219 (33.1%)	1661 (41.0%)	2880 (37.3%)***
Smoking			
Smoked 3 months before pregnancy	323 (8.5%)	1187 (28.7%)	1510 (19.1%)***

	African-American (n=3782)	White (n=4141)	Total (n=7923)
Smoked during pregnancy	229 (6.1%)	918 (22.2%)	1147 (14.5%)***

[a] Missing data comprise less than 5% for the variable.

***Differences significant at p<.001. Unmarked variables were non-significant (p>.05).

Table 4. Mean Census-Tract Characteristics by Racial Status (Paper 1)***

	African-American (n=3782)	White (n=4141)
Median household income	$36,781	$43,738
Poverty proportion	25.3%	16.9%
Unemployment rate	13.8%	10.6%
Percentage of people 25 years old and older that graduated high school	78.2%	81.4%
Gini inequality index	.43	.41
Percentage of households receiving public assistance	20.5%	12.4%
Percentage of households headed by single females with children age 18 and younger	12.6%	7.7%
Percentage of households residing in rental housing	44.0%	30.3%
Neighborhood risk	0.39	-0.36

***All differences were significant at p<.001.

Table 5. Multilevel Analyses for Birth Weight in Grams [values are in B (95% CI) for fixed effects]

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5
African American (AA)[a]	-222.47 (-241.22, -203.72)***	-222.62 (-241.37, -203.87)***	-232.19 (-251.25, -213.13)***	-217.37 (-237.09, -197.65)***	-243.27 (-263.72, -222.82)***
Neighborhood risk		-49.91 (-56.58, -43.24)***	-49.72 (-56.39, -43.05)***	-49.98 (-56.69, -43.27)***	-50.33 (-56.98, -43.70)***
AA x Neighborhood			34.06 (10.76, 57.36)	33.61 (10.48, 56.74)	23.41 (-0.38, 47.20)
Demographic Covariates					
Age[b]				0.45 (-24.59, 25.49)	-20.33 (-45.39, 4.73)
Education - ≤ 8th grade				-62.09 (-99.96, -24.22)	-30.48 (-68.12, 7.16)
Education – 9th-12th, no diploma				-40.03 (-55.72, -24.34)*	-31.38 (-47.30, -15.45)*
Marital status				58.39 (35.93, 80.85)*	38.91 (16.71, 61.12)
MRF presence				-158.58 (-183.63, -133.53)***	-142.83 (-167.49, -118.16)***
Previous pregnancy status				4.34 (-14.05, 22.73)	17.42 (-0.63, 35.49)

Table 5 cont.

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Tobacco Use					
Smoke before pregnancy					34.28 (3.31, 65.25)
Smoke during pregnancy					-177.23 (-211.29, -143.17)***
Prenatal Care Adequacy variables[c]					
Inadequate					-63.32 (-82.58, -44.06)**
Intermediate					-12.25 (-39.84, 15.34)
Adequate-plus					-195.88 (-213.18, -178.58)***
Random Variance					
Intercept (SD)	9591.33 (97.95)*	6979.61 (83.54)*	6982.72 (83.56)*	7560.60 (86.95)*	7614.26 (87.26)**
Statistics comparisons					
Chi-square	833.55*	812.98*	813.11*	821.60*	824.20**
Degrees of freedom	747	746	746	746	731
R^2 (combined)	0.02	0.03	0.03	0.03	0.09

[a] White is the referent category for racial status
[b] Age 17-19 is the referent category for maternal age
[c] Adequate is the referent category for prenatal care
*p<.05, **p<.01, ***p<.001

Table 6. Multilevel Analyses for LBW [values are in OR (95% CI) for fixed effects]

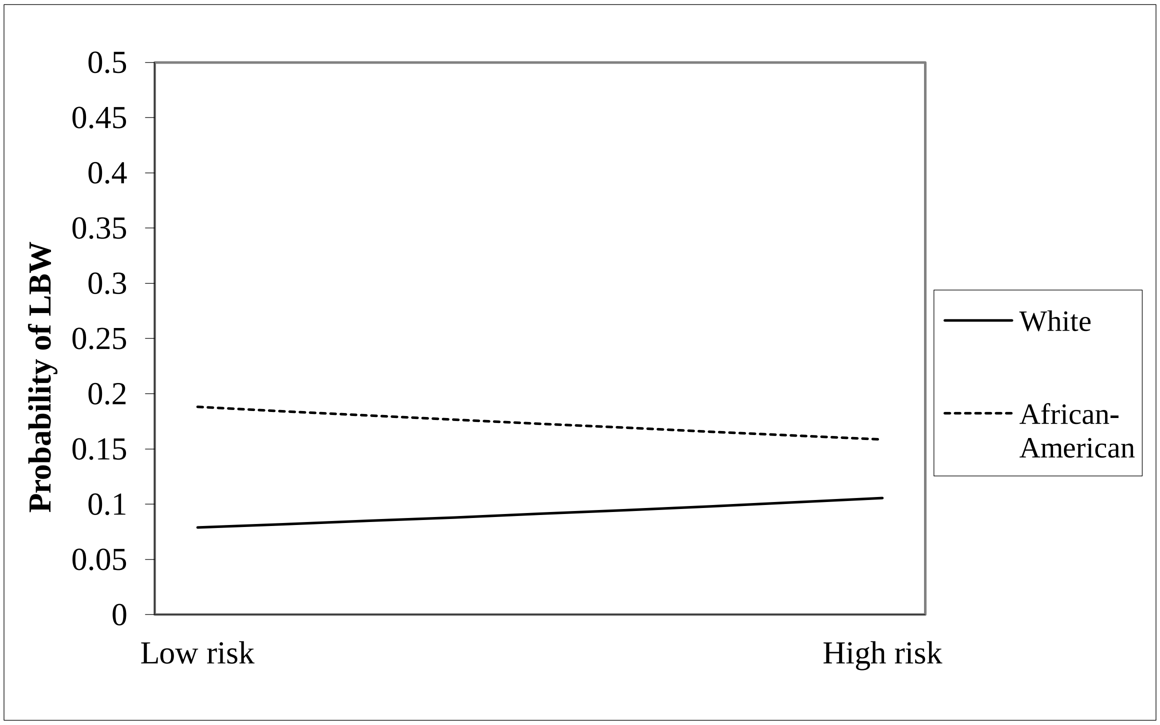
Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5
African American (AA)[a]	1.89 (1.53, 2.34)***	1.90 (1.56, 2.31)***	2.08 (1.69, 2.55)***	1.96 (1.59, 2.43)***	2.17 (1.74, 2.69)***
Neighborhood risk		1.16 (1.08, 1.24)***	1.17 (1.10, 1.26)***	1.17 (1.10, 1.26)***	1.18 (1.10, 1.26)***
AA x Neighborhood risk			0.76 (0.60, 0.98)*	0.77 (0.61, 0.98)*	0.82 (0.64, 1.06)
Demographic Covariates					
Age[b]				1.09 (0.85, 1.40)	1.15 (0.89, 1.49)
Education - ≤ 8th grade				1.10 (0.74, 1.62)	1.01 (0.68, 1.52)
Education – 9th-12th, no diploma				1.14 (0.97, 1.35)	1.13 (0.95, 1.34)
Marital status				0.87 (0.67, 1.13)	0.93 (0.72, 1.21)
MRF presence				2.68 (2.16, 3.31)***	2.49 (2.00, 3.10)***
Previous pregnancy status				0.93 (0.77, 1.14)	0.89 (0.73, 1.09)
Tobacco Use					
Smoke before pregnancy					0.71 (0.48, 1.04)
Smoke during pregnancy					2.09 (1.40, 3.12)***

Table 6 cont.

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Prenatal Care Adequacy variables[c]					
Inadequate					1.47 (1.18, 1.82) ***
Intermediate					1.01 (0.73, 1.39)
Adequate-plus					2.59 (2.16, 3.11) ***
Random Variance					
Intercept (SD)	0.20 (0.45)	0.18 (0.43)	0.19 (0.43)	0.20 (0.45)	0.25 (0.50)
Statistics comparisons					
Chi-square	704.46	706.33	722.03	725.02	713.75
Degrees of freedom	747	746	746	746	731

[a] White is the referent category for racial status
[b] Age 17-19 is the referent category for maternal age
[c] Adequate is the referent category for prenatal care
*p<.05, **p<.01, ***p<.001

Figure 5. Racial Status x Nneighborhood Risk Interaction and LBW Odds



CHAPTER V

RACE, SOCIOECONOMIC STATUS, AND AGE: EXPLORING INTERSECTIONS IN PRETERM BIRTH DISPARITIES AMONG TEEN MOTHERS

Abstract

Previous studies consistently demonstrated greater prevalence of preterm birth and other adverse outcomes among infants born to teen mothers in comparison to adult mothers. However, few studies examined adverse birth outcome disparities specifically between African-American and white teen mothers. This study examined intersections between neighborhood socioeconomic status, maternal age, and racial disparities in infant gestational age and preterm birth outcomes between African-American and white teen mothers in North Carolina. Using birth record data from the North Carolina State Center of Health Statistics for the years 2010-2011, street addresses of teen mothers (n=16,472) were geocoded and linked to census-tract income information from the 2010 US Census. Two-way and three-way interaction terms within multilevel models were used to examine intersections between racial status, maternal age, and neighborhood socioeconomic status (as defined by census-tract median income) and their associations with infant gestational age and preterm birth.

Results indicated that African-American teens had infants of significantly lower gestational ages and higher odds of preterm birth in comparison to white teens across all census-tracts. However, racial differences in gestational age and preterm birth outcomes significantly varied by neighborhood income, and the greatest disparities were identified

between African-American and white teens living in higher income neighborhoods. Disparities in gestational age and preterm birth did not significantly vary by maternal age. These results justify further investigations through intersectional frameworks of neighborhood socioeconomic status and birth outcome disparities among infants born to teen mothers.

Key Words: adolescent mother, preterm birth, gestational age, race, birth outcomes, neighborhood, socioeconomic factors, intersectionality

Introduction

Birth outcome disparities continue to present a critical health concern in the United States among mothers in different racial and age groups and varied socioeconomic status. Despite improvements in recent years, the US consistently ranks behind other industrialized countries in infant mortality rates (Kim & Saada, 2013). Furthermore, previous research on various US populations has identified persistent disparities in adverse birth outcomes based on maternal characteristics which include racial status as Black or African-American, younger maternal age (younger than 17 years old), and low socioeconomic status (Institute of Medicine, 1985 & 2007). Nationwide African American mothers have greater prevalence of adverse birth outcomes than white mothers (Mathews & MacDorman, 2013), and these racial disparities have been previously identified across all age groups in various states (ex. Buescher & Mittal, 2006; Gilbert et al., 2004). Previous studies also consistently demonstrated greater prevalence of low birth weight (weight less than 2500 grams), preterm birth (birth prior to 37 weeks gestation), and neonatal mortality outcomes among infants born to teen mothers in comparison to adult mothers (Chen et al., 2007; Eure, Lindsay, & Graves, 2002; Gilbert et al., 2004; Markovitz, Cook, Flick, & Leet, 2005). Meanwhile, greater proportions of adverse birth outcomes and associated disparities were found among mothers in environments of lower socioeconomic status in comparison to mothers residing in higher socioeconomic environments (Collins, Wambach, David, & Rankin, 2009; Lhila & Long, 2012).

The continued importance in examining preterm birth (PTB) outcomes rests on the increased risk of infant mortality for preterm infants before they turn one year old. Currently PTB is one of the leading causes of infant death overall in the US (Mathews & MacDorman, 2013). Despite this critical nature of PTB, few studies examined PTB specifically between African-American and white teen mothers. Instead, studies in PTB disparities mostly focused on adult mothers. Because younger maternal age is consistently noted as a risk factor of PTB (Institute of Medicine, 2007), the higher teen pregnancy rates of African-American mothers drives the assumption that younger maternal age sufficiently explains racial disparities in PTB and other adverse outcomes among infants born to teen mothers. Subsequently this assumption limits investigation of other factors, and few studies specifically examined the interplay of race and socioeconomic factors in associations with adverse birth outcomes among teen mothers (Madkour, Harville, & Xie, 2013; Partington, Steber, Blair, & Cisler, 2009).

Research has recently increased in examinations of health disparities and associated factors using intersectional frameworks (Bengiamin, Capitman, & Ruwe, 2010; Cummings & Jackson, 2008; Jackson & Williams, 2006; Notaro, 2012). As theoretical perspectives for public health, intersectional frameworks incorporate several principle tenets (Bowleg, 2012): 1) multiple social identities intersect and are interdependent of each other, 2) members of historically oppressed or marginalized groups are examined from their context, 3) multiple social identities at the individual level intersect with multiple level structural factors to contribute to disparities in health outcomes and 4) social categories are considered equally important in their influence. Using intersectional frameworks can allow researchers to explore birth outcome disparities among teen mothers through examining relationships between race and socioeconomic status as "historically created relationships of differential distribution of resources, privilege, and power, of advantage and disadvantage" (Mullings, 2005, p.79-80) in order to identify where disparities exist within disadvantaged groups of teen mothers and the context that may contribute to these disparities.

Despite the potential contributions that the use of intersectional frameworks can provide, intersectionality had been sparsely incorporated in quantitative research as noted previously by researchers of health disparities (Williams et al., 2012). Some may view intersectional approaches as unfeasible to implement in quantitative research because of the lack of consensus in methodological guidelines for developing research designs and operationalizing variables (Bowleg, 2012), although several recent quantitative studies utilized intersectional approaches to explore racial disparities among adults (examples include Hinze, Lin, & Andersson, 2012; Mair, 2010; Seng et al., 2012). However, fewer studies have used intersectional frameworks in quantitative examinations of health outcomes among teens (Kennedy, Bybee, Kulkarni, & Archer, 2012; Seaton, Caldwell, Sellers, & Jackson, 2010). Given this research gap, more examinations of racial disparities among teens using intersectional approaches are needed.

This study examined gestational age and PTB disparities between African-American and white teen mothers using an intersectional socio-ecological framework. To date, no studies have been found that previously examined racial disparities in birth outcomes among teen mothers using intersectional frameworks. Given the persistence of racial disparities in birth outcomes among teen mothers in the US, further investigations of these disparities are justified to identify ways to improve prenatal services for teen mothers and subsequently increase positive birth outcomes.

Theoretical Framework and Research Questions

This study incorporated an intersectional framework in context of previous social-ecological perspectives (Bronfenbrenner, 1994; Glanz & Bishop, 2010; McLeroy, Bibeau, Steckler, & Glanz, 1988). Social ecological frameworks posit that health is affected by multiple circumstances at the intrapersonal, interpersonal, community, institutional and policy levels. Using this combination of perspectives can provide deeper insight into relationships between factors that contribute to health outcomes at different levels as well as the amount of variance attributed at each level under examination (Seng et al., 2012). Through this framework, this study investigated how race as an intrapersonal construct intersects with socioeconomic factors at the community level to affect PTB outcomes and associated racial disparities.

Although previous research consistently identified infant gestational age and PTB disparities between African-American and white teen mothers, research has not identified which groups within African-American teen populations experience more disparate outcomes. Based on the intersectionality tenets previously described, the research team examined this research question in order to identify intersecting relationships between race and socioeconomic status in explaining birth outcome disparities: Does neighborhood socioeconomic status moderate racial differences in gestational age and PTB outcomes of infants born to teen mothers? Given previous research that younger mothers (under 17 years old) experience greater risk of adverse birth outcomes (Institute of Medicine, 1985, 2007), a second research question was examined in order to identify intersecting relationships between race, socioeconomic status, and age: Does neighborhood socioeconomic status moderate racial differences in gestational age & PTB outcomes differently between younger and older teen mothers? The research team proposed that African-American teen mothers' identities based on race and maternal age uniquely intersect with socioeconomic factors, and these intersectional effects contribute to disparities in infant gestational ages and greater proportions of PTB outcomes among infants born to African-American teen mothers in comparison to white teen mothers.

Methods

Data Sources

This cross-sectional study examined birth record data from the North Carolina State Center of Health Statistics (NCSCHS) for the years 2010-2011. The NCSCHS and authors' institutional review board approved this study. These data were collected based on 2003 US birth certificate standards which ensure accuracy in data reporting (Jones-Vessey, 2012). The NCSCHS de-identified these cases to preserve the anonymity for the mothers and their infants. To add socioeconomic information to these birth cases, the mothers' street addresses were geocoded to census-tract identification numbers using ArcGIS 10.0 (Redlands, CA: Environmental Systems Research Institute) and the Federal Financial Institutions Examination Council geocoder. Geocoded cases were subsequently linked to statistics from the 2007-2011 American Community Survey and the 2010 US Census.

Study Sample

This study included teen mothers who had the following characteristics: racial and ethnic status as non-Hispanic African-American or white, United States birthplace (teens born outside of the US were excluded to avoid potential confounding of ethnic considerations in comparing racial groups), age 19 and under at the date of their infants' birth, North Carolina residency, and live birth delivery of singleton infants at gestational ages of 20 weeks or more. Mothers with non-geocodible addresses were excluded from analyses, which resulted in the final study sample of 16,472 teen mothers (~93% of all eligible mothers) who resided in 1,991 census-tracts. Descriptive analyses for the 7% of non-geocodible cases confirmed that these cases did not significantly differ from the study sample in maternal characteristics or birth outcomes.

Study Measures

Infant gestational age and PTB were the dependent variables for this study. Gestational age was assessed as a continuous variable. In contrast, PTB was assessed as a dichotomous variable given the consistent literature of PTB as an adverse birth outcome. PTB was defined as births that occur prior to 37 weeks gestation per previous obstetric guidelines (Institute of Medicine, 2007).

Based on the study's focus on racial disparities and differences between age groups, racial status and maternal age were the primary independent variables. Racial status was dichotomized (African-American / white) with other racial categories excluded from these analyses. Consistent with past literature that examined birth outcomes between age groups of teen mothers (Eure et al., 2002), maternal age was treated as a dichotomous variable (younger than 17 years old vs. 17-19 years old).

Income is the most commonly used socioeconomic variable in research (Cummings & Jackson, 2008; Jackson & Williams, 2006) because of the influence of income on access to health services (i.e. prenatal care) and general resources. Because of the lack of information on household income for teens' residencies, census-tract median household income was used to operationalize socioeconomic status as done in previous research (Culhane & Elo, 2005). Using census-tract median household income information obtained from the US Census, teens was separated into three income groups (low, middle, high) as recommended in prior research guidelines for teen samples (Leventhal & Brooks-Gunn, 2000). Following previous research that examined socioeconomic associations with birth outcome disparities between adult mothers (e.g. Collins, David, Simon, and Prachand, 2007), teens in the lowest 25% income quartile were considered "low" income, teens in the middle 50% income quartiles were considered "middle" income, and teens in the highest 25% income quartile were considered “high” income. The high income group was the referent category for all analyses because teens in the high income group were expected to have more opportunity for resources and subsequently have better health statuses, prenatal behaviors, and birth outcomes.

Analysis Plan

Past research has generally applied intersectional theoretical approaches by examining interactions between variables (Cummings & Jackson, 2008; Hinze et al., 2012; McCall, 2005). This study therefore replicated previous intersectional research with the use of two-way and three-way interactions to test whether neighborhood socioeconomic status moderated relationships between racial status and birth outcomes and relationships between age and birth outcomes. Significant interactions were probed through simple slope tests, omnibus interaction tests, and examination of 95% confidence intervals (Dawson, 2013; Jaccard, 2001; Preacher, Curran, & Bauer, 2006).

Multilevel modeling (Raudenbush & Bryk, 2002) was completed to identify cross-level interactions between variables at the individual level (racial status, maternal age) and variables at the neighborhood level (income). The main benefit of multilevel modeling is the ability to capture variations between neighborhoods in addition to differences in outcomes between individuals. By examining cross-level interactions, multilevel analyses theoretically treat individual characteristics and neighborhood characteristics at their appropriate ecological levels to identify relationships between these two types of characteristics. A null one-way ANOVA with random effects model identified significant variance in gestational age across census-tracts ($p<.05$); this significant variance justified the use of multilevel modeling for these analyses. Hierarchical linear models were used to test associations with gestational age in weeks. Binomial hierarchical generalized linear models were used to test associations with PTB outcomes.

Five models were completed for each outcome. Model 1 only included racial status to identify significant racial differences in gestational age and PTB outcomes across census-tracts. Model 2 tested the two-way interaction between racial status and income, Model 3 tested the two-way interaction between racial status and age, Model 4 tested the two-way interaction between age and income, and Model 5 tested the three-way interaction between racial status, income, and age. Two-sided p-values $< .05$ determined significance for all analyses.

Results

Table 7 describes the maternal and birth outcome characteristics for this sample, and Table 8 provides the census-tract income levels and distribution by racial group. Similar to previous study samples, infants born to African-American teens in this sample had lower gestational ages and a greater proportion of PTB outcomes than infants born to white teens ($p<.001$). More African-American teens resided in low income environments than white teens in this sample ($p<.001$).

Gestational Age

Table 9 provides the multilevel model summary of results for gestational age. As shown in Model 1, African-American teens had infants of significantly lower gestational ages than white teens across all census-tracts (B = -0.38, 95% CI -0.43, -0.33). The significant racial status x income interaction terms in Model 2 indicated that neighborhood income moderated the relationship between racial status and gestational age. In contrast to white teens, African-American teens of low income and middle income neighborhoods had infants of higher gestational ages than high income African-American teens. Moreover, disparities in infant gestational ages between African-American and white teens were greater at the high income level than the low and middle income levels. Figure 6 illustrates this significant race x neighborhood income interaction. The simple slope tests confirmed that the association between neighborhood income and gestational age significantly differed by mothers' racial status ($p<.001$).

The non-significant maternal age interactions in Models 3, 4 & 5 indicated that racial and neighborhood income differences in gestational age did not vary by age group in this sample. In Model 3, there were no significant differences with maternal age younger than 17 nor the two-way racial status x maternal age interaction. In Model 4, teens in lower income neighborhoods had infants of significantly lower gestational ages in comparison to high income teens, but there were no significant differences found with maternal age nor the maternal age x income interactions. No significant differences were found between middle income and high income teens in infant gestational ages. When all interaction terms were combined in Model 5, the results were consistent with previous models in which the racial status x income interactions remained significant. However, there were no significant differences relative to maternal age, nor were the two-way and three-way interaction terms that included maternal age significant.

Overall, neighborhood income moderated racial differences in gestational age outcomes for this sample. Although African-American teens in this study sample were significantly younger than white teens, racial disparities in gestational age and moderating effects of neighborhood income did not vary by maternal age group in this study sample. The gestational age variable was not normally distributed, so analyses were rerun with a natural-log transformed gestational age variable. Results from these analyses were identical to results in these models presented here.

Preterm Birth

Table 10 provides the multilevel model summary of the PTB results. Consistent with gestational age in Model 1 and 2, African-American teens had significantly greater odds of PTB than white teens (OR = 1.38, 95% CI 1.21, 1.56) and the significant racial status x income interactions indicated that neighborhood income moderated the relationship between racial status and PTB odds. Figure 7 illustrates the results for Model 2. In contrast to white teens, the significant interaction terms indicated that African-American teens of low income and middle income neighborhoods had lower odds of PTB births than high income African-American teens. Furthermore, disparities in PTB odds between African-American and white teens were the greatest at the high income level, and African-American teens in high income neighborhoods had the highest odds of PTB among all teens in this sample.

The non-significant maternal age interactions in Models 3, 4 & 5 indicated that racial and neighborhood income differences in PTB odds did not vary by age group in this sample. In Model 3, no significant differences were found with maternal age younger than 17 nor the two-way racial status x age interaction. Similar to the Model 4 results for gestational age, there were no significant differences found with maternal age nor the maternal age x income interactions. Contrary to the significant differences that low income had with gestational age in comparison to high income, no significant differences in PTB odds were found in Model 4 between the main effects of the low and high income groups. These non-significant associations with PTB indicated that low neighborhood income was only significantly associated with differences in PTB odds in context of racial status. When all interaction terms were combined in Model 5, the results were consistent with the gestational age results. The racial status x income interactions remained significant, but there were no significant differences relative to maternal age, nor were the two-way and three-way interaction terms that included maternal age significant.

Overall, neighborhood income significantly moderated racial differences in PTB odds for this sample although neighborhood income did not have significant relationships with PTB odds when assessed with maternal age. Consistent with the gestational age results, racial disparities in PTB outcomes and moderating effects of neighborhood income did not vary by maternal age group in this study sample.

Discussion

All analyses identified significant racial differences in infant gestational ages and likelihood of PTB outcomes for this sample across census-tracts. More importantly, these results showed that the significant racial differences in infant gestational age and PTB outcomes can potentially vary by neighborhood income level. Taking all models into account, the modifying relationships of neighborhood income suggests that racial status for African-American teen mothers intersects with socioeconomic status to affect gestational age and PTB outcomes, and these intersectional effects can occur regardless of the mothers' age group. These results resemble previous findings for adult mothers of high income neighborhoods (Collins, David, Simon, & Prachand, 2007) in showing that African-American teen mothers living in areas of higher socioeconomic status can experience unique health burdens based on racial status that consequentially contribute to birth outcome disparities. Given these findings, future intervention efforts to reduce birth outcome disparities may need to expand outreach in prenatal education and support to more African-American teens of higher socioeconomic status. In response to previous research on alternate prenatal care models and community pregnancy support programs that yielded favorable birth outcomes among young African-American mothers (Grady & Bloom, 2004; Gruber, Cupito, & Dobson, 2013; Ickovics et al., 2003; Ickovics et al., 2007), future planning efforts can experiment with these avenues for reducing PTB outcomes among African-American teen mothers of higher socioecomomic levels.

Contrary to expectations from previous literature, the highest disparities surfaced between African-American and white teens among the highest income groups. Other community factors such as racial concentration of neighborhoods may potentially help to explain this phenomenon and should be explored for relationships to these disparities. Although areas of higher socioeconomic status have greater access to resources, these neighborhoods tend to have lower proportions of African-American residents. These lower neighborhood proportions of African-American residents could subsequently result in lower social support, higher levels of stigmatization, and consequently greater levels of stress experienced during pregnancy for teen African-American residents of these neighborhoods as previously hypothesized for adult African-American mothers (Pickett, Collins, Masi, & Wilkinson, 2005). In contrast, areas of higher African-American concentration have previously been identified as protective for teen mothers regarding infant birth outcomes. Madkour et al. (2013) identified significant racial differences in infant birth weight related to racial concentration of neighborhoods of teen mothers in which concentrations of African-American residents was positively correlated with infant birth weight outcomes among African-American teen mothers. Future examinations need to further explore intersections between racial status and socioeconomic status through the assessment of racial concentration and other community level factors.

These findings overall have implications for future research on teen mothers, particularly teen mothers in middle income environments. Despite the identification of the highest disparities among teens in the highest 25th income percentile, readers should note that the majority of the teens in this study's "high income" group were in the middle class for the state. According to the US Census Bureau (2012), the NC median household income was $46,291 during the years 2007-2011. Although this median income is included in the middle income distribution, it is noted that the median incomes across these census tracts overall appear skewed to the lower income range in comparison to the state median. Therefore, the high-income group in this study represented mostly middle class residents when compared to the NC population at large. In interpreting the results, the highest 25th income percentile of mothers in this study may include mothers that do not qualify for enough public assistance but still lack the financial means to obtain the necessary resources during pregnancy. Because most literature that examines socioeconomic factors focuses on the dichotomy between low and high socioeconomic status, more research is warranted for studying the effects of middle class environments on birth outcome disparities as advocated by previous literature (Jackson & Williams, 2006). Future explorations are also warranted to determine the effects of the Affordable Care Act and other policy measures to provide assistance for teens that live in middle class environments.

These findings also showed a weaker relationship between younger maternal age and PTB than suggested by prior literature (Chen et al., 2007; Gilbert et al., 2004). Contrary to previous findings, no significant differences were found between younger and older teens in infant gestational age and PTB outcomes. Although African-American teens in this sample were significantly younger than white teens, racial differences in gestational age and PTB outcomes did not significantly vary by age group in this sample. In addition, neighborhood socioeconomic status did not moderate racial differences in gestational age & PTB outcomes differently between younger and older teen mothers. Future research could further explore racial differences more between age groups of teen mothers to enhance understanding on associations between age and racial disparities. Few studies explored birth outcome disparities between age groups of teen mothers in context of socioeconomic factors (Markovitz et al., 2005); therefore more attention is warranted to explore disparities between age groups in other study samples.

Several other factors should be explored to further investigate racial disparities in PTB outcomes among teen mothers. Examining the intersectional influences of racial status in the context of other individual factors, interpersonal factors, and social context is warranted. Maternal stress has been shown to influence birth outcomes (Rosenthal & Lobel, 2011), and prior research had also identified racial differences in types of maternal stress that mothers experience during pregnancy (Nkansah-Amankra, Luchok, Hussey, Watkins, & Liu, 2010). Moreover, a greater number of pregnancies for African-American teen mothers could have stemmed from coercive circumstances and resulted in high biological stress from conception. Current research identified higher prevalence of sexual coercion and intimate partner violence among African-American teen females in comparison to the national average for teens (Howard, Debnam, & Wang, 2013; Kennedy et al., 2012). These interpersonal factors could lead to higher maternal stress for African-American teen mothers and subsequently poorer outcomes. Future studies could therefore investigate if differences in maternal stress explain differences in subsequent birth outcomes between African-American and white teen mothers. More exploration on the influence of social support during pregnancy is also warranted, particularly support from infants' fathers. Previous studies identified the lack of paternal support as a risk factor for teen mothers experiencing adverse birth outcomes, and this risk was more pervasive among African-American teen mothers (Alio, Mbah, Grunsten, & Salihu, 2011). Overall, disparities in interpersonal factors and social context could explain differences in trauma levels between African-American & white teen mothers, thus investigating social context and disparities could identify points of intervention in providing tailored support for African-American teen mothers during pregnancy.

This study was completed with the recognition of several limitations. One main limitation is the inability to sufficiently capture the concept of racial identity in one demographic self-reported variable. Warner (2008) cautions against the use of “master categories” (i.e. race) that might lead to stereotypical interpretations of results. To avoid stereotyping in quantitative health disparities research, future studies could explore race-related maternal stressors such as racial discrimination and inequity. The use of this information could potentially explain a larger proportion of racial differences in adverse birth outcomes among teen mothers. Current research found associations for African-American teens that experience multiple forms of racial discrimination and poor health outcomes that exceed the contribution of a singular type (Grollman, 2012). This prior research justifies further investigation of these experiences for African-American teens.

Other limitations stemmed from the cross-sectional nature of the study and operationalization of variables. Given the study’s cross-sectional nature, no information was available about the length of time that the mothers spent in current residencies. Variations in mothers’ residential tenure could have contributed to differences in neighborhood influence on these teens’ health during pregnancy and subsequent outcomes in infant gestational ages and preterm births. Previous research noted detrimental effects of long-term poverty on birth outcomes for African-American women that grew up in deprived neighborhoods (Collins, Wambach, David, & Rankin, 2009;

Love, David, Rankin, & Collins, 2010), and future research can explore similar longitudinal effects of deprived neighborhood environments for teen mothers. Second, this study used only one neighborhood income variable to operationalize socioeconomic status because of the lack of available information for mothers' household income and other socioeconomic information. The socioeconomic environment of teens' households could have deviated from the census-tract median income characteristics. Consequently, these study results should be interpreted with caution that census-tract information cannot fully represent the socioeconomic environment of these mothers' households. Finally, interactions can only capture limited understanding of intersections at the descriptive level (Cole, 2009). Factorial designs and the use of variables that are hypothesized to explain effects of identity variables had previously been suggested as an alternate means of capturing intersectional effects in research (Warner, 2008). Future studies could improve efforts to operationalize intersections in quantitative research in exploring alternate approaches.

The strengths of this study outweigh the limitations. To date, no other studies have been found that takes a multilevel intersectional approach to investigating birth outcome disparities between African-American and white teens. Future studies can further refine intersectional approaches in order to improve quantitative examinations of maternal and infant health disparities. This study also exemplifies an intersectional approach for examining health outcomes among a state sample of teen mothers using vital records data, and future research for state samples can employ this same approach. Another strength stems from the study's use of US Census household income data for operationalizing socioeconomic status of neighborhoods; this technique allows these study’s findings to build on previous research that found significant associations between characteristics of neighborhood context and health outcomes (Messer, Vinikoor-Imler, & Laraia, 2012; Nkansah-Amankra, Dhawain, Hussey, & Luchok, 2010; Nkansah-Amankra, Luchok, et al., 2010). To delve further into socioeconomic status and relationships with birth outcomes for teen mothers, future studies could explore other measures of socioeconomic status (i.e. poverty, public assistance, housing, crime) with relationships to birth outcomes. Finally, this study examined a large sample that provided the statistical power necessary for examining subgroups of teen cases for interactions and testing complex hypotheses in accordance with other research recommendations and prior quantitative examinations of birth outcome disparities (Griffith, Neighbors, & Johnson, 2009; Nkansah-Amankra, Luchok, et al., 2010).

Overall, this study contributes to the limited examinations of neighborhood factors related to infant gestational age and PTB disparities among teen mothers. Despite the limitations, intersectional approaches could be used for enhancing discussion in ameliorating these disparities for teen populations. Continued exploration of disparities is critical as an introductory step for development of interventions that can reduce disparities (Meyer et al., 2013), and these disparities justify further exploration for the benefits of improvement of perinatal services, improving birth outcomes, and reducing disparities among teen mothers.

Table 7. Demographic Characteristics (Paper 2)

	African-American (n=7781)	White (n=8691)
Gestational Age	38.46 ± 2.55	38.77 ± 2.05
Birth Term Status	Normal = 6942 (89.3%) Preterm = 833 (10.7%) Unknown = 6	Normal = 7936 (91.3%) Preterm = 754 (8.7%) Unknown = 1
Mother's age	17.87 ± 1.26 Age < 17 = 1145 (14.7%) Age 17-19 = 6636 (85.3%)	18.08 ± 1.09 Age < 17 = 852 (9.8%) Age 17-19 = 7839 (90.2%)

Table 8. Number and Percentage of Participants in Income Categories by Race (Paper 2)

	Low (<$31,389)		Middle ($31,389-$48,466)		High (>$48,466)	
	N	%	N	%	N	%
African-American	2986	38.4	3287	42.2	1508	19.4
White	1138	13.1	4942	56.9	2611	30.0

Table 9. Intersectional Analyses for Gestational Age [values are in B (95% CI)]

	Model 1	Model 2	Model 3	Model 4	Model 5
African American (AA)[a]	-0.38 (-0.43, -0.33)***	-0.43 (-0.48, -0.38)***	-0.36 (-0.41, -0.31)***		-0.40 (-0.45, -0.35)***
Low income [b]		-0.18 (-0.23, -0.13)**		-0.18 (-0.23, -0.13)**	-0.18 (-0.23, -0.13)**
Middle income		-0.07 (-0.11, -0.03)		-0.07 (-0.12, -0.02)	-0.07 (-0.11, -0.03)
AA x low income		0.48 (0.33, 0.63)**			0.49 (0.33, 0.65)**
AA x middle income		0.35 (0.23, 0.47)**			0.35 (0.23, 0.47)**
Age < 17[c]			0.01 (-0.07, 0.09)	-0.12 (-0.19, -0.05)	0.02 (-0.07, 0.11)
AA x Age < 17			-0.14 (-0.26, -0.02)		-0.19 (-0.33, -0.05)
Age < 17 x low income				0.18 (-0.01, 0.37)	0.26 (0.03, 0.49)
Age < 17 x middle income				0.09 (-0.08, 0.26)	0.01 (-0.19, 0.21)
AA x Age < 17 x low income					-0.14 (-0.26, -0.02)
AA x Age < 17 x middle income					0.06 (-0.28, 0.04)
Random Variance					
Intercept (SD)	0.06 (0.25)	0.06 (0.25)	0.07 (0.27)	0.04 (0.21)	0.07 (0.27)
Statistics comparisons					
Chi-square	1250.73	1249.31	138.44	1099.70	138.68
Degrees of freedom	1173	1171	146	1040	144
R^2 (combined)[d]	0.02	0.02	0.04	0.02	0.04

[a] White is the referent category for racial status

[b] High income is the referent category for income

[c] Age 17-19 is the referent category for maternal age

[d] All models were compared with a null model.

*p<.05, **p<.01, ***p<.001

Table 10. Intersectional Analyses for PTB [OR (95% CI)]

	Model 1	Model 2	Model 3	Model 4	Model 5
African American (AA)[a]	1.38 (1.21, 1.56)***	1.49 (1.29, 1.71)***	1.33 (1.17, 1.51)***		1.40 (1.23, 1.60)***
Low income[b]		1.13 (0.98, 1.31)		1.10 (0.95, 1.27)	1.13 (0.99, 1.29)
Middle income		1.05 (0.92, 1.18)		1.02 (0.90, 1.15)	1.05 (0.93, 1.17)
AA x low income		0.50 (0.33, 0.74)**			0.50 (0.35, 0.72)***
AA x middle income		0.59 (0.43, 0.82)**			0.61 (0.45, 0.89)**
Age <17[c]			0.97 (0.78, 1.21)	1.14 (0.97, 1.36)	0.94 (0.75, 1.19)
AA status x Age <17			1.31 (1.00, 1.71)		1.35 (0.98, 1.84)
Age <17 x low income				1.01 (0.67, 1.53)	1.15 (0.60, 2.20)
Age <17 x middle income				1.00 (0.66, 1.49)	1.15 (0.67, 1.97)
AA x Age <17 x low income					0.81 (0.36, 1.83)
AA x Age <17 x middle income					0.85 (0.40, 1.78)
Random Variance Intercept (SD)	0.03 (0.17)	0.03 (0.17)	0.03 (0.18)	0.03 (0.18)	0.04 (0.19)
Statistics comparisons					
Chi-square	1048.35	1073.93	128.72	1020.30	132.67
Degrees of freedom	1173	1171	144	1040	144

[a]White is the referent category for racial status
[b]High income is the referent category for income
[c]Age 17-19 is the referent category for maternal age
*p<.05, **p<.01, ***p<.001

Figure 6. Interaction between Racial Status and Neighborhood Income on Gestational Age

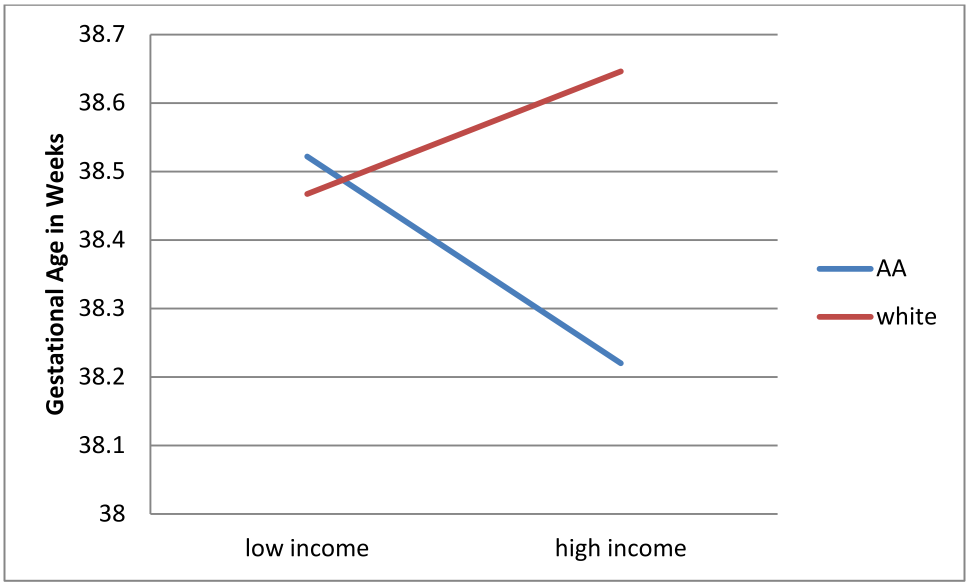
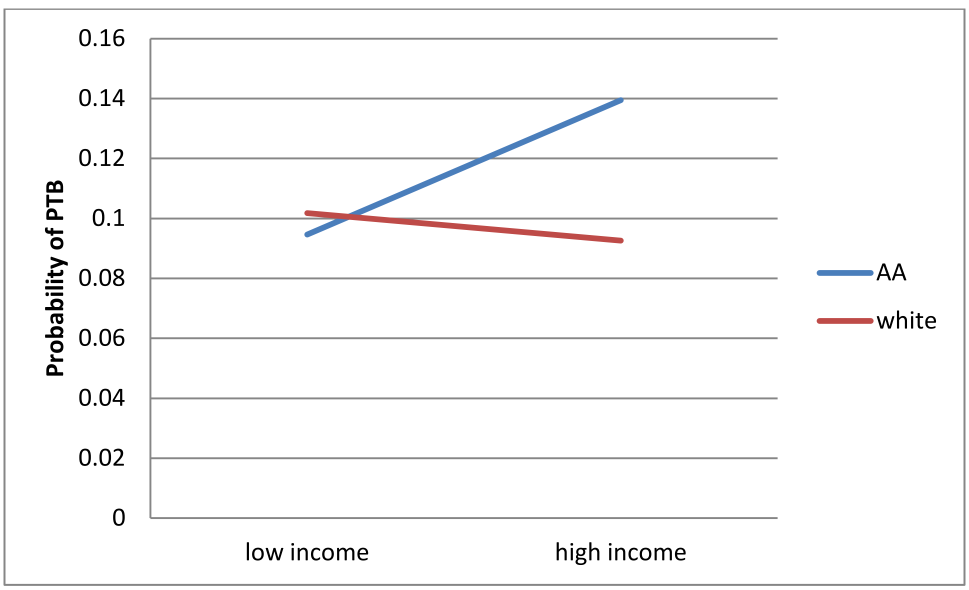


Figure 7. Interaction between Racial Status and Neighborhood Income on PTB Odds



CHAPTER VI

DISCUSSION

Summary of Study Findings

Through using an intersectional multilevel approach, this study examined and compared individual and structural factors between non-Hispanic African-American and white teen mothers as potential contributors to racial disparities in adverse birth outcomes for teen mothers. The two papers included in this dissertation focused on the results for birth weight and gestational age although more analyses were completed for health status (medical risk factor presence) and health behaviors (prenatal care and smoking) as outcomes according to the procedures outlined in Chapter 3.

These findings altogether indicated that neighborhood socioeconomic status, as defined by neighborhood risk and income, could potentially impact birth weight outcomes and racial disparities for teen populations. As found in both papers, African-American teens in areas of higher neighborhood risk and lower income had better birth outcomes than African-American teens living in more favorable circumstances. These results show that African-American teens experience unique health burdens based on racial status that consequentially contribute to health disparities across more affluent neighborhoods. These results were consistent with previous research with adult mothers (Collins, David, Simon, & Prachand, 2007) which identified disparities in adverse birth outcomes between African-American and white women in high income neighborhoods.

In contrast to expectations from previous studies, the worst birth outcomes were not found among African-American and white teens that lived in high-risk and low-income environments. These findings revealed the opposite in illustrating the highest disparities between African-American and white teens among the highest income groups. In addition, there was no reduction of racial disparities when accounting for SES which is contrary to other examinations of birth outcome disparities with adult populations (Lhila & Long, 2012; Schempf, Kaufman, Messer, & Mendola, 2011). Therefore, these socioeconomic factors used in this study might not sufficiently explain racial disparities in adverse birth outcomes for teen mothers in the same manner as adult mothers. Given these deviations from previous studies, more investigations on relationships between characteristics of socioeconomic status and racial disparities specifically among teen mothers are needed.

Although neighborhood risk and SES defined by income had significant relationships with birth weight and gestational age outcomes, neighborhood context as defined by these variables did not explain the majority of between-census-tract variance in these outcomes for this teen sample. The variables used in this dissertation were grounded in previous literature for older populations; however, other characteristics might better explain neighborhood context for teen populations. These results justify the previous assertion that more sensitive ways are needed for examining the effects of socioeconomic characteristics among teen populations (Doucette-Gates, Brooks-Gunn, & Chase-Lindale, 1998). Future studies could test alternate variables or improve the use of existing variables for explaining neighborhood context for teen populations.

In all models for birth outcomes, significant racial differences were found in context of maternal age. These findings also showed weaker relationships between younger age and adverse birth outcomes than suggested by prior literature (Chen et al., 2007; Gilbert et al., 2004). Although African-American teens in this sample were significantly younger than white teens and had a higher proportion of teens younger than 17 years old, racial differences in birth outcomes did not significantly vary by age group. Future research could explore racial differences more between age groups of teen mothers to clarify understanding on maternal age associations with birth outcome disparities.

Strengths

The main strength of this study comes from the use of multilevel modeling for examining the role of neighborhood context in explaining racial disparities within a teen mother sample. Previous research illustrated the continued significance of birth outcome disparities between African-American and white teen mothers when controlling for demographic, health status, and health behaviors (Coley & Aronson, 2013; Harville, Madkour, & Xie, 2012), and this study expands this research with the results that these disparities also continue in context of neighborhood factors.

Furthermore, this study also provides an example on how birth records data can be used in intersectional approaches to examine birth outcome disparities across a teen sample. To our knowledge, this study is among the first to examine these questions across a statewide sample of infants born to teen mothers using an intersectional framework. Therefore this study shows the utility that can come from using state birth records data to examine racial disparities in birth outcomes and the influence of neighborhood context and SES through an intersectional lens.

As a final strength, this study had the advantage of a large, multilevel dataset with a robust study sample. The study's use of census-tract data for operationalizing neighborhood characteristics builds on existing literature that found significant associations between neighborhood context and health outcomes (Messer, Vinikoor-Imler, & Laraia, 2012; Nkansah-Amankra, Dhawain, et al., 2010; Nkansah-Amankra, Luchok, et al., 2010). The large sample provided the statistical power necessary for examining subgroups of teen cases for interactions in accordance with other prior quantitative examinations (Nkansah-Amankra, Luchok, et al., 2010).

Limitations

This study was completed with several limitations. One main limitation includes the inability to sufficiently capture the concept of racial status in one demographic self-reported variable. Warner (2008) cautions against the use of "master categories" (i.e. race) that might lead to stereotypical viewpoints of results. To avoid stereotyping in quantitative health disparities research, future studies could explore related maternal stressors related to racial status such as racial discrimination and inequity. Current research on teen populations found associations for African-American teens that experience multiple forms of racial discrimination and poor health outcomes that exceed the contribution of a singular type (Grollman, 2012). This prior research justifies further investigation of these experiences for African-American teens.

Other limitations stem from the cross-sectional nature of the study in which no information was available about the length of time that the mothers spent in current residencies. Previous research noted detrimental effects of long-term poverty on birth outcomes for African-American women that grew up in deprived neighborhoods (Collins, Wambach, David, & Rankin, 2009; Love, David, Rankin, & Collins, 2010), and future research can explore similar longitudinal effects of deprived neighborhood environments for teen mothers.

Finally, limitations with the demographic variables and interactions were recognized with these analyses. Marital status was the only variable available for operationalizing social support. Although paternal demographic information was available in the birth records dataset, majority of teens had non-random missing data which makes data for these demographics unreliable for statistical analyses (Jones-Vessey, 2012). Therefore, more exploration on social support factors is needed for investigating racial disparities in teen populations. In addition, interactions can only capture limited understanding of intersections at the descriptive level (Cole, 2009). Therefore future studies could improve efforts to operationalize intersectionality in quantitative research.

Implications for Future Research

Several other factors should be explored to investigate further into these identified intersectional effects on birth outcomes. Future examinations need to explore these intersectional influences in context of other individual and interpersonal factors, community and social context. Maternal stress has been shown to influence birth outcomes (Rosenthal & Lobel, 2011), and prior research had also identified racial differences in types of maternal stress that mothers experience during pregnancy (Nkansah-Amankra, Luchok, et al., 2010). Moreover, pregnancies for African-American teen mothers could have stemmed from coercive circumstances and resulted in high biological stress from conception. Current research identified higher prevalence of sexual coercion and intimate partner violence among African-American teen females in comparison to the national average for teens (Howard, Debnam, & Wang, 2013; Kennedy et al., 2012). These interpersonal and environmental factors could lead to increased maternal stress for teen mothers and subsequently poorer outcomes, therefore future studies could investigate if these factors contribute to differences in maternal stress and subsequent birth outcomes between African-American and white teen mothers. More exploration on the influence of social support during pregnancy is also warranted, particularly from infants' fathers. Previous studies identified the lack of paternal support as a risk factor for teen mothers experiencing adverse birth outcomes, and this risk was more pervasive among African-American teen mothers (Alio, Mbah, Grunsten, & Salihu, 2011). Overall, disparities in social context could explain differences in trauma levels between African-American and white teen mothers, thus investigating social context and disparities could identify points of intervention in providing tailored support for African-American teen mothers during pregnancy.

Future examinations also need to explore these intersections in context of other community level factors. Madkour et al. (2013) identified significant racial differences in infant birth weight related to racial concentration of neighborhoods of teen mothers although neighborhood disadvantage did not have significant relationships among that study sample. Therefore, future intersectional examinations could investigate other factors related to neighborhood context. Future studies can also incorporate analyses of neighborhood factors at the census block level with teen populations which could explain greater proportions of differences in birth outcomes and associated disparities.

Overall, these results show that racial disparities can remain in birth weight and gestational age outcomes between African-American and white teen mothers in context of demographic, medical risk, and neighborhood factors. More research is needed regarding these racial disparities given these results. Despite the limitations in quantitative analyses, intersectional and multilevel approaches could be used as a starting point for discussion in ameliorating birth outcome disparities. As a critical step in intervention development, continued exploration of these disparities must continue for the benefits of enhancing perinatal services, improving birth outcomes, and reducing disparities among these teen populations.

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APPENDIX A

AIM 1 ANALYSES

The purpose of Aim 1 was to assess racial differences in individual-level maternal characteristics (demographics, health conditions, health behaviors) and birth outcome disparities between African-American and white teen mothers in North Carolina. Answering the questions for this aim identified which demographic and health risk factors had associations with birth outcomes to teen mothers and associated racial disparities.

NOTE: The North Carolina State Center of Health Statistics updated data collection standards for birth records data during the year 2010. As a result, variables for mothers' demographics, health conditions, and prenatal care use were unavailable for the 2010 dataset. This section covers analyses for the 2011 dataset in order to provide a comprehensive set of analyses for the questions outlined in Aim 1.

Descriptive Characteristics

Cases for a total of 8,302 teens were included in the descriptive analyses for 2011. Table A1 provides the demographic characteristics for the overall sample.

Table A1. Demographic Characteristics for 2011 Teen Mother Sample

Characteristic	N (%) or Mean ± SD
Race of mother	African-American = 3943 (47.5%) White = 4359 (52.5%)
Total prior pregnancies	0 = 6394 (77.0%) 1 = 1513 (18.3%) 2 = 318 (3.8%) 3 = 54 (0.7%) 4 or more = 22 (0.2%) Missing = 1
Prior pregnancies	No = 6394 (77.0%) Yes = 1907 (23.0%) Missing = 1
Mother's age	18.01 ± 1.18 Less than 17 years old = 978 (11.8%) 17-19 years old = 7324 (88.2%)
Mother's education	8th grade or less = 340 (4.1%) 9-12th grade; no diploma = 3816 (46.0%) High school graduate / GED = 2998 (36.1%) Education after high school = 1147 (13.8%) Missing = 1
Insufficient education (mothers 15 years and older having education 8th grade or less; mothers 19 years old having 9-12th grade education and no diploma)	Adequate education = 7008 (84.4%) Insufficient education = 1293 (15.6%) Missing = 1
Marital status	Married = 1004 (12.1%) Single = 7291 (87.9%) Unknown = 4
Birth weight in grams	3153.87 ± 576.78
Birth weight status	Normal = 7488 (90.2%) LBW = 810 (9.8%) Missing = 4
Gestational age (weeks)	38.62 ± 2.30
Birth term status	Normal = 7523 (90.7%) PTB = 775 (9.3%) Missing = 4
Mean number of prenatal visits	11.2 ± 4.05
Weight gained during pregnancy (pounds)	33.02 ± 16.35 Missing = 190
Medical Risk Factors	Pre-pregnancy diabetes = 21 (0.3%) Gestational diabetes = 179 (2.2%) Pre-pregnancy hypertension = 78 (0.9%) Gestational hypertension = 469 (5.6%) Eclampsia = 32 (0.4%) Previous PTB = 60 (0.7%) Other previous poor pregnancy outcomes = 36 (0.4%) Previous Cesarean = 197 (2.4%)
Smoking	Ever smoke before / during pregnancy = 1608 (19.4%)

Characteristic	N (%) or Mean ± SD
	Smoke 3 months before pregnancy = 1580 (19.0%) Smoke 3 months during pregnancy = 1156 (13.9%) Smoke 2nd 3 months during pregnancy = 938 (11.3%) Smoke 3rd 3 months during pregnancy = 890 (10.7%)
APNCU index	Inadequate = 1984 (23.9%) Intermediate = 608 (7.3%) Adequate = 2506 (30.2%) Adequate Plus = 3003 (36.2%) Missing = 201 (2.4%)

Aim 1 Questions

This section addresses the Aim 1 questions for 2011 as proposed in Chapter 3.

Aim 1, Question 1: Do the individual-level characteristics significantly differ between African-American and white teen mothers in this study?

a. Demographic hypotheses

   i. African-American teen mothers would be significantly younger than white teen mothers.

      a. A Mann-Whitney U test was completed to answer this hypothesis instead of an independent sample t-test due to age variable being a non-normally distributed variable. Results illustrate that African-American teen mothers are significantly younger than white teen mothers ($p<.05$).

   ii. A smaller proportion of African-American teen mothers would have sufficient education than White teens for their age.

      a. Chi-square statistics were completed to answer this hypothesis. Results illustrate that significantly <u>more</u> African-American teen mothers have sufficient education than White teens for their age (85.5% vs. 83.5% respectively, $p<.05$). Due to the direction of this hypothesis, we fail to reject the null hypothesis.

iii. Interpersonal: African-American teen mothers would be more likely to be single than white teen mothers.

a. Chi-square statistics were completed to answer this hypothesis. Results illustrate that significantly more African-American teen mothers are single than white teen mothers (97.6% vs. 78.9% respectively, $p<.05$).

b. Medical risk hypotheses

i. The prevalence of pre-existing risk factors would be greater among African-American mothers than white mothers.

a. Chi-square statistics were completed to answer this hypothesis. All assumptions were checked, and results illustrate that:

i. No significant differences exist between the number of African-American and white teens that have diabetes prior to pregnancy ($p=.139$).

ii. Significantly more African-American teens have hypertension prior to pregnancy than white teens (1.1% vs. 0.8% respectively, $p<.05$).

iii. No significant differences exist between the number of African-American and white teens that had a previous preterm birth (p=.149).

iv. No significant differences exist between the number of African-American and white teens that had previous poor pregnancy outcomes (p=.211).

v. No significant differences exist between the number of African-American and white teens that had previous cesarean births (p=.285).

ii. The prevalence of pregnancy risk factors would be greater among African-American mothers than white mothers.

a. Chi-square statistics were completed to answer this hypothesis. All assumptions were checked, and results illustrate that:

i. No significant differences exist between the number of African-American and white teens that have gestational diabetes (p=.075).

ii. No significant differences exist between the number of African-American and white teens that have gestational hypertension (p=.292).

iii. No significant differences exist between the number of African-American and white teens that have eclampsia (p=.207).

iii. The prevalence of prior pregnancies, births, and terminations would be greater among African-American mothers than white mothers.

   a. Mann-Whitney U tests were completed to answer these hypotheses for prior living children, prior live births of children now dead, prior terminations / ectopic pregnancies, and total prior pregnancies instead of independent sample t-tests due to these totals being non-normally distributed variables.

   b. Results illustrate that:

      i. The prevalence of prior living children is higher among African-American mothers than white mothers ($p<.05$).

      ii. No significant differences exist between the number of African-American and white teens that have prior live births of children now dead ($p=.561$).

      iii. The prevalence of terminations / ectopic pregnancies is higher among African-American mothers than white mothers ($p<.05$).

      iv. The number of total prior pregnancies is higher among African-American mothers than white mothers ($p<.05$).

iv. African-American mothers will report a higher number of medical risk factors that white mothers.

   a. A medical risk factor index was calculated by summing up the prepregnancy and pregnancy risk factors per person. A Mann-

Whitney U test was completed to answer this hypothesis instead of an independent sample t-test due to the MRF index being a non-normally distributed variable. Results illustrate that no significant differences exist between the total number of medical risk factors between African-American and white teens ($p=.239$).

c. Behavioral risk hypotheses

   i. African-American teen mothers would be less likely to smoke than white teen mothers.

      a. Chi-square statistics were completed to answer this hypothesis about smoking before and during pregnancy. Results illustrate that significantly less African American teens smoked before and during pregnancy than white teen mothers ($p<.05$).

   ii. African-American mothers would have lower PNC adequacy levels than white mothers.

      a. An independent sample t-test was completed first to answer the PNC visit hypothesis. Results illustrate that African American teens have significantly lower mean PNC visit numbers than white teen mothers ($p<.05$).

      b. Chi-square statistics were also completed to answer this hypothesis about PNC adequacy. Results illustrate that African American teens have significantly lower levels of PNC adequacy than white teen mothers ($p<.05$).

Aim 1, Question 2: Do the gestational ages and birth weights significantly differ among infants born to African-American and white teen mothers in this study?

a. Infants born to African American teens will have significantly lower mean gestational ages and birth weights than white teens.

   i. A Mann-Whitney U test was completed to answer the gestational age hypothesis instead of an independent sample t-test due to the gestational age variable being a non-normally distributed variable. Results illustrate that infants born to African American teens have significantly lower mean gestational ages than white teen mothers ($p<.05$).

   ii. An independent sample t-test was completed to answer the birth weight hypothesis. Results illustrate that infants born to African American teens have significantly lower mean birth weights in grams than white teen mothers ($p<.05$).

b. Infants born to African American teens will have significantly greater rates of PTB and LBW than white teens.

   i. Chi-square statistics were completed to answer this hypothesis for both PTB and LBW. Results illustrate that infants born to African American teens had significantly greater rates of PTB and LBW than white teens ($p<.05$).

Table A2 provides descriptive statistics by racial status and summarizes the Question 1 and 2 results.

Table A2. Maternal Statistics by Race and Significant Differences

	African-American (n=3943)	White (n=4359)	Significant differences at p < .05?
Total prior pregnancies	0 = 2925 (74.2%) 1 = 800 (20.3%) 2 = 175 (4.4%) 3 = 27 (0.7%) 4 or more = 16 (0.5%)	0 = 3469 (79.6%) 1 = 713 (16.4%) 2 = 143 (3.3%) 3 = 27 (0.6%) 4 or more = 6 (0.1%) Missing = 1	Yes
Prior pregnancies	No = 2925 (74.2%) Yes = 1018 (25.8%)	No = 3469 (79.6%) Yes = 889 (20.4%) Missing = 1	Yes
Mother's age	17.89 ± 1.27 Less than 17 years old = 570 (14.5%) 17-19 = 3373 (85.5%)	18.11 ± 1.08 Less than 17 years old = 408 (9.4%) 17-19 = 3951 (90.6%)	Yes
Insufficient education (mothers 15 years and older having education 8th grade or less; mothers 19 years old having 9-12th grade education and no diploma)	Adequate education = 3370 (85.5%) Insufficient education = 573 (14.5%)	Adequate education = 3638 (83.5%) Insufficient education = 720 (16.5%) Missing = 1	No
Marital status	Married = 91 (2.3%) Single = 3850 (97.6%) Unknown = 2 (0.1%)	Married = 916 (21.0%) Single = 3441 (78.9%) Unknown = 2 (0.1%)	Yes
Birth weight in grams	3034.44 ± 577.49	3261.85 ± 554.47	Yes
Birth weight status	Normal = 3528 (87.1%) LBW = 507 (12.9%) Missing = 3	Normal = 4055 (93.0%) LBW = 303 (7.0%) Missing = 1	Yes
Gestational age	38.48 ± 2.51	38.76 ± 2.08	Yes
Birth term status	Normal = 3528 (89.5%) PTB = 412 (10.4%) Missing = 3	Normal = 3996 (91.7%) PTB = 362 (8.3%) Missing = 1	Yes
Month of PNC initiation	3.47 ± 1.93	3.11 ± 1.56	
Mean number of prenatal visits	10.5 ± 4.2	11.9 ± 3.7	Yes
APNCU index	Inadequate = 1209 (30.7%) Intermediate = 309 (7.8%) Adequate = 1066 (27.0%) Adequate Plus = 1255 (31.8%) Missing = 104 (2.6%)	Inadequate = 775 (17.8%) Intermediate = 299 (6.9%) Adequate = 1440 (33.0%) Adequate Plus = 1748 (40.1%) Missing = 97 (2.2%)	Yes

	African-American (n=3943)	White (n=4359)	Significant differences at $p < .05$?
Medical Risk Factors	Pre-pregnancy diabetes = 7 (.2%) Gestational diabetes = 75 (1.9%) Pre-pregnancy hypertension = 45 (1.1%) Gestational hypertension = 229 (5.8%) Eclampsia = 18 (.5%) Previous PTB = 33 (.8%) Other previous poor pregnancy outcomes = 20 (.5%) Previous Cesarean = 98 (2.5%)	Pre-pregnancy diabetes = 14 (.3%) Gestational diabetes = 104 (2.4%) Pre-pregnancy hypertension = 33 (.8) Gestational hypertension = 240 (5.5%) Eclampsia = 14 (.3%) Previous PTB = 27 (.6%) Other previous poor pregnancy outcomes = 16 (.4%) Previous Cesarean = 99 (2.3%)	No except for pre-pregnancy hypertension; no significant differences in total number of medical risk factors
Smoking	Ever smoke before / during pregnancy = 349 (8.9%) Smoke 3 months before pregnancy = 336 (8.5%) Smoke 3 months during pregnancy = 227 (5.8%) Smoke 2^{nd} 3 months during pregnancy = 167 (4.2%) Smoke 3^{rd} 3 months during pregnancy = 149 (3.8%)	Ever smoke before / during pregnancy = 1259 (28.9%) Smoke 3 months before pregnancy = 1244 (28.5%) Smoke 3 months during pregnancy = 929 (21.3%) Smoke 2^{nd} 3 months during pregnancy = 771 (17.7%) Smoke 3^{rd} 3 months during pregnancy = 741 (17.0%)	Yes

Aim 1, question 3: What other individual-level characteristics are associated with adverse birth outcomes among the overall sample of teen mothers in this study?

a. Significant associations will exist between positive birth outcomes (higher gestational age, higher birth weights) and the following demographic factors: higher age and higher educational levels. (Both normal and non-parametric tests were completed for birth weight in grams depending on whether or not the assumption for equal variances was identified in the Levene's tests. All non-parametric tests – Mann-Whitney and Kruskal-Wallis tests were completed for gestational age associations because of the lack of normality in the gestational age distribution.)

i. Birth weight associations

   i. Age – An independent sample t-test was completed to compare birth weight means between age groups of teens. Results illustrate that older teens (age 17-19) have significantly higher birth weights than teen mothers less than 17 years old ($p<.05$).

   ii. Education levels – An ANOVA test was completed to compare birth weight means between the different educational levels of teens. Results illustrate that significant differences exist between teens in the 9^{th}-12^{th} grade and teens that graduated high school and have some college after HS graduation. No significant differences exist between teens that have less than 8^{th} grade education and teens of higher education levels. The Levene's test illustrated equal variances, so the ANOVA test is appropriate for this analysis w/o needing nonparametric tests.

   iii. Education sufficiency – An independent sample t-test was completed to compare birth weight means between teens of sufficient and insufficient education. No significant differences were found between the two groups of teens.

ii. Gestational age

i. Age – A Mann-Whitney test was completed to compare gestational age between age groups of teens. No significant differences were found between the two groups of teens.

ii. Education – The overall Kruskal-Willis tests do not show significant results (p>.05). Pairwise tests results illustrate that significant differences barely exist only between 1) teens with less than 8th grade education and teens in the 9th-12th grade (p=.049) and 2) teens in the 9th-12th grade and teens that have some college after HS graduation (p=.048). Contrary to hypotheses, teens with less than 8th grade education had higher gestational ages overall than teens in the 9th-12th grade. Teens that had some college education after HS graduation had higher gestational ages as expected. No significant differences were found in the other pairwise comparisons.

iii. Education sufficiency – A Mann-Whitney test was completed to compare gestational age between teens of sufficient and insufficient education. No significant differences were found between the two groups of teens.

b. Significant associations will exist between positive birth outcomes (higher gestational age, higher birth weights) and marital status as married.

iii. Birth weight associations - An independent sample t-test was completed to compare birth weight means between single and married teens. Results illustrate that married teens have significantly higher birth weights than unmarried teens (3301 vs. 3133 g respectively, $p<.05$).

iv. Gestational age - A Mann-Whitney test was completed to compare gestational age between marital groups of teens. No significant differences were found between the two groups of teens.

c. Significant associations will exist between negative birth outcomes (lower gestational age, lower birth weights) and the presence of medical risk factors: pre-existing medical risk factors, current pregnancy risk factors, and prior pregnancies.

v. Birth weight associations

i. MRFs – Independent sample t-tests were completed because birth weight in grams has a normal distribution. Results indicated that the following MRFs have significant associations with birth weight ($p<.05$): Gestational diabetes, Gestational hypertension, Eclampsia, Previous PTB, Other previous poor pregnancy outcomes. Pre-pregnancy diabetes, pre-pregnancy hypertension, and previous Cesareans did not have significant associations with birth weight. Gestational diabetes had an association w/higher birth weights whereas the other MRFs had associations with lower birth weights.

ii. MRF index – Pearson correlation was not completed due to the number of risk factors ranging from 0-3 and the large number of teens having no MRFs. An ANOVA test was completed first, and results illustrate significant differences exist in mean birth weight according to number of MRFs. Post-hoc tests show that differences exist between teens that have no MRF and those that have 1 MRF, but the rest of the groups do not have significant differences. However, the Levene's test showed that equal variances were not present as an assumption for this test ($p<.001$). Therefore a Kruskal-Wallis test and pairwise comparisons were also completed to confirm significance of differences between categories. It is possible that the low number of teens that have 2 or 3 MRFs compromise the validity of these results. (These results could stem from the MRF index only evaluating the count and not the type of MRF; gestational hypertension can carry greater weight than pre-pregnancy hypertension for example.)

iii. MRF presence – Due to the results for the MRF index, a new variable was computed (MRFpresence) to dichotomize teens in groups – 0 if teens have no MRFs and 1 if teens have at least 1 MRF. Results indicate that significant differences exist in birth weight in which teens that have at least one medical risk factor have lower birth weights than teens that do not have any MRFs ($p<.05$).

iv. Prior pregnancies - An independent sample t-test was completed to compare birth weight means between teens that had prior pregnancies vs. those that had no prior pregnancies. No significant differences were found between the two groups of teens.

v. Total prior pregnancies – Spearman rank correlation was completed because of the non-normal distribution for total prior pregnancies. There was not a significant correlation found between birth weight in grams and total of prior pregnancies.

vi. Gestational age

i. MRFs – Mann-Whitney tests were completed because gestational age has an abnormal distribution. Results indicated that all MRFs independently have significant associations with gestational age ($p<.05$): Pre-pregnancy diabetes, Gestational diabetes, Pre-pregnancy hypertension, Gestational hypertension, Eclampsia, Previous PTB, Other previous poor pregnancy outcomes, Previous Cesareans. All MRFs had associations with lower gestational ages.

ii. MRF index – Kruskal-Wallis results illustrate significant differences exist in gestational age according to number of MRFs. Post-hoc tests show that differences exist between teens that have no MRF and those that have 1, 2, or 3 MRFs, but no significant differences were found in the rest of the comparisons.

iii. MRF presence – Mann-Whitney results indicate that significant differences exist in gestational age in which teens that have at least one medical risk factor have lower gestational ages than teens that do not have any MRFs ($p<.05$).

iv. Prior pregnancies – A Mann-Whitney test was completed to compare mean gestational age between teens that had prior pregnancies vs. those that had no prior pregnancies. Results indicate that teens that had prior pregnancies had significantly lower gestational ages than teens w/no prior pregnancies ($p<.05$).

v. Total prior pregnancies – A Spearman rank correlation was completed because of the non-normal distribution for total prior pregnancies. A significant correlation was found where lower gestational ages were found with higher totals of prior pregnancies ($p<.05$).

d. Significant associations will exist between negative birth outcomes (lower gestational age, lower birth weights) and tobacco use.

vii. Birth weight associations

i. Ever smoked before / during pregnancy - An independent sample t-test was completed to compare birth weight means between teens that smoked at any time before / during pregnancy and those without any smoking history. No significant differences were found between the two groups of teens.

ii. Smoking before pregnancy - An independent sample t-test was completed to compare birth weight means between teens that smoked prior to pregnancy vs. those w/o prior smoking history. No significant differences were found between the two groups of teens.

iii. Smoking 3 months pregnant - An independent sample t-test was completed to compare birth weight means between teens that smoked during 1st 3 months of pregnancy vs. non-smoking teens. Results illustrate that teens that smoked during 1st 3 months of pregnancy had slightly lower birth weights than non-smoking teens ($p<.05$).

iv. Smoking 6 months pregnant - An independent sample t-test was completed to compare birth weight means between teens that smoked during 2nd 3 months of pregnancy vs. non-smoking teens. Results illustrate that teens that smoked during 2nd 3 months of pregnancy had slightly lower birth weights than non-smoking teens ($p<.05$). The differences were greater between these two groups than the differences between teens that smoked during 1st 3 months and non-smoking teens.

v. Smoking last 3 months of pregnancy - An independent sample t-test was completed to compare birth weight means between teens that smoked during 2nd 3 months of pregnancy vs. non-smoking teens. Results illustrate that teens that smoked during 2nd 3 months of pregnancy had slightly lower birth weights than non-smoking teens ($p<.05$). The differences were greatest in this comparison between these two groups.

viii. Gestational age

i. Smoking before pregnancy – A Mann-Whitney test was completed to compare birth weight means between teens that smoked at any time before / during pregnancy and those without any smoking history. No significant differences were found between the two groups of teens.

ii. Smoking before pregnancy – A Mann-Whitney test was completed to compare birth weight means between teens that smoked prior to pregnancy vs. those w/o prior smoking history. No significant differences were found between the two groups of teens.

iii. Smoking 3 months pregnant - A Mann-Whitney t-test was completed to compare birth weight means between teens that smoked during 1st 3 months of pregnancy vs. non-smoking teens. No significant differences were found between the two groups of teens.

iv. Smoking 6 months pregnant - A Mann-Whitney t-test was completed to compare birth weight means between teens that smoked during 2nd 3 months of pregnancy vs. non-smoking teens. No significant differences were found between the two groups of teens.

v. Smoking last 3 months of pregnancy - A Mann-Whitney t-test was completed to compare birth weight means between teens that smoked during 2nd 3 months of pregnancy vs. non-smoking teens. No significant differences were found between the two groups of teens.

e. Significant associations will exist between positive birth outcomes (lower gestational age, lower birth weights) and higher levels of PNC adequacy.

ix. Birth weight associations – An ANOVA test was completed first, and results illustrate significant differences exist in mean birth weight between PNC adequacy levels. Teens in the adequate PNC category had the highest mean birth weight in grams with teens in the adequate-plus category had the lowest. Significant mean differences were not found between the inadequate and intermediate categories, but all other categories had significant differences with each other. However, the Levene's test showed that equal variances were not present as an assumption for this test ($p<.001$). Therefore a Kruskal-Wallis test and pairwise comparisons were also completed to confirm significance of differences between categories.

x. Gestational age – Kruskal-Wallis results illustrate that significant differences exist in gestational age between teens in different PNC adequacy levels. Teens in the intermediate PNC category had the highest mean rank gestational age (i.e. higher than adequate PNC) with teens in the adequate-plus category had the lowest. With the Mann-Whitney tests, significant mean differences were not found between the inadequate and intermediate categories, but all other categories had significant differences with each other.

f. Significant associations will exist between birth outcomes and total weight gained.

xi. Birth weight associations

i. Continuous – A Pearson correlation was completed because of the normal distribution for weight gain. As expected, higher birth weight in grams was associated with higher amounts of weight gained during pregnancy (r=.276, p<.05).

ii. Weight gained categories (normal / underweight)

1. A t-test was conducted to determine if significant differences existed between normal and underweight teens and mean birth weight. Results illustrate that infants born to underweight teens had a significantly lower mean birth weight average than infants born to teens that gained more than 25 lbs (2944 lbs vs. 3245 lbs, respectively, p<.001).

2. A chi-square test was conducted to determine significant differences existed between normal and underweight teens with respect to infants of normal / LBW status. Results illustrate that significantly more underweight teens delivered LBW infants in comparison to teens that gained more than 25 lbs (16.2% vs. 6.8%, respectively, p<.001).

xii. Gestational age

i. Continuous – Spearman rank correlation was completed due to the non-normal distribution for gestational age. Weight gain was positively associated with higher gestational ages even though the correlation was less than the correlation between total weight gained and birth weight (.152, $p<.05$).

Question 3 results are summarized in Table A3.

Table A3.Maternal Characteristics and Significant Associations for Birth Weight and Gestational Age

Variable	Significant for birth weight?	Significant for gestational age?
Age	Yes; $p<.05$	No
Educational level	Mean Birth Weight: 8th grade = 3125g 9th grade = 3120g HS/GED = 3182g Some college = 3197g Yes; $p<.05$ only between 1) 9th-12th grade and HS/GED graduates and 2) 9th-12th grade and teens w/some college education	No overall ($p>.05$) Yes; $p<.05$ (barely) between 1) 8th grade or less and 9th-12th grade and 2) 9th-12th grade and teens w/some college education
Educational sufficiency	No	No
Marital status	Yes; $p<.05$	No
MRFs	Pre-pregnancy diabetes - No Gestational diabetes - Yes; $p<.05$ Pre-pregnancy hypertension – No Gestational hypertension - Yes; $p<.05$ Eclampsia - Yes; $p<.05$ Previous PTB - Yes; $p<.05$ Other previous poor pregnancy outcomes - Yes; $p<.05$ Previous Cesarean - No	Pre-pregnancy diabetes - Yes; $p<.05$ Gestational diabetes - Yes; $p<.05$ Pre-pregnancy hypertension – Yes; $p<.05$ Gestational hypertension - Yes; $p<.05$ Eclampsia - Yes; $p<.05$ Previous PTB - Yes; $p<.05$ Other previous poor pregnancy outcomes - Yes; $p<.05$ Previous Cesarean - Yes; $p<.05$
MRF index	None – 3172 g 1 MRF – 3014 g 2 MRF – 3081 g 3 MRF – 3027 g Yes; $p<.05$ between none & 1 MRF	Yes; $p<.05$ between 0 MRFs and all other MRF levels; not significant between 1 & 2 MRFs, 1 &3 MRFs and 2 & 3 MRFs
MRF presence	Yes; $p<.05$	Yes; $p<.05$
Prior pregnancy status	No	Yes; $p<.05$
Total prior pregnancies	No	Yes; $p<.05$, but weak correlation (-.022)
Tobacco use	Ever smoke – No 3 months before – No 3 months – Yes; $p<.05$ Six months – Yes; $p<.05$	Ever smoke – No 3 months before – No 3 months – No Six months – No

Variable	Significant for birth weight?	Significant for gestational age?
	Last 3 months - Yes; p<.05	Last 3 months – No
PNC adequacy	Inadequate – 3146 g Intermediate – 3225 g Adequate – 3271 g Adequate plus – 3066 g Yes; p<.05 except between intermediate and adequate	Yes; p<.05 except between intermediate and adequate

Aim 1, question 4: Are there racial differences in birth outcomes between African-American and white teen mothers after controlling for demographic, medical risk, and behavioral factors?

Sequential multiple linear regressions were completed to determine if the association between African-American racial status, birth weight, and gestational age changed when controlling for other health risk factors. Birth weight in grams and gestational age functioned as the dependent variables for infant birth outcomes. (Due to the negatively skewed distribution of the gestational age variable, a natural-log transformation was performed and separate analyses were run to confirm the results.) The existence of the racial contribution after controlling for risk and behavior factors was assessed by looking at the significance level for beta weight for race in the final model.

Sequential multiple logistic regressions were also completed to determine if the association between African-American racial status and adverse birth outcomes (LBW, PTB) changed when controlling for other demographic and health risk factors. Birth weight status (normal / LBW) and gestational age status (normal / PTB) functioned as the dependent variables for infant birth outcomes. The existence of the racial contribution after controlling for risk and behavior factors was assessed by looking at the significance level for odds ratios for race in the final model for each outcome.

Variables were entered in the regression models for each outcome according to the following process:

- Model 1 included demographic independent variables only (race, age, education, & marital status). Age groups were used (less than 17, 17-19) because of the non-normal distribution of the variable. Education was entered in Model 1 in three dummy variables (8th grade or less, 9th-12th grade, HS/GED) with the HS plus category excluded from the model as the referent group.
- Model 2 added medical risk presence (yes / no) and prior pregnancies (yes / no) to test the additive contribution of these factors while holding everything else constant. Given the non-normal nature of the medical risk variable and lack of significant differences between 2 or more medical risk counts and birth outcomes, medical risk presence was entered as a dichotomous variable (0 = no medical risks, 1 = one or more medical risks). Prior pregnancies was also added as a dichotomous variable (0 = no prior pregnancies, 1 = one or more prior pregnancies).
- Model 3 added the behavioral independent variables (tobacco use and prenatal care adequacy). Based on the results for Question 2, smoking was entered in step 3 in two dummy variables for smoking pre-pregnancy and smoking during pregnancy. Prenatal care adequacy was entered in step 3 in three dummy variables

for inadequate, intermediate, and adequate plus prenatal care. The adequate prenatal care category served as the referent group and was not entered into the model.

Tables 4 through 7 provide the results from the regression models. These findings illustrate significant racial disparities in all birth and maternal outcomes among North Carolina teen mothers after accounting for other demographic and medical risk characteristics, mother's education, smoking status & prenatal care adequacy. Therefore the racial disparities in adverse birth outcomes cannot be fully explained by just looking at demographic, behavioral, and medical risk characteristics. Comparing these results to previous literature reveals the following similarities and differences:

- African American teen mothers experienced higher rates of low birth weight births and preterm births than White teen mothers, and this finding resembles previous statistics for mothers in older age groups.
- Based on previous literature, it was unexpected that younger age (less than 17 years old) did not have significantly contribute to differences in birth weight nor gestational age in the final model when controlling for other factors.

These analyses also point to the need to examine social, economic, and environmental factors for explaining racial disparities in teen moms. These models only explained 8.0% of variation in birth weight and 10.7% of variation in gestational age. These low percentages indicate that further exploration is needed for other factors associated with these outcomes.

Table A4. Multiple Regression Analysis Summary for Birth Weight in Grams

Independent variables	Model 1			Model 2			Model 3		
	B	S.E.	β	B	S.E.	β	B	S.E.	β
Intercept	3286.58***	18.84***		3302.91***	18.99***		3426.08***	21.08***	
Demographic									
African American (AA) [a]	-208.69***	13.22***	-0.18***	-207.47***	13.23***	-0.18***	-238.29***	13.62***	-0.21***
Age [b]	15.70	21.19	0.01	9.87	21.39	0.01	6.84	21.28	<0.01
Education - ≤ 8th grade	-78.27*	37.24*	-0.03*	-72.63	37.21	-0.03	-52.68	36.86	-0.02
Education – 9th-12th, no diploma	-59.20**	19.95**	-0.05**	-58.57**	19.91**	-0.05**	-49.13*	19.68*	-0.04*
Education – HS/GED	-13.85	19.95	-0.01	-13.17	19.87	-0.01	-11.13	19.55	-0.01
Marital status	64.22**	20.75**	0.04**	65.49**	20.74**	0.04**	51.53*	20.46*	0.03*
Medical Risk MRF									
presence Previous				-157.99***	19.57***	-0.09***	-144.90***	19.28***	-0.08***
pregnancy				8.02	15.47	0.01	16.49	15.31	0.01
Tobacco Use									
Before pregnancy							24.64	27.90	0.02
During pregnancy							-163.84***	31.03***	-0.10***
Prenatal Care Adequacy variables [c]									
Inadequate							-72.19***	17.09***	-0.06***

Table A4 cont.

Independent variables	Model 1			Model 2			Model 3		
	B	S.E.	β	B	S.E.	β	B	S.E.	β
Intermediate							-18.46	25.25	-0.01
Adequate Plus							-204.61***	15.08***	-0.18***
R^2	.04			.05			.08		

[a] Reference group = White Non-Hispanic

[b] Reference group = 17-19 years old

[c] Reference group = Adequate prenatal care

*p<.05, **p<.01, ***p<.001

Table A5. Multiple Regression Analysis Summary for Low Birth Weight

Independent variables	Model 1		Model 2		Model 3	
	OR	95% CI	OR	95% CI	OR	95% CI
Demographic						
African American (AA) [a]	1.90***	(1.61, 2.24)***	1.90***	(1.61, 2.25)***	2.19***	(1.83, 2.62)***
Age [b]	1.07	(0.84, 1.36)	1.11	(0.87, 1.42)	1.16	(0.90, 1.50)
Education - ≤ 8th grade	0.99	(0.63, 1.55)	0.96	(0.60, 1.51)	0.93	(0.59, 1.48)
Education – 9th-12th, no diploma	1.07	(0.84, 1.36)	1.07	(0.83, 1.36)	1.03	(0.81, 1.32)
Education – HS/GED	0.88	(0.69, 1.13)	0.88	(0.68, 1.13)	0.87	(0.67, 1.11)
Marital status	0.84	(0.62, 1.13)	0.83	(0.61, 1.12)	0.88	(0.65, 1.19)
Medical Risk MRF						
presence Previous			2.48***	(2.05, 3.02)***	2.40***	(1.97, 2.92)***
pregnancy			0.93	(0.77, 1.12)	0.91	(0.75, 1.10)
Tobacco Use						
Before pregnancy					0.76	(0.50, 1.16)
During pregnancy					2.09**	(1.35, 3.25)**
Prenatal Care Adequacy variables [c]						
Inadequate					1.57***	(1.23, 2.00)***
Intermediate					1.10	(0.74, 1.61)
Adequate Plus					2.81***	(2.27, 3.47)***

Table A5 cont.

Independent variables	Model 1		Model 2		Model 3	
	OR	95% CI	OR	95% CI	OR	95% CI
R^2 (Cox & Snell)	.01		.02		.04	
R^2 (Nagelkerke)	.02		.04		.08	

[a] Reference group = White Non-Hispanic
[b] Reference group = 17-19 years old
[c] Reference group = Adequate prenatal care
*p<.05, **p<.01, ***p<.001

Table A6. Multiple Regression Analysis Summary for Gestational Age

Independent variables	Model 1			Model 2			Model 3		
	B	S.E.	β	B	S.E.	β	B	S.E.	β
Intercept	38.77***	0.11***		38.90***	0.08***		39.49***	0.08***	
Demographic									
African American (AA) [a]	-0.23***	0.05***	-0.03***	-0.21***	0.05***	-0.05***	-0.27***	0.05***	-0.06***
Age [b]	-0.12	0.09	-0.02	-0.20*	0.09*	-0.03*	-0.20*	0.09*	-0.03*
Education - ≤ 8th grade	0.24	0.15	0.02	0.31*	0.15*	0.03*	0.26	0.14	0.02
Education – 9th-12th, no diploma	-0.02	0.08	-0.01	<0.01	0.08	<0.01	-0.02	0.08	-0.01
Education – HS/GED	0.06	0.08	0.01	0.07	0.08	0.02	0.08	0.08	0.02
Marital status	0.04	0.08	0.01	0.08	0.08	0.01	0.04	0.08	0.01
Medical Risk MRF									
presence Previous				-0.97***	0.08***	-0.14***	-0.88***	0.08***	-0.13***
pregnancy				-0.16*	0.06*	-0.03*	-0.16**	0.06**	-0.03**
Tobacco Use									
Before pregnancy							0.08	0.11	0.01
During pregnancy							-0.15	0.12	-0.02
Prenatal Care Adequacy variables [c]									
Inadequate							-0.40***	0.07***	-0.08***

Table A6 cont.

Independent variables	Model 1			Model 2			Model 3		
	B	S.E.	β	B	S.E.	β	B	S.E.	β
Intermediate							<0.01	0.10	<0.01
Adequate Plus							-1.21***	0.06***	-0.26***
R^2	<0.01			.03			.08		

[a] Reference group = White Non-Hispanic
[b] Reference group = 17-19 years old
[c] Reference group = Adequate prenatal care
*p<.05, **p<.01, ***p<.001

Table A7. Multiple Regression Analysis Summary for Preterm Birth

Independent variables	Model 1		Model 2		Model 3	
	OR	95% CI	OR	95% CI	OR	95% CI
Demographic						
African American (AA) [a]	1.25**	(1.07, 1.48)**	1.22*	(1.03, 1.44)*	1.31**	(1.10, 1.57)**
Age [b]	1.15	(0.89, 1.47)	1.29	(1.00, 1.67)	1.28	(0.98, 1.67)
Education - ≤ 8th grade	0.88	(0.57, 1.38)	0.83	(0.53, 1.31)	0.87	(0.55, 1.38)
Education – 9th-12th, no diploma	0.92	(0.59, 1.44)	0.82	(0.65, 1.05)	0.81	(0.64, 1.04)
Education – HS/GED	0.80	(0.63, 1.02)	0.78	(0.61, 0.99)	0.77*	(0.60, 0.99)*
Marital status	0.93	(0.71, 1.23)	0.89	(0.68, 1.17)	0.94	(0.71, 1.25)
Medical Risk MRF						
presence Previous			2.31***	(1.89, 2.81)***	2.18***	(1.78, 2.67)***
pregnancy			1.29**	(1.08, 1.55)**	1.29**	(1.07, 1.55)**
Tobacco Use						
Before pregnancy					0.83	(0.56, 1.26)
During pregnancy					1.45	(0.94, 2.25)
Prenatal Care Adequacy variables [c]						
Inadequate					3.85***	(2.82, 5.27)***
Intermediate					2.20**	(1.39, 3.47)**
Adequate Plus					7.20***	(5.40, 9.59)***

Table A7 cont.

Independent variables	Model 1		Model 2		Model 3	
	OR	95% CI	OR	95% CI	OR	95% CI
R^2 (Cox & Snell)	<.01		.01		.05	
R^2 (Nagelkerke)	<.01		.03		.11	

[a] Reference group = White Non-Hispanic

[b] Reference group = 17-19 years old

[c] Reference group = Adequate prenatal care

*p<.05, **p<.01, ***p<.001

APPENDIX B

DEVELOPMENT OF NEIGHBORHOOD RISK INDEX

Principal component analyses (PCA) were used to create a "neighborhood risk" index based on the creation of neighborhood deprivation variables in previous research (Madkour, Harville, & Xie, 2013; Messer et al., 2006; O'Campo et al., 2008). The following census-tract variables were considered for this index: median household income, poverty proportion, unemployment rate, percentage of people 25 years old and older with no high school diploma, percentage of people 25 years old and older with high school diploma or more, percentage of households headed by single females with children younger than age 18, percentage of households that received public assistance, the Gini inequality index, teen pregnancy incidence rate, household crowding, and proportion of households residing in rental housing. These variables were chosen based on prior research (Janevic et al., 2010; Madkour et al., 2013; Messer et al., 2008; Nkansah-Amankra, Dhawain, Hussey, & Luchok, 2010; O'Campo et al., 2008; Schempf, Kaufman, Messer, & Mendola, 2011). SPSS v.21 was used to complete these analyses.

For the first analysis, the variables loaded on three components. Total variance explained in the first component was 49.2%; the second explained an additional 11.3%; the third explained an additional 9.1%. Teen pregnancy incident rate and household crowding had loadings less than .3 on component 1, so these variables were removed for the second analysis. (See Tables B1 & B2 for these results.)

Table B1. Total Variance Explained for First PCA

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.416	49.238	49.238	5.416	49.238	49.238
2	1.240	11.272	60.510	1.240	11.272	60.510
3	1.001	9.104	69.614	1.001	9.104	69.614
4	.937	8.517	78.131			
5	.843	7.660	85.791			
6	.470	4.274	90.065			
7	.426	3.876	93.941			
8	.223	2.023	95.964			
9	.201	1.828	97.793			
10	.142	1.295	99.088			
11	.100	.912	100.000			

Table B2. Component Matrix for First PCA

	Component		
	1	2	3
Gini index	.465	.040	-.400
Median household income	.876	-.073	-.101
Teen pregnancy incidence rate	.208	-.189	.558
Percentage of people 25 years old and older – no diploma	.739	-.585	-.091
Percentage of people 25 years old and older – HS graduate or higher	.763	.559	-.036
Poverty proportion	.916	.119	-.058
Unemployment rate	.757	.159	-.033
Percentage of households headed by a single female householder with children age 18 and younger	.688	.484	.125
Percentage of households receiving public assistance	.911	.076	-.045
Percentage of households residing in rental housing	.683	.501	.139
Household crowding (occupants per room ≥ 1.51)	.280	-.107	.684

For the 2nd analysis, the variables loaded on two components. Total variance explained in the first component was 58.8%; the second explained an additional 13.7%. While all variables had loadings greater than .3, percentage of people 25 years old and older with high school diplomas or higher had a -.893 correlation with the percentage of people 25 years old and older with no high school diploma. This correlation was the highest among the variables. This high correlation means that these variables measure items that are too similar because the correlation was ~.9. (See Tables B3 & B4 for these results.) Because the non-high school diploma rate variable had a lower loading than the high school graduation rate variable, the non-high school diploma rate variable was taken out for the model and analyses were redone.

Table B3. Total Variance Explained for Second PCA

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.289	58.764	58.764	5.289	58.764	58.764
2	1.231	13.679	72.443	1.231	13.679	72.443
3	.877	9.742	82.185			
4	.485	5.392	87.576			
5	.429	4.767	92.343			
6	.229	2.546	94.889			
7	.210	2.334	97.224			
8	.148	1.639	98.863			
9	.102	1.137	100.000			

Table B4. Component Matrix for Second PCA

	Component	
	1	2
Gini index	.469	.029
Median household income	.876	-.084
Percentage of people 25 years old and older – no diploma	.736	-.607
Percentage of people 25 years old and older – HS graduate or higher	.760	-.571
Poverty proportion	.914	.113
Unemployment rate	.762	.139
Percentage of households headed by a single female householder with children age 18 and younger	.685	.480
Percentage of households receiving public assistance	.912	.059
Percentage of households residing in rental housing	.682	.512

For the third analysis, variable loaded on only one component with the total variance explained as 60.1%. Therefore, taking out the additional educational variable further improved the variance explained with this component when compared with the previous analyses. (See Tables B5 & B6 for these results.) This component served as the final neighborhood risk index to use for the Aim 2 analyses.

Table B5. Total Variance Explained for Third PCA

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.807	60.084	60.084	4.807	60.084	60.084
2	.931	11.636	71.719			
3	.793	9.915	81.634			
4	.482	6.028	87.663			
5	.426	5.330	92.993			
6	.214	2.679	95.672			
7	.199	2.486	98.158			
8	.147	1.842	100.000			

Table B6. Component Matrix for Third PCA

	Component 1
Gini index	.483
Median household income	.868
Percentage of people 25 years old and older – HS graduate or higher	.692
Poverty proportion	.925
Unemployment rate	.773
Percentage of households headed by a single female householder with children age 18 and younger	.724
Percentage of households receiving public assistance	.913
Percentage of households residing in rental housing	.727

The final neighborhood risk index included these variables: census tract median household income, poverty proportion, unemployment rate, percentage of people 25 years old and older with high school diplomas or higher, percentage of households headed by single females that have children younger than age 18, percentage of households that receive public assistance, the Gini index, and proportion of households residing in rental housing. Higher values of this index indicate more neighborhood risk, whereas lower values of this index indicate less neighborhood risk.

The correlation matrix for the variables included in the final index is on the next page. All correlations were statistically significant ($p<.001$).

Table B7. Correlation Matrix for Variables Included in Neighborhood Risk Index

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) Gini index		.429	.467	.260	.243	.379	.184	.254
(2) Median household income	.429		.774	.589	.681	.733	.492	.590
(3) Poverty proportion	.467	.774		.660	.612	.833	.635	.645
(4) Unemployment rate	.260	.589	.660		.457	.704	.515	.500
(5) Percentage of people 25 years old and older – HS graduate or higher	.243	.681	.612	.457		.639	.305	.280
(6) Percentage of households receiving public assistance	.379	-733	.833	.704	.639		.668	.574
(7) Percentage of households headed by a single female householder w/children age 18 and younger	.184	.492	.635	.515	.305	.668		.596
(8) Percentage of households residing in rental housing	.254	.590	.645	.500	.280	.574	.596	

APPENDIX C

IRB APPROVAL

IRB <irbcorre@uncg.edu> Wed, May 15, 2013 at 12:00 PM
To: slcoley@uncg.edu
Cc: trnicho2@uncg.edu, rearonso@uncg.edu
To: Sheryl Coley
School of Nursing

From: UNCG IRB

Date: 5/15/2013

RE: Determination that Research or Research-Like Activity does not require IRB Approval

Study #: 13-0098

Study Title: Multi-level correlates of pregnancy outcomes and racial disparities in pregnancy outcomes for teen mothers in North Carolina.

This submission was reviewed by the above-referenced IRB. The IRB has determined that this submission does not constitute human subjects research as defined under federal regulations [45 CFR 46.102 (d or f)] and does not require IRB approval.

Study Description:

The purpose of this study is to explore the impact of demographic and neighborhood factors on prenatal care utilization and birth outcomes to teen parents, and to explore factors that may help to explain racial disparities in these outcomes. In contrast to previous research, this quantitative analysis will incorporate a deeper social ecological lens with the additional focus on neighborhood factors and their impact on teen parents' prenatal care utilization and birth outcomes. This proposed study will examine:

- Adequacy of prenatal care utilization among teen parents through the use of Kotelchuck's index
- Parental demographics and residence and potential correlation with prenatal care and birth outcomes

- Neighborhood factors surrounding teen parents' residence and potential correlation with prenatal care and birth outcomes

This study will use geocoded (census tract) and deidentified birth certificate records provided by the NC State Center for Health Statistics, including all birth records in NC from 2009-2012.

If your study protocol changes in such a way that this determination will no longer apply, you should contact the above IRB before making the changes.

CC:

Tracy Nichols, Public Health Education

Robert Aronson, Public Health Education