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The Impacts of Race, Residence, and Prenatal Care on Infant Mortality

Mary Christine Dorley
Walden University

Walden University

College of Health Sciences

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Mary Christine Dorley

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Review Committee
Dr. Patrick Tschida, Committee Chairperson, Public Health Faculty
Dr. Aimee Ferraro, Committee Member, Public Health Faculty
Dr. Shingairai Feresu, University Reviewer, Public Health Faculty

Chief Academic Officer and Provost
Sue Subocz, Ph.D.

Walden University
2019

Abstract

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by

Mary Christine Dorley

MSP, Cumberland University, 1999

BS, Western Kentucky University, 1992

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Public Health

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Abstract

Tennessee ranks high for infant mortality (IM) in the United States. Despite public health efforts, the IM rate for Blacks is twice that of Whites mimicking what is observed nationally. Several risk factors for IM have been identified; however, it was still unclear how places of residence and prenatal care (PNC) affect IM for Tennesseans. The purpose of this study was to assess the relationship between places of residence (conceptualized by rurality and racial concentration), PNC, and IM among racial groups across Tennessee and to determine if race modified these associations. This was a cross-sectional study using data from the Tennessee PRAMS survey (2009-2011) and geocoded to 2010 U.S. Census Bureau and U.S. Department of Agriculture data. The study was grounded on the theory of racial residential segregation and concentrated poverty. General linear model (GLM) and hierarchical binomial logistic regression were used to analyze the data. High racial concentration was associated with IM for Non-Hispanic women and remained significant even after controlling for demographic variables (*aOR* = 5.33, *95%CI [*1.11, 25.67*]*). Disparity in PNC access for Blacks, Other races, and Hispanics were observed based on racial concentration and rurality; however, PNC was not a risk factor for IM. Black race modified the relationship between high racial concentration and IM. Implications for social change include greater public awareness, education on risk factors, advocacy to decrease disparities in access to care, and resource allocation to highly impacted areas potentially mitigating health outcomes for the most vulnerable women and infants.

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Dedication

First, I dedicate my dissertation to my mother, Martha A. Lane who has always showered me with unconditional love. Secondly, I dedicate my dissertation to my father Mohammed A. Dorley, who wanted to obtain his doctorate but never had the opportunity and who has already added to his vocabulary "What's up Doc." Lastly, I dedicate this dissertation to the women of Tennessee who have been impacted by infant mortality. There are many of you who have dealt with this heartbreaking issue; it is my hope that this work can make a difference.

Acknowledgments

I thank my committee, Dr. Patrick Tschida, Dr. Aimee Ferraro, and Dr. Shingairai Feresu for always giving great advice and keeping me on task. I acknowledge Dr. Michael Kimberly and Dr. David Smalley, who mentored me and were instrumental in directing me to take this journey to further my education. To my siblings, thank you for supporting me in all of my endeavors; for this I am eternally grateful. To my "sister circle," your friendship has meant so much to me. You encouraged me to keep going when I wanted to give up and you perfectly understood when I had to say no to your invitations and even when I said yes, you tolerated my reasons for bringing my laptop. To Nichelle Foster, thank you for accompanying me to the Walden University informational meeting and helping me to jump start this process. Your care and concern are appreciated and your sistership is beyond compare. To Arnita McKeever, my forever sister, thank you for checking up on me and for your timely reminders to always back-up my computer hard drive and to email myself copies of my dissertation just in case. To Dr. Everald Walker, thank you for being my cheerleader and for giving me the extra encouragement when it was needed the most. To all of my extended family and friends, thank you for your continued boosts of confidence; your support of my ambition is incredible. Thank you Dr. Yinmei Li and Dr. Ellen Zheng for helping me to navigate PRAMS and to access the U.S. Census tables. To my team at the Tennessee Department of Health Newborn Screening Laboratory and many others colleagues, thank you for your kindness and always affirming that yes, achieving my doctorate was possible!

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Chapter 1: Introduction to the Study

Infant mortality (IM) is the death of an infant before the first year of life (Matthews & Driscoll, 2017). When expressed as a rate, IM is the number of infant deaths per 1,000 live births (Johansson et al., 2014). IM comprises neonatal mortality or death before 28 days of life and postneonatal mortality or death between 28 and 365 days of life (Collins, Soskolne, Rankin, & Bennett, 2013). The IM rate, therefore, serves as an epidemiologic measure with utility as a health indicator for comparing the health status within a country or among countries (He, Akil, Aker, Hwang, & Ahmad, 2015; Mantoba & Collins, 2017). In a comparison of IM rates for 36 economically developed nations in 2016, the United States ranked 32nd for IM, with almost three times the rate of Japan and twice that of Germany (Organisation for Economic Co-operation and Development [OECD], 2016), thereby highlighting global disparity.

Similar disparity has been observed across the United States, as evidenced by the IM rate comparison between New Hampshire and Tennessee. In 2017, New Hampshire ranked lowest in the nation for IM with a rate of 4.2 deaths per 1,000 live births, far below the national average of 5.9 deaths per 1,000 live births (America's Health Rankings [AHR], 2017). In contrast, Tennessee had one death more than the national average (6.9 deaths per 1,000 live births) and ranked 38th (AHR, 2017). This disparity has also been observed across Tennessee counties (County Health Rankings & Roadmaps [CHRR], 2018) and across racial groups (Matthews, MacDorman, & Thoma, 2015) in the state. The IM rate for African Americans (hereafter Blacks) for 2017 averaged 1.96 times that of non-Hispanic Whites (hereafter Whites) and 2.33 times that of Hispanics (AHR, 2017). The rate gap for Blacks and Whites and for Blacks and Hispanics has further highlighted the disproportionate burden of IM for Blacks in Tennessee (Tennessee Department of Health [TDH], 2014a).

Similar racial disparities have extended into other disease rates such as ovarian and breast cancers (Callaghan, 2014; Onega, Duell, Shi, Demindenko, & Goodman, 2010), cancer treatments (Onega et al., 2010), and cancer mortality (Callaghan, 2014). Researchers have attributed racial disparity in cancer care (Onega et al., 2010) and differences in mortality and life expectancy to places of residence (Singh & Siahpush, 2014). These observations have partly reflected the context of Southern states with a history of racial segregation especially during the 1950s and 1960s (Smith, 2005). Segregation not only limited housing, education, and employment (Bailey et al., 2017) but extended to the provision of health care services and other humanitarian assistance much to the disadvantage of Blacks (Zheng, 2016). Although segregation officially ended with the passage of the Civil Rights Act of 1964, the lingering effects of poor health services provided under segregation to Blacks endures (Feagin & Bennefield, 2013; Bailey et al., 2017).

The past history of racial segregation, the higher IM ranking, and rate disparity across races for Tennessee were reasons to evaluate an assocation between prenatal care (PNC), places of residence utilizing neighborhoods as units of analysis (measured by census tracts consisting of rurality and racial concentration), and IM across racial groups residing in the State of Tennessee. As researchers have estimated that reducing the U.S. IM rate to that of Scandanavian countries will save an average of 84 billion dollars each year using standard value of life estimates (Chen, Oster & Williams, 2016), the results from this study may support efforts to reduce IM rates in Tennessee and advise stakeholders and policy makers in targeting funding to assist areas highly impacted by IM. Specifically, these results may pinpoint places of residence where there are increased rates of IM and identify factors contributing to the variation in rates that stakeholders and policy makers can use in targeting funding and programming.

Chapter 1 begins with the study background showing the inconsistent findings from previous researchers studying these issues. I include a problem statement which highlights existing gaps within the literature of which this study was intended to fill. In this chapter, I also detail the purpose of the study along with specific research questions and hypotheses identifying the specific variables included in the study. In addition, this chapter includes an outline of the theoretical foundation and nature of the study as well as key definitions of terms used in the study. Last, the assumptions, scope and delimitations, limitations, and significance of the study are discussed before a final summary that leads to the literature review in Chapter 2.

Background

Discriminatory practices have contributed to social inequalities within the United States resulting in poor health outcomes for Blacks and other minority groups (Bailey et al., 2017). Discriminatory practices stemming from segregation, for example in employment and housing, created racialized neighborhoods (Feagin & Bennefield, 2013) that have not differed demographically from what has existed in the past (Bailey et al., 2017). Segregation extended into health care with hospitals designated as Black or White and few Black doctors who were available to care for Blacks in the South (Smith, 2005; Zheng, 2016). Rarely would a White doctor treat a Black patient; consequently, some Blacks died from treatable illnesses that stemmed from the lack of access to medical attention (Zheng, 2016). With limited availability of Black physicians during segregation, most Black women delivered their babies with the help of a midwife or layperson (Smith, 2005).

Despite midwifery services, the IM rates for other races including Blacks exceeded the rate for Whites in Tennessee. For example, in 1950 the IM rate for Whites was 34.0 deaths per 1,000 live births but was 46.2 deaths per 1,000 live births for non-Whites with a IM rate gap of 1.36 (Centers for Disease Control and Prevention [CDC], 2015; see Figure 1). One year prior to the end of legal segregation in 1964, IM rates in Tennessee had declined for Whites (23.5 per 1,000 live births) but changed little for non-Whites (44.2 per 1,000 live births) contributing to an increase in the IM rate gap to 1.88 (CDC, 2015). The post segregation era brought declines in IM rates for both Whites and non-Whites, and this decrease has been attributed to hospital desegregation (Elder, Goddeeris, & Haider, 2016). By 1974, Whites had an IM rate of 15.1 deaths per 1,000 live births whereas other races had 25.2 deaths per 1,000 live births equating to a lowered IM rate gap of 1.67 (CDC, 2015). Although Tennessee has documented efforts to reduce IM such as decreasing unintended pregnancies and decreasing the percentage of women who smoke while pregnant (TDH, 2014a), the 2017 IM rate gap between Blacks and Whites widened to 1.96 (AHR, 2017) giving continual evidence of racial disparity (Brown-Speights et al., 2017).

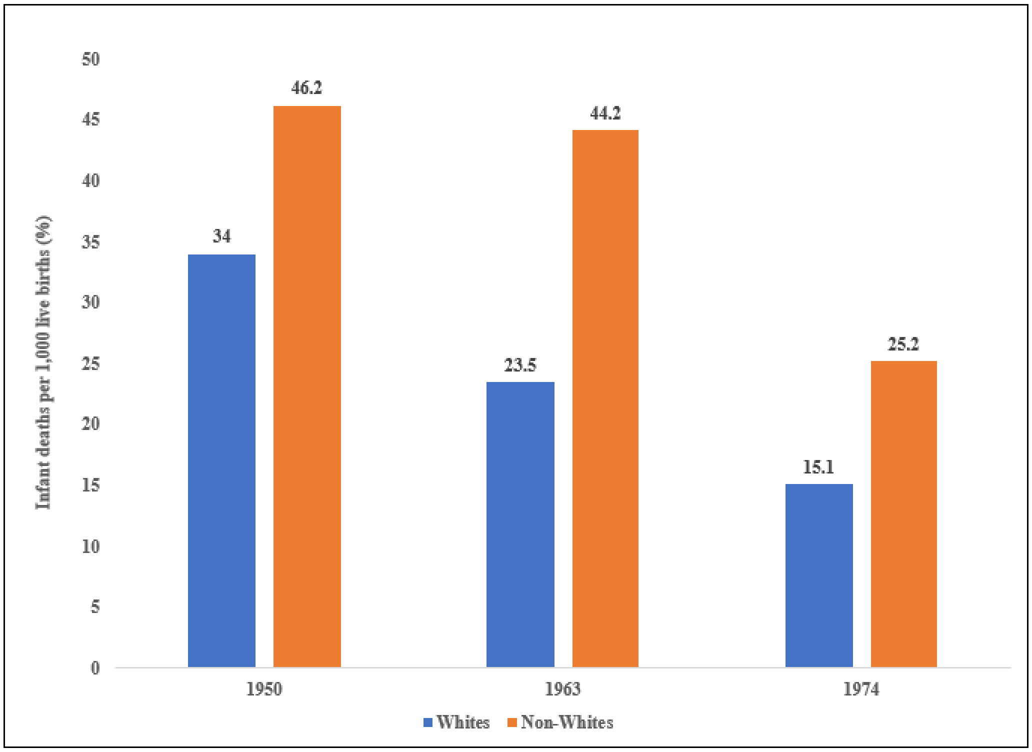

Figure 1. Past U.S. infant mortality rate comparison for Whites versus Non-Whites. I created the figure using data from the CDC (2015).

Past researchers who have studied the effects of segregation have identified racial residential segregation as a risk factor for poor birth outcomes and IM for Black women in the United States (Nkansah-Amankra, 2010; Nyarko & Wehby, 2012). One measure of residential segregation, namely, racial concentration, has also been linked to prematurity (PTB), low birth weight (LBW), and IM for Blacks and other minorities (DeCamp, Choi, Fuentes-Afflick, & Sastry, 2015; deGraaf, Ravelli, deHaan, Steegers, & Bonsel, 2013; Roche, Abdul-Hakeem, Davidow, Thomas, & Kruse, 2016). Even rural places of residence and certain zip codes have been related to health disadvantages for minorities (Caldwell, Ford, Wallace, Wang, & Takahashi, 2016) and have been implicated as risk factors for IM (Cox, Zhang, Zotti, & Graham, 2011; Roche et al., 2016). Despite these findings, other researchers have presented results for residential segregation and poor birth outcomes that were incongruent (Hearst, Oakes, & Johnson, 2008; Madkour, Harville, & Xie, 2014; Mason et al., 2011, McFarland & Smith, 2011; Shaw, Pickett, & Wilkinson, 2010; Sparks, Sparks, & Campbell, 2013; Wallace, Green, Richardson, Theall, & Crear-Perry, 2017).

Several researchers have assessed racial residential segregation which comprises racial concentration in association with adverse infant outcomes such as LBW, PTB, and IM, but they have only evaluated metropolitan or urban areas (Debbink & Bader, 2011; DeCamp et al., 2015; Kramer, Cooper, Drews-Botsch, Waller, & Hogue, 2010; McFarland & Smith, 2011; Nyarko & Wehby, 2012; Wallace et al., 2017). In contrast, this research expands on the topic of racial concentration as a neighborhood unit by assessing the entire State of Tennessee, comprised of rural and urban areas. Past researchers have also found conflicting results for racial concentration and other dimensions of residential segregation in association with IM.

As an example, one measure of residential segregation, the dissimilarity index, has been associated with IM for Whites (McFarland & Smith, 2011). In contrast, protection against adverse birth outcomes has been observed for Whites living in neighborhoods with a higher concentration of Whites (Mason et al., 2011). Further inconsistencies are highlighted with the finding that increasing ethnic or racial concentration is protective for Hispanics against IM (McFarland & Smith, 2011; Shaw et al., 2010) and for Blacks against LBW (Madkour et al., 2014); however, some researchers have found no association between segregation and IM for Blacks or

Hispanics (Hearst et al., 2008; McFarland & Smith, 2011). Still others have found an increased risk of IM for Hispanics in association with Hispanic concentration (DeCamp et al., 2015) and a similar risk for Blacks due to higher racial concentration (Mason et al., 2011; Sparks et al., 2013) or residential segregation with IM rate variations attributed to income inequality and joblessness (Wallace et al., 2017).

Additional risk factors for poor birth outcomes and IM include: socio-economic status (e.g., lack of education; Elder et al., 2016; high poverty; He et al., 2015; marital status; Loggins & Andrade, 2013), infant health characteristics (e.g., PTB and congenital defects; Hirai et al., 2014), maternal demographics and health (e.g., maternal age; He et al., 2015; multiple pregnancies, smoking, pre-existing conditions and insurance type; Xaverius, Alman, Holtz, & Yarber, 2015), and lack of PNC (He et al., 2015; Loggins & Andrade, 2013; Peoples & Danawi, 2015) with black women having higher odds for IM compared to White women when receiving no PNC or inadequate PNC (Cox et al,. 2011; Peoples & Danawi, 2015). Although much work has been done to uncover the risk factors for IM along with expenditures and resources invested into understanding the observed IM rate disparity in the United States, the mechanisms governing Black IM have remained poorly understood (Burris & Hacker, 2017). More recent work has involved evaluating IM from a community-level perspective as individual risk factors have not fully explained IM (Mantoba & Collins, 2017). Therefore, risk factors such as PNC access and use in conjunction with places of residence in association with IM, warranted further explanation.

Results from this study filled a gap in the literature given that findings from other researchers have produced conflicting results related to whether places of residence harm or protect against IM and to what extent PNC is necessary to prevent poor infant health outcomes. In addition, previous researchers have targeted women specifically in urban areas and have not thoroughly examined racial concentration in the context of rurality. Tennessee has not been fully studied based on my review of the literature, to determine whether these risk factors are applicable to IM for Tennessee infants; therefore, a second gap in the literature was filled by conducting this study. The continual IM rate disparity in Tennessee has emphasized IM as a persistent public health challenge. This study has the potential to provide insight that stakeholders and policy makers can use to help reduce the IM rates and improve outcomes for those most vulnerable.

Problem Statement

In the United States, rural isolation has been associated with health disadvantages (Caldwell et al., 2016) and some of these disadvantages have equated to poor infant health and IM rate disparities (Cox et al., 2011). Researchers have shown that some women have poor access to obstetric care during and after pregnancy (Yerramilli & Fonseca, 2014) due to the lack of doctors or other health care providers, lack of medical insurance, and geographic distance (Meyer et al., 2016; Phillippi, Myers, & Schorn, 2014; Yerramilli & Fonseca, 2014). These barriers have resulted in prolonged initiation of PNC, unrecognized pregnancy complications (Lisonkova et al., 2016), shorter birth intervals, and PTB, which is a proximate factor for IM (Thiel de Bocanegra et al., 2017). In some urban areas, the lack of PNC or inadequate PNC has been associated with higher odds of poor birth outcomes for Blacks compared to Whites (Loggins & Andrade, 2013;

Peoples & Danawi, 2015). According to a 2013 report published by the State of Tennessee, more Blacks entered PNC after the first trimester of pregnancy or had no PNC compared to Whites (TDH, 2014c).

Because PNC is thought to reduce IM (Phillippi et al., 2014; Schlenker, Dresang, Ndiaye, Buckingham, & Leavitt, 2012), adverse birth outcomes for women in rural and urban areas suggest that PNC access and utilization in Tennessee may be dependent on places of residence. Considering that more than two thirds of Tennesseans live in urban areas (United States Census Bureau [USCB], 2015), it is unclear how disparities in access to health services like PNC disadvantage Black IM disproportionately across the state. Tennessee as a southern state has a unique social, political, and cultural history; however, proximate urban and rural factors underlying IM have not been adequately assessed.

Researchers have further shown that Blacks are less likely to have needed health care access when living in predominantly Black neighborhoods (Satyamurthy & Montanera, 2016). Although some Blacks reside in areas with greater PNC resources which translate into better access to health care, due to segregation effects, the risk of adverse birth outcomes have remained elevated (Nyarko & Wehby, 2012). Other researchers have lent support to this notion, showing that Black women regardless of income are more likely to have a LBW baby when living in a White neighborhood compared to a Black neighborhood (Kothari et al., 2016). Negative consequences to infant health have resulted as an effect of racial concentration (de Graff et al., 2013; Nkansah-Amankra, 2010; Peoples & Danawi, 2015).

Racial concentration is one measure of residential segregation and is the physical space occupied by one race (McFarland & Smith, 2011). Racial concentration is high when the proportion of minorities in an area is 50% or greater, is medium when the proportion is between 25% and less than 50%, and is low if less than 25% (Stuber, Galea, Ahern, Blaney, & Fuller, 2003). IM rate disparities have been observed when comparing racial concentration in Tennessee (CHRR, 2018; USCB, n.d.c). Between 2010 and 2016, Williamson County and Sullivan County both of which have low racial concentration (4.4% and 2.3% Black, respectively; USCB, n.d.c), had a 40% difference in average IM rates (CHRR, 2018). When Sullivan County was compared to Rhea County-- also with low racial concentration (2.3% Black; USCB, n.d.c)--an even higher percentage difference (50%) in the average IM rate was observed (CHRR, 2018). A comparison of medium racial concentrated counties namely Madison County (37.6% Black) and Lauderdale County (35% Black; USCB, n.d.c), showed an average IM rate difference of 48% (CHRR, 2018). The two counties in Tennessee with high racial concentration, Shelby (54.1% Black) and Haywood (50.6% Black), counties had a 26% average IM rate difference (CHRR, 2018).

Considering the IM rate disparity noted in Tennessee, previous research results applied inconsistently across places and races. Research has been sparse regarding racial concentration in application to rural areas in association with IM. A case for racial concentration and IM had to be argued for minorities living in low and medium concentrated areas of Tennessee and suggested that the IM rate disparities could stem from places of residence coupled with PNC access and use.

Purpose of the Study

The purpose of this study was to assess the relationship between places of residence using neighborhoods as units of analysis consisting of rurality and racial concentration, PNC, and IM across racial groups in Tennessee. Secondly, this study aimed to determine whether race modified these associations. I used a quantitative cross-sectional design to analyze proximate relationships linked to observed higher IM rates in areas of higher racial concentrations for this study.

Research Questions and Hypotheses

RQ1-Quantitative: What is the relationship between places of residence using neighborhoods as units of analysis and infant mortality among racial groups across the state of Tennessee?

$H_0 1$: There is no relationship between places of residence using neighborhoods as units of analysis and infant mortality among racial groups across the state of Tennessee.

$H_1 1$: There is a relationship between places of residence using neighborhoods as units of analysis and infant mortality among racial groups across the state of Tennessee.

RQ2-Quantitative: How does access to prenatal care among racial groups compare across Tennessee when stratified by places of residence?

$H_0 2$: There is no difference in access to prenatal care among racial groups across Tennessee when stratified by places of residence.

$H_1 2$: There is a difference in access to prenatal care among racial groups across Tennessee when stratified by places of residence.

RQ3-Quantitative: Does maternal race modify the relationship between places of residence, prenatal care, and infant mortality across the State of Tennessee?

$H_0 3$: Maternal race does not modify the relationship between places of residence, prenatal care, and infant mortality across the State of Tennessee.

$H_1 3$: Maternal race does modify the relationship between places of residence, prenatal care and infant mortality across the State of Tennessee.

Theoretical Framework

This study was grounded in the theory of racial residential segregation and concentrated poverty, which is founded on the idea that increasing racial segregation into high and low poverty groups results in concentrated poverty with the eventual degradation of families and neighborhoods (Massey & Fischer, 2000; Quillian, 2012, 2017). This theory stems from the research of several individuals such as William J. Wilson, Douglas Massey, and Lincoln Quillian (Quillian, 2012, 2017). Wilson hypothesized that an out-migration of middle-class Blacks into more affluent areas in years past created concentrated poverty for the minorities left behind (Massey, 1990; Massey, Gross, & Shibuya, 1994). Eventually, these communities suffered from deindustrialization thereby limiting jobs for unskilled workers with the subsequent creation of low paying jobs in a service-oriented sector contributing to the rise of underemployment, neighborhood degradation, and concentrated poverty (Massey, 1990; Quillian, 2012, 2017). As minority communities became increasingly isolated from outside communities, harmful conditions were created within the minority communities resulting in deleterious effects (Massey, 1990).

Massey supplemented Wilson's work by adding that residential segregation acts as a catalyst for concentrated poverty but did not support that the out-migration of middle-class Blacks created concentrated poverty (Massey, 1990; Quillian, 2012; 2017). Instead, Massey argued that interaction effects are observed based on the level of segregation and changes in income distribution so that minorities with the highest poverty levels also have the highest level of segregation (Massey, 1990; Massey & Fischer, 2000). An increase in poverty changes the social and economic environment so much so that these neighborhoods deteriorate due to lack of investments (Massey, 1990; Massey et al., 1994). With neighborhood deterioration comes crime ridden areas, poorly functioning schools, negative consequences to the health and well-being of residents, and increased mortality including IM (Massey, 1990; Massey et al., 1994). Individuals in poverty have little to no income for medical services and the services which are offered in minority communities may be subpar compared to services offered in affluent and White segregated neighborhoods (Massey, 1990). Furthermore, any economic shifts which affect income distribution and further separate social classes serve to further concentrate poverty resulting in greater isolation of the poor (Massey & Fischer, 2000; Massey, 1990).

Quillian (2012, 2017) supported Massey's work but further added to the theory other factors which he hypothesized could alter the effects of segregation and hence concentrate poverty or increase advantage. Spatial factors such as group poverty, the influence of income on interactions between racial groups, and group size can interact to weaken or increase segregation effects and determine the context of advantage or disadvantage for segregated groups (Quillian, 2012, 2017). Nevertheless, segregation serves to increase inequality furthering advantage for Whites and increasing disadvantage for minorities (Quillian, 2012, 2017; Massey, 1990; Massey et al., 1994; Massey & Fischer, 2000).

He et al. (2015) identified poverty as a risk factor for IM in the Southern United States. Since concentrated poverty has been theorized as a contributor to morbidity and mortality for minorities and the poor (Massey, 1990), it is worthwhile to look at the theory of racial residential segregation and concentrated poverty in the context of IM across Tennessee. Individuals who are residentially segregated and at the same time poor have limited income and may not afford needed medical services or have access to services within their communities (Massey, 1990; Massey et al., 1994). Researchers have noted that in Tennessee over half of PNC providers practice in four metropolitan counties resulting in lengthy commutes for rural women who need care (Phillippi et al., 2014). PNC utilization and access could therefore be a consequence of where one lives and a relationship with IM could potentially be explained using the theory of racial residential segregation and concentrated poverty.

In addition, residential segregation increases disadvantages for minorities but increases advantages for Whites (Massey, 1990; Massey et al., 1994; Massey & Fischer, 2000; Quillian, 2012, 2017). The Black-White IM rate gap of 1.9 for Tennessee (Brown-Speights et al., 2017) highlights a disadvantage in that Blacks are disproportionately impacted by IM compared to Hispanics and Whites (Matthews et al., 2015). Rate disparities are observed across counties (CHRR, 2018; TDH, 2014) and when considering racial concentration (USCB, n.d.c). Therefore, the theory of racial residential segregation and concentrated poverty was intended to explain rate disparities for racial groups across Tennessee based on places of residence.

Nature of the Study

This study was an observational study and quantitative in nature. The intent of this study was to assess the relationship between places of residence (using neighborhoods as units of analysis consisting of rurality and racial concentration), PNC, and IM. I analyzed these variables to assess the prolonged IM disparity among racial groups across Tennessee. I used several data sources for this study to create a final data set. The data sets are as follows: Tennessee Phase VI PRAMS spanning years 2009-2011 geocoded to Tennessee 2010 USCB data and 2010 Rural-Urban Commuting Area (RUCA) codes data from the U.S. Department of Agriculture data (USDA; 2016).

Definitions

Key words used in this study are defined as follows:

Census tracts: Subdivisions at the county level consisting of 1,200 to 8,000 people and covering a contiguous area that varies in size and depends on the density of settlement (USCB, 2012a). Census tracts are maintained for statistical comparisons between census years and can be adjusted based on population growth or decline (USCB, 2012a).

Ethnic diversity scores: Scores that are calculated by subtracting one from the sum of the squared percentages of every racial or ethnic group within a census tract (DeCamp et al., 2015).

Infant mortality: The death of an infant during the period preceding his or her first birthday (Johansson et al., 2014; Matthews & Driscoll, 2017); it is comprised of neonatal mortality and post-neonatal mortality (Collins et al., 2013).

Infant mortality rate: A rate expressed as the number of infant deaths per 1,000 live births in a year (Johansson et al., 2014; Matthews & Driscoll, 2017).

Low birth weight: The weight of an infant at the time of birth that is less than 2500 grams (Roche et al., 2016).

Neighborhoods as units of analysis*:* As defined in this study, census tracts delineated by racial concentration and rurality.

Neonatal mortality: The death of an infant prior to his or her 28th day of life (Collins et al., 2013).

Place of residence: A concept that can be defined as a geographical area or unit qualified using postal codes (Lee et al., 2014) or designated as rural or urban spaces (Huot et al., 2013; Onega et al., 2010); it may also be characterized by neighborhood-level attributes, such as poverty concentration or racial concentration (Nkansah-Amankra, 2010).

Prenatal care: The care a woman receives during pregnancy that involves monitoring fetal growth and development as well as maternal health (CDC, 2017a). PNC has five levels based on Kotelchuck's index: no care, inadequate care, intermediate care, adequate care, and intensive care (as cited in Cox et al., 2011). Inadequate care begins after the fourth month of pregnancy and is equivalent to receiving less than half the number of recommended visits (Cox et al., 2011; Schlenker et al., 2012). Intermediate refers to starting PNC after the fourth month of pregnancy and achieving greater than

50% but less than 80% of recommended visits whereas adequate care begins by the fourth month of pregnancy with 80% to 109% of recommended visits (Cox et al., 2011; Schlenker et al., 2012). Last, intensive care is started by Month 4 and involves having at least 110% of recommended visits achieved (Cox et al., 2011; Schlenker et al., 2012).

Preterm birth: The birth of an infant before 37 weeks gestation (Alibekova, Huang, & Chen, 2013; Nkansah-Amankra, 2010).

Population density: The total population in a geographical area divided by the land area measured in square miles or square kilometers and can be expressed as people per square miles or people per square kilometers (USCB, 2012b)

Post-neonatal mortality: The death of an infant between Day of life 28 and Day of life 365 (Collins et al., 2013).

Racial concentration: A component of residential segregation that is the occupation of physical space by a single race (Massey & Denton, 1988; McFarland & Smith, 2011). Racial concentration is graded into high, medium, and low (Stuber et al., 2003). Racial concentration is high when the proportion of the minority race surpasses 50%, is medium concentration when the minority race is greater than 25% but less than 50%, and is low concentration when the proportion is less than 25% (Stuber et al., 2003). Racial concentration has also served as a proxy for segregation to explain various health outcomes at the community level (Mehra, Boyd, & Ickovics, 2017; White & Borrell, 2011).

Residential segregation: The degree to which two or more racial or ethnic groups are separated by geographical space (Nyarko & Wehby, 2012).

Rural: A geographical area consisting of 2,500 residents or less or consisting of all areas not considered urban (USCB, n.d.b).

Urban: A densely developed geographical area encompassing business, residential, and non-residential use of land and consisting of urban areas with more than 50,000 residents and urban clusters with more than 2,500 residents but less than 50,000 with at least 1,500 persons not living in an institutional setting (USCB, n.d.b).

Assumptions

I made four assumptions concerning this study. Because PRAMS data were a secondary data set collected for another purpose, I assumed that the data adequately represented the birth population of Tennessee for the time period of 2009-2011. I also assumed that the responses to the survey questions contained in the PRAMS data set were accurate concerning maternal-and-infant level characteristics as respondents were surveyed months after having delivered their babies. The PRAMS data set also contains birth certificate information recorded by health care professionals. I therefore assumed that birth certificate information was recorded accurately and that this information as included in PRAMS was also linked accurately. In addition, I assumed that the U.S. Census data for 2010 and USDA 2010 data were accurate and reflective of the neighborhood-level characteristics that were necessary for this study.

Scope and Delimitations

Women with singleton live births between 2009 and 2011 encompassed this study. Multiple births and stillbirths were excluded as these factors increase the likelihood of IM (Kenney et al., 2013). Blacks, Whites, and Hispanics were represented in the data set however, additional racial groups were categorized as Other races (TDH, 2014d). Other races included unknown ethnicities that cannot be studied as an individual group, therefore, results from this study may not be applicable to these ethnicities. The PRAMS data set included only women who had a live birth in Tennessee between 2009-2011 so results were not generalizable to populations outside of the State of Tennessee.

I considered two theories for this study but deemed these as impractical. These theories were the ecological perspective or systems theory and the socio-ecological model. The ecological perspective indicates that the health of an individual is shaped by encountering multiple systems (Broffenbrenner, 1977). These systems are micro (family, schools, and peers), meso (interactions between microsystems), exo (the environment which exerts indirect influence), and macro systems or societal and cultural values (Broffenbrenner, 1977). Each system is comprised of a network of influences which ultimately impacts health (Broffenbrenner, 1977).

The socio-ecological model shares similar concepts with the ecological perspective. This model posits that an individual's health is influenced at five levels: individual (self-behavior or actions), interpersonal (formal and informal support systems such as peers or family), organizational (social institutions with operational policies and procedures), community (informational networks with relationships between organizations and institutions), and policies or laws governing society (McLeroy, Bibeau, Steckler, & Glanz, 1988). Although these theories could have explained places of residence and PNC and the influence these variables may have upon IM for the women of Tennessee, I opted for the theory of racial residential segregation and concentrated poverty which was more suitable for this study (see section on Theoretical Framework).

Limitations

The most current PRAMS data set for the State of Tennessee available for this study was Phase VI collected between 2009-2011; hence, the data set may no longer accurately reflect the present status of maternal or infant characteristics for the women of Tennessee. The PRAMS data set excluded women who are residents of Tennessee but gave birth outside of the state (CDC, 2017b; TDH, 2014d). Recruitment for PRAMS occurred through the birth certificate registry so women who had incomplete birth certificates were excluded as well as women who had late filings for birth certificates (CDC, 2017b). Point estimates for questions with less than 30 responses prior to weighting of the sample were not reported as advised by PRAMS officials (CDC, 2017b; TDH, 2014d). The PRAMS survey was administered months after a woman gave birth (TDH, 2014d) so recall bias is possible and may have affected the results of the study. I used the 2010 U.S. census data to calculate percent racial concentration which represented the population in 2010; therefore, percent racial concentration may not accurately reflect the racial distribution which now exists in Tennessee.

I used a quantitative study and a cross-sectional or correlational design which has limitations. Correlational design captures data at a single point in time and cannot establish temporal sequence (Setia, 2016; Frankfort-Nachmias, Nachmias, & DeWaard, 2015; Aschengrau & Seage, 2014). Only experimental studies can establish causation (Frankfort-Nachmias et al., 2015) so the results from this study can only make inferences to correlation (Setia, 2016) and cannot state whether places of residence or PNC cause

IM across races for Tennessee. Cross-sectional study designs can suffer from internal validity issues and may have problems with selection bias (Salazar, Crosby, & DiClemente, 2015), so added to the limitations of this study.

The data set had missing data for some of the participants which is another limitation of this study. It was impossible to delete participants with missing data as originally intended; therefore, imputation was employed to correct the issue. Imputation is based on whether variables are missing completely at random, missing at random, or not missing at random; however, for this study it was impossible to determine whether the missing data was missing at random or not missing at random. Consequently, the results generated from this study may have differed had it been possible to make the differentiation (Osman, Abu-Mahfouz, & Page, 2018; Stephens et al., 2018).

The statistical method of analysis also presented with limitations for this study. While hierarchical or multilevel modeling has good predictive accuracy in that it allows analysis of individual level and group level effects simultaneously, it presents a challenge in that group level variables may measure constructs which vary from individual level variables (Diez-Roux, 2000). Moreover, hierarchical modeling can direct one to conclusions which may be misleading (Diez-Roux, 2000; Gelman, 2006). For example, effects that are non-existent can be misinterpreted resulting in erroneous inferences (Diez-Roux, 2000; Gelman, 2006).

Data stratification resulted in smaller sample sizes for analyses so presented challenges thereby adding to the limitations of this study. Since there were no deaths in rural areas for certain racial groups and Hispanic ethnicity, some of the research questions could not be fully answered. In addition, several variables required compression to facilitate answering the research questions and perhaps could have resulted in different results if the compression had not occurred.

Significance

Despite a reduction in the Black-White IM gap in Tennessee to 1.9 (Brown-Speights et al., 2017), recent estimates for IM in Tennessee at 6.9 deaths per 1,000 live births when compared to the national average of 5.9 deaths per 1,000 live births (AHR, 2017) highlighted a persistent public health challenge with disparity across racial groups (Matthews et al., 2015). The Black IM rate in Tennessee for 2017 was 11.3 deaths per 1,000 live births compared to the IM rate of White live births (AHR, 2017). These rates helped to emphasize that continual efforts are needed to reduce IM in Tennessee. Since studies involving racial concentration as well as rurality have offered conflicting results in relation to IM, this research was intended to lend greater clarity and explain precisely the influence these variables have on IM for Tennessee women and perhaps women elsewhere. This study also has the potential to explain how PNC use and timing impacts IM rates for women in Tennessee thereby building upon the existing body of literature.

This research may bring into focus areas within Tennessee which have been successful at reducing IM leading to the subsequent introduction of similar models or interventions in areas requiring improvement. This research may help to motivate the medical community to design better approaches for pregnancy care for women at higher risk of IM and for women living in areas that are highly impacted. Research findings can lead to an increase in public awareness, can motivate resource allocation, and design of targeted social intervention programs with places of residence as a basis. Results have the potential to benefit infants who are the most vulnerable through facilitating changes in how women access care across the state and how PNC care is managed mitigating infant health outcomes for Tennessee.

Social Change Implications

My research can contribute to IM reduction efforts and spark social change by highlighting places of residence where IM rates are elevated and what accounts for rate variations. Social change can also stem from underscoring the persistence of IM across Tennessee society and from pinpointing some social and health factors which require modification. Results from my research can accentuate actions necessary for improving health outcomes across social groups and hence motivate social change. Results could empower and galvanize women who are disproportionately impacted by IM to become advocates for better infant health outcomes thereby bringing attention to the issue of IM along with potential solutions.

Summary

In Tennessee, IM disparity exists among races and is especially disproportionate for Blacks. Multiple factors have been investigated for an association with IM for women in the United States including places of residence based on residential segregation using racial concentration as a measure. However, researchers have found conflicting results. Researchers have also identified PNC as a risk factor for IM, although it is unclear how access to PNC and PNC use in Tennessee result in a disproportional disadvantage for Blacks. The proximate underlying factors concerning rural and urban places of residence have also not had adequate assessment. This research intended to fill a gap in the literature through assessing relationships between places of residences (using neighborhood as units of analysis consisting of racial concentration and rurality), PNC, and IM among racial groups in Tennessee. Results may identify areas highly impacted by IM and provide legislators and stakeholders with information that could potentially facilitate targeted resources and interventions. The implications for social change include spotlighting actions necessary to improve health outcomes for groups severely impacted by IM and a reduction in the observed IM disparity across races.

In Chapter 2, I discuss my search strategy for the literature review conducted for this study. I also include a synopsis of current literature in which I discuss the study variables which are places of residence (using neighborhoods as units of analysis to include racial concentration and rurality), PNC, and IM. I give more details on the theory of racial residential segregation and concentrated poverty in addition to the study designs and statistical methodologies used by other researchers who have conducted similar studies along with their findings.

Chapter 2: Literature Review

Introduction

The purpose of this study was to assess the relationships between places of residence (using neighborhoods as units of analysis represented by rurality and racial concentration), PNC, and IM across racial groups residing in the State of Tennessee. This was a quantitative study to analyze proximate relationships linked to higher IM rates observed in Tennessee while considering whether race has a modifying effect on these relationships. This study was observational and was based on a cross-sectional design using secondary data from the State of Tennessee PRAMS, Phase VI collected between 2009 and 2011 and geocoded to USCB data from 2010.

In the United States overall and in Tennessee specifically, IM rate disparity is observed across races (AHR, 2017; Brown-Speights et al., 2017; Matthews et al., 2015). Multiple researchers have attributed IM rate disparities to risk factors such as lack of PNC (Phillippi et al., 2014; Schlenker et al., 2012). Disparity in PNC use and access have been observed based on rurality (Meyer et al., 2016; Phillipi et al., 2014; Yerramilli & Fonseca, 2014); however, PNC has not been adequately assessed as to how it disproportionately impacts Blacks in Tennessee nor have proximate urban and rural underlying factors related to IM been examined. Factors like racial concentration in the context of IM vary across Tennessee with high racial concentrated counties exhibiting equal or lower IM rates compared to some low racial concentrated counties (CHRR, 2018; USCB, n.d.c). Those who have studied racial residential segregation using racial concentration and other segregation measures have provided conflicting results in connection to birth outcomes (Debbink & Bader, 2011; DeCamp et al., 2015; Hearst et al., 2008; Kramer et al., 2010; Madkour et al., 2014; McFarland & Smith, 2011; Nyarko & Wehby, 2012; Wallace et al., 2017). Although IM is not completely understood, it is clear that it is a persistent issue for Tennesseans (CHRR, 2018). Therefore, I assessed places of residence, PNC, and IM to more clearly explain the impact these risk factors have on IM for Tennesseans.

There were multiple articles that addressed the individual study variables. Regarding rurality, articles concerned health disadvantages (Caldwell et al., 2016; Gallagher, Liu, Probst, Martin, & Hall, 2013; Singh & Siapush, 2014), access to care (Cox et al., 2011; Harris et al., 2015; Phillippi et al., 2014), geographic distances that created barriers to care (Yerramilli & Fonseca, 2014), adverse birth outcomes (Darling & Atav, 2012; Darling & Atav, 2017; Chen, Oster, & Williams, 2016; Herd, Gruenewald, Remer, & Guendelman, 2015; Kent, McClure, Zaitchik & Gohlke, 2013; Lisonkova et al., 2016; Sparks et al., 2009; Strutz, Dozier, van Wijngaarden, & Glantz, 2012;), and the urban advantage against IM (Akinyemi, Bamgboye, & Ayeni, 2015; Batton, Nubani, Burnett, Verhulst, & Batton, 2013). For racial concentration, articles covered adult health outcomes at the community level (Davids, Hutchins, Jones, & Hood, 2014; Gaskin, Dinwiddie, Chan, & McCleary, 2012; Hung, Henning-Smith, Casey, & Kozhimannil, 2017; Satyamurthy & Montanera, 2016; Yang & Matthews, 2015), and Hispanic and or Black concentration relative to IM (DeCamp et al., 2015; Huynh et al., 2017; Logan & Parham, 2017; McFarland & Smith, 2011; Shaw & Pickett, 2013; White, Horton, & Simpson, 2017). Regarding PNC, articles spanned LBW and PTB (Coley & Aronson, 2013; Darling & Atav, 2012; Darling & Atav, 2017; Guillory, Lai, Suminski & Crawford, 2015; Loftus, Stewart, Hensley, Enquobahrie, & Hawes, 2015; Masho, Munn, & Archer, 2014; Slaughter et al, 2013; Xaverius, Alman, Holtz, & Yarber, 2016), PNC adequacy and IM (Collins et al., 2013; Cox et al., 2011; El-Sayed, Finkton, Paczkowski, Keyes, & Galea, 2015a; Holland, Young & Jiroutek, 2016; Meghea, You, Raffo, Leach, & Roman, 2015; Owais et al., 2013; Partridge, Balayla, Holcroft, & Abenhaim, 2012; VanderWeele, Lauderdale, &Lantos, 2013), and PNC timing (He et al., 2015; Kananura et al., 2016; Li, Yan, Zeng, Dibley, & Wang, 2015; Roche et al., 2016; White et al., 2017).

In this chapter, I first outline my literature search strategy followed by a discussion of the current literature on the study variables and covariates. I also include more details on the theory used for this study and present findings from other researchers who have used the same theory in their research. I discuss the study designs and statistical methods that other researchers who have conducted similar studies as this one have used and also present their findings. I include a literature synthesis and end the chapter with a summary and conclusions.

Literature Search Strategy

My literature search started with the Walden University Library. I used Thoreau, which allowed a simultaneous search of multiple databases and ended with individual database searches for relevant articles. I used the following databases to find additional articles: Academic Search Complete, CINAHL, EBSCO, Medline, ProQuest, PubMed, Research Gate, Science Direct, Social Science Citation Index, and Wiley Online Library. Search engines such as Bing and Google Scholar were also helpful to identify relevant articles. I also searched the F1000 Research and HERO databases; however, these did not yield useful articles. Searches using key words yielded multiple articles, and these were filtered using Boolean operators to provide greater specificity. At times, I surrounded words and phrases by quotation marks to ensure exact search and delivery of articles containing the key terms.

Key terms used to search articles on race included race, African American, Black, Hispanic, and minorities. To find articles on outcomes, I used the key terms, adverse birth outcomes, birth outcomes, IM, infant death, neonatal mortality, poor birth outcomes, post-neonatal mortality, and pregnancy outcomes. For articles on places of residence, I used the following key terms: census tracts, location, maternal residence, metropolitan statistical areas (MSAs), Tennessee, places of residence, racial concentration, racial residential segregation, residence, residential segregation, rural, rurality, Rural-Urban Commuting Area, RUCA, Rural-Urban Commuting Code, RUCC, South, Southern United States, segregation, and urban. For articles on prenatal care, the key terms or phrases used to search were access to care, antenatal care, health care access, prenatal access, prenatal care, prenatal care use, pregnancy care, and timing of prenatal care. Some combined search terms included residential segregation, infant mortality, and prenatal care; racial concentration, infant mortality, and prenatal care; rurality, infant mortality, and adverse birth outcomes; and rurality, prenatal care or pregnancy care.

I performed a search between the years 2013 and 2018 to further filter articles for relevance in each database. Most articles older than 2013 were rejected except for a few. I included some older works that were seminal in nature to support the constructs of racial concentration, rurality, and PNC in relation to adverse birth outcomes. Articles were also limited to peer-reviewed literature from a broad range of publication types including geospatial and geography, medicine, nursing, public health, public policy, social work, and urban planning. I reviewed the reference lists from several articles and found additional articles related to the topic. Most of the articles found were quantitative studies; however, a few studies were qualitative with one mixed-methods study and one quasi-experimental study included. Some information and statistics specifically related to the State of Tennessee were from websites such as AHR, CHRR, CDC, and the TDH.

Theoretical Foundation

The theory of racial residential segregation and concentrated poverty is based on the evolving work of individuals such as William J. Wilson, Douglas Massey, and Lincoln Quillian (Quillian, 2012, 2017). The theory posits that concentrated poverty stems from increasing racial segregation into low-poverty and high-poverty groups with subsequent degradation of the family unit, neighborhood, and community (Massey & Fischer, 2000; Quillian, 2012, 2017; Wilson, 1987). As neighborhoods become increasingly segregated, they also become socially isolated resulting in damaging effects for minority residents (Massey, 1990). As early as 1903, W. E. B. Dubois discussed the importance of neighborhoods for social interactions and lamented the separation of Blacks and Whites, commenting that this separation only served to have each group view the other group in a negative manner (Charles, 2003). Dubois, himself, was not immune from the effects of racial segregation, having lost his son to a treatable infection in a place where White doctors refused to treat Black patients (Zheng, 2016).

Dr. Alfred Yankauer discussed similar segregation effects in a seminal work which appeared in the *American Sociological Review* of 1950. Yankauer (1950) indicated that the high IM rates for Blacks in New York City (NYC) were likely due to racial residential segregation meaning the denial of the right to Blacks to live in any area except where designated. Between 1945 and 1947 most Black births in NYC were concentrated in three small areas of the city, whereas, births to Whites happened in areas with less than 5% Blacks (Yankauer, 1950). IM rates for Blacks were significantly higher as racial concentration became denser in comparison to areas with low Black concentration (Yankauer, 1950). Noteworthy, in racially concentrated neighborhoods, was inadequate housing with correspondingly high rents due to demand and overcrowding (Yankauer, 1950). In neighborhoods with greater than 75% Black concentration, approximately 319 persons occupied an acre of land compared to 78 persons in areas of less than 5% Blacks (Yankauer, 1950). Poor sanitation, limited options for shopping, the high cost of food, and inferior medical facilities were noted (Yankauer, 1950).

Theory Development and Modification

Deteriorating neighborhood conditions persisted and by the mid-1960s an urban crisis had formed with the development of a social underclass demonstrating behaviors that enormously contrasted with societal norms (Wilson, 1987). Underclass represented low-income families and individuals living in urban environments within the core of cities who experienced long bouts of poverty, welfare dependency, crime, and lacked the skills and training needed for employment; therefore, these individuals experienced a total dropout from the workforce (Wilson, 1987). As segregation restrictions were lifted with the Civil Rights Act of 1964, stable professional Blacks (e.g. teachers and physicians) who lived within segregated urban communities and provided their services to the community and who served to reinforce societal norms and patterns, migrated into less segregated areas and higher income neighborhoods leaving behind individuals who were disadvantaged and socially isolated (Wilson, 1987). By the mid-1970s the number of unwed mothers, female-headed families, unemployed persons, teen pregnancies, drug addicts, and crime had reached catastrophic levels in stark contrast to previous decades which saw an integration of low, working, and middle-class Black families living within the same communities (Wilson, 1987).

The out-migration of middle-class Blacks, technological changes, shift from a manufacturing to a service oriented economy, the relocation of manufacturing job out of cities, and a greater demand for skilled workers, gave rise to lower paying jobs, unemployment, neighborhood decay, and concentrated poverty acting further to disadvantage minorities (Massey, 1990; Massey, Gross, & Shibuya, 1994; Quillian, 2012, 2017; Wilson, 1987). The economic and social structural changes promoted the concepts of social buffering and concentration. Social buffering refers to the tempering of economic shifts within urban neighborhoods by Black middle-class families while concentration refers to restrictions and opportunities associated with neighborhood residence of which the population was vastly disadvantaged (Wilson, 1987).

These concepts formed the basic premise of Wilson's theory, that out-migration caused remaining minorities to experience greater difficulties in maintaining the fundamental institutions within their urban environments such as churches, schools, and businesses.

Consequently, the demise of these institutions resulted in the decline of social organization, the displacement of a sense of community, and the abandonment of societal norms which prohibited degeneracy (Wilson, 1987).

Contrarily, Douglas Massey did not support Wilson's argument that out-migration created concentrated poverty and he countered that residential segregation catalyzes concentrated poverty (Massey, 1990; Quillian, 2012, 2017). He added that economic shifts affecting the distribution of income perpetuates social class separation with subsequent poverty concentration serving to further isolate those who are poor (Massey & Fischer, 2000; Massey, 1990). Consequently, because of rising poverty compounded by pre-existing racially segmented housing in urban areas, Blacks were forced into geographic isolation, resulting in racially homogeneous, small, and densely clustered neighborhoods (Massey, Gross, & Shibuya, 1994; Massey & Denton, 1988).

Increasing poverty modifies the social and economic environment and results in neighborhood decay due to disinvestments which subsequently produce areas of high crime, schools which function poorly, and deleterious health effects contributing to increased morbidity and mortality for community residents (Massey, 1990; Massey et al., 1994). Because Black segregated communities are most often impoverished, residents have little monetary resources for health care and even when services are available, they may be inferior to what is offered in White segregated communities (Massey, 1990). Interaction effects from segregation and income changes are observable so that minorities at the highest poverty levels also reside at the highest levels of racial segregation (Massey, 1990; Massey & Fischer, 2000). In addition, the interaction of segregation and rising poverty provides an explanation for the incapacity of some minorities to escape segregation and its effects despite increasing class segregation within these communities (Charles, 2003). Hence, many despite their social status experience the ill-effects of living in concentrated disadvantage stemming from racially segregated poor neighborhoods (Quillian, 2012).

Quillian indicated that the ideas of Wilson and that of Massey provided a sociological perspective on poverty concentration, however, was incomplete as to the influencing factors related to concentrating poverty. Besides racial segregation and poverty segregation within race, Quillian argued that a third element which considered spatial factors was necessary to explain concentrated poverty in minority neighborhoods. Factors such as segregation of non-poor minorities from non-poor members of other races, disproportionate contact between racial group members and those outside of the racial group, group and non-group poverty, and group size interact and serve to weaken or strengthen segregation effects thereby determining the context of advantage or disadvantage for groups in segregation (Quillian, 2012, 2017). It cannot be debated that the effects of racial segregation on poverty concentration are magnified in many areas across the United States and that racial residential segregation has increased income inequalities in neighborhoods furthering disadvantages for minorities while promoting advantages for Whites (Massey, 1990; Massey et al., 1994; Massey & Fischer, 2000; Quillian, 2012, 2017).

What has been debatable is how to measure the complexities of racial residential segregation (Massey & Denton, 1988; Yang & Matthews, 2015). Because groups can be segregated in various ways, five dimensions of racial residential segregation have been identified: evenness, exposure, concentration, centralization, and clustering (Massey & Denton, 1988). Evenness is the variation in minority representation in an area (Massey & Denton, 1988). Segregation measured by exposure is characterized by a racial distribution which limits interactions with other racial groups due to living in separate communities (Caldwell, Ford, Wallace, Wang, & Takahashi, 2017; Massey & Denton, 1988; McFarland & Smith, 2011). Concentration is the physical space occupied by one race in an urban environment (Massey & Denton, 1998). Centralization is like concentration but refers to spatial proximity or racial groups to the urban center with concentration confined to declining areas (Massey & Denton, 1988). Last, clustering is the degree to which minority neighborhoods adjoin to form contiguous closely packed enclaves or scatter spatially around the urban environment (Massey & Denton, 1988; McFarland & Smith, 2011). These indices have served as a basis for theoretical application to population health research.

Theoretical Applications to Health and Mortality

Several researchers have used the theory of racial residential segregation and concentrated poverty or have included it into conceptual frameworks to explain health issues or racial disparities in the United States. For example, Do, Frank, and Iceland (2017) used the theory to explain the relationship between segregation, poverty, and poor health for U.S. Black and White residents in metropolitan areas. They found a positive association between segregation (measured by the dissimilarity, isolation, and spatial proximity indices) and high poverty neighborhoods for Blacks (*aOR* = 1.46, *95%CI[*1.21, 1.77*]*, $p < .05$; *aOR* = 1.23, *95%CI[*1.06 1.43*]*, $p < .05$; *aOR* = 1.22, *95%CI[*1.07, 1.38*]*, $p < .05$ respectively) but not for Whites. In addition, racial residential segregation and concentrated poverty play a role in some health outcomes and mortality for minority and poor populations (Britton & Shin, 2013; Britton & Vélez, 2015; Do et al., 2017; Gaskin et al., 2014; Nuru-Jeter, Williams, & LaViest, 2014; Viruell-Fuentes, Ponce, & Alegria, 2012).

Further using the theory of racial residential segregation and concentrated poverty, some researchers have highlighted an association between residential segregation measured by isolation and very preterm birth or prematurity (PTB) for Black U.S. women living in metropolitan areas even after controlling for neighborhood poverty and individual-level variables (*aOR* = 1.07, $b = .004$, $SE = .001$, $p < .05$; Britton & Shin, 2013) and for very PTB for Puerto Rican born women (*aOR* = 1.22, $b = .022$, $SE = .008$, $p < .05$) after controlling for neighborhood factors such as Latino poverty rate and individual level factors like age, education, maternal health conditions, and behavior during pregnancy (Britton & Vélez, 2015). Nuru-Jeter et al. (2014) explained the relationship between income inequality (defined by the GINI coefficient) and all-cause mortality for U.S. Blacks and Whites in metropolitan areas using the theory of residential segregation and concentrated poverty. They found that racial segregation positively correlated ($\beta = 11.62$, $p < .05$) with mortality for Blacks however completely attenuated the relationship between income inequality and mortality and was not statistically significant for Whites. Concentrated poverty was also positively associated ($\beta = 6.49$, $p < .05$) with all-cause mortality for Blacks and for Whites ($\beta = 81.27$, $p < .05$) but was not a confounder between income inequality and mortality (Nuru-Jeter et al., 2014). These results give indication that racial residential segregation is more detrimental to Blacks than Whites, however concentrated poverty has a greater effect on White mortality.

Similar effects were observed for poor whites in poor neighborhoods regarding diabetes (*OR* = 2.51, *95%CI [*1.31, 4.81*]*, $p < .05$) compared to poor Blacks in poor neighborhoods (*OR* = 2.45, *95%CI [*1.5, 4.01*]*, $p <.05$) suggesting that poverty and neighborhood disadvantage is a significant contributor to negative health outcomes for Blacks and poor Whites (Gaskin et al., 2014). Using the theory to study an association between Latino immigrant concentration, neighborhood disadvantage, regentrification, and hypertension for Latinos residing in Chicago, Illinois, researchers found that living in higher Latino immigrant neighborhoods is associated with lowered odds of hypertension (*aOR* = .60, *95%CI [* .38, .94*]*, $p < .05$) which signifies a positive benefit to living in a racially segregated neighborhood (Viruell-Fuentes et al., 2012). Contrarily, this advantage did not contribute to having treatment as Latinos had lowered odds of taking hypertensive medications (*aOR* = .54, *95%CI [*.30, .96*]*, $p < .05$); however, neighborhood disadvantage was associated with seeking treatment for hypertension (*aOR* = 2.02, *95%CI [* 1.13, 3.*61]*, $p < .05$) and may be explained by commonly shared beliefs regarding health seeking behaviors in formal settings or through alternative medicine (Viruell-Fuentes et al., 2012). With neighborhood advantage (measured by gentrification), Latinos were less likely to see a doctor for hypertension (*aOR* = .50, *95%CI [* .26, *.95]*, $p < .05$) a possible indication that in these areas, health care is less accessible due to cost, distance, and language barriers (Viruell-Fuentes et al., 2012).

The same may be true for Blacks residing at high levels of neighborhood poverty compared to low poverty. Blacks in high poverty neighborhoods (20% or more poor residents) based on the dissimilarity and spatial proximity indices were more likely to have poor self-rated health (*aOR* = 1.10, *95%CI [* 1.02, 1.*19], p* <.05; *aOR* = 1.06, *95%CI [* 1.02, 1.11*], p* <.05 respectively) with no associations observed for Blacks in low poverty and medium poverty neighborhoods (Do et al., 2017). When controlling for individual level covariates, associations were marginal for Blacks in high poverty, but the indices were not associated with poor self-rated health for Blacks in medium and low poverty neighborhoods (Do et al., 2017).

Few health advantages have been documented for minorities living in residentially segregated areas and most findings were overwhelmingly suggestive that for Blacks and for those who are poor, that places of residence do matter. Blacks and ethnic minorities tend to live in highly segregated communities not necessarily by choice but because of historical racial segmentation stemming from past segregation laws and policies, and from discrimination in housing practices (Charles, 2003). Concentrated poverty also has a documented deleterious effect on minority health and on the health of those who are poor since it is wedded to highly racial concentrated areas. Persons living in residentially segregated neighborhoods who are at the same time poor may be severely restricted to the use of inferior health care services within their communities or may not have access to health care due to limited facilities within the neighborhoods (Massey, 1990; Massey et al., 1994). In addition, income limitations and lack of resources have been cited as a contributing factor restricting access to quality health care (Massey, 1990; Massey et al., 1994).

Theoretical Application to Present Study

Racial residential segregation has been shown to increase advantages for Whites while promoting disadvantages for minorities (Massey, 1990; Massey et al., 1994; Massey & Fischer, 2000; Quillian, 2012, 2017). This disadvantage is evidenced by the Black-White IM rate gap (1.9) for the State of Tennessee (Brown-Speights et al., 2017). For every White infant that dies before his or her first birthday in Tennessee, approximately two Black infants also die, thereby highlighting a disproportionate disadvantage for Blacks (Matthews et al., 2015). IM rate disparities are also observed across high and low racial concentrated areas of Tennessee (TDH, 2014a; USCB, n.d.c); therefore, the theory of residential segregation and concentrated poverty was ideally suited for explaining IM rate disparities for racial groups across Tennessee using places of residence.

Furthermore, poverty has been identified as a risk factor for IM within Southern states which experience higher poverty rates compared to the remaining United States (He et al., 2015). As of 2016 estimates derived from the American Community Survey, 22.6% of the population of Tennessee lived at less than 125% of the federal poverty level and almost 46% of women giving birth in that 12-month time frame lived at or below 200% of the federal poverty level (USCB, n.d.a). Since concentrated poverty coupled with residential segregation restricts health care access, it was worthwhile to assess the theory for IM due to the observation that in some rural areas of Tennessee, PNC services are inaccessible for women due to the concentration of services relegated to four metropolitan counties (Phillippi et al., 2014). Including the aspect of residential segregation proxied by racial concentration not only for urban areas but for rural areas of Tennessee was intended to add to the theory since little research has be conducted on rurality in this context. Using the theory of racial residential segregation and concentrated poverty could help explain if PNC use and access is a consequence of neighborhood-level racial residential segregation and whether PNC impacts IM for vulnerable populations based on rurality or because of race.

Study Variables

Dependent Variable

For this study, I chose IM as my dependent variable. IM is the death of an infant before the first year of life (Matthews & Driscoll, 2017) and encompasses neonatal mortality and post neo-natal mortality (Collins et al., 2013). Neonatal mortality is death before Day of life 28; post-neonatal mortality is death occurring between Day of life 28 and Day of life 365 (Collins et al., 2013). Risk factors such as socio-economic status (e.g., lack of education; Elder et al., 2016; high poverty; He et al., 2015; marital status; Loggins & Andrade, 2013), infant health characteristics (e.g., PTB and congenital defects; Hirai et al., 2014), maternal demographics and health (e.g., maternal age; He et al., 2015; multiple pregnancies, smoking, pre-existing conditions and insurance type; Xaverius, Alman, Holtz, & Yarber, 2015), and lack of PNC (He et al., 2015; Loggins & Andrade, 2013; Peoples & Danawi, 2015) have been documented as contributing to IM.

Currently, the IM rate for the US is 5.90 deaths per 1,000 live births (CDC, 2018c) with variations observed across races (Matthews et al., 2015). Nationally, Blacks have twice the rate of IM as that of Whites (Matthews et al., 2015) and similar rate trends have been observed for Tennessee (Brown-Speights et al., 2017). However, the overall rate of IM for Tennessee at 6.9 deaths per 1,000 live births (AHR, 2017) exceeds that of the US national average (AHR, 2017) suggesting that additional factors required further study.

Independent Variables

For my independent variables I chose places of residence and PNC. Places of residence can be geographical areas defined by postal codes (Lee et al., 2014) and designated as rural or urban areas (Huot et al., 2013; Onega et al., 2010) or may be characterized by attributes measured at the neighborhood level like the concentration of poverty or the concentration of one race (Nkansah-Amankra, 2010). Places of residence for the context of this study were characterized by two variables: rurality and racial concentration.

Rurality. Rural areas have been documented in the literature as related to greater risk of poor outcomes with some races disproportionately affected. Caldwell et al. (2016) found that rural Blacks were less likely to have cholesterol and cervical screens. Singh and Siapush (2014) determined that persons living in rural areas had life expectancy of 2.4 years lower compared to persons living in urban areas; poor Whites compared to Blacks living in rural areas lived 4.7 years longer. Gallagher et al. (2013) determined that normal weight women who lived in rural areas were more likely to gain inadequate weight during pregnancy compared to urban women resulting in harmful consequences for infants.

Rurality in association with poor birth outcomes such as LBW and PTB have been well documented however with varied results (Chen et al., 2016; Darling & Atav, 2017; Darling & Atav, 2012; Herd et al., 2015; Kent et al. 2013; Strutz et al., 2012). Strutz et al., (2012) found that women living in greater than 75% rurality compared to women in urban areas had higher odds of LBW and PTB, but odds were not significant regarding small for gestational age (SGA); Rurality categories less than 75% were not statistically significant predictors of LBW, PTB, or SGA. Slaughter et al. (2013) concluded that rurality levels (categorized by central city, MSAs, rural adjacent to urban, and rural not adjacent to urban) were not associated with LBW or PTB. Similarly, Darling and Atav (2012) found that rurality based on Rural-Urban Continuum Codes was not associated with LBW.

Because racial disparities exist for adult health outcomes, a consideration of rurality from the perspective of neighborhood-level attributes was needed to help explain IM for Tennessee. In addition, the documented inconsistency of results for an association between adult health outcomes and birth outcomes like PTB and LBW, though these are proximal risk factors for IM, gave reason for an examination of rurality in association with IM. Determining the effect that rurality has on IM may guide future developments and implementation of interventions for the most vulnerable women and infants.

Rurality and IM. In a retrospective population based cohort study using registry data linked to census data for women in British Columbia between 2005-2010, Lisonkova et al. (2016), determined that women in rural areas had no greater odds of IM during the perinatal period in comparison to women in urban areas even after controlling for early PTB (< 34 weeks) and late PTB (<37 weeks) (*aOR* = 0.95, *95%CI [*.81, 1.10*]*). The same was true for neonatal mortality; no statistically significant odds were demonstrated based on rurality (Lisonkova et al., 2016). On the contrary, other researchers have demonstrated that rural counties in the US have a non-metropolitan advantage against neonatal mortality after controlling for factors relative to socio-economic status (SES), social capital, and health care availability (Sparks et al., 2009).

In a retrospective cohort study using National Center for Health Statistics (NCHS) compressed mortality data from 1998-2002 linked to census files and other data sources, women in U.S. rural counties between 2,500-9,999 population not adjacent to any metropolitan counties had .154 neonatal deaths per 1,000 population. However, between rurality and neonatal mortality, the association was not statistically significant until after controlling for socio-economic conditions, health care availability, and local conditions (Sparks et al., 2009). Sparks et al. (2009) indicated a subsequent advantage of .55 deaths less per 1,000 population ($p < .05$) in rural counties compared to large metropolitan counties with one million residents or more. This rurality advantage did not extend to post-neonatal mortality as rural counties were associated with more post-neonatal deaths per 1,000 population (ranging from .79-1.31 deaths per 1,000 population); the relationship remained statistically significant after controlling for covariates especially for women in the most rural towns of at least 2,500 population (Sparks et al., 2009).

These rural counties had .65 post-neonatal deaths per 1,000 population more ($p < .05$) than large metropolitan counties (Sparks et al., 2009).

Some researchers have demonstrated that rurality is a risk factor for neonatal mortality but that the risk changes over time. In a national retrospective analysis of secondary data on women with live births in Nigeria between 1990-2013, trends in rural and urban differences were demonstrated with more neonatal deaths occurring in rural rather than urban areas (Akinyemi, Bamgboye, & Ayeni, 2015). In 1990, rurality was not associated with neonatal mortality; however by 2008 urban residency was protective against neonatal mortality (*aHR* = .76, *95%CI [*.63, .92*]*) and in 2013 (*aHR* = .73, *95%CI [*.57, .93*]*) even after controlling for covariates such as education, marital status, infant sex, birth order, and PNC (Akinyemi et al., 2015). Similar findings for an urban advantage have been observed for U.S. infants (Batton et al., 2013).

In a national retrospective cohort of U.S. infants born early preterm (between 20-27 weeks) between 1995-2005, rural birth was associated with a higher early preterm IM rate compared to urban birth ($p < .05$) and the association remained statistically significant across races as demonstrated through multiple logistic regression (Batton et al., 2013). Black women living in rural areas giving birth to early preterm infants had a higher risk of IM compared to Black women in urban areas (*OR* = 1.07, *95%CI [*1.04, 1.09*]*). White women in rural areas compared to White women in urban areas had similar risk of early preterm IM (*OR* = 1.05, *95%CI [*1.03, 1.07*]*) whereas Asian and Pacific Islanders in rural areas had the highest risk of early preterm IM (*OR* = 1.32, *95%CI [*1.18, 1.48*]*) (Batton et al., 2013). Contrarily, a comparison of the Black IM rate versus the

White IM rate among extremely preterm births was significantly lower for Blacks than for Whites (Batton et al., 2013).

Rurality and PNC. Some researchers have indicated that some rural areas lack resources such as obstetric care and pediatric services due to geographic inaccessibility thereby affecting IM (Cox et al., 2011; Phillippi et al., 2014;Yerramilli & Fonseca, 2014). However, other researchers have indicated that rurality does not impact a woman's ability to access PNC (Harris et al., 2015).Yerramilli and Fonseca (2014) used Mississippi Primary Health Care Association data sets geocoded to the U.S. 2010 Census data. They applied Geographical Information Systems technology to pinpoint hotspots of vulnerable populations and to analyze health care accessibility geographically and spatially for Central Mississippi based on travel time. The authors found that 30% of women lived outside the optimal travel time with the greatest impact to access observed in rural counties. More women were underserved who lived in rural areas corresponding to higher IM rates (Yerramilli & Fonseca, 2014). In addition, they found that 10% of women live in high population density with less access to care.

In a cross-sectional study using PRAMS data collected between 2000-2010, women at every rurality tier (urban, suburban, rural town, and isolated rural town) in Maine were able to access PNC as early as they wanted and had their first PNC visit within the first trimester of pregnancy or at 8.6 weeks gestation (Harris et al., 2015). Other researchers found a statistically significant difference ($p < .05$) between rural and urban women and the number of PNC visits; more rural women compared to urban women had no PNC, however for rural women who did have PNC they had between one and three PNC visits and similar numbers in both areas had greater than or equal to four visits (Lisonkova et al., 2016).

Some researchers have excluded PNC from multivariable analysis as it was not found to be a predictor of neonatal mortality or stillbirths for women living in rural areas. For example, Owais et al. (2013) in a case control study of 2,400 Bangladeshi rural women found that PNC was not a predictor for stillbirth or for neonatal mortality. Although PNC was associated with neonatal mortality for women in Nigeria, PNC was not a confounder when comparing rural and urban residence. Living in urban areas was protective against neonatal mortality compared to rural women (*aOR* = .76, *95%CI [*.63, .92*]*) (Akinyemi et al., 2015).

Racial concentration. Racial concentration refers to a minority group occupying physical space in an urban environment and is one measure among others of racial residential segregation (Massey & Denton, 1988). Researchers have seemingly preferred to study other indices of racial residential segregation (Sparks et al., 2013; Wallace et al., 2017) more so than racial concentration and have found varying results in association with adverse birth outcomes using these measures. McFarland and Smith (2011) using the dissimilarity index found that residential segregation was associated with IM for Whites. Mason et al. (2011) using ethnic density found that Whites had lower odds of PTB when living in neighborhoods with a higher concentration of Whites (Mason et al., 2011). Hearst et al. (2008) using the isolation index found no association between residential segregation and IM for Blacks. Similarly, Levine et al. (2014) found no association between residential segregation using the isolation index and a common factor mortality defined by a composite of IM, death by assault, and malignant neoplasms for Black women in large and fringe metropolitan U.S. counties. Contrarily, residential segregation was protective against common factor mortality for White women (Levine et al., 2014).

Nyarko and Wehby (2012) using the isolation index found that Black women in racial residential segregated areas which have lower prevalence of LBW and PTB have higher odds of adverse birth outcomes despite available PNC resources. Sparks et al. (2013) using the dissimilarity, interaction, and spatial proximity indices to measure residential segregation found an increased risk of IM for Blacks. Wallace et al. (2017) using the isolation measure for residential segregation found similar risk of IM for Blacks with IM rate variations likely because of income inequality and unemployment. Debbink et al. (2011) found similar results using the isolation index for residential segregation and increased odds of LBW for Blacks.

Despite the seemingly favored use of other measures of residential segregation, racial concentration has served as a proxy for residential segregation to explain various health outcomes at the community level (Britton & Vélez, 2015; Do et al., 2017; Margerison-Zilko et al., 2017; Mehra et al., 2017; White & Borrell, 2011). Davids et al. (2014) found that decreasing Black racial concentration was correlated with increasing life expectancy for Blacks. Yang and Matthews (2015) determined that Whites had decreased life expectancy when living in Black racial concentrated areas but increased life expectancy when living in Hispanic concentration. Hung et al. (2017) found that rural counties with higher Black concentration had higher odds of no obstetric services compared to predominantly White concentrated counties. Gaskin et al. (2012) determined that MSAs with greater than 50% Black residents were more likely to have primary care physician shortages as opposed to majority Hispanic areas. Satyamurthy and Montanera (2016) found that living in an entirely concentrated Black neighborhood was negatively correlated with the number of annual visits to a health care facility.

Considering the negative outcomes that have been associated with racial concentration and the inconsistent results other researchers have found for residential segregation measures and birth outcomes, a study of racial concentration as a proxy for residential segregation was necessary to help explain the variations in IM rates that are observed across Tennessee. Examining the role of racial concentration and IM for infants in Tennessee was needed to explain the higher rates experienced by Blacks compared to Whites and to Hispanics. Determining the effects of racial concentration in affected populations may help to highlight areas severely impacted and motivate necessary actions to reduce IM rates. The following describes literature on racial concentration in association with IM which gave further evidence of the need for additional study. Lastly, there have been no studies to my knowledge that have assessed this construct in association with IM for Tennessee.

Racial concentration and IM. Regarding racial concentration, Shaw and Pickett (2013) used Hispanic concentration to determine the effect on IM for racial groups nationally. They used a cross-sectional study of linked birth and mortality files from the year 2000 provided by the NCHS geocoded to U.S. census files from 2000 by maternal county of residence. They controlled for individual level variables including parity, maternal age, marital status, maternal education, and area level confounders such as median household income, and percent Black residents. Shaw and Pickett (2013) found that Whites living in Hispanic neighborhoods had a gradient effect with the lowest risk of IM at 15% to 49.99% Hispanic density (*aOR* = 0.72; *95%CI [*.63, .83*]*; $p < .05$) compared to Whites living in 0% to .99% Hispanic density. Blacks had a similar gradient effect with the greatest reduction of IM at 15% to 49.99% density (*aOR* = .66, *95%CI [*.55, .79*]; p* < .05; Shaw & Pickett, 2013). Hispanics at higher Hispanic densities of 50% or greater had lower risk of IM (*aOR* = 0.53; *95% CI [*.38, .73*]*; $p < .05$) but there was no association between lower Hispanic density and IM (Shaw & Pickett, 2013).

McFarland and Smith (2011) found that racial concentration is protective for Hispanics against IM. In a retrospective analysis of U.S. vital statistics and compressed mortality files for 1999-2001 geocoded to U.S. census data for 2000, they found that in MSAs, racial concentration reduced the risk of IM for Hispanics (*aOR* = .87, *95%CI [*.77, .99*]*) when controlling for variables such as percent female-headed household, percent poverty concentration, percent teen births, and median household income.

Similarly, Logan and Parman (2017) showed that racial concentration was protective against IM in rural and urban areas in a retrospective cohort study to assess the impact of segregation on adult mortality, child mortality, and IM in Southern states from a historical context between 1909-1975. They used mortality data geocoded to U.S. Census data and determined that Black racial concentration (percent Black) as a control variable was weakly but negatively correlated with IM ($\beta = -.067$, $SE = .024$, $p < .05$) in rural areas and in urban areas ($\beta = -.048$, $SE = .018$, $p < .05$). The interaction term of

Black race and percent Black was statistically significant but weakly correlated with IM for urban (β = .088, *SE* = .025, $p < .05$) and rural areas (β = .057, *SE* = .017, $p < .05$) (Logan & Parman, 2017). The racial effect of segregation was not strongly correlated for Blacks in urban (β = .083, *SE* = .007, $p < .05$) or rural areas (β = .075, *SE* = .006, $p < .05$) prior to or after control of Black racial concentration although coefficients were decreased for urban (β = .048, *SE* = .025, $p < .10$) and rural areas (β = .067, *SE* = .017, $p < .05$; Logan & Parman, 2017).

On the contrary, other researchers have not found an association between racial concentration and IM (DeCamp et al., 2015; McFarland & Smith, 2011). McFarland and Smith (2011) found for Blacks in MSAs, that racial concentration was not associated with IM although other indices of residential segregation were statistically significant. In a cross-sectional study using birth and mortality files geocoded to U.S. 2000 census data, DeCamp et al. (2015) found that racial concentration (measured by ethnic-diversity scores) was not associated with IM even after adjusting for maternal and infant characteristics, pregnancy complications, infant birth weight, SES factors, and neighborhood characteristics for U.S. born or foreign-born Latinas living in Los Angeles, California. When using Latino immigrant concentration (the proportion of foreign-born residents, non-citizens, immigrants, Spanish speaking adults, and Latinos in a census tract), they found no association with IM for U.S. born Latinas, however Latino immigrant concentration was associated with IM for foreign born Latinas even after adjusting for covariates (*aOR* = 1.29, *95%CI [*1.01, 1.66*]*).

Other researchers have indicated that racial concentration is associated with IM (Huynh et al., 2017; White et al., 2017) further highlighting inconsistencies. White et al. (2017) in a cross-sectional study assessing community-level correlates for IM using linked birth and death files from 2000-2002 geocoded to U.S. Census data from 2000, indicated that racial concentration is not protective against IM for Hispanics in Chicago. They noted that a one-unit increase in Hispanic concentration increased IM by eight percentage points ($\beta = .08$, $SE = .03$, $p < .05$) whereas a one-unit increase in foreign born individuals increased IM by 12 percentage points ($\beta = .12$, $SE = .04$, $p < .05$) (White et al., 2017). They found similar results for Blacks at the community level; a one-unit increase in neighborhood Black racial concentration increased IM by five percentage points ($\beta = .05$, $SE = .01$, $p < .05$).

Huynh et al. (2017) presented further evidence of the negative consequences of racial concentration and IM in a cross-sectional study of women in NYC between 2010-2014 using birth and mortality files geocoded to U.S. Census data. They used the index of the concentration of extremes (income, racial concentration, and the combination of race and income at the census tract level) to determine the effects on PTB and IM when stratified by neighborhood privilege. The highest odds for racial concentration and IM were experienced by women living in the least privileged areas compared to those living in the highest privileged areas (*aOR* = 1.80, *95%CI [*1.43, 2.86*]*) when adjusting for infant gender and for the following maternal characteristics: age, race or ethnicity, nativity, education, marital status, insurance, body mass index, and WIC use (Huynh et al., 2017). They observed a gradient like effect for increasing privilege in association with decreasing odds of IM; similar effects were also observed for PTB.

Prenatal care. PNC has been recognized as important for detecting diseases which have the potential to impact fetal and maternal mortality especially when conducted early and with frequency (Yates, 1909). Several measures have been used to determine the adequacy of PNC: timing of PNC initiation (Forrest & Singh, 1987), the Kessner Index, the Adequacy of Prenatal Care Utilization Index (APNCU Index) also known as the Kotelchuck Index (Kotelchuck, 1994-a, 1994-b; Partridge et al., 2012). Timing of PNC initiation has four categories: no care, initiation in the first trimester, second trimester, and third trimester (Forrest & Singh, 1987). While the Kessner Index measured PNC into three categories (inadequate, intermediate, and adequate), it did not separate women with more than nine PNC visits from the adequate category whereas the APNCU separated this group into a fourth category called adequate plus and utilizes initiation of PNC to calculate the index (Kotelchuck, 1994-a). Other less widely used indices have also been developed such as PCM (prenatal care management using PNC dosage) (Slaughter et al., 2013), the G-Index, Revised G-Index, and cluster analysis (Guillory et al., 2015).

Studies of PNC in association with adverse birth outcomes like PTB and LBW have been well documented (Coley & Aronson, 2013; Darling & Atav, 2017; Darling & Atav, 2012; Guillory et al., 2015; Loftus et al., 2015; Masho et al., 2014; Slaughter et al, 2013; Xaverius et al., 2016). Slaughter et al. (2013) using PCM determined that any participation in PNC was not associated with either LBW or PTB, however when evaluating dosage, they found that low dose PCM increased odds for LBW and PTB, medium dose PCM was protective against LBW and PTB, and high dose PCM was not associated with LBW or PTB. Guillory et al. (2015) using the APNCU Index found that adequate plus PNC carried greater risk for LBW, whereas Coley et al. (2015) with the APNCU Index found that adequate plus PNC compared to adequate PNC was protective against LBW and SGA.

Loftus et al. (2015) using the APNCU Index, found that switching from intermediate PNC to adequate PNC between births offered no statistically significant benefit of reduced risk for LBW nor did they find statistically significant risk for women who changed between births from intermediate PNC care to inadequate PNC. Coley & Aronson (2013) did not find an association between intermediate PNC and LBW. Xaverius et al. (2016) compressed the APNCU Index into a dichotomous variable and determined that women with inadequate PNC had greater prevalence of very LBW compared to women with adequate PNC. Darling and Atav (2012) used timing of PNC and found no association between maternal late initiation of PNC or no PNC and LBW; however, in a later study, Darling and Atav (2017) found that early initiation of PNC predicted extremely LBW and LBW categories whereas late PNC predicted LBW, extremely LBW, very LBW, and moderate LBW with statistical significance.

The varying measures of PNC found in the literature have produced differing risk results in association with PTB and LBW. Considering the impact PNC has on these proximal factors for IM warranted a further look at the impact PNC has on IM (Holland et al., 2016; Kananura et al., 2016; Roche et al., 2016). Evaluating PNC in association with IM was necessary to explain the IM rate disparity observed across the State of Tennessee as well as the Black-White IM gap which continues to exist in Tennessee (Brown-Speights et al., 2017). The following details what other researchers have found using PNC in association with IM.

Prenatal care and IM. Owais et al. (2013) compressed PNC into a dichotomous variable in a case-control study of Bangladeshi women giving birth in 2011 and found that PNC was not a predictor for neonatal mortality, but that maternal complications and nutrition were primary risk factors even after adjusting the model for covariates. Cox et al. (2011) using the APNCU Index in a retrospective analysis consisting of linked birth and mortality files for Mississippi between 1996-2003, found that women with no PNC had higher odds of IM (*aOR* = 4.7; *95% CI [*3.7, 6.0*]*) compared to those with adequate PNC. Akinyemi et al. (2015) highlighted the protective nature of PNC for Nigerian women compared to women without PNC over time. Women who had PNC were less likely to experience IM over three-time periods: 1990, (*aHR* = 0.76, *95%CI [*.61, .95*]*), 2008 (*aHR* = 0.80, *95%CI [* .67, .97]), and 2013 (*aHR* = 0.59, *95%CI [*.47, .74*]*) (Akinyemi et al., 2015). Meghea et al. (2015) in a quasi-experimental study using linked birth and death records of Medicaid insured singleton births in Michigan between 2009-2012, found that women with any participation in a home visitation program for enhanced prenatal and postnatal care were less likely to experience IM compared to those who did not participate (*OR* = 0.73, *95%CI[* .63, .84*]*, $p < .05$). They found similar protective associations for neonatal mortality and postneonatal mortality. Adjusting for adequacy of PNC using the APNCU Index did not influence their findings (Meghea et al., 2015).

Inadequate PNC. In a retrospective cohort study of over 28 million U.S. births between 1995-2002, women with inadequate PNC (as determined by the APNCU Index) had greater odds of IM (*aOR* = 1.79; *95%CI [1.*76, 1.82*]*) compared to women with adequate PNC when controlling for maternal characteristics including race, age, education, marital status, parity, smoking, and alcohol use (Partridge et al., 2012). In another retrospective cohort study using the APNCU Index, women in Mississippi with inadequate PNC compared to women with adequate PNC were 1.5 times more likely to experience IM (*aOR* = 1.5; *95%CI [*1.3, 1.7*]*) when controlling for maternal characteristics (Cox et al., 2011). Holland et al. (2016) found similar results in a cross-sectional study using linked birth and death files for North Carolina between 2008-2009; women with inadequate PNC (as defined by the Kessner Index) compared to those with adequate PNC had greater odds of IM (*aOR* = 1.41, *95%CI [*1.17, 1.71*]*). When controlling for PNC to determine racial differences for IM, El-Sayed et al. (2015a) in a retrospective cohort study of linked birth and mortality files for births between 1989-2005 to women in Michigan found that inadequate PNC measured by the Kessner Index compared to adequate PNC carried greater risk of IM (*RR* = 1.48, *95%CI [*1.43, 1.54*]*) and Blacks still had a twofold risk of IM compared to Whites (*RR* = 1.96, *95% CI [*1.88, 2.04*]*).

Adequate PNC. VanderWeele et al. (2013) stratified IM by medically induced PTB and non-medically induced PTB and found that women who had adequate PNC measured by the APNCU index without medically induced PTB reduced their risk by 40% (*aOR* = 0.60, *95%CI [*.56, .64*]*). Women with adequate PNC and medically induced PTB were at high risk of IM (*aOR* = 5.71, *95%CI [*5.24, 6.22*]*). When using inadequate PNC as the reference group in a cross-sectional study of U.S. births from 2003, VanderWeele et al. (2013) highlighted adequate PNC as a protection against IM. Women who had adequate PNC compared to women with inadequate PNC reduced their risk of IM by 48% (*aOR* = 0.62, *95%CI [*.58, .66*]*) even after controlling for geography and maternal characteristics such as marital status, nativity, education, number of pregnancies, smoking and drinking during pregnancy, and health conditions (VanderWeele et al., 2013).

Intermediate PNC and adequate plus PNC. At the level of intermediate PNC, women increased their odds by 30% compared to women with adequate PNC (*OR* = 1.3, *95%CI [*1.1, 1.5*]*) (Cox et al., 2011). Partridge et al. (2012) indicated that women with intermediate PNC had higher odds for IM compared to women who had adequate PNC (*OR* = 1.14, *95%CI [*1.12, 1.17*]*). Holland et al. (2016) had similar observations for women in North Carolina; they were 1.39 times more likely to experience IM with intermediate PNC than those with adequate PNC (*aOR* = 1.39, *95%CI [*1.22, 1.58*]*).

Women with adequate plus PNC without medically induced PTB had greater likelihood of IM compared to those with inadequate PNC (*aOR* = 1.07, *95%CI [*1.01, 1.14*]*) (VanderWeele et al., 2013). Women with adequate plus PNC who had medically induced PTB had even higher odds of IM (*aOR* = 3.08, *95%CI [*2.88, 3.30*]*; VanderWeele et al., 2013). Partridge et al. (2012) found that adequate plus PNC carried increased risk of IM compared to adequate PNC (a*OR* = 2.22; *95%CI [*2.19, 2.26*]*). Collins et al. (2013) in a retrospective study of linked birth and death files for 2003-2004, found that U.S. born women across all racial categories had increased risk of IM compared to foreign born women regardless of PNC levels measured by the APNCU index. White U.S. born women with adequate plus PNC had higher risk of IM compared to White foreign-born women with adequate plus PNC (*RR* = 1.8, *95%CI [*1.5, 2.3*]*); however, this risk was lower in comparison to women with inadequate PNC (*RR* = 2.3, *95%CI [*1.7, 3.2*]*) and intermediate PNC (*RR* = 2.3, *95%CI [* 1.6, 3.2*]*; Collins et al., 2013).

U.S. born Whites with adequate PNC also had higher risk of IM compared to foreign born Whites although this risk was lower than that of adequate plus PNC (*RR* = 1.5, *95%CI [*1.3, 1.8*]*). U.S. born Blacks compared to foreign born Blacks had similar risk to U.S. born Whites based on PNC levels (Collins et al., 2013). Adequate plus PNC was not statistically significant for U.S. born Mexican Americans compared to foreign born Mexicans, however inadequate PNC (*RR* = 1.7, *95%CI [*1.4, 2.0*]*), intermediate PNC (*RR* = 1.4, *95%CI [*1.1, 1.7*]*), and adequate PNC (*RR* = 1.4, *95%CI [*1.2, 1.6*]*) although statistically significant were much lower in comparison to the risk denoted for Whites and Blacks (Collins et al., 2013).

Maternal and Infant Level Covariates

Researchers evaluating a relationship between rurality, PNC, racial concentration, and IM have included additional covariates at the individual level covering demographic characteristics, health conditions, behaviors (Akinyemi et al., 2015; Partridge et al., 2012;

Roche et al., 2016) as well as infant characteristics (DeCamp et al, 2015). Since this study assesses the relationship between places of residence characterized by rurality and racial concentration, PNC, and IM for races across Tennessee, the following maternal variables based on the literature review were also assessed: race or ethnicity, age, socio-economic status (represented by income and maternal education), marital status, and tobacco use. Infant level variables include PTB and LBW since these are proximal factors influencing IM.

Race or ethnicity. Blacks have consistently higher odds for adverse birth outcomes including IM compared to other racial groups in the United States (Borrell, Rodriguez-Alvarez, Savitz, & Baquero, 2016; Coley et al., 2015; Cox et al., 2011; El-Sayed, Paczkowski, Rutherford, Keyes, & Galea, 2015-b; Matthews et al., 2015). Blacks using Medicaid in 14 Southern states were also more likely to experience PTB (*aOR* = 1.34, *95%CI [*1.32, 1.36*]*, $p < .05$) and fetal or still birth (*aOR* = 1.89, *95%CI [*1.81, 1.98*]*, $p < .05$) in comparison to Whites (Zhang et al., 2013). Regarding IM in NYC between 2000-2010, Black mothers were over three times more likely to experience IM than White mothers (*aRR* = 3.1, *95%CI [*2.7, 3.5*]*) (Borrell et al., 2016). Blacks in Newark, New Jersey were 2.6 times more likely to experience IM compared to Whites (*OR* = 2.6, *95%CI [* 1.4, 4.4*]*) and the association remained statistically significant even after adjustment for covariates (Roche et al., 2016).

In Mississippi, researchers found similar statistically significant findings for Black mothers and IM in comparison to White mothers (*aOR* = 1.7, *95%CI [* 1.5, 1.9*]*) (Cox et al., 2011). Black dyad couples in Michigan have higher IM rates compared to

White dyad couples over time (El-Sayed et al., 2015b). Black couples were 2.29 times more likely to experience IM (*95%CI [*2.15, 244*]*) with higher odds (*aOR* = 2.55, *95%CI [*2.3, 2.81*]*) compared to White couples for births between the years 1989-2006 (El-Sayed et al., 2015b). Black teen mothers in North Carolina have had higher likelihood of adverse birth outcomes relative to PTB compared to White teen mothers even after adjusting for age and neighborhood income (a*OR* = 1.36, *95%CI [*1.20, 1.56*]*; Coley et al., 2015).

Although the risk of IM for Hispanics in NYC was 1.8 times higher (*95%CI [*1.6, 2.1*]*) compared to Whites (Borrell et al., 2016), Hispanics still have lowered risk of IM compared to Blacks. Hispanic women across the United States living in high ethnically dense Hispanic neighborhoods were observed to have decreased risk of IM (*OR* = 0.58, *95%CI [*.38, .73*]*, $p < .05$) (Shaw & Pickett, 2013) and the lowered risk may be attributed to what is considered the Hispanic paradox or more favorable health outcomes despite living in disadvantage and with lower socio-economic status (Powers, 2016; Shaw, Pickett, & Wilkinson, 2010). This paradox is again evident in the lowered risk for preterm births and fetal mortality (Zhang et al., 2013). Hispanic women had reduced risk of PTB birth and lowered risk of fetal mortality and still births compared to Whites (*aOR* = .94, *95%CI [*.92, .96*]*, $p < .05$; *aOR* = .86, *95%CI [*.81, .92*]*, $p < .05$ respectively; Zhang et al., 2013).

Age. Younger age has been shown to be protective against IM. Women ages 15-19 were 90% less likely to experience IM (*RR* = .10, *95%CI [*.01, .77*]*) (Kananura et al., 2016). Contrarily, increasing age has been shown to be associated with IM (Kananura et al., 2016; VanderWeele et al., 2013). Ugandan women between the ages of 35-39 were at risk for IM compared to women aged 25-29 (*RR* = 2.11, *95%CI [*1.02, 4.32*]*), however women aged 40 and above had even greater risk of IM (*RR* = 2.99, *95%CI [*1.31, 6.83*]*) (Kananura et al., 2016).

Researchers have observed a gradient-like effect for increasing age for American women and IM (VanderWeele et al., 2013). The following ages demonstrated an increasing gradient in association with IM for U.S. women: women ages 35-39 had the lowest odds for IM (*aOR* = 1.09, *95%CI [*1.01, 1.17*]*), whereas women ages 40-45 were 1.38 times more likely to experience IM (*aOR* = 1.38, *95%CI [* 1.22, 1.55*]*), and women ages 45-49 had even higher odds (*aOR* = 1.55, *95%CI [*1.06, 2.21*]*, VanderWeele et al., 2013). Powers (2016) noted similar age-related findings for ethnic women in the United States (Powers, 2016). For example, Mexican American women and Mexican immigrant women over age 35 had higher risk of IM compared to women less than 35 years (*RR* = 1.20, $p < .05$; *RR* = 1.25, $p < .05$ respectively); however, the risk of IM for White women although statistically significant was lower in comparison (*RR* = 1.03, $p < .05$; Powers, 2016). On the contrary, age was not a statistically significant predictor of neonatal mortality for a subset of Chinese women in a rural province of China (Li et al., 2016).

Socio-economic status. SES can be represented by a person's education or income (Elder et al., 2016; El-Sayed et al., 2015a) and researchers have indicated that higher SES reduces stress and protects against poor birth outcomes at higher levels (Loggins & Andrade, 2013). Nkansah-Amankra (2010) controlled for income in a study to assess neighborhood-level variables in association with poor birth outcomes since income can influence birth outcomes and is related to neighborhood location. However, income is often unavailable for researchers using linked birth and mortality records, therefore, some researchers have used education as a proxy (Cox et al., 2011). Cox et al., 2011 used education to represent SES and found that women in Mississippi with less than a high school education had higher risk of IM compared to women who attended college (*OR* = 1.4, *95%CI [*1.2, 1.6*]*). Similarities have been observed for women in North Carolina; women with less than a high school education versus those who attended college were 1.60 times more likely to experience infant death (*aOR* = 1.60, *95%CI [* 1.31, 1.95*]*) (Holland et al., 2016). Women in Mississippi who graduated high school versus those who went to college were also at risk for IM (*OR* = 1.2, *95%CI [*1.1, 1.4*]*) (Cox et al., 2011).

White women 25 years or older with less than a high school education had 25% greater risk of IM ($RR = 1.25$, $p < .05$) compared to White women with a high school education (Powers, 2016). Lack of education also posed increased risk for IM for Mexican American and Mexican immigrants (Powers, 2016). In accounting for the IM gap between races, Elder et al. (2016) found that if White mothers had the distribution of education like that of Black mothers, 0.56 deaths per 1,000 live births would have resulted when retaining their own distribution of other characteristics such as age, PNC, and marital status ($\beta = 0.56$, $SE = .05$). Likewise, White women would have had 1.51 more deaths per 1,000 live births compared to Mexican women ($\beta = 1.15$, $SE = .14$) (Elder et al., 2016).

Marital status. Some researchers have shown that marriage is protective against IM (Akinyemi et al., 2015; Elder et al., 2016; Ngui, Cortright, & Michalski, 2015). Using a retrospective analysis of birth outcomes for infants in Milwaukee, Wisconsin for 1993-2009, Ngui et al. (2015) showed that women who were married had decreased odds of IM (*OR* = 0.48, *95%CI [*.43, 54*]*). Akinyemi et al. (2015) observed similar findings for married Nigerian women compared to women who were unmarried. Married women had reduced risk for neonatal mortality even after adjustment over two-time periods: 2008 (*aOR* = 0.52, *95%CI [* 39, .68*]*) and 2013 (*aOR* = 0.59, *95%CI [*.38, .91*]*) (Akinyemi et al., 2015).

After stratifying by race, Ngui et al. (2015) found that singleness for Black or Hispanic women with undocumented fathers was a positive predictor of IM, however women who were unmarried and White with undocumented fathers had the greatest odds of IM (*OR* = 4.38, *95%CI [*3.50, 5.48*]*, p < .05). Unmarried White mothers age 25 and older had greater risk of IM (*RR* = 1.25, p < .05) compared to unmarried White women younger than 25 and although marital status carried significant risk for unmarried Mexican Americans and Mexican immigrants, their risk of IM was lower than unmarried Whites (Powers, 2016). Unmarried women in New Jersey had twice the odds of IM compared to married women (*OR* = 2.1; *95%CI [* 1.6, 2.6*]*); odds remained statistically significant after adjustment (Roche et al., 2016).

Tobacco use. Some researchers have established tobacco use as detrimental to fetal growth and development (Gardosi, Madurasinghe, Williams, Malik, & Francis, 2013) resulting in adverse birth outcomes (Mei-Dan et al., 2015; Holland et al., 2016).

Maternal tobacco use in pregnancy resulted in a higher risk of IM (*aOR* = 1.19, *95%CI [*1.04, 1.37*]*) compared to maternal non-users of tobacco (Holland et al., 2016). Regarding cigarette use, Metzger, Halperin, Manhart, and Hawes (2013) found that women who smoked during pregnancy were more likely to have experienced IM stemming from respiratory infections compared to women who did not smoke during pregnancy (*aOR* = 1.51, *95%CI [*1.17, 1.96*]*). Researchers have also observed a dose response in association with IM (McDonnell-Naughton, McGarvey, O'Regan, & Matthews, 2012; Cox et al., 2011). Women who smoked one to 10 cigarettes per day were 2.93 times more likely to experience IM from SIDS (*aOR* = 2.93, *95%CI [*1.50, 5.71*]*), whereas women who smoked 10 or more cigarettes had an even higher risk of SIDS (*OR* = 4.36, *95%CI [*2.50, 7.61*]*; McDonnell-Naughton et al., 2012). Cox et al. (2011) observed similar results for women during pregnancy in Mississippi, noting that those who smoked 10 or more cigarettes per day were 80% more likely to experience IM compared to non-smokers (*OR* = 1.80, 95*%CI [*1.5, 2.1*]*); women who smoked one to nine cigarettes daily were also at risk (*OR* = 1.5, *95%CI [*1.2, 1.8*]*), although their risk was lower in comparison.

Prematurity and birthweight. According to some researchers, LBW is a contributing factor to IM (Holland et al., 2016; Kananura et al., 2016; Roche et al., 2016) and is a strong predictor of IM especially for Blacks (Mantoba & Collins, 2017). Women with LBW infants had greater risk of neonatal mortality compared to women with normal weight infants (*RR* = 2.18, *95%CI [*1.02, 4.72*]*; Kananura et al., 2016). U.S. infants born at less than 2,500 grams had statistically significant odds of IM compared to infants weighing 2,500 grams or greater (Roche et al., 2016). Infants born at less than 1,500 grams were 123 times more likely to die within the first year of life compared to infants with birthweight of 2,500 grams or more (*OR* = 123.0, *95%CI [*96.0, 158.0*]*; Roche et al., 2016). Infants with birthweight between 1,500 and 2,500 grams also had higher odds of IM (*OR* = 7.8, *95%CI [*5.7, 10.7*]*; Roche et al., 2016). Holland et al. (2016) found similarly that infants born less than 2,500 grams had higher odds for IM than normal weight infants (*aOR* = 3.14, *95%CI [*2.64, 3.73*]*). Conversely, infants born at the other extreme of greater than 3,697 grams had reduced odds of IM (*aOR* = .48, *95%CI [*.31, .74*]*; Holland et al., 2016).

U.S. born women with very preterm delivery (less than 28 weeks gestation), had a higher risk of IM (*OR* = 2.79, *95%CI [*1.73, 4.52*]*) compared to U.S. born women with term infants (DeCamp et al., 2015). Odds of PTB (less than 28 weeks gestation and between 34 to 36 weeks gestation) for foreign born women living in the United States was also high (*OR* = 2.59, *95%CI [*1.76, 3.81*]*; *OR* = 1.61, *95%CI [*1.24, 2.10*]*) respectively (DeCamp et al., 2015). Less than 37 weeks gestation was associated with perinatal mortality for women in rural areas compared to urban areas (*aOR* = 1.06, *95%CI [*1.01, 1.11*]*; Lisonkova et al., 2016). Infants born at less than 32 weeks gestation, had the highest odds of IM compared to those born at 36 weeks gestation or more (*OR* = 98.7, *95%CI [* 77.3, 126.1*]*); those born between 32 to 36 weeks gestation also carried risk but not as high as those born at less than 32 weeks (*OR* = 5.2, *95%CI [*3.7, 7.2*]*; Roche et al., 2016) signifying that increasing gestational age decreased risk of IM. Supporting this notion are results on infants born in North Carolina; 32 weeks or less gestation and between 33-36 weeks gestation had decreasing risk of IM (*aOR* = 27.84, *95%CI [*23.50, 32.98*]*) and (*aOR* = 1.61, *95%CI [*1.32, 1.96*]*) respectively though still statistically significant for IM (Holland et al., 2016).

When evaluating the overall IM rate for the U.S., Lau, Ambalavanan, Chakraborty, Wingate, and Carlo (2013) attributed the stagnant IM rate to less than 500-gram births and premature gestational age groups between 2000-2005. They indicated that births in these subgroups have increased significantly over time and impact neonatal mortality more so than other birth weight groups. In addition, when these type of births and deaths were excluded from mortality rate calculations, it was only then that significant improvements were observed in the IM and neonatal mortality rates (Lau et al., 2013).

Researchers have presented counterfactual arguments that the IM rate disparity observed between Blacks and Whites can be largely explained by LBW and PTB (Elder, Goddeeris, Haider, & Paneth, 2014). Schempf, Branum, Lukacs, & Schoendorf (2007) indicated that almost 80% of excess deaths among pre-term Blacks contributed to the Black-White IM gap whereas more than 50% of excess deaths were among Black infants born pre-term at less than 28 weeks. They noted increases in excess deaths for Black infants to 54% in 1990 and to 62% by 2000. Although the racial disparity in preterm birth declined during this time period, its contribution to the Black-White IM rate gap remained unchanged (Schempf et al., 2007). Authors, Luke and Brown (2006) attributed the observed Black-White differences to poor access to health care, available technologies, and differences in health behaviors for mothers with infants at earlier gestational ages and lower birth weights. However, other researchers have noted that

White infants born prematurely and with lower birth weights have improved survivability because of improved technology (Alexander, Wingate, Bader, & Kogan, 2008), surfactant therapy, and access to care, thereby counterbalancing the observed declines in overall IM rates (Schempf et al., 2007).

Further delineating the Black-White IM gap into explained and unexplained gaps, Elder et al. (2014) found that the explained IM rate gap showed a statistically significant decline between 1983-2004, with much of the gap emerging in birth weight groups greater than 1,000 grams. They weighted Blacks to match risk factors of Whites and found that infants born at lower births weights (<1,000 grams) accounted for 60% of the overall Black-White IM rate gap. Risk factors for the explained IM rate gap had identifiable and distinct risk factors and the declining explained gap was likely due to the decreasing association between risk factors (birth certificate variables) and IM as well as convergence of risk factors for Blacks and Whites (Elder et al., 2014). On the contrary, the unexplained Black-White IM gap which has remained relatively the same over two decades has been concentrated in the less than 1,000-gram birth weight group with unchanged and unknown risk factors thereby gave indication of the need for further study (Elder et al., 2014).

In brief, researchers have identified multiple variables contributing to IM including maternal age, race, ethnicity, socio-economic status, marital status, tobacco use, PTB, and LBW. These maternal and infant level variables in conjunction with neighborhood characteristics including racial concentration and rurality, along with PNC may shed more light on the increased rate of IM for certain racial groups in Tennessee.

Much is still uncertain as to how these variables impact IM, further characterizing gaps in knowledge as discussed in greater detail in the literature synthesis section of this chapter.

Literature Synthesis

Living in a racially concentrated neighborhood especially when the neighborhood is predominantly Black suggests poor access to resources and consequently the potential for poor health for residents (Gaskin et al., 2012; Hung et al., 2017; Satyamurthy & Montenera, 2016) extending into adverse birth outcomes including IM (Huynh et al., 2017; White et al., 2017). These effects extrapolated to Whites living in predominantly Black neighborhoods and odds improved for health outcomes as racial concentration decreased (Yang & Matthews, 2015)

Of the studies which concerned rurality and IM, results were inconsistent. Results varied from no association with IM (Lisonkova et al., 2016), to negative consequences related to IM (Akinyemi et al., 2015; Batton et al., 2013; Cox et al., 2011), and at the far extreme positive benefits against IM (Sparks et al., 2009). Regarding U.S. populations (Batton et al., 2013; Sparks et al., 2009; Yerramilli & Fonseca, 2014), researchers gave strong indication that the effects of rurality are inconsistent across the United States similar to the results observed for a relationship between rurality and PTB and LBW (Chen et al., 2016; Darling & Atav, 2017; Darling & Atav, 2012; Herd et al., 2015; Kent et al., 2013; Strutz et al., 2012). Stratifying, IM into neonatal mortality and post-neonatal mortality did not provide conclusive evidence that rurality has a consistent association with IM (Sparks et al., 2009). While rurality conferred an advantage against neonatal mortality, it was not protective against post-neonatal mortality and the most rural women suffered the greatest risk (Sparks et al., 2009). An urban advantage was noted against IM (Akinyemi et al., 2015) however more women had increasing risk for poor birth outcomes in urban areas (Kent et al., 2013).

Dissecting rurality and IM based on race revealed significant racial differences (Batton et al., 2013; Cox et al., 2011) for other infant health outcomes like PTB, LBW (Darling & Atav, 2017; Herd et al., 2015) and access to health care services (Caldwell et al., 2016; Singh & Siapush, 2014). Blacks in rural areas suffered worse outcomes than Blacks living in urban areas regarding IM, whereas rural Whites had similar risk of IM as their urban counterparts (Batton et al., 2013). When comparing Blacks to Whites, Blacks had higher odds of IM although geographic disadvantage was a factor for poor birth outcomes for all races (Cox et al., 2011). Other researchers evaluated data for racial differences based on rurality but grouped all minorities together and compared them to Whites (Harris et al., 2015). Group separation may have pinpointed racial differences at each rurality tier, but results would not have been generalizable, potentially due to the lack of racial diversity in the sample. When accounting for race and evaluating the entire United States, others limited the sample to deaths in the PTB population and did not account for full term infant deaths although the data revealed a statistically significant relationship between maternal race and preterm IM rates for rural areas (Batton et al., 2013).

Some women in rural areas did not have problems accessing PNC (Harris et al., 2015). However, there were noted differences in access to care (Yerramilli & Fonseca, 2014) and PNC use for other rural areas (Lisonkova et al., 2016) regardless of race (Cox et al., 2011). These findings suggest that access to care is likely dependent on where a woman lives with some areas lacking PNC resources more so than others, resulting in a trickle-down effect with negative consequences to infants. Seemingly, rural areas have a disadvantage regarding IM especially for Blacks and if coupled with a lack of resources, consequences are more disastrous and could explain the higher IM rate observed for Blacks in Tennessee.

Several researchers assessed racial concentration in association with other health outcomes such as adult health (Davids et al., 2014; Yang & Matthews, 2015), LBW, PTB (Chae et al., 2017; Kothari et al., 2016; Madkour et al., 2014; Vang & Elo, 2013), and access to care (Hung et al., 2017; Satyamurthy & Montanera, 2016; Gaskin et al., 2012) with varying results. Living in high Black concentration was positively related to adult mortality for Whites and Blacks (Davids et al., 2014; Yang & Matthews, 2015) and increased the odds of PTB and LBW for Black infants in some areas (Chae et al., 2017). In other areas, high racial concentration protected Blacks and minorities against LBW, however, had no significant effect for Whites (Madkour et al., 2014; Vang & Elo, 2013). The same varied associations were observed in relation to IM with no association between racial concentration and IM for Blacks but significant protection for Hispanics (McFarland & Smith, 2011). In some areas, odds for Black IM increased with increasing racial concentration (White et al., 2017). The same was true for Hispanics in metropolitan areas (White et al., 2017) but only based on nativity (DeCamp et al., 2015). However, these studies focused on metropolitan areas with no extension to rural populations or to Tennessee.

Contrarily, when evaluating racial concentration and IM for population in rural and urban areas, racial concentration was shown as protective against IM for Blacks and Whites (Logan & Parman, 2017). However, racial concentration coupled with Black race was harmful for Blacks regardless of place of residence (Logan & Parman, 2017). Although these results shed light on the negative consequences of IM for Blacks, results may not be generalizable. Furthermore, protection against IM may be due to the type of racial concentration and the continuum of concentration since Blacks and Whites have an advantage against IM when living in lower concentrated Hispanic neighborhoods (Shaw & Pickett, 2013). Protection against IM may stem from the availability of resources as Hispanic concentrated areas were less prone to shortages of primary care resources (Gaskin et al., 2012). On the contrary, high Black concentrated areas have less resources available for health care services (Hung et al., 2017) and less satisfaction with access to health in comparison to predominantly White areas (Satyamurthy & Montanera, 2016).

PNC was overwhelmingly supported in the literature review as necessary for protection against IM with increasing odds demonstrated when PNC levels decreased (Cox et al., 2011; El-Sayed et al., 2015a; Holland et al., 2016; Partridge et al., 2012). Adequate plus care had the greatest risk of IM (Cox et al., 2011; Partridge et al., 2012; VanderWeele et al., 2013) but was inconsistent due to lowered odds which were observed for some groups compared to others with inadequate or intermediate care (Collins et al., 2013). Because adequate plus care should start by the fourth month of pregnancy, it is questionable whether the first trimester is the most optimal time for entry since it has been shown to be inconsequential if initiation happened during the second or even the third trimester of pregnancy (Kananura et al., 2016; Roche et al., 2016). Also, IM rates for each month of initiation into PNC was no different for women in some Southern states compared to the remaining United States (He et al., 2015), which suggested that PNC may not be as critical as it is commonly believed.

While some studies for this review specifically covered PNC for the U.S. population, no quantitative studies specifically evaluated use in Tennessee. Cox et al. (2011) evaluated PNC use in Mississippi utilizing data from 1996-2003 to analyze this relationship, however results are not generalizable to Tennessee. He et al. (2015) covered several Southeastern states using data from 2005-2009, however this data was at the state level and only looked at group differences among the states not within states and did not include data for Tennessee. Further, most researchers relied on linked birth and mortality records using a retrospective cohort design and while some opted for a cross-sectional design only one used PRAMS data to study a relationship with IM (Harris et al., 2015). Few geocoded to the tract level (DeCamp et al., 2015; Huynh et al., 2017; White et al., 2017). This study used PRAMS geocoded to U.S. census data at the census tract level for a study of IM for the population of Tennessee. PRAMS as a data source was a viable option for studying infant health consequences especially when evaluating risk factors at the neighborhood-level. Studies directly evaluating IM involved data sets that were 10 years old or greater and were concentrated on populations outside of Tennessee (Cox et al., 2011; He et al., 2015; Holland et al., 2016; Logan & Parham, 2017; Roche et al., 2016; Partridge et al., 2012; VanderWeele et al., 2013). This study used more current data which may be better suited and have greater application to the population of

Tennessee.

Summary and Conclusions

Although I found multiple studies regarding the individual constructs of rurality, PNC, and racial concentration, I found none in my literature review that considered all three factors simultaneously in relation to IM. Several researchers considered each of these constructs uniquely in association with adverse birth outcomes finding varying results. Some considered two constructs in relation to each other such as rurality in association with PNC and these studies helped to establish that there are variations in access to care based on place of residence. Literature on rurality in association with PTB and LBW or racial concentration in association with those same outcomes were plentiful; however, current evaluations of these factors in relation to IM were few.

From the review, it is clear that IM rates do vary across the United States and IM for Tennessee has been understudied. Blacks bear a disproportionate burden of IM across the United States with similar trends observed in Tennessee. While multiple factors for IM exist, rurality has been shown to impact health outcomes and the odds do vary across the United States and can be a product of race. Racial concentration in association with IM can either be a detriment or a protection, but the effect is seemingly dependent on the type of racial concentration and the concentration gradient. While the effects of rurality were demonstrated for Tennesseans, it is unknown whether racial concentration in the context of rurality impacts IM for Blacks or other races in Tennessee when levels of Black concentration increases or whether the effects are negligent.

Since lack of health care resources in some areas which are racially concentrated may subsequently impact IM, it is supposed that PNC when lacking also threaten birth outcomes for women in these areas. PNC use in Tennessee has been shown to be disproportionate for Blacks and it may be that when PNC coupled with living in rural areas which are racially concentrated has an even greater effect on IM thereby explaining IM for Tennessee; however, more research was needed. While PNC has been shown to be beneficial for a woman during pregnancy, it was still unclear whether adequate plus PNC is a predictor of IM based on race for Tennessee women.

This study has added to the body of literature by assessing whether PNC for women in Tennessee is a product of where a woman lives and if so, how PNC influences IM. In addition, racial concentration at the neighborhood-level and in conjunction with rurality has helped to determine the impact if any that these variables have on IM for Tennesseans. Since none of the studies reviewed evaluated the effect of racial concentration and IM for the population of Tennessee, this study intended to fill this gap through a detailed assessment across races and places in conjunction with rurality and PNC. Assessing for maternal-and-infant level variables in the context of rurality, racial concentration, and PNC determined the effect these variables have on IM for races across Tennessee. Evaluating these factors has given a unique perspective for the disproportionate IM rates and the disproportionate impact IM has for Blacks. In addition, applying the theory of racial residential segregation and concentrated poverty has helped to explain the IM differences across Tennessee since the theory posits that as Black racial concentration increases, poverty ensues due to a lack of supporting resources with subsequent negative consequences to health.

In Chapter 3, I discuss aspects of the secondary data set used for the study including the population sampled and the data collection procedures. I include information on geocoding the data set to the 2010 U.S. Census data and USDA 2010 data. In addition, I discuss how rurality, racial concentration, PNC, and IM are measured and coded for the study. I also review the maternal-and-infant level covariates, the study design, and I outline my plan for analyzing the data statistically. Last, I discuss ethical concerns and data confidentiality precautions.

Chapter 3: Research Method

Introduction

The purpose of this study was to assess the relationship between places of residence (using neighborhoods as units of analysis inclusive of the constructs of racial concentration and rurality), PNC, and IM across racial groups in Tennessee and to determine whether race modifies these relationships. The theory employed to assess these relationships was racial residential segregation and concentrated poverty. The theory posits that concentrated poverty results from growing racial segregation into low and high poverty groups with eventual decline of families, neighborhoods, and communities (Massey & Fischer, 2000; Quillian, 2012, 2017; Wilson, 1987). This study was observational and quantitative using a cross-sectional design. I used archival data to analyze proximate relationships linked to the higher IM rates in racially concentrated areas of Tennessee. In Chapter 3, I discuss the choice of study design, the target population, the source of secondary data, the variables used and their operationalization. Ethical considerations are also discussed including access to the data, data protection, and confidentiality.

Research Design and Rationale

The main independent variables for this study were PNC and places of residence. Places of residence are inclusive of the constructs of rurality and racial concentration. Places of residence can be geographical areas defined by postal codes (Lee et al., 2014) and designated as rural or urban areas (Huot et al., 2013; Onega et al., 2010) or may be characterized by attributes measured at the neighborhood-level like the concentration of poverty or the concentration of one race (Nkansah-Amankra, 2010).

The dependent variable was IM. I also assessed the following maternal-level and infant-level covariates for a relationship with IM: race, ethnicity, age, socio-economic status (proxied by maternal education and income), marital status, and tobacco use (represented by smoking cigarettes during the third trimester of pregnancy). Infant-level variables were birthweight and prematurity.

I used a cross-sectional design for this study like other researchers identified in the literature review (DeCamp et al., 2015; Harris et al., 2015; Huynh et al., 2017; Kananura et al., 2016; Li et al., 2015; Shaw & Pickett, 2013; VanderWeele et al., 2013; White et al., 2017). The archival data used in the study, specifically PRAMS or the Pregnancy Risk Assessment Monitoring System for Tennessee and U.S. Census data for 2010, were collected at one point in time and by questionnaire or survey, making a cross-sectional design the best approach for studying the relationships between variables. The use of a cross-sectional design allowed an adequate evaluation of the population of Tennessee since PRAMS collected a representative sample of all live births (CDC, 2018; TDH, n.d.a). Although a cross-sectional design cannot be used to establish causality (Aschengrau & Seage, 2014; Setia, 2016), results can be generalized to the entire birthing population of Tennessee.

A caveat to using the PRAMS data set was that the most recent data for release from the State of Tennessee were collected between 2009-2011. PRAMS excluded Tennessee women who delivered outside of Tennessee as well as women who were not

Tennessee residents who had a live birth in Tennessee; so, the data set, while representative of Tennessee, does not fully capture all live births occurring in Tennessee. PRAMS data were geocoded to U.S. Census data at the census tract level; however, the census data are collected every 10 years. The most recent census for Tennessee that was available, was performed in 2010. Despite these caveats, multiple researchers have opted to use a cross-sectional design to study some of the same variables as I did in this study (Caldwell et al, 2016; Coley & Aronson, 2013; Harris et al., 2015; Kananura et al., 2016; Kent et al., 2013; Li et al., 2015; Nkansah-Amankra, 2010; Satyamurthy & Montanera, 2016) .In addition, multiple researchers have opted to geocode records to U.S. Census data to establish multi-level characteristics based on location (DeCamp et al., 2015; Harris et al., 2015; Huynh et al., 2017; Logan & Parman, 2017; McFarland & Smith, 2011; Shaw & Pickett, 2013; Sparks et al., 2009; White et al., 2017) similar to what I did in this study. Therefore, this study was consistent with past research and offered value toward explaining factors that contribute to the disparate IM rates in Tennessee.

Methodology

Population

The target population for this study were women residing in Tennessee who delivered a live birth within Tennessee. The women chosen for the PRAMS data set between 2009-2011 correspondingly represent the Tennessee birth population for those years. The annual birth rates for 2009, 2010, and 2011 were 79,462, 79,345, and 79,462 respectively for a total of 238,269 live births (TDH, n.d.a).

Sampling and Sampling Procedures for PRAMS

PRAMS investigators used a sampling frame of women in Tennessee with live births drawn from birth certificate files (CDC, 2017b). Researchers used a stratified random sampling technique based on maternal race or ethnicity and adhered to a standardized approach set forth by the CDC (2017b). Women with LBW were oversampled to ensure adequate representation of this subpopulation (CDC, 2017b; TDH, 2014b). Once the researchers selected the women, they contacted the women through an introductory letter followed by the PRAMS questionnaire. Incentives were included to encourage participation and rewards were given for participating (CDC, 2017b; Shulman, Gilbert, & Lansky, 2006). After 7 days of mailing the questionnaire, researchers sent a card to the women serving as a reminder or as a thank you (CDC, 2017b). To those who did not respond, researchers sent two subsequent questionnaires at specified intervals with a final attempt at contact through phone calls (CDC, 2017b). Women were contacted approximately two to four months post birth and the data collection cycle started with the mailed letter through the last phone call and lasted between 60 and 95 days (CDC, 2017b). This cycle of sampling and data collection occurred each month (TDH, n.d.b). Approximately 110 new mothers were mailed a survey monthly in Tennessee (TDH, n.d.b).

Because the sampling frame was chosen from the birth certificate files, women were ineligible for selection if they met the following exclusion criteria: out-of-state residency, delivery less than two months or greater than six months before the sampling date, and women with multiple births such as triplets (TDH, 2014b). The number of women sampled for 2009, 2010, and 2011 were 1,162, 2,124, and 2,209 (TDH, n.d.b), respectively, for a cumulative sample of 5,495. Responses to the surveys were 740, 1,265, and 1,309 for 2009, 2010, and 2011 respectively for a total of 3,314 participants (TDH, n.d.b).

Sampling and Sampling Procedures for U.S. 2010 Census

The U.S. Census began in 1790 and occurs every 10 years (USCB, 2017). Its purpose is to determine how many people live in the United States so that the number of seats in the House of Representatives is correctly apportioned for each state. The census is a requirement of the U.S. constitution and is taken in years that end in zero and begins on census day or April 1st (USCB, 2017). As a cost savings in 2010, census officials utilized a short form for data collection as opposed to the long questionnaire used for previous census years (USCB, 2017). This short form comprised 10 questions related to name, gender, age, race, ethnicity, relationship (meaning marital status including same-sex marriage or unmarried partnership), and home ownership (USCB, 2017). Approximately 134 million households were reached with the survey by mail (USCB, 2017). For those households that could not be reached by mail, census representatives visited these households and conducted one-on-one interviews to ensure each person was counted (USCB, 2017). The census covered all 50 states and Puerto Rico (USCB, 2017).

Sample Size Calculation

Using Epi Info Version 7.2 software developed by CDC (2018a), I calculated a sample size based on a population of 238,269, which was the number of infants born in Tennessee between 2009-2011, and the number from which the PRAMS data set was derived. I used an expected frequency of rurality at 30% considering that nearly 30% of Tennessee mothers live in rural areas (TDH, 2014b) and an acceptable margin of error at 5%. With two clusters and a 95% confidence interval, the estimated sample size was 322 as designated in Figure 2. Adding a contingency of 25% or 80.5, the sample size was 402.5, and rounding to 404 allowed for 202 mothers living in rural areas and 202 mothers from urban areas.

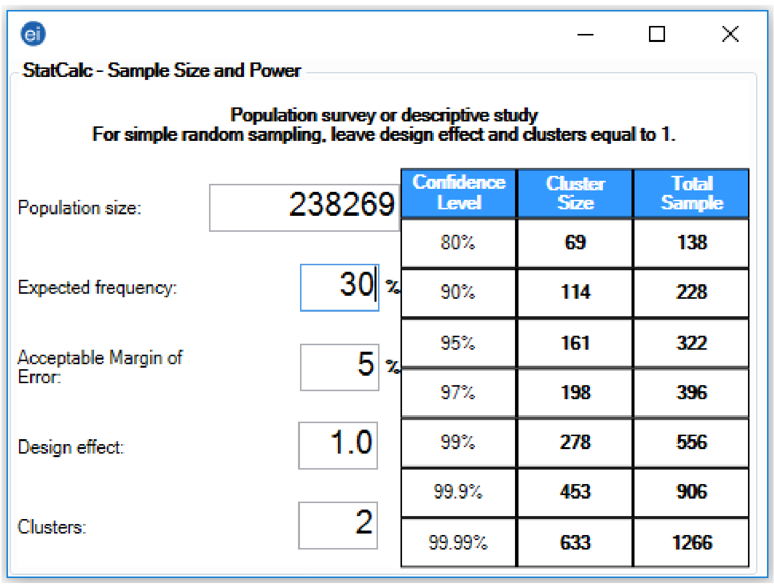

Figure 2: Sample size estimation based on 238,269 births between 2009-2011.

Access to Archival Data

Officials from the TDH Research Division of the Office of Policy, Planning, and Assessment required outside researchers to obtain permission to access the PRAMS data set. They also required a signed data use agreement. This agreement outlined the requirements and restrictions for use of the data. TDH officials also required an Institutional Review Board (IRB) application which outlined the project and study design and included the details of the study, a listing of the variables, and the statistical analysis plan. An IRB approval was necessary, since maternal census information was needed to geocode to the census data was considered as private health information by the TDH. The 2010 census data and USDA 2010 data were publicly available for download since participant information was deidentified.

Instrumentation and Operationalization of Constructs

PRAMS. Through collaboration between CDC and multiple state health departments, PRAMS identifies and evaluates risk factors for IM covering over 83% of all U.S. births with the aim of improving health outcomes for mothers and infants (CDC, 2018b). CDC developed PRAMS as a result from key observations regarding IM and its stagnant decline over time in addition to the prevalence of LBW deliveries across the United States (Gilbert, Shulman, Fischer, & Rogers, 1999). The pilot phase or Phase one of PRAMS began in 1987 and has since been administered annually through on-going data collection by participating states (Shulman, et al., 2006; Gilbert et al., 1999). PRAMS began data collection with six states initially (Gilbert et al., 1999) but has expanded to 47 participating states including the State of Tennessee (CDC, 2018b). Tennessee began to administer PRAMS in 2006 during Phase V of the survey (TDH, n.d.a).

PRAMS contains core questions and is designed to allow each participating state to tailor the survey to meet state specific needs (Shulman et al., 2006; CDC, 2017b). Core questions collect information on breastfeeding, attitudes regarding pregnancy, tobacco and alcohol use, contraception, and infant health (CDC, 2017b). Since this study was focused on places of residence inclusive of racial concentration and rurality, PNC, and

IM across races, Tennessee PRAMS was ideal to explain these relationships. Tennessee PRAMS contained the variables including maternal race, PNC, maternal demographic information, and infant level variables. When geocoded to the U.S. 2010 Census data and USDA 2010 data, the evaluation of neighborhood-level characteristics (racial concentration and rurality) contributing to IM were facilitated for Tennessee women and infants.

U.S. 2010 Census. The decennial census has been collected since 1790 as required by the U.S. constitution. Each household in the United States and Puerto Rico for 2010 was sent a short mail-in survey consisting of 10 questions regarding demographics and housing information. The census file contains demographic and housing characteristics down to the census block. The census file is constructed with the following hierarchy of information: State> County> County subdivision> Place (or place part) > Census tract> Block group> Block. The files contains demographic information on race as well as the classification of areas as rural, urban cluster, and urban at each hierarchy. SF1 files contain 82 population tables labeled as PCT and four housing tables labeled as HCT at the census tract level. SF1 files also contain urban and rural updates at the census tract level (USCB, 2016).

Validity and reliability of PRAMS and the U.S. 2010 Census. Since PRAMS is based on maternal self-reported data, Hosler, Nayak, and Radigan (2010) to test for validity, used data from the New York State birth certificate files reporting gestational diabetes to determine how closely the two data sources matched. They calculated a prevalence adjusted and bias adjusted kappa (PABAK) score of .88 indicating agreement between PRAMS and the birth certificate data. The authors concluded that PRAMS is valid for use in epidemiological research. Dietz et al. (2014) tested PRAMS validity for the 2009 survey for self-reported data on pregnancy complications, medical care, maternal pregnancy, and infant health comparing this information to maternal medical records. The authors reported greater than 90% specificity for most indicators but found lower sensitivity (less than 70%) for indicators such as maternal health issues including pregnancy complications and being tested for HIV during pregnancy. They indicated that lower sensitivity was most likely due to the lower prevalence of these conditions at both sites and that the utility of PRAMS for research should not be negated.

Using a test-retest method, Kharaghani, Shariati, Yunesian, Keramat, and Moghisi (2014) established reliability for PRAMS. They conducted a feasibility study to assess the utility of PRAMS for collecting maternal and infant health data in Iran. For categorical variables, Kharaghani et al. (2014) calculated a kappa coefficient of .71 while they achieved a Pearson's coefficient of .74 for quantitative variables. Scores above 0.6 indicate substantial agreement for reliability according to Landis and Koch (as cited by Szklo & Nieto, 2014).

To test for reliability and validity of PRAMS, Ahluwalia, Helms, and Morrow (2013) used the kappa coefficient as well as a sensitivity analysis comparing PRAMS to birth certificate data from 12 states. Using three self-reported indicators namely participation in the Special Supplemental Nutrition Program for Women, Infants and Children, payment for delivery through Medicaid, and initiation of breastfeeding, Ahluwalia et al. (2013) calculated kappa coefficients for reliability of .81, .67, and .72

respectively. For validity, they obtained sensitivity scores ranging from 82% to 94% and specificity scores between 76% and 91% concluding that PRAMS was acceptable for epidemiological research.

Arias, Heron, and Hakes (2016), established validity and reliability for racial and ethnic classification from U.S. Census data as these are used as numerators and denominators for calculating mortality rates in the United States. They compared the census data with death records from the National Vital Statistics System (NVSS) for three periods 1979–1989, 1990–1998, and 1999–2011. Census data is self-reported for race, whereas funeral directors report death certificate information based on observation. Arias et al. (2016) found that reporting for Blacks and Whites agreed with a sensitivity of 100% and 90% for Hispanics over three periods, whereas reporting for American Indian or Alaskan Native (AIAN) differed. Fifty-one to 55% of decedents self-reporting as AIAN were correctly classified on the death certificate, whereas 72 to 80% classified as AIAN on the death certificate harmonized with census records. AIAN were often misclassified as White on death certificates (Arias et al., 2016). For Asian and Pacific Islander (API), sensitivity and positive predictive values exceeded 90% (Arias et al., 2016).

Regarding rural or urban areas, there were no misclassification or variability for Blacks and Whites (Arias et al., 2016). However, variability was observed across these geographic areas for AIAN and API. In areas with high concentrations of AIAN and API, Arias et al. (2016) observed accurate reporting, whereas they noted misclassifications in areas that were less concentrated.

Operationalization of each variable. I chose the variables for this study based on an extensive literature review, on my research questions, and what was available in the PRAMS data set subsequently geocoded to the USCB 2010 data and USDA 2010 data. The outcome variable was IM. For my main independent variables, I used PNC and places of residence. For this study, places of residence served as an umbrella term representing the constructs of racial concentration and of rurality. Maternal level covariates included maternal race and ethnicity, age, socio-economic status (proxied by maternal education and income), marital status, and tobacco use (represented by smoking during the third trimester of pregnancy). I used two infant-level variables: PTB and birthweight.

IM. The construct of IM represented the death of an infant during the period prior to the first year of life. It was measured in the PRAMS data set on a categorical scale and was represented as a dichotomous variable. The PRAMS question to measure IM for the periods of 2009-2011, was, “Is your baby alive now?” and responses were coded as No = 0 and Yes = 1.

Racial concentration. I operationalized percent racial concentration at the census tract level to characterize places of residence. The source of this information was derived from the USCB SF1 file for Population and Housing containing information from the decennial census conducted in 2010 for the State of Tennessee. The USCB for 2010 changed its procedure for surveying households by combining the historical short and long form into one form consisting of 10 questions. Questions included the number and ages of persons in a household as well as race and ethnicity. Hispanic, Latino, or Spanish origin was used to determine ethnicity and included persons of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin regardless of race.

For the construct of race, the U.S. Census used the Office of Management and Budget (OMB) categories consisting of five categories: White, Black or African American, AIAN, Asian, and Native Hawaiian and Other Pacific Islander. Participants could mark one or more races. For those who did not identify with any race, they could report some other race or write in a specific race. For participants indicating one of the five OMB race categories and marking some other race, census officials assigned the OMB race category instead. For example, marking White and some other race was assigned to the construct of White.

For this study, I calculated racial concentration using the total reporting as Black or African American at each census tract divided by the total population of all races reported at each census tract and converted into percent racial concentration. I next transformed these percentages into three categories based on Stuber et al. (2003). The three levels of this categorical variable were: low racial concentration representing areas with less than 25% Black = 0, medium concentration representing 25% to less than 50% Black = 1, and high racial concentration representing areas with 50% or greater Black = 2 (Stuber et al., 2003).

Rurality. The USCB classifies land areas based on the number of residents. For the U.S. 2010 Census, officials categorized areas as rural if there were 2,500 residents or less, as urban cluster if there were 2.500 residents up to less than 50,000 residents with at least 1,500 residents not institutionalized, and as urban with 50,000 or more residents. I had intended to use the data from the USCB SF1 file for Population and Housing, however opted to use the 2010 USDA RUCA file which had a complete listing of rural and urban designations at the census tract level. For this study, I compressed the variable into two categories and coded it as follows: rural = 1, and urban comprising urban clusters and areas with more than 50,000 residents = 0.

PNC. The care a woman receives during her pregnancy including monitoring of fetal growth and development is PNC (CDC, 2017a). PNC for PRAMS was collected based on two questions: “How many weeks or months pregnant were you when you were sure you were pregnant?” and “How many weeks or months pregnant were you when you had your first visit for PNC?”. Participants gave their responses in weeks or months. PRAMS survey administrators also recorded birth certificate information on the number of PNC visits.

I operationalized PNC two ways. First, I calculated adequacy of PNC defined by the ACOG recommendations of one visit per month through 28 weeks, one visit every 2 weeks through 36 weeks, and one visit per week thereafter, adjusted for date of initiation of PNC. The number of PNC visits (PNC_VST) was collected as a continuous variable taken from the birth certificate information. Number of PNC visits along with initiation at the first trimester were used to determine adequacy of PNC based on Kotelchuck’s index where, adequate PNC = 0, adequate plus PNC = 1, intermediate PNC = 2, and No PNC or inadequate PNC = 3. Second, I used the number of PNC visits (PNC_VST) as a continuous variable to determine differences between racial groups on use and or access to PNC.

Maternal race. This variable (Mat_Race) for PRAMS was derived from birth certificate files and was measured as a categorical variable however with 11 levels. The levels were: Other Asian =1, White = 2, Black = 3, American Indian = 4, Chinese = 5, Japanese = 6, Filipino = 7, Hawaiian = 8, Other Non-White = 9, Alaskan Native = 10, and Mixed Race = 11. For this study, race categories were compressed into three levels: White = 0, Black = 1, and Other (comprised of other Asian, Chinese, Japanese and Filipino, AIAN, Hawaiian, Other Non-White, and Mixed Race) = 2.

Maternal ethnicity. This variable was measured as categorical (Hisp_BC) to determine Hispanic ethnicity with Yes = 1 and No = 0. It too was derived from birth certificate information for PRAMS.

Age. Maternal age was measured on a continuous scale and was derived from birth certificate information representing the mother's age at the time of giving birth. For this study, I transformed maternal age into a categorical variable comprising four levels: ≤19 years = 1, 20 to 29 years = 0, 30 to 34 years = 2, and ≥35 years = 3**.**

Socio-economic status. For this study, I used income a proxy for socio-economic status. PRAMS officials measured income (Income5) as the total yearly income before taxes for the mother. This income included spousal or partner income and any other income that may have been received. This variable was measured categorically with 14 levels. Less than $10,000 = 1, $10,000 to $14,999 = 2, $15,000 to $19,999 = 3, $20,000 to $24,999 = 4, $25,000 to $34,999 = 5, $35,000 to $ $49,999 = 6, $50,000 or more = 7, less than $8,000 = 8, $8,000 to $9,999 = 9, $50,000 to $74,999 = 10, $75,000 or more = 11, $50,000 to $64,999 = 14, $65,000 to $79,999 = 15, and $80,000 or more = 16. For this study, I compressed income into four categories: <$10,000 = 1, $10,000 to $24,999 = 2, $25,000 to $49,999 = 3, and ≥50,000 = 0.

Maternal education. This variable for the PRAMS data set was also derived from birth certificate records. Maternal education (Mat_ED) was measured categorically representing years of education with eight levels. Less than or equal to 8th grade = 1, 9 to 12th grade, no diploma = 2, High school graduate/GED = 3, Some college, No degree = 4, Associates degree = 5, Bachelor's degree = 6, Master's degree = 7, and Doctorate/professional degree = 8. I compressed maternal education into four categories and served as a proxy for socio-economic status.

Marital status. This variable too was captured from birth certificate information and was measured as a categorical variable. The variable was dichotomous with Married = 0 and Other = 1. This variable was used as measured.

Tobacco use. PRAMS officials inquired whether maternal cigarette consumption occurred during the last three months of pregnancy (SMK6_3L). The variable was measured on a categorical level indicating the average number of cigarettes smoked daily with seven levels: 41 cigarettes or more = 1, 21 to 40 cigarettes = 2, 11 to 20 cigarettes = 3, 6 to 10 cigarettes = 4, 1 to 5 cigarettes = 5, less than 1 cigarette = 6, and none or zero cigarettes = 7. I also compressed this variable into two categories and coded it as follows for analysis: non-smoking = 0 and smoking = 1.

Prematurity. This infant level variable was a measure of PTB. PRAMS officials acquired this data from birth certificate information (GEST_WK). PTB was measured as a continuous variable based on the computed gestational age in weeks. For this study, I transformed the variable into a categorical variable with four levels. I coded it as follows: less than 28 weeks gestation or early preterm = 1, 28 to 32 weeks gestation or very preterm = 2, 33-37 weeks gestation or moderate to later preterm = 3, and >37 weeks or term = 0.

Birthweight. This infant level variable was used as a sign of prematurity and can represent fetal uterine restriction. PRAMS captures the infant birthweight (GRAM) from birth certificate data. Data was measured on a continuous scale. For this study, I transformed the variable into a categorical variable with three levels and I coded it as follows: very low birth weight (VLBW) or (<1,500 grams) = 1, low birth weight (LBW) (1,500 to 2,499 grams) = 2, and normal birth weight (≥2,500 grams) = 0.

Data Analysis Plan

I linked the PRAMS data set to the USCB 2010 SF 1 file based on the birth certificate information and census tracts. These variables served as key fields to accomplish geocoding. Once linkages occurred, I removed the variables that were not directly included as a part of this study from the data set for better manageability. I evaluated the data set for outliers, skip patterns, and any missing data. I intended to delete cases with missing data, however deleting cases would lessen the amount of IM cases. To resolve this problem, I opted to impute the missing data and preserve the data set with all cases. I performed all analyses using the IBM Statistical Package for Social Sciences, SPSS (v. 25).

I used frequency distributions to assess the demographic characteristics of the sample and to evaluate the categorical variables. I evaluated quantitative variables using histograms and central tendency measures (mean, median, mode, range, and standard deviation). I also used the measures of central tendency and the histograms to determine the assumption of normality. I give a synopsis of the data analysis plan in Table 1 for each research question and the variables used in this study. I used an alpha of .05 for all statistical tests.

Research Questions, Hypotheses, and Analysis Plan

RQ1-Quantitative: What is the relationship between places of residence using neighborhoods as units of analysis and infant mortality among racial groups across the state of Tennessee?

$H_0 1$: There is no relationship between places of residence using neighborhoods as units of analysis and infant mortality among racial groups across the state of Tennessee.

$H_1 1$: There is a relationship between places of residence using neighborhoods as units of analysis and infant mortality among racial groups across the state of Tennessee.

To test the null hypothesis and answer RQ1, I intended to use multi-level hierarchical regression. However, I used hierarchical binomial logistic regression instead, since this was the only option for complex samples analysis in SPSS. This method allowed me to control for possible confounders and to determine the contribution of the variables to predict the dependent variable (Field, 2013). For this question, I separated the data set by racial groups (Whites, Blacks, and Other) then built three models to determine the relationship between the variables for each group. I repeated the process for Hispanic ethnicity. I first calculated the crude odds for the association between racial concentration and IM. In the next model, I added the maternal-level variables and added the infant-level variables in the last model. I repeated the same process for rurality. I presented the results using odds ratios, 95% confidence intervals as well as *p* values.

RQ2-Quantitative: How does access to prenatal care among racial groups compare across Tennessee when stratified by places of residence?

H_02: There is no difference in access to prenatal care among racial groups across Tennessee when stratified by places of residence.

H_12: There is a difference in access to prenatal care among racial groups across Tennessee when stratified by places of residence.

Answering RQ2, required evaluating racial groups and ethnicity on PNC access and use at each rurality tier and at each racial concentration tier. I evaluated PNC based on the number of visits identified by PRAMS using the birth certificate information. I intended to use one-way ANOVA consisting of maternal race as the independent variable with three groups (White, Black, and Other) and PNC as the dependent variable; however, I opted to use the GLM since complex samples analysis in SPSS does not have an ANOVA option. I stratified the data set by racial concentration and then analyzed against PNC for race followed by ethnicity. I stratified once more by rurality and repeated the process. I presented the results using *Beta* values, *p* values, and 95% confidence intervals.

RQ3-Quantitative: Does maternal race modify the relationship between places of residence, prenatal care and infant mortality across the State of Tennessee?

H_03: Maternal race does not modify the relationship between places of residence, prenatal care, and infant mortality across the State of Tennessee.

$H_1 3$: Maternal race does modify the relationship between places of residence, prenatal care, and infant mortality across the State of Tennessee.

To assess whether maternal race modified the relationship between places of residences (proxied by racial concentration and rurality), PNC, and IM across the state of Tennessee, I used hierarchical binomial logistic regression as opposed to multi-level hierarchical regression due to analysis of complex samples in SPSS. Model one tested the main effect between the independent variable and IM. Subsequent models included interaction terms for race and for ethnicity. Each independent variable was tested separately. I presented the results using odds ratios, 95% confidence intervals, and *p* values.

Table 1

Data Analysis Plan Summarized

Research question	Statistical test	Variables	Variable type
1	Hierarchical binomial logistic regression	Rurality	Categorical
		Racial concentration	Categorical
		Maternal age	Categorical
		Income	Categorical
		Maternal education	Categorical
		Marital status	Categorical
		Tobacco use	Categorical
		Prematurity	Categorical
		Birthweight	Categorical
2	General linear model	Prematurity	Continuous
		Race	Categorical
		Ethnicity	Categorical
3	Hierarchical binomial logistic regression	Rurality	Categorical
		Racial concentration	Categorical
		Prenatal care (APNCU)	Categorical
		Race	Categorical
		Maternal age	Categorical
		Income	Categorical
		Maternal education	Categorical
		Marital status	Categorical
		Tobacco use	Categorical
		Prematurity	Categorical
		Birthweight	Categorical

Threats to Internal and External Validity

PRAMS researchers preserved external validity with the development of a standardized protocol for data collection (Shulman et al., 2006). The population of interest was all women with a live birth in the state during the period of surveillance (Shulman et al., 2006). Women are sampled retrospectively two to six months after having a live birth through a randomized stratified sampling (Shulman et al., 2006; Williams et al., 2003). Eligible birth certificate files serve as the sampling frame (CDC, 2017b; Shulman et al., 2006). Officials minimize selection bias since the birth certificate files cover all women with a live birth for the state. In addition, stratification permitted oversampling of population subgroups that have a public health interest (Shulman et al., 2006). Since PRAMS officials sample randomly for each state, results are generalizable to the population of the individual state and the results can be used for comparison purposes across states (Shulman et al., 2006).

Regarding internal validity, CDC officials developed the protocol for PRAMS data collection describing in detail the recommended strategies for successful data collection by participating states (Gilbert et al., 1999; Shulman et al., 2006). PRAMS consists of a core questionnaire and a state specific questionnaire (CDC, 2017b). Staff from each state selected topics for inclusion in the core questionnaire covering information on risk factors surrounding pregnancy and infant health (Adams et al., 1991). Focus groups comprised of a convenience sample of five to 10 women who had a recent live birth pretested the survey. Women read the questions aloud, paraphrased the questions, marked their responses, and gave explanations of their responses (Adams et al., 1991). Official used the results from pretesting to revise the questionnaire thereby preserving internal validity and construct validity (Adams et al., 1991; Williams et al., 2003). Once the initial revisions were concluded and the questionnaire was implemented, the questionnaire was once again revised based on the responses (Adams et al., 1991; CDC, 2017b; Williams et al., 2003). Evaluators looked for questions in which the majority were comprised of similar answers, write-in responses, and blank responses and revised these questions in the next iteration of the survey (Adams et al., 1991). Revisions are periodic and in phases (CDC, 2017b). Since the beginning of PRAMS there have been eight phases. For this study, I used PRAMS Phase VI spanning from 2009-2011.

Regarding U.S. 2010 Census data, selection bias was minimized as surveys were sent to most U.S. households. Census enumerators made personal visits to homes where mail did not reach as well as households for which the survey was not returned to conduct one-on-one interviews to obtain census information (USCB, 2017). Census enumerators are trained to conduct interviews (USCB, 2017) thereby minimizing interviewer bias.

Ethical Procedures

TDH officials required a data use agreement and IRB approval to access PRAMS survey data. Normally, PRAMS data is publicly accessible, however, these procedures were necessary, as I was requesting participant census tract information to geocode to USCB 2010 data. Census data and RUCA files are downloadable from the U.S. Census website and USDA website respectively and do not require any permissions for access. Regarding data collection procedures, PRAMS officials contacted women for participation in the survey and gave women a small incentive to participate and a subsequent reward for participation (CDC, 2017b). They contacted women who did not complete the survey in the established time frames by telephone. They also selected participants through random stratified sampling, so, there was no violation of any principles surrounding human subjects research. In addition, since this data was archival data, I had no physical contact with PRAMS participants.

For data storage and confidentiality, I stored the PRAMS data set on a password protected computer and only shared the data set with those involved in the study. The only private health information in the data set was census tracts which I used to geocode the PRAMS data set to USCB data for neighborhood-level characteristics. Breaches in confidentiality although unlikely, would stem from the potential to identify women with an infant death living in a remote area as IM is a rare event. Participant self-identification could be likely especially for remote areas, however, the data was presented in aggregate form spanning several census tracts, so it is unlikely that self-identification can occur. I intend to delete the data set from my password protected computer within one year from the study conclusion.

Summary

In summary, I used a quantitative cross-sectional design and PRAMS data obtained from the TDH after IRB approval. I geocoded the data set to the USCB 2010 data for Tennessee and 2010 USDA RUCA data. The sample represented the population of women with a live birth in Tennessee for 2009-2011. Threats to validity existed, however through survey design and data collection procedures by CDC, these were minimized. I used hierarchical binomial logistic regression to construct models to evaluate the relationships between places of residence, PNC and IM and to determine the modifying effects of race. I considered the ethical aspects of the study recognizing minimal risk to participants. In Chapter 4, I present the baseline demographics for the sample. I discuss discrepancies in the data from what was expected, and assumptions of each statistical test used. I also report the results for each of my research questions.

Chapter 4: Results

Introduction

The purpose of this study was to assess the relationship between places of residence (using neighborhoods as units of analysis inclusive of the constructs of racial concentration and rurality), PNC, and IM across racial groups in Tennessee. A second aspect of this study was to determine whether race modifies these relationships. In this chapter, I present the demographic characteristics of the sample. Additionally, the results from the statistical analysis for each research question are presented. The study was based on the following research questions:

RQ1-Quantitative: What is the relationship between places of residence using neighborhoods as units of analysis and infant mortality among racial groups across the state of Tennessee? Tables 5 and 6 present the data to answer this question.

$H_0 1$: There is no relationship between places of residence using neighborhoods as units of analysis and infant mortality among racial groups across the state of Tennessee.

$H_1 1$: There is a relationship between places of residence using neighborhoods as units of analysis and infant mortality among racial groups across the state of Tennessee.

RQ2-Quantitative: How does access to prenatal care among racial groups compare across Tennessee when stratified by places of residence? Tables 8 and 10 present data to answer this question.

$H_0 2$: There is no difference in access to prenatal care among racial groups across Tennessee when stratified by places of residence.

$H_1 2$: There is a difference in access to prenatal care among racial groups across

Tennessee when stratified by places of residence.

RQ3-Quantitative: Does maternal race modify the relationship between places of residence, prenatal care and infant mortality across the State of Tennessee? Table 11 presents data to answer this question.

$H_0 3$: Maternal race does not modify the relationship between places of residence, prenatal care, and infant mortality across the State of Tennessee.

$H_1 3$: Maternal race does modify the relationship between places of residence, prenatal care, and infant mortality across the State of Tennessee.

Data Collection

The survey administrators for the State of Tennessee followed CDC protocol for recruitment of survey participants and administration of the survey (CDC, 2017b) for the PRAMS data collected for 2009-2011. They took a stratified random sample from a sampling frame of women with live births from 2009-2011 drawn from birth certificates files (CDC, 2017b). For the three years combined, there were 5,495 women sampled and 3.314 responses (TDH, n.d.b). Regarding census tracts, the data were derived from the USCB 2010 census SF1 files (USCB, 2017). The U.S. Census occurs every 10 years, and approximately 134 million households were reached by mail for the 2010 census, covering 50 states and Puerto Rico (USCB, 2017).

After obtaining IRB approval from Walden University (number 11-27-18-0513908) and the State of Tennessee (number 1217379-1), I constructed the data set for this study by linking four separate files. The State of Tennessee gave me three files. One contained the PRAMS sample with birth certificate numbers. The second contained the census tracts by birth certificate numbers, and the third contained the census tracts with population distributed by race. The fourth file was a publicly available file containing rural and urban designations at the census tract level downloaded from the Internet. The birth certificate and census tract numbers served as the key identifiers to link all files.

PRAMS officials selected 5,495 individuals from the 2009-2011 sampling frame, however, 3,314 participants answered the survey, so, 2,181 records were deleted due to no response. Next, I linked the PRAMS file to the census tracts by the birth certificate numbers. All records except 82 matched. For the rurality variable at the census tract level, I merged a data set I publicly accessed from the 2010 USDA RUCA data (2016). All records matched except 75.

In Chapter 3, I discussed my expectations for the data set and indicated that I would delete missing data. After receiving the data set, I conducted a missing values analysis to determine percentages of missing values. There were no variables exceeding missingness by more than 10%; however, deleting cases with missing values would have resulted in deletion of some infant deaths, which in the data set were already few. The variables with the highest amount of missing information were the number of PNC visits at 8.2%, income at 6.5%, infant mortality at 4.6%, and 1st PNC visit at 3.6% (used to calculate the APNCU index). The remaining variables (maternal education, tobacco use, maternal race, ethnicity, gestational age, rurality, and variables used to calculate percent racial concentration) had less than 2.6% missing information.

I next conducted a Little's MCAR test on the variables listed in Table 2 to test the hypothesis that missing cases were missing completely at random (Li, 2013; Little, 1988). For both variable types (categorical and continuous), I rejected the null hypothesis concluding that the missing data were not missing completely at random (MCAR) but were either missing at random (MAR) or not missing at random (NMAR). I corrected for this using multiple imputation (Fully Conditional Specification Markov Chain Monte Carlo method) in SPSS for arbitrary patterns of missingness along with linear regression for scale variables (IBM Knowledge Center, n.d.; van Buuren, 2007). Prior to imputation some categorical variables, I compressed some variables into fewer levels from the original data set. I did not transform quantitative variables used for analysis and for computing other variables before imputation. Marital status, maternal age, and birthweight had no missing information, so I included these as predictors for imputation. I ran eight iterations, combined the imputed files into one file, and proceeded with analysis of the imputed data set now containing 3,314 complete records.

Additional discrepancies compared to what I expected in Chapter 3, included use of the census data for the 2010 U.S. Census for rurality to evaluate the association between rurality and IM. When determining rurality from the census files based on the population at the census tract level, I realized there were measurement challenges. The SF1 files contained overlap for rural and urban for multiple census tracts in the files, therefore, it was unclear how to classify each record. I decided to use the 2010 USDA (2016) files which designated rural and urban through RUCA codes at the census tract level. Census tracts are classified into 10 codes based on population density and urbanization and commuting daily. Codes one through three are considered urban and codes four through 10 are considered rural. I transformed these 10 codes into two levels to classify rural and urban. I was unable to analyze for an association for rurality and IM for Blacks and for Hispanics due to no infant deaths for women living in rural areas.

I transformed racial concentration into three categories as stated in Chapter 3 (<25%, 25% to 49%, and ≥50%). However, for analysis of the stratified data set for Whites, the 25% to 49% and the ≥50% categories were combined due to the absence of deaths in the 50% or greater racial concentration category. Regarding the income variable, I used it in the analysis except when I analyzed for Other races and for Hispanics for RQ1. For Other races, there were no deaths in the $25,000-$49,999 category, so, this category was compressed into the $10,000-$24,999 category. For Hispanics, there were no infant deaths in the $25,000-$49,999 category nor in the ≥$50,000 category, therefore, I compressed these categories into the $10,000- $24,999 category, renamed this ≥$10,000, and designated this category as the reference group during analysis.

Maternal education was represented in the data set as total years of education not type of degree; therefore, I used the MAT_DEG variable instead which represented the highest degree received. Since the categories for women with associates through professional degrees were sparse, I compressed these categories and ended with four levels: <12th grade with no diploma, high school graduate or GED, some college with no degree and college degree (Table 2). However, when analyzing for the data set stratified for Other races, there were no deaths in the high school graduate or GED category, so I compressed this category into the <12th grade no diploma category to facilitate analysis. For Hispanics, I compressed the high school graduate or GED category into the <12th

grade with no diploma category due to no deaths at that level. Also, there were no deaths in the some college with no degree category for Hispanics, so I compressed this category into the college graduate category.

I transformed maternal age into four levels as expected: ≤19, 20 – 29, 30 – 34, and ≥35 years. When analyzing the stratified data set for Blacks, I compressed maternal age was into three levels, ≤19, 20-29 and ≥30, as there were no deaths in the ≥ 35 age category. For Other races, there were no deaths in the ≤19 category, so, I compressed this level into the 20-29 age group and renamed ≤29 and designated it as the reference category. For Hispanics, I compressed age into two categories: ≤29 and ≥30 due to no deaths in previously established categories.

I intended to use the SMK_6L variable which measured smoking in the third trimester from PRAMS. Upon examination of the data set, CIG_3TRI variable seemed more appropriate as it only had five missing values. Although imputation would have corrected for the missing data, I opted for the CIG_3TRI variable which was measured continuously in the data set. I indicated that I would transform the variable into multiple smoking categories based on the number of cigarettes smoked, however, I opted for only two levels (non-smoking and smoking) due to few deaths present in the smoking categories when the data set was stratified by race (see Table 3). I was unable to control for tobacco use in the third trimester for Hispanic ethnicity, since all the women in this stratified data set were non-smokers.

Kotelchuck’s Index or the APNCU index combines women with no PNC, women who started PNC after month four and women who had less than 50% of expected PNC visits for their pregnancy into the inadequate PNC category. I intended to separate out the women with no PNC, however doing so would not have categorized these women adequately for the index. To calculate Kotelchuck's index or the Adequacy of Prenatal Care Index (APNCU), I used several variables. First, I subtracted the gestation age of the infant at birth from the gestation week of entry into PNC and then transformed the resulting variable into the ACOG number of expected PNC. Next, I calculated the proportion of visits by dividing the observed number of PNC visits (PNC_VST) by the expected number of PNC visits and converted to a percentage. These percentages were transformed into the Adequacy of Received Services. I transformed the week of initiation into PNC into two variables representing initiation into PNC by month four and entry after month four combined with no PNC and called this new variable Adequacy of Initiation. Last, Adequacy of Received Services and Adequacy of Initiation were computed into the APNCU index and then recoded into four levels: inadequate, adequate plus, adequate, and intermediate.

The variable in the PRAMS data set named BC_GEST measuring prematurity was continuous and I transformed it into four levels representing stages of prematurity and term births as follows: <28 weeks, 28-32 weeks, 33-37 weeks and ≥37 weeks. However, when evaluating the stratified data set for Blacks, Other races and Hispanics, I compressed 28-32 weeks into the <28 week category since there were no deaths present. Regarding the variable GRAM which measured infant birthweight quantitatively, I transformed it into three categories; however, for Hispanics, there were only two groupings for birthweight <1,500 grams and ≥1500 grams due to no deaths in the ≥2,500 gram category. Since, the PRAMS data set was weighted for non-response, non-coverage, and sampling, I used the SPSS complex samples analysis feature to apply the three weighting variables. The following section details the descriptive statistics as well as statistical analyses, and results.

Baseline Demographics

I outline in Table 2 the baseline demographics for the entire sample and give the frequencies and percentages for each independent variable for the total sample and also the sample when stratified by the dependent variable. The reference category is noted when appropriate. When the cells were less than 30, I complied with the Tennessee IRB and suppressed this data. Regarding the mean number of PNC visits, women who had IM had 9.91 PNC visits (*S.D.* = 4.68), whereas women who had not experienced IM had 11.41 PNC visits (*S.D.* = 4.13).

Table 2

Baseline Frequencies and Demographic Statistics for the Variables Stratified by Infant Mortality

	Infant Mortality		
Variable	Total n (%)	Alive n (%)	Dead n (%)
Racial concentration			
<25% (reference)	2401(72.4)	2367 (98.6)	34 (1.4)
25-49.9%	410 (12.4)	397 (96.8)	*
≥50%	503 (15.2)	485 (96.4)	*
Rurality			
Urban (reference)	2594 (78.3)	2540 (97.9)	54 (2.1)
Rural	720 (21.7)	709 (98.5)	*
Kotelchuck's or APNCU index			
Adequate (reference)	614 (18.5)	598 (97.4)	*
Adequate plus	2180 (65.8)	2148 (98.5)	32 (1.5)
Intermediate	121 (3.7)	117 (96.7)	*
Inadequate	399 (22.0)	386 (96.7)	*
Maternal race			
White (reference)	2271 (68.6)	2241 (98.7)	30 (1.3)
Black	720 (21.7)	693 (96.3)	*
Other	323 (9.7)	315 (97.5)	*
Hispanic ethnicity			
No (reference)	3088 (93.2)	3027 (98.0)	61 (2.0)
Yes	226 (6.8)	222 (98.2)	*
Maternal age			
20-29 (reference)	1819 (54.9)	1777 (97.7)	42 (2.3)
≤19	359 (10.8)	354 (98.6)	*
30-34	1027 (31.0)	1011 (98.4)	*
≥35	109 (3.3)	107 (98.2)	*
Maternal education			
College graduate (reference)	1012 (30.5)	993 (98.0)	*
<12th grade, no diploma	599 (18.1)	588 (98.2)	*
High school graduate/GED	939 (28.3)	913 (97.2)	*
Some college/no degree	764 (23.1)	755 (98.8)	*
Income			
≥$50,000 (reference)	884 (26.7)	872 (98.6)	*
<$10,000	1056 (31.9)	1033 (97.8)	*
$10,000-$24,999	783 (23.6)	767 (98.0)	*
$25,000-$49,999	591 (17.8)	577 (97.6)	*

table continues

	Infant Mortality		
Variable	Total n (%)	Alive n (%)	Dead n (%)
Marital status			
Married (reference)	1885 (56.9)	1858 (98.6)	*
Other	1429 (43.1)	1391 (97.3)	38 (2.7)
Tobacco use			
Non-smoking (reference)	2763 (83.4)	2703 (97.8)	60 (2.2)
Smoking	551 (16.6)	546 (99.1)	*
Prematurity			
>37 weeks (reference)	1829 (55.2)	1815 (99.2)	*
<28 weeks	118 (3.6)	80 (67.8)	38 (32.2)
28-32 weeks	235 (7.1)	234 (99.6)	*
33-37 weeks	1132 (34.1)	1120 (98.9)	*
Birthweight			
≥2500 grams (reference)	1807 (54.5)	1798 (99.5)	*
<1500 grams	252 (7.6)	214 (84.9)	38 (15.1)
1500-2499 grams	1255 (37.9)	1237 (98.6)	*

*Frequency less than 30 so data suppressed.

Univariate Analysis for Model Inclusion

To demonstrate the appropriateness of variables for the subsequent regression models, I conducted crosstabs for complex samples analysis with a test for independence. The crosstabs test reported a Rao-Scott adjusted chi-square statistic with significance based on the adjusted *F* and its degrees of freedom. The assumptions of the chi-square is that the variables must be categorical or ordinal and that each group must have two or more levels for analysis (Field, 2013). In addition, expected cell counts must be greater than five (Field, 2013). I noted no cells less than 5 for the crosstabs for complex samples. The significant relationships were racial concentration (χ^2 = 21.46; *Adjusted F* (1.42, 4686.39) = 15.87; p <.05); rurality (χ^2 = 2.682; *Adjusted F* (1.00, 3311) = 9.60; p < .05); prenatal care initiation in the 1st trimester (χ^2 = 86.90; *Adjusted F* (1.21, 4012.28) = 33.19; p < .05); maternal race (χ^2 = 33.44; *Adjusted F* (1.81, 5987.35) = 30.80; p < .05);

maternal education (χ^2 = 10.030; *Adjusted F* (2.42, 8014.02) = 4.96; $p < .05$); marital status (χ^2 = 3.81; *Adjusted F* (1.00, 3311) = 4.30; $p < .05$); prematurity (χ^2 275.51; *Adjusted F* (2.05, 6799.42) = 174.73; $p < .05$), and birthweight (χ^2 = 129.39; *Adjusted F* (1.46, 4835.04) = 139.15; $p < .05$). Although the APNCU index, Hispanic ethnicity, maternal age, income, and tobacco use were not statistically significant, I included all of the variables in the models to answer my research questions.

Results

Research Question 1

RQ1 was, What is the relationship between places of residence using neighborhoods as units of analysis and infant mortality among racial groups across the state of Tennessee? For RQ1, I stratified the data set by maternal race and then once more for maternal ethnicity. The places of residence variable was comprised of racial concentration and rurality. I analyzed the main independent variables separately for an association with IM. I calculated crude odds ratios then for subsequent models I entered maternal predictors followed by infant predictors.

Descriptive statistics. Tables 3 and 4 outline the descriptive statistics for the sample for each race and ethnicity stratified by IM. For analysis, I compressed the high racial concentration for Whites into the 25-49.9% category due to no deaths present at this level. I could not analyze rurality for Blacks, Other races, or for Hispanics due to no deaths present for these women living in rural areas. I could not control for tobacco use during the third trimester of pregnancy for Hispanic women or for women of Other races due to no deaths present in the category of women who smoked.

Table 3

Descriptive Statistics for Variables Stratified by the Dependent Variable and by Race

	White			Black			Other races		
	Infant mortality								
Variable	Total n(%)	Alive n(%)	Dead n(%)	Total n(%)	Alive n(%)	Dead n(%)	Total n(%)	Alive n(%)	Dead n(%)
Racial concentration									
<25%	2026 (89.2)	2001 (89.3)	*	167 (23.2)	164 (23.7)	*	208 (64.4)	202 (64.1)	*
25%-49.9%	195 (8.6)	190 (8.5)	*	150 (20.8)	143 (20.6)	*	65 (20.1)	64 (20.3)	*
≥50%	50 (2.2)	50 (2.2)	*	403 (56.0)	386 (55.7)	*	50 (15.5)	49 (15.6)	*
Rurality									
Urban	1657 (73.0)	1638 (73.1)	*	660 (91.7)	633 (31.3)	*	277 (85.8)	269 (85.4)	*
Rural	614 (27.0)	603 (26.9)	*	60 (8.3)	60 (8.7)	*	46 (14.2)	46 (14.6)	*
Maternal age									
20-29	1242 (54.7)	1220 (54.4)	*	412 (57.2)	395 (57.0)	*	165 (51.1)	162 (51.4)	*
≤19	226 (10.0)	223 (10.0)	*	110 (15.3)	108 (15.6)	*	*	*	*
30-34	720 (31.7)	716 (32.0)	*	185 (25.7)	177 (25.5)	*	122 (37.8)	118 (37.5)	*
≥35	83 (3.7)	82 (3.7)	*	*	*	*	*	*	*
Maternal education									
College graduate	810 (35.7)	799 (35.7)	*	126 (17.5)	122 (17.6)	*	76 (23.5)	72 (22.9)	*
<12th grade or no diploma	303 (13.3)	302 (13.5)	*	152 (21.1)	145 (20.9)	*	144 (44.6)	141 (44.8)	*
High school graduate or GED	653 (28.8)	636 (28.4)	*	224 (31.1)	215 (31.0)	*	62 (19.2)	62 (19.7)	*
Some college or no degree	505 (22.2)	504 (22.5)	*	218 (30.3)	211 (30.4)	*	41 (12.7)	40 (12.7)	*

table continues

Variable	White Total n(%)	White Alive n(%)	White Dead n(%)	Black Total n(%)	Black Alive n(%)	Black Dead n(%)	Other races Total n(%)	Other races Alive n(%)	Other races Dead n(%)
	Infant mortality								
Income									
≥$50,000	749 (33.0)	742 (33.1)	*	73 (10.1)	71 (10.2)	*	62 (19.2)	59 (18.7)	*
<$10,000	549 (24.2)	542 (24.2)	*	393 (54.6)	381 (55.0)	*	114 (35.3)	110 (34.9)	*
$10,000 - $24,999	507 (22.3)	502 (22.4)	*	169 (23.5)	159 (22.9)	*	107 (33.1)	106 (33.7)	*
$25,000 - $49,999	466 (20.5)	455 (20.3)	*	85 (11.8)	782 (11.8)	*	40 (12.4)	40 (12.7)	*
Marital status									
Married	1528 (67.3)	1509 (67.3)	*	165 (22.9)	162 (23.4)	*	192 (59.4)	187 (59.4)	*
Other	743 (32.7)	732 (32.7)	*	555 (77.1)	531 (76.6)	*	131 (40.6)	128 (40.6)	*
Tobacco use									
Non-smoking	1794 (79.0)	1766 (78.8)	*	657 (91.3)	633 (8.7)	*	312 (96.6)	304 (96.5)	*
Smoking	477 (21.0)	475 (21.2)	*	63 (8.8)	60 (8.7)	*	*	*	*
Prematurity									
>37 weeks	1310 (57.7)	1304 (58.2)	*	322 (44.7)	317 (45.7)	*	197 (61.0)	194 (61.6)	*
<28 weeks	62 (2.7)	46 (2.1)	*	49 (6.8)	30 (4.3)	*	*	*	*
28-32 weeks	158 (7.0)	157 (7.0)	*	65 (9.0)	65 (9.4)	*	*	*	*
33-37 weeks	741 (32.6)	734 (32.8)	*	284 (39.4)	281 (40.5)	*	107 (33.1)	105 (33.3)	*
Birthweight									
≥2500 (normal)	1323 (58.3)	1322 (59.0)	*	289 (40.1)	282 (40.7)	*	195 (60.4)	194 (61.6)	*
<1500 (VLBW)	145 (6.4)	128 (5.7)	*	94 (13.1)	76 (11.0)	*	*	*	*
1500-2499 (LBW)	803 (35.4)	791 (35.3)	*	337 (46.8)	335 (48.3)	*	115 (35.6)	111 (35.2)	*

*Frequency less than 30 so data suppressed.

Table 4

Descriptive Statistics for Variables Stratified by the Dependent Variable and by Ethnicity

	Hispanic			Non-Hispanic		
	Infant Mortality					
Variable	Total n(%)	Alive n(%)	Dead n(%)	Total n(%)	Alive n(%)	Dead n(%)
Racial Concentration						
<25%	141.0 (62.4)	139.0 (62.6)	*	2260 (73.2)	2228.0 (73.6)	32.0 (52.5)
25%-49.9%	50.0 (22.1)	49.0 (22.1)	*	360.0 (11.7)	348.0 (11.5)	*
≥50%	35.0 (15.5)	34.0 (15.3)	*	468.0 (15.2)	451.0 (14.9)	*
Rurality						
Urban	191.0 (84.5)	187.0 (84.2)	*	2403.0 (77.8)	2353.0 (77.7)	50.0 (82.0)
Rural	35.0 (15.5)	35.0 (15.8)	*	685.0 (22.2)	674.0 (22.3)	*
Maternal age						
20-29	111.0 (49.1)	109.0 (49.1)	*	1708.0 (55.3)	1668.0 (55.1)	40.0 (65.6)
≤19	21.0 (9.3)	21.0 (9.3)	*	338.0 (10.9)	333.0 (11.0)	*
30-34	87.0 (38.5)	85.0 (38.3)	*	940.0 (30.4)	926.0 (30.6)	*
≥35	7.0 (3.1)	7.0 (3.2)	*	102.0 (3.3)	100.0 (3.3)	*
Maternal education						
College graduate	30.0 (13.3)	30.0 (13.5)	*	982.0 (31.8)	963.0 (31.8)	*
<12th grade or no diploma	137.0 (60.6)	134.0 (60.4)	*	462.0 (15.0)	454.0 (15.0)	*
High school graduate or GED	42.0 (18.6)	42.0 (18.9)	*	897 (29.0)	871.0 (28.8)	*
Some college or no degree	*	*	*	747 (24.2)	739.0 (24.4)	*

table continues

Variable	Hispanic Total n(%)	Hispanic Alive n(%)	Hispanic Dead n(%)	Non-Hispanic Total n(%)	Non-Hispanic Alive n(%)	Non-Hispanic Dead n(%)
	Infant Mortality					
Marital status						
Married	110.0 (48.7)	109.0 (49.1)	*	1775.0 (57.5)	1749.0 (57.8)	*
Other	116.0 (51.3)	113.0 (50.9)	*	1313.0 (42.5)	1278.0 (42.2)	35.0 (57.4)
Tobacco use						
Non-smoking	222.0 (98.2)	218.0 (98.2)	*	2541.0 (82.3)	2485.0 (82.1)	56.0 (91.8)
Smoking	*	*	*	547.0 (17.7)	542.0 (17.9)	*
Prematurity						
>37 Weeks	136.0 (60.2	135.0 (60.8)	*	1693.0 (54.8)	1680.0 (55.5)	*
<28 Weeks	*	*	*	112.0 (3.6)	76.0 (2.5)	36.0 (59.0)
28-32 Weeks	*	*	*	229.0 (7.4)	228.0 (34.5)	*
33-37 Weeks	78.0 (34.5)	77.0 (34.7)	*	1054.0 (54.8)	1043.0 (34.5)	*
Birthweight						
≥2500 (normal)	139.0 (61.5)	139.0 (62.6)	*	1668.0 (54.0)	1659.0 (54.8)	*
<1500 (VLBW)	*	*	*	244.0 (7.9)	208.0 (6.9)	36.0 (59.0)
1500-2499 (LBW)	79.0 (35.0)	77.0 (34.7)	*	1176.0 (38.1)	1160.0 (38.3)	*

*Frequency less than 30 so data suppressed.

Assumptions of hierarchical binomial logistic regression. In testing the assumptions for hierarchical binomial logistic regression, the assumption of independence was met since the PRAMS survey was administered by randomized sampling. Each of the variables categories was mutually exclusive. The dependent variable was dichotomous, and the main independent variables and covariates were categorical thereby meeting another assumption. Since all the variables for RQ 1 were categorical, I did not test for multicollinearity or check for a linear relationship between the independent and dependent variables as these were unnecessary. For the data set, I stratified first by race. In Model 1, I entered racial concentration as a predictor for IM and calculated the crude odds. I next added into Model 2 the maternal-level variables and in Model 3, I added the infant variables. I repeated the same process for rurality. Last, I performed the same analysis for the data set stratified by ethnicity.

Racial concentration, rurality, and infant mortality across races and ethnicity. There was not a statistically significant association between racial concentration, rurality and IM for Whites, Blacks, or for Other races (see Table 5). I observed the same for Hispanic ethnicity, however, there was a significant association for women with Non-Hispanic ethnicity at high racial concentration (see Table 6). The crude odds were statistically significant (OR = 5.30, *95%CI[*2.09, 13.48*]*, $p < .05$). After controlling for income, education, maternal age, marital status, and tobacco use, the adjusted odds decreased but remained statistically significant indicating positive confounding. Non-Hispanic women living at high racial concentration were over four times more likely to experience IM compared to Non-Hispanic women living at low racial concentration (*aOR* = 4.51, *95%CI[*1.16, 17.63*]*, *p* <.05). When controlling for infant-level variables namely prematurity and birthweight in addition to maternal-level variables, the adjusted odds remained statistically significant (*aOR* = 5.33, *95%CI[*1.11, 25.67*]*, *p* <.05) but were similar to the crude odds.

Table 5

Regression Model for Racial Concentration, Rurality, and Infant Mortality Across Races

	Whites			Blacks			Other Races		
	Crude OR [95%CI]	[+]Model 2 adjusted OR [95%CI]	[++]Model 3 adjusted OR [95%CI]	Crude OR [95%CI]	[+]Model 2 adjusted OR [95%CI]	[++]Model 3 adjusted OR [95%CI]	Crude OR [95%CI]	[+]Model 2 adjusted OR [95%CI]	[++]Model 3 adjusted OR [95%CI]
Racial concentration									
<25%		reference			reference			reference	
25%-49.9%	1.40 [0.45, 4.39]	1.17 [0.37, 3.73]	1.31 [0.35, 4.82]	0.39 [0.09, 1.75]	0.26 [0.04. 1.60]	0.20 [0.03, 1.32]	0.50 [0.05, 5.13]	0.85 [0.11, 6.93]	1.18 [0.17, 8.36]
≥50%		[+++] not applicable		1.30 [0.29, 5.87]	1.30 [0.21, 7.16]	1.12 [0.19, 7.47]	0.49 [0.05, 4.90]	1.57 [0.19, 12.72]	2.54 [0.27, 23.65]
Rurality									
Urban		reference			reference			reference	
Rural	1.39 [0.53, 3.65]	1.20 [0.46, 3.14]	1.05 [0.33, 3.33]		[+++]not applicable			[+++]not applicable	

[+]Model 1 included income (≥$50,000 (reference), <$10,000, $10,000-$24,999, and $25,000-$49,999), maternal education (College graduate (reference), <12th grade/No diploma, High school graduate/GED, and Some college/No degree), maternal age (20-29 reference, ≤19, 30-34, and ≥35), marital status (Married (reference) or Other), and tobacco use (Non-smoking (reference) or Smoking). Some categories were compressed for analysis.

[++]Model 2 included variables from Model 1 plus prematurity (>37 weeks (reference), <28 weeks, 28-32 weeks, and 33-37 weeks) and birthweight (≥2,500 grams (reference), <1500 grams, and 1500-2499 grams). Some categories were compressed for analysis.

[+++]Could not analyze. No infant deaths present at these categories.

Table 6

Regression Model for Racial Concentration, Rurality, and Infant Mortality for Ethnicity

	Hispanic			Non-Hispanic		
	Crude OR [95%CI]	+Model 1 adjusted OR [95%CI]	++Model 2 adjusted OR [95%CI]	Crude OR [95%CI]	+Model 1 adjusted OR [95%CI]	++Model 2 adjusted OR [95%CI]
Racial concentration						
<25%		reference			reference	
25-49.9%	3.12 [0.27, 35.97]	3.54 [0.44, 28.83]	2.19 [0.31, 15.28]	1.24 [0.57, 2.70]	1.07 [0.43, 2.68]	0.78 [0.30, 2.02]
≥50%	3.35 [0.29, 38.54]	4.08 [0.26, 63.19]	11.78 [.22, 622.10]	*5.30 [2.09, 13.48]	*4.51 [1.16, 17.63]	*5.33 [1.11, 25.67]
Rurality						
Urban		reference			reference	
Rural		+++not applicable		0.50 [0.23, 1.07]	0.47 [0.20, 1.07]	0.43 [0.18, 1.02]

+Model 1 included income (≥$50,000 (reference), <$10,000, $10,000-$24,999, and $25,000-$49,999), maternal education (College graduate (reference), <12th grade/No diploma, High school graduate/GED, and Some college/No degree), maternal age (20-29 reference, ≤19, 30-34, and ≥35), marital status (Married (reference) or Other), and tobacco use (Non-smoking (reference) or Smoking). Some categories compressed for analysis.
++Model 2 included variables from Model 1 plus prematurity (>37 weeks (reference), <28 weeks, 28-32 weeks, and 33-37 weeks) and birthweight (≥2,500 grams (reference), <1500 grams, and 1500-2499 grams). Some categories were compressed for analysis.
+++Could not analyze due to no infant deaths present.
*Significant at p <.05.

RQ1 answers summarized. I retained the null hypothesis for a relationship between racial concentration and IM when evaluating for Blacks, Whites, Other races, and Hispanics. Racial concentration was not associated with IM even when I controlled for maternal and infant demographic variables for these groups. Regarding Non-Hispanic ethnicity, I rejected the null hypothesis. Racial concentration was associated with IM. When evaluating for an association between rurality and IM, I retained the null hypothesis for Whites and Non-Hispanics. I could not evaluate rurality for Blacks, Other races or for Hispanics.

Research Question 2

RQ2 was, How does access to prenatal care among racial groups compare across Tennessee when stratified by places of residence? I stratified the data set by racial concentration then by rurality and performed the analysis to evaluate for race and for ethnicity.

Assumptions for general linear model. To answer this question, I first evaluated the data for skewness and kurtosis (Figures 3 through 7) because the dependent variable was continuous. The dependent variable (number of PNC visits) appeared to have slight positive skew when I analyzed the descriptive statistics for the unweighted sample against the independent variables (race and ethnicity). The values for skewness were within acceptable limits of ± 1. Regarding kurtosis, the values were outside of ± 3 for some groups compared to PNC visits denoting the presence of outliers. The respective values for skewness and kurtosis are as follows: PNC visits vs. Black (skewness = .169; kurtosis = .979); PNC visits versus Other races (skewness = .751; kurtosis = 4.923); Whites (skewness = .681; kurtosis = 3.243); PNC visits versus Hispanic (skewness = .728; kurtosis = 5.512), and PNC visits versus Non-Hispanics (skewness = .455; kurtosis = 2.546). I performed the Shapiro Wilks test to assess normal distribution and it was statistically significant for all racial groups ($p < .05$) and for ethnicity ($p < .05$) against PNC visits giving indication that the distribution for PNC visits was not normally distributed. Therefore, I utilized the complex samples GLM for analysis.

I used the *Wald F* statistic which was adjusted for equal variances not assumed as the Levene's test for homogeneity of variance was statistically significant (*Levene's statistic* (2, 3311) = 6.829, $p < .05$) for race. For Ethnicity and PNC, the Levene's test was not statistically significant, so, I used the F statistic. The test variables met the assumptions for GLM as the independent variables (race and ethnicity) were categorical with at least two levels and the dependent variable (PNC visits) was quantitative. Because PRAMS was a randomized sampling, the test variables met the assumption of independence (Field, 2013). Beta values and 95% confidence intervals are presented.

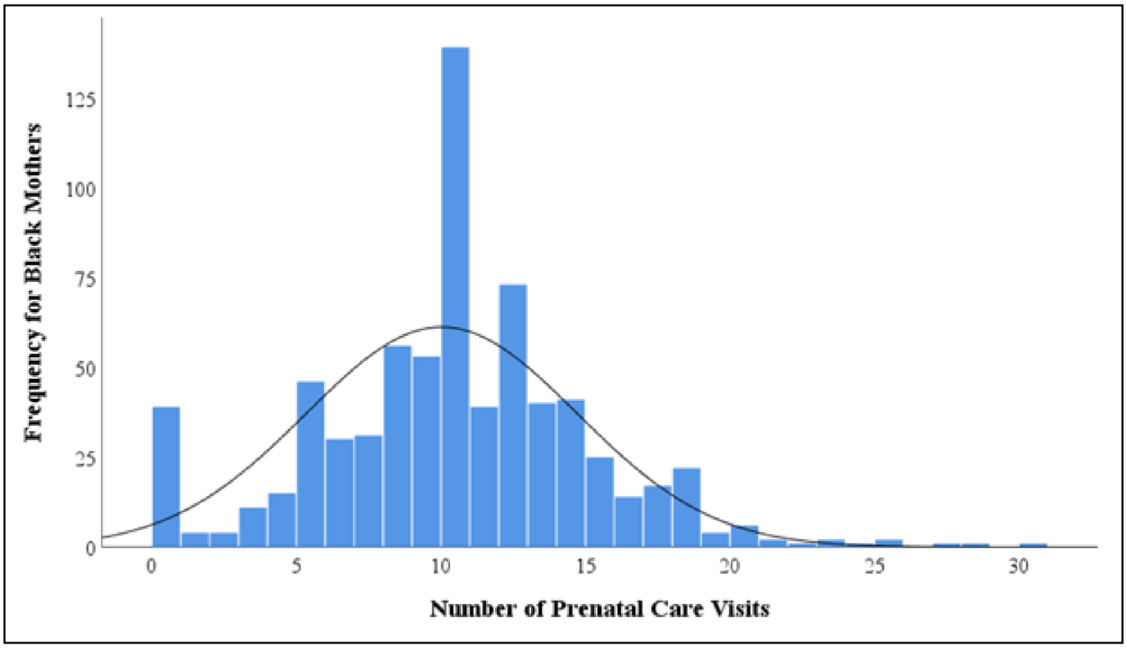

Figure 3. Distribution of Black mothers and prenatal care visits.

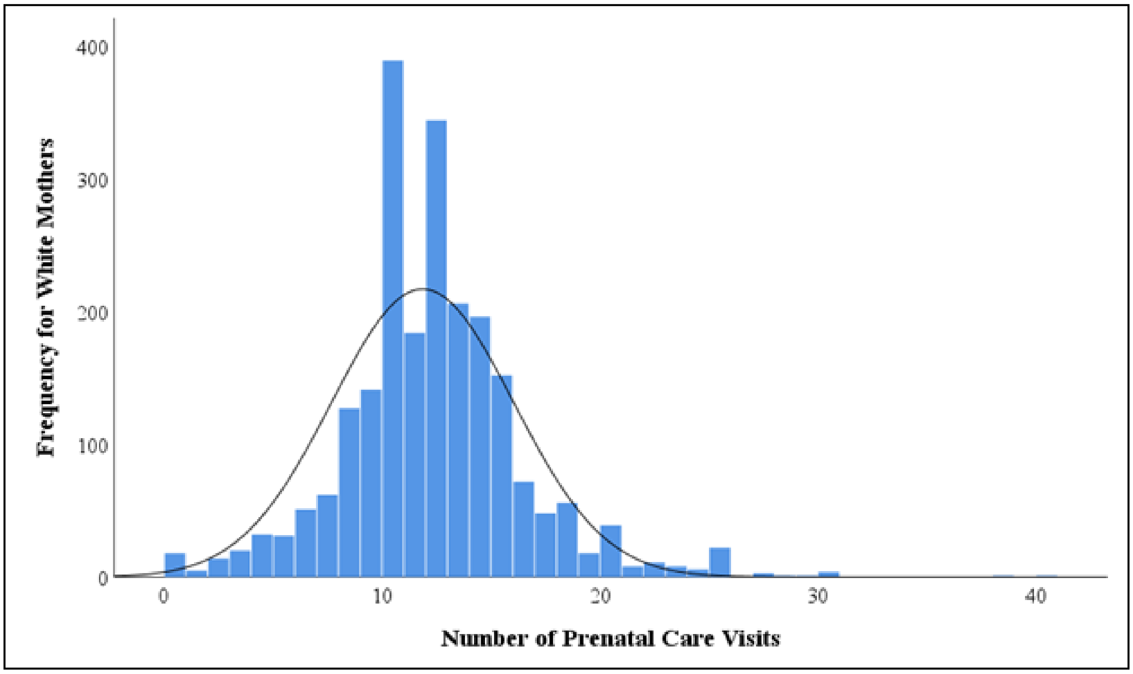

Figure 4. Distribution of White mothers and prenatal care visits.

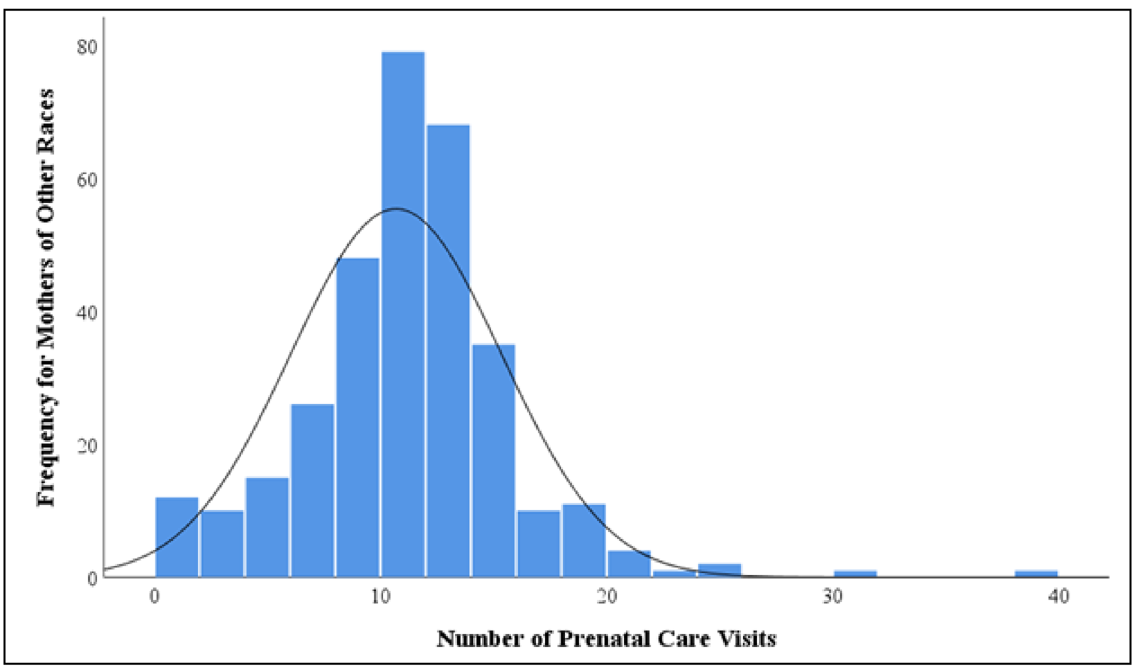

Figure 5. Distribution of mothers of Other races and prenatal care visits.

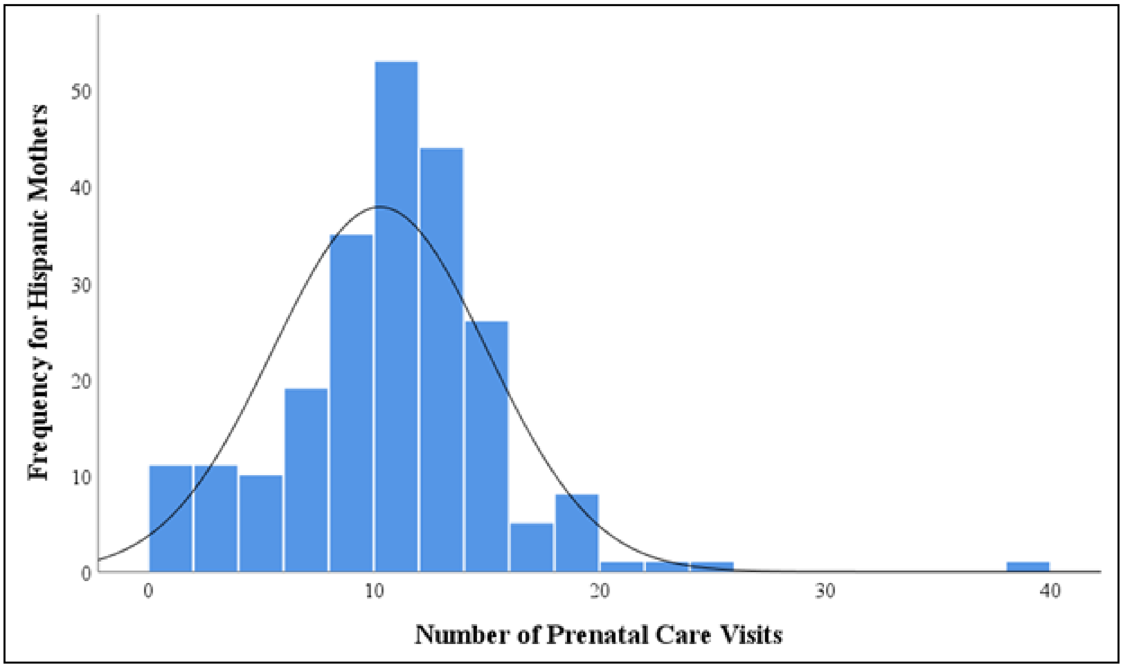

Figure 6. Distribution of Hispanic mothers and prenatal care visits.

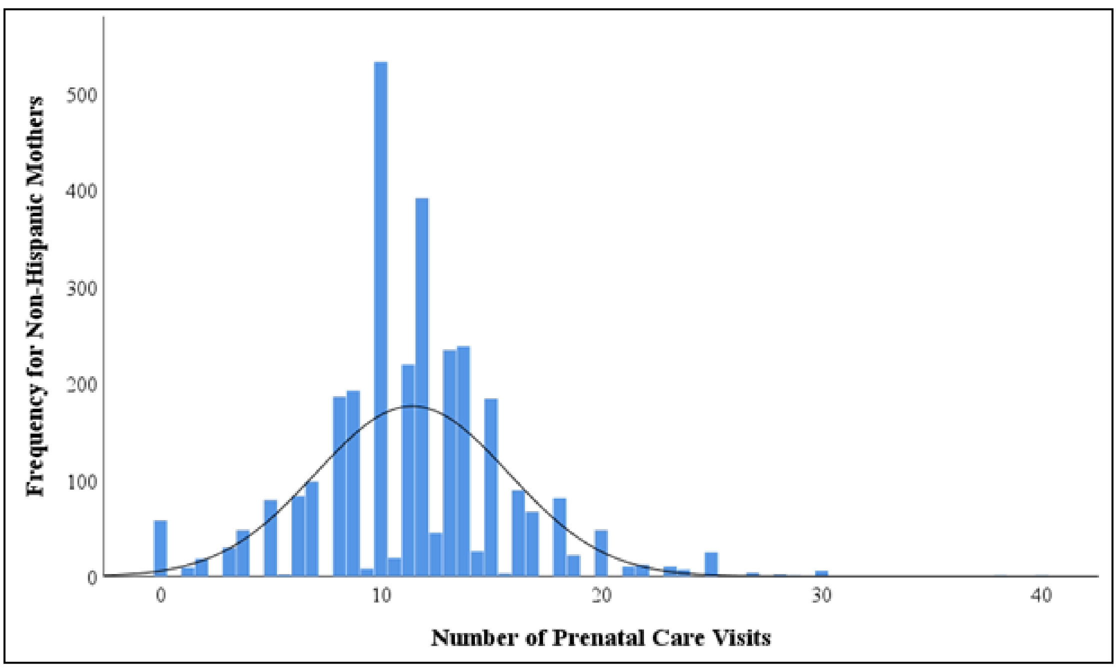

Figure 7. Distribution of Non-Hispanic mothers and prenatal care visits.

Results for race, ethnicity, and PNC visits when stratified by racial concentration and by rurality. Mean PNC visits (see Table 7) was seemingly on a gradient with decreasing PNC visits as racial concentration increased for each racial group and ethnicity. White women living at low racial concentration had the highest mean PNC visits compared to Blacks and Other races. I noted this same observation at medium and high racial concentrations. Blacks did not differ from Whites statistically at any racial concentration nor did they differ from Other races. Contrarily, women of Other races living at low racial concentration compared to White women (see Table 8) were statistically different regarding the mean number of PNC visits. Women of Other races were less likely to have PNC visits compared to White women (β = -1.22, *95%CI[*-2.10, -0.34*]*, $p < .05$). Other races did not differ from Whites at medium or high racial concentrations.

Non-Hispanic women had higher mean PNC visits at low racial concentration and medium racial concentration compared to Hispanic women, however mean PNC visits were the same at high racial concentration. As I indicated in Tables 7 and 8, Hispanic women differed statistically from Non-Hispanic women at low racial concentration and were less likely to have PNC visits compared to Non-Hispanic women (β = -1.22, *95%CI[*-2.10, -0.34*]*, $p < .05$).

Table 7

Prenatal Care Visits for Race and Ethnicity when Stratified by Racial Concentration

	Low racial concentration (<25%)			Medium racial concentration (25 – 49%)			High racial concentration (≥50%)		
	Total visits	Mean	S.D.	Total visits	Mean	S.D.	Total visits	Mean	S.D.
Race									
White	2026	11.91	4.13	195	11.69	4.63	50	10.68	4.03
Black	167	10.73	4.40	150	10.28	4.55	403	9.64	4.83
Other	208	10.73	4.64	65	10.93	4.49	50	10.21	4.95
Ethnicity									
Non-Hispanic	2260	11.82	4.17	360	11.15	4.60	468	9.80	4.76
Hispanic	141	10.35	4.76	50	10.38	4.70	35	9.80	4.98

Table 8

Comparison of Race and of Ethnicity on Mean Prenatal Care Visits across Racial Concentration

	Low racial concentration (<25%) β [95%CI]	Medium racial concentration (25-49.9%) β [95%CI]	High racial concentration (≥50%) β [95%CI]
Black vs. White	-0.66 [-1.54, 0.22]	-0.74 [-1.89, 0.40]	-0.08 [-1.70, 1.55]
Other races vs. White	*-1.22 [-2.10, -0.34]	0.46 [-0.80, 1.72]	-0.10 [-2.32, 2.12]
Other races vs. Black	-0.56 [-1.71, 0.60]	1.21 [-0.08, 2.49]	-0.22 [-1.74, 1.70]
Hispanic vs. Non-Hispanic	* -1.22 [-2.10, -0.34]	-0.08 [-1.29, 1.14]	-0.26 [-2.38, 1.86]

*Significant at p <.05.

Regarding rurality, White women had higher PNC visits in both rural and urban areas in comparison to Black women and women of Other races (see Table 9). I found similar results for Non-Hispanic women compared to Hispanic women. There was a statistically significant difference between Black women and White women living in urban areas and the mean number of PNC visits received during pregnancy. Blacks were less likely to receive PNC compared to Whites (β = -1.57, *95%CI[*-2.02, -1.12*]*, *p* < .05). as indicated in Table 10. Blacks did not differ from Whites in rural areas nor did they differ from Other races in rural or urban areas. Contrarily, women of Other races differed statistically from White women in urban areas (β = -0.93, *95%CI[*-1.62, -0.23*]*, *p* < .05) and in rural areas (β = -2.09 *95%CI[*-3.61, -0.57*]*, *p* < .05) indicating they were less likely to receive PNC. In addition, Hispanic women did not differ from Non-Hispanic women in urban areas. However, a statistically significant difference was evident in rural areas between these women (β = -2.12, *95%CI[*-3.53, -0.72*]*, *p* < .05) (see Table 10).

Table 9

Prenatal Care Visits for Race and Ethnicity when Stratified by Rurality

	Urban			Rural		
	Total visits	Mean	S.D.	Total visits	Mean	S.D.
Race						
White	1657	11.97	4.16	614	11.57	4.21
Black	660	10.00	4.78	60	10.31	3.67
Other	277	10.75	4.83	46	10.37	3.44
Ethnicity						
Non-Hispanic	2403	11.42	4.43	685	11.47	4.17
Hispanic	191	10.36	5.01	35	9.76	3.07

Table 10

Comparison of Race and Ethnicity on Mean Prenatal Care Visits across Rurality

	Urban β [95%CI]	Rural β [95%CI]
Black vs. White	*-1.57 [-2.02, -1.12]	-0.64 [-1.55, 0.27]
Other races vs. White	*-0.93 [-1.62, -0.23]	*-2.09 [-3.61, -0.57]
Other races vs. Black	0.64 [-0.14, 1.43]	1.45 [-3.14, 0.23]
Hispanic vs. Non-Hispanic	-0.69 [-1.41, 0.03]	*-2.12 [-3.53, -0.72]

*Significant at p <.05.

RQ2 answers summarized. I rejected null hypothesis when evaluating for low racial concentration. There was a statistically significant difference between races and between ethnicity on the mean number of PNC visits in low racial concentrated areas. I retained the null hypothesis for medium and high racial concentrated areas. Regarding rurality, I retained the null hypothesis for rural areas but rejected it when I evaluated for race in urban areas; there was a statistically significant difference between races and the mean number of PNC visits. When evaluating for ethnicity, I retained the null hypothesis; there was no statistically significant difference between Hispanics and Non-Hispanics and the mean number of PNC visits in urban areas. For rural areas, I rejected the null hypothesis. There was a statistically significant difference between races and ethnicity on the mean number of PNC visits.

Research Question 3

RQ3 was, Does maternal race modify the relationship between places of residence, prenatal care, and infant mortality across the State of Tennessee? To answer this research question, I used hierarchical binomial logistic regression, however I analyzed using the entire data set. I analyzed for racial concentration and IM in the main effect model, followed by interaction terms of race and of ethnicity in subsequent models. I repeated this process for the remaining independent variables.

Descriptive statistics. Descriptive statistics which characterized the sample were detailed in Tables 1 and 2.

Assumptions of hierarchical binomial logistic regression. Statistical assumptions were the same as RQ1. All assumptions were met for RQ3.

Places of residence, PNC, and IM modified by race and by ethnicity. The relationship between medium racial concentration and IM was not statistically significant for Tennessee women in the main effects model, however high racial concentration was associated with IM (*OR* = 5.86, *95%CI[*2.39, 14.33*]*, $p < .05$) as indicated in Table 11. The interaction between racial concentration and Black versus White race modified this relationship rendering it no longer statistically significant. The same was true for the other race interaction combinations. When evaluating the interaction of Hispanic ethnicity versus Non-Hispanic ethnicity on racial concentration and IM, the relationship remained statistically significant with little change in the adjusted odds from the crude odds observed. In the main effects model for rurality, there was a statistically significant association between rurality and IM (*OR* = 0.32, *95%CI[*0.15, 0.69*]*, $p < .05$), however interaction terms could not be analyzed due to no infant deaths present in rural areas for Blacks and Other races. PNC as represented by the APNCU was not statistically significant for IM at any level and this relationship was not modified by race or by ethnicity.

Table 11

Regression Model to Determine if Race or Ethnicity Modifies the Relationship between Racial Concentration, Rurality, Prenatal Care and Infant Mortality for Tennessee Women

	Main effects model OR [95%CI]	+Model 1 OR [95%CI]	++Model 2 OR [95%CI]	+++Model 3 OR [95%CI]	++++Model 4 OR [95%CI]
Racial concentration					
<25%	reference	reference	reference	reference	reference
25-49.9%	1.40 [0.68, 2.90]	0.60 [0.19, 1.94]	0.39 [0.11, 1.35]	0.62 [0.22, 1.75]	1.48 [0.72, 3.03]
≥50%	*5.86 [2.39, 14.33]	1.42 [0.36, 5.51]	1.20 [0.34, 4.23]	1.40 [0.42, 4.71]	*5.95 [2.43, 14.59]
Rurality					
Urban	reference	reference	reference	reference	reference
Rural	*0.32 [0.15, 0.69]	**not applicable	**not applicable	**not applicable	**not applicable
APNCU Index					
Adequate	reference	reference	reference	reference	reference
Adequate plus	0.85 [0.37, 1.92]	1.26 [0.48, 3.28]	2.19 [0.62, 7.75]	1.02 [0.42, 2.47]	0.86 [0.38, 1.94]
Intermediate	0.85 [0.28, 2.55]	0.81 [0.25, 2.60]	0.79 [.014, 4.33]	0.65 [0.21,1.99]	0.86 [0.29, 2.59]
Inadequate	1.95 [0.50, 7.66]	1.85 [0.43, 8.05]	2.56 [0.43, 15.17]	1.56 [0.41, 5.97]	2.17 [0.54, 8.74]

*Significant at $p < .05$.
+Model 1 added the interaction term of Black vs. Whites.
++Model 2 added the interaction term of Blacks vs. Other races.
+++Model 3 added the interaction term of Blacks vs. Whites and Other races.
++++Model 4 added the interaction term of Hispanics vs. Non-Hispanics.
**Could not analyze because no deaths present for Blacks, Other races, or Hispanic in rural areas.

RQ3 answers summarized. I rejected the null hypothesis in favor of the alternative hypothesis; Black race does modify the relationship between high racial concentration and IM for Tennessee women. For the interaction of Hispanic ethnicity on the association of racial concentration and IM, I retained the null hypothesis. I also retained the null for the interaction of race and of ethnicity on the relationship between

PNC and IM. The interaction of race on the relationship between rurality and IM could not be analyzed completely.

Summary

RQ1 was, What is the relationship between places of residence using neighborhoods as units of analysis and IM among racial groups across the State of Tennessee? Racial concentration was not associated with IM for any race. For ethnicity, Non-Hispanic women had increased odds of IM when racial concentration was 50% or greater. Rurality was not a significant predictor of IM for Whites or for Non-Hispanic women and an association could not be analyzed for Blacks, Other races, or Hispanics.

RQ2 was, How does access to prenatal care among racial groups compare across Tennessee when stratified by places of residence? Regarding racial concentration, Blacks and Whites did not differ at any level of racial concentration on the mean number of PNC visits, however there were mean differences between women of Other races and women who were White. Other races had less PNC visits at low racial concentration but no significant differences from Whites at medium or high racial concentrations. Other races did not differ from Black women. Hispanic women differed from Non-Hispanic women on the mean number of PNC visits at low racial concentration having significantly lower visits. On the contrary, there were no significant differences at medium or high racial concentrations for Hispanics compared to Non-Hispanics.

Blacks and Whites did differ on the mean number of PNC visits in urban areas with Blacks having a lower number of visits. The same was true for women of Other races in comparison to Whites. Other races did not differ on PNC visits when compared to Blacks. Regarding Hispanic women compared to Non-Hispanic women, there were no significant differences observed in the mean number of visits in urban areas. For rural areas, Other races again differed from Whites on the mean number of PNC visits as did Hispanic and Non-Hispanic women.

RQ3 was, Does maternal race modify the relationship between places of residence, PNC, and IM across the State of Tennessee? The relationship between racial concentration and IM for women living at high racial concentration was statistically significant however after adding the interaction terms of Black race compared to White and Other races, the relationship was no longer statistically significant giving indication that race does modify the association between racial concentration and IM. Race did not modify the relationship between PNC and IM. Regarding ethnicity, Hispanic ethnicity did not modify the relationship between racial concentration and IM or PNC and IM. Rurality and IM could not be fully assessed for interactions with race or ethnicity. In Chapter 5, I give a thorough explanation of my findings and I discuss these finding in relation to the literature and in relation to the theoretical framework.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

The purpose of this study was to assess the relationship between places of residence (using neighborhoods as units of analysis consisting of rurality and racial concentration), PNC, and IM across racial groups in Tennessee. A second aim of this study was to determine whether race modified these associations. This study was an observational study and quantitative in nature. I used a cross-sectional design to analyze proximate relationships linked to observed higher IM rates in areas of higher racial concentrations.

I found that racial concentration was not associated at any level with IM for Whites, Blacks, or Other races. For Non-Hispanic women, high racial concentration was associated with IM. PNC access did not differ for racial groups across the levels of racial concentration except for Other races and Hispanics. At low racial concentration Other races and Hispanics had less PNC compared to Whites and Non-Hispanics respectively.

Living in rural areas was not associated with IM for Whites or for Non-Hispanic women. Rurality in association with IM could not be analyzed for Blacks, Other races, or for Hispanic women. Nonetheless, Hispanic women had less access to PNC in rural areas with a similar observation for women of Other races. In urban areas, Black women and women of Other races had less access to PNC, however when evaluating race for an interaction between PNC and IM, race did not modify the relationship. In contrast, Black race did modify the relationship between high racial concentration and IM.

Interpretation of the Findings

I found that racial concentration was not statistically significant for IM for Whites, Blacks, or Other races, which was consistent with the findings of some researchers (Darling & Atav, 2012; Hearst et al., 2008; McFarland & Smith, 2011; Shaw & Pickett, 2013). This finding was contrary to what has been found regarding the harmful nature of increasing ethnic density (Mason et al., 2011); increasing racial concentration, or decreasing privilege in association with IM (Huynh et al., 2017; White et al., 2017; Wallace et al., 2017); or other adverse birth outcomes (Margerison-Zilko et al., 2017), and contrary to the protective nature of increasing racial concentration on infant health that others have identified (Madkour et al., 2014).

The finding that high racial concentration (≥ 50%) was associated with IM for Non-Hispanic ethnicity even after controlling for maternal-and-infant level demographic variables was surprising. Although limited resources for health care have been noted in high racial concentrated areas (Gaskin et al., 2012; Hung et al., 2017; Satyamurthy & Montenera, 2016), the lack of association between high racial concentration and IM for individual racial groups in Tennessee from this study indicated that other underlying factors related to race that influence this relationship have not been accounted for as stratification by race did not reveal any associations.

Race as a modifier in this study gave credence to what Kothari et al. (2016) wrote regarding living in high racial concentration and the mitigation of risk for adverse birth outcomes for women. Mitigation may potentially be due to racial-ethnic clustering, sharing of resources, and social support (Kothari et al., 2016). Contrarily, racial concentration at any level for Hispanic ethnicity was not associated with IM and may be attributed to the Hispanic paradox in which Hispanic women are either not at risk for adverse birth outcomes or have reduced risk despite living in disadvantage and with lower socio-economic status (Powers, 2016; Shaw et al., 2010).

Results from this study for an association between rurality and IM were not statistically significant for Whites or for Non-Hispanics in Tennessee confirming the results found in the literature (Lisonkova et al., 2016). These findings were also incongruent with what other researchers have indicated: that rurality is associated with IM (Akinyemi et al., 2015; Batton et al., 2013). In contrast, Tennessee women living in rural areas and regardless of race were protected against IM aligning with what other researchers have indicated as a rural advantage (Sparks et al., 2009). Rurality remained largely unexplored in this study in relation to IM for Blacks, Other races, and Hispanics due to the lack of infant deaths in rural areas for these groups.

Blacks and Other races differed significantly from Whites in urban areas on the number of PNC visits which is consistent with the findings for other minority women in urban surroundings (People & Danawi, 2015) but inconsistent with other researchers (Lisonkova et al., 2016) regarding urban environments. PNC seeking behavior in urban areas for Black and Other races can be influenced by multiple factors including communication, stigma, insurance coverage, and continuity of care (Meyer et al., 2016; Phillippi et al., 2014) which may be applicable to the women in this study. Interestingly Hispanics did not differ on the number of PNC visits in urban areas.

In rural areas, Blacks did not differ from Whites on the number of PNC visits as Harris et al. (2015) had found. However, Other races and Hispanics had fewer PNC visits. This finding coincides with what some researchers have found regarding poor access to obstetric care during and after pregnancy (Yerramilli & Fonseca, 2014) and lower rates of PNC use (Danhausen et al., 2015) due to the lack of doctors or other health care providers, lack of medical insurance, and geographic distance (Meyer et al., 2016; Phillippi et al., 2014; Yerramilli & Fonseca, 2014) in rural areas.

When stratifying by racial concentration, Other races differed from Whites on the number of PNC visits in low racial concentrated areas similar to Hispanics when compared to Non-Hispanics. Although women in low racial concentrated areas have greater access to PNC resources, researchers have found that they have a greater risk for adverse birth outcomes due to segregation effects from living in low racial concentrated areas (Nyarko & Wehby, 2012). Similar findings have been cited for Blacks living in majority-White neighborhoods (Kothari et al., 2016); however, this study found no differences in PNC between Blacks and Whites at any level of racial concentration.

In medium and high racial concentrated areas, there were no differences between races or between Hispanic and Non-Hispanic ethnicity and the number of PNC visits. This finding may allude to equality of access for these groups living in these areas. Other researchers have noted similar observations for some rural areas in which residents had greater odds of having a usual source of health care due to few existing options for choosing a physician or clinic (Caldwell et al., 2016).

In this study, PNC as measured by the APNCU index at any level was not statistically significant for IM for Tennessee women consistent with the findings of Owais et al. (2013) but in contrast to the idea that PNC is crucial for prevention of neonatal mortality (Li et al., 2015) and other adverse birth outcomes (Darling & Atav, 2017). There were no disadvantages to having adequate plus PNC, intermediate PNC, or inadequate PNC when compared to adequate PNC against IM in this study similar to the findings of other researchers (Akinyemi et al., 2015; Holland et al., 2016; Meghea et al., 2015; Partridge et al., 2012; VanderWeele, 2013). Results for this study were in contrast to what some have found regarding an increased risk of adverse birth outcomes with decreasing amounts of PNC (Loftus et al., 2015) and adverse birth outcomes with inadequate PNC (Xaverius et al., 2016). Researchers have indicated that a third of the Black-White disparity in IM was explained by PNC access in addition to factors such as SES and maternal demographics (El-Sayed et al., 2015b) which stands in contrast to the results from this study. Race or ethnicity as an interaction term did not modify the relationship between PNC and IM.

Findings in Relation to the Theoretical Framework

Results from this study did not give complete evidence to confirm or deny the theory of racial residential segregation and concentrated poverty. The theory posits that racial segregation into high and low poverty groups stems from concentrated poverty (Massey & Fischer, 2000; Quillian, 2012, 2017; Wilson, 1987) and as neighborhoods become increasingly segregated the effects are observed in poor health outcomes for residents due to less or inferior health services (Massey, 1990; Massey et al., 1994).

Racial concentration in this study was not associated with IM for any race or for Hispanics but remained statistically significant at high concentrations for Non-Hispanics even after controlling for maternal and infant level variables. Consequently, this association between high racial concentration and IM for Non-Hispanics may coincide with what Quillen (2012, 2017) discussed as spatial factors which either weaken or strengthen segregation effects in some areas. Blacks and Other races had lower mean visits PNC visits compared to Whites, but the association was significant for low racial concentrated areas but not medium or high racial concentrated areas perhaps giving indication of segregation effects (Quillen, 2012, 2017). The results for a statistically insignificant association between medium and high racial concentration and IM perhaps confirm that all residents in these areas are equally disadvantaged regarding access to care (Massey, 1990; Massey et al., 1994).

Limitations of the Study

Use of a secondary data set was a limitation. Missing data can be problematic with secondary data and this was the case for this study. Since there were so few cases of IM in the data set, it was impossible to delete participants with missing data therefore, multiple imputation was favored to correct the issue. Imputation is based on whether variables are missing completely at random, missing at random, or not missing at random (IBM, n.d.; Li, 2013; Little, 1988; van Buuren, 2007). Tests ruled out missing completely at random, however it was impossible to determine whether the missing data was missing at random or not missing at random. Therefore, imputation was performed for both continuous and categorical variables with the downside related to the introduction of bias

(Osman et al. 2018) due to estimated values rather than actual measures (Stephens et al., 2018).

The cross-sectional design used in this study was a limitation. Cross-sectional design cannot establish causation and only captures data at a single point in time (Aschengrau & Seage, 2014; Frankfort-Nachmias et al., 2015; Setia, 2016) so only inferences were made in this study. In addition, cross-sectional study designs can suffer from internal validity issues and may have problems with selection bias (Salazar, Crosby, & DiClemente, 2015).

Another limitation was the combination of Native American, Pacific Islanders, Asian, and Mixed races into the category of Other races. This study could not determine if significant associations existed for these races since they were combined into one. Several other variables were compressed to enable analysis for women of Other races and for women who were Hispanic. For example, associate's degree and professional degree were combined into one category to represent having a college degree as a control variable so any associations or relationships that would have existed to confound relationships could not be clearly identified. Compressing the RUCA census tract information into two categories (rural and urban) may also have changed the association between variables since urban clusters which are part of rural areas were categorized as urban. Also, there was no consideration of secondary RUCA classification which accounts for even further subdivisions of rural and urban based on additional factors.

Stratifying the data set by racial concentration and rurality presented challenges adding to the limitations of this study. Some populations in the Unites States have been underreported for infant deaths (Hummer, Powers, Pullum, Gossman, & Frisbie, 2007; Swanson, Kposowa, & Baker, 2019) so present difficulties for epidemiologic research. This was the case for this study. There were no reported infant deaths for Blacks, Other races and Hispanic ethnicity in rural areas, therefore RQ1 and RQ3 could not be fully answered. In addition, there were no deaths for Whites in high racial concentrated areas, so the racial concentration variable had to be compressed into two levels to facilitate answering RQ1. While the overall sample size was enough to evaluate IM for Tennessee women, stratifying the data by rurality, racial concentration, and by race resulted in smaller sample sizes for the analysis therefore could have contributed to a Type II error.

While hierarchical or multilevel modeling has good predictive accuracy due to the analysis of individual level and group level effects simultaneously (Diez-Roux, 2000; Gelman, 2006), this type of analysis presented a challenge for this study. The group level variables used in this study could have measured constructs that were different from individual level variables (Diez-Roux, 2000). Therefore, results could mislead, and the effects could be misinterpreted, resulting in erroneous inferences (Diez-Roux, 2000; Gelman, 2006).

Data recency was another limitation. The available data set from the State of Tennessee was the PRAMS 2009-2011 survey hence may not accurately represent the current population of Tennessee births. The PRAMS data set was randomly sampled so was representative of the Tennessee population between 2009-2011, however generalizability to birth populations outside of the state of Tennessee is questionable. The 2010 census data was used to calculate percent racial concentration and therefore represented the population in 2010, so, may not be an accurate reflection of the racial distribution which exists now.

Recommendations

Other data sources such as linked birth and death records may be a better alternative to determine the relationships between variables as opposed to using a cross-sectional survey. A larger sample size consisting of all births in the State of Tennessee may give a truer picture on what contributes to Tennessee IM. In addition, conducting a retrospective cohort study or a case control study may shed more light on the relationship between rurality, racial concentration, PNC, and IM for Tennessee women. A future study could evaluate other dimensions of racial segregation in addition to racial concentration to determine if there is an association with IM. Also, a study that evaluates spatial factors influencing segregation effects may be warranted to further determine if these factors have an effect on IM for Tennessee women and for racial groups.

A future study could expand on the number of variables utilized to assess for a relationship with IM. Other neighborhood-level variables like high school graduation rates, SES, and neighborhood poverty in addition to maternal-level variables like social support, pregnancy intention, and alcohol use could have a bearing on IM when evaluated from the perspective of racial concentration and rurality. Evaluating infant variables for some racial groups without data compression may be advantageous to explain IM for Tennessee women. Although tobacco use was evaluated in this study, it was compressed into smoking and non-smoking categories. Future research could evaluate a dose response relationship for Tennessee women to explain IM.

A future look at rurality for Blacks, Other races, and Hispanics are warranted due to the limited sample size for this study when stratified and the lack of deaths in rural areas for these groups. In addition, women of Other races as a population need closer examination. For example, a future study could evaluate Native American women or Asian women in Tennessee for IM from the perspective of rurality, racial concentration, and PNC utilization.

A future study could expand on PNC utilization to examine the quality of PNC received by Tennessee women and its impact on IM with rurality and racial concentration in mind. Future studies could evaluate subpopulations of Tennessee infants based on birth weight or prematurity to determine risk factors for IM. In addition, IM specifically for neonatal and post-neonatal groups regarding racial concentration and rurality may reveal associations not otherwise observed in this study.

Implications

This research may bring into focus areas within Tennessee which have been successful at reducing IM leading to the subsequent introduction of similar models or interventions in areas requiring improvement. This research may help to motivate the medical community to design better approaches for pregnancy care for women at higher risk of IM and for women living in areas that are highly impacted. Research findings can lead to an increase in public awareness, can motivate resource allocation, and design of targeted social intervention programs with places of residence as a basis. Results have the potential to benefit infants who are the most vulnerable through facilitating changes in how women access care across the state and how PNC care is managed ending in improved infant health outcomes for Tennessee.

Social Change

This research highlighted areas impacted by IM and what accounts for the rates as well as which racial groups experience disparity in PNC access. Hence this research has the potential to impact social change at the individual level, interpersonal level, community level, and societal level.

Individual level. The introduction of appropriate interventions targeted specifically at Black women and women of Other races in places with increased IM may be advantageous for decreasing risk. Interventions shaped around health beliefs for these specific groups may potentially promote behavior change and aid in improving knowledge and attitudes surrounding pregnancy, PNC, and risk of IM.

Interpersonal level. As Tennessee women gain greater awareness regarding IM, they have the potential to exert positive influences on family members, friends, and even workmates regarding behaviors and attitudes toward pregnancy and PNC to decrease risk of IM. They could encourage peers to seek PNC potentially decreasing disparities especially since Black women and women of Other races have less PNC visits in urban areas. Physicians and other health care providers could be trained to recognize the existing IM disparity between races and should be encouraged to maximize their educational efforts toward these groups during in-office visits with the purpose of mitigating poor birth outcomes. Medical providers could also customize care plans for these women that specifically address their risks for IM.

Community level. At the community level, education and awareness of risk factors are needed to decrease IM. Schools could become involved by adding information to their curriculum regarding risk of IM and how to mitigate said risk in highly impacted areas. Community centers in these neighborhoods could provide information to members through the inclusion of programs that present the individual risk factors and subsequent outcomes during health fairs or special events that bring in health professionals for pregnancy education. These centers could also link women to PNC resources to decrease disparity. Since social media has the ability to reach across multiple audiences at various societal levels, campaigns could be designed to bring awareness to risk of IM and also link women to local health care resources. Other outreach programs could be designed to present information in public areas where women frequent such as shopping malls, baby fairs, concerts, and other public events.

Societal level. At the societal level, legislators could institute policies to provide funding which is earmarked for developing health facilities in highly impacted areas across Tennessee to decrease IM disparity. Funding can ameliorate PNC disparity by providing easier access to Blacks, Hispanic women, and women of Other races in areas identified by this study. Policies could specifically mandate how many facilities each impacted area should have to service the population at the local level and state level. The state and local governments could supply bonuses or supplemental income to physicians and other health care providers to attract them to work in high racial concentrated areas with the potential benefit of decreasing IM risk.

Conclusion

It is extremely important to recognize that Black IM in Tennessee is considerably higher compared to that of Whites and Other races. Although race modified the relationship between racial concentration and IM, the elevated rates of IM in high racial concentrated areas and urban areas cannot be ignored. Disparity in access to health services highlighted through lower PNC visits in some areas persists for Blacks, women of Other races, and for Hispanics although PNC resources are available. And while significant associations were not observed for PNC and IM for Tennessee women, it stands to reason that other factors remain undiscovered which may explain why rates are higher in some areas and for certain populations and why the Tennessee IM rate surpasses that of the national rate.

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