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Analysis of the role of residential segregation on perinatal outcomes in Florida, Georgia, and Louisiana

Tabia Henry Akintobi
University of South Florida

Analysis of the Role of Residential Segregation on Perinatal Outcomes in Florida, Georgia and Louisiana

by

Tabia Henry Akintobi

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Department of Community and Family Health
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University of South Florida

Co-Major Professor: Melinda S. Forthofer, Ph.D.
Co-Major Professor: Carol Bryant, Ph.D.
Elleen Daley, Ph.D.
Wendy N. Nembhard, Ph.D.
Kathleen O'Rourke, Ph.D.

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DEDICATION

I dedicate this work, first, to my Lord, Jesus Christ. To my husband, Adebayo A. Akintobi, M.D.; you have been my biggest cheerleader, a professional colleague, and the man of my dreams. To my daughter, Ifelola; you were a good baby and are now a big girl. I love who you are and eagerly anticipate all that you will become. To my parents, Leila and Zadoc Henry; your steadfast examples of faith and excellence in education will be legacies I will pass on. Thanks for always believing in me, not matter what I thought. To my first brother, David Henry; when I think of your life, I know that absolutely nothing is impossible and that giving up is never an option. To my baby brother, Joshua Henry; your tireless energy, enormous talent and tunnel vision have always motivated me to be more.

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ABSTRACT

The purpose of this study was to investigate the relationship between residential segregation (the physical separation of Blacks and Whites in residential contexts) and adverse perinatal outcomes (low birth weight, preterm delivery and small for gestational age births) in Florida, Georgia and Louisiana. The study determined the independent effect of the level of residential segregation on the likelihood of adverse perinatal outcomes after controlling for contextual and individual factors. The study also assessed whether the relationship between residential segregation and adverse perinatal outcomes were moderated by ethnicity and median income.

The studied employed an observational, cross-sectional study design that utilized secondary data. Live birth certificates between 1999 and 2001 provided information on individual covariates and perinatal outcomes. Structural indicators of residential segregation and contextual covariates were obtained from the U.S. Census Bureau. The nested data structure for each birth outcome model was composed of individual, contextual, and structural data. Three-level, hierarchical generalized linear models were used to test research hypotheses.

The study population consisted of non-Hispanic White and Black primaparous women between 15 and 49 years of age experiencing singleton live births delivered at

less than or equal to 45 weeks gestation. The final sample consisted of 255,548 women nested within 4,360 census tracts and 63 Metropolitan or Micropolitan Statistical Areas.

Residential segregation did not have a direct relationship with low birth weight, preterm delivery or small for gestational age, after controlling for other variables in multilevel models. Models testing the moderating effects of ethnicity indicated that increased Isolation decreased the risk of LBW among Black women. Several contextual – level variables and the majority of individual-level variables were significantly associated with perinatal outcome risk.

Findings indicate that effects of residential segregation may be birth outcome and ethnic group specific. Relationships between individual factors, contextual factors and adverse perinatal outcomes signal the importance of proximal factors to perinatal outcomes. There is a need for specification of a broader constellation of biological, social and spatial factors and a thorough assessment of residential preferences and experiences in order to better understand the associations between neighborhoods and perinatal outcomes.

CHAPTER ONE: INTRODUCTION

The health status of mothers and infants are critical indicators of the nation's health. Public health professionals view infant mortality as "a measure of community health, economic efficiency, collective moral well being, and future military strength" (Brosco, 1999). Healthy People 2010 objectives to reduce low birth weight to 5.0 % and preterm deliveries to 7.6% are critical because they represent perinatal health indicators that are the leading causes of neonatal death and compromised quality of life to infants and families (United States Department of Health and Human Services, 2000). Regional findings indicate that low birth weight, neonatal mortality rates (death of live born from birth to < 28 days of life), and infant mortality rates (death of live born before first birthday) are highest in the Southern United States[1] (U.S.) (National Center for Health Statistics, 2004).

Adverse perinatal outcomes that contribute to increased infant mortality include low birth weight (LBW) (birth weight <2,500 grams), preterm delivery (delivery <37th complete weeks of gestation), and small for gestational age (SGA) birth (birthweight below the 10th percentile for gestational age and sex). LBW infants are 40 times more likely to die during their first month of life (Health Beat, 1998). Preterm infants are 70 times more likely to die than infants born at term (37-41 weeks) (Matthews, Menacker & MacDorman, 2002). SGA infants experience a 6-fold risk for neonatal mortality when compared to infants born appropriate for gestational age (Doctor, et al., 2001).

[1] Delaware, District of Columbia, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, West Virginia, Alabama, Kentucky, Mississippi, Tennessee, Arkansas, Louisiana, Oklahoma, Texas

National trends indicate that the prevalences of adverse perinatal outcomes has increased and ethnic disparities have persisted over time. LBW rates have increased 15% (from 6.8%) since the middle of the 1980s (National Center for Health Statistics, 2004). In 2002, LBW increased to 7.8%, the highest reported rate in three decades (Martin, et al., 2003). Infants born preterm have increased 29% since 1981 and 14% since 1990. Preterm births reached a high of 12.1% of all births in 2002 (2003).

The largest disparities in birth outcomes are by maternal ethnicity. Despite a 6% decrease in preterm deliveries among Black women and an increase of 29% among White women since 1990, rates were higher among Black women (17.7%) when compared to White women (11%) in 2002 (2003). Black-White trends in SGA births indicate that while rates have decreased for both Blacks and Whites since 1990, Blacks maintained a rate of term SGA (16%) that was 1.5 to 2.0 times higher than Whites (9%) in 2000 (Ananth, Balsubramanian, Demissie & Kinzler, 2004). Black women are almost twice as likely to have a LBW infant (Guyer, Martin, MacDorman, Anderson & Strobino, 1997). While LBW rates have increased for White women (from 5.6%) and rates among Black women have remained relatively unchanged (from 13.6%) since 1990, the LBW rate for Black and White infants in 2002 were 13.4% and 6.9%, respectively (Martin et al., 2003).

Purpose of the Study and Study Significance

The purpose of this study was to investigate the direct relationship between residential segregation (the physical separation of Blacks and Whites in residential contexts) and adverse perinatal outcomes (LBW, preterm delivery and SGA births) in the Southern states Florida, Georgia and Louisiana. This study specifically determined the independent effect of residence in an area characterized by high residential segregation on the likelihood of adverse perinatal outcomes after controlling for contextual factors (e.g., poverty level, unemployment) and individual factors (e.g., prenatal care, substance use). The study also determined whether the direct relationship between residence in an area with high residential segregation and adverse perinatal outcomes were moderated by ethnicity and median income, respectively.

The variables of interest in this study were captured by concepts that represent the multilevel nature of factors that influence health. Structural factors operate at the macro level (in this study, dimensions of residential segregation) and are indicative of broader social, political or economic conditions (e.g. discrimination, racism). Contextual or mezzo level factors (e.g. poverty level, proportion of female-headed households) represent characteristics of the social and physical environment that are a product of structural effects. Individual factors represent genetic, behavioral, demographic and economic characteristics at the micro level (Table 1.0).

Table 1

Multilevel Influences on Health Outcomes

LEVEL OF INFLUENCE	CONCEPTUAL TERM	OPERATIONAL DEFINITION	STUDY VARIABLE
Macro	Structural	Indicators of broad social, economic or political conditions	Residential Segregation
Mezzo	Contextual	Features of the immediate residential environments	Social, Physical and Economic Environments
Micro	Individual	Individual behaviors, risk factors of health outcomes	Maternal Characteristics and Perinatal Outcomes

The majority of etiologic research on infant mortality and morbidity has focused on individual factors. The identification of individual determinants of perinatal outcomes, including maternal age, parity, weight gain, smoking and prenatal care, have been the foundation upon which numerous national and community-based initiatives have been developed (Goldenberg, et al., 1996; Schiono, Rauh, Park, Lederman, & Zuskar, 1997). Ethnic disparities in perinatal outcomes continue to exist, despite these efforts (Ananth, Balsubramanian, Demissie & Kinzler, 2004; Guyer, Martin, MacDorman, Anderson & Strobino, 1997; Martin, et al., 2003).

Challenges Associated With Use of the Term Race

The term ethnicity is used instead of race in this study due to numerous problems with the concept of racial differences. While genetically determined diseases that are more prevalent among certain ethnic groups (e.g., Crohn's disease among Whites; Sickle Cell among Blacks) do exist, studies indicate that individuals are not identical within a group, and the perceived physical traits used for such purposes may not be biological in origin (Cooper, Kaufman & Ward, 2003; Hessol, Fuentes-Afflick, & Bacchetti, 1998; Jones, 2001; Rowley, 1994).

Limitations associated with the term *race* are further complicated by changing definitions and terms. The U.S. Census Bureau's use of 26 different terms since 1990 to identify populations may contribute to limited understanding and/or delineation of terms (Hayes-Bautista & Chapa, 1987). Changes in terminology over time have depended upon an unreliable mixture of factors, including national origin, language, surname, minority status and physical characteristics. Terms have been ambiguously used with no clarity or consistency by investigators in research studies or by the lay public when completing surveys (Gerber & de la Puenta, 1996; Kissim, Herrara, & Nakamoto, 1993; Rodriguez & Cordero-Guzman, 1992).

One problem with use of the term *race* rather than *ethnicity* is related to the limited biological connotations with which it is associated, despite its social meanings. *Race* is associated with the power to determine a group's identity through a unidimensional label and the way such labeling translates to a group's experience with others. Health is not affected by ethnic or racial identity, but by the respective consequences of these identities on social, economic and political positions (American Anthropological Association, 1997).

Most public health investigators agree that consideration of social and environmental factors are crucial to investigating the determinants of health outcomes in general, and ethnic health disparities in particular. Efforts to eliminate ethnic health disparities can begin with avoidance of the term race and use of more appropriate labels for social and cultural population subgroups, In contrast to *race,* traditionally understood to represent perceived biological traits, *ethnicity* refers to social groups characterized by distinctive cultural traditions that are maintained across generations, and a common history or origin (Last, 1995). For this reason, *ethnicity* is used instead of *race* in this dissertation.

The current state of the perinatal literature sets the foundation for further expansion of the field's understanding of ethnic health disparities. Contextual factors associated with preterm delivery and LBW have been identified with evidence that risk factors vary across space and ethnic groups (Buka, Brennan, Rick-Edwards, Raudenbush, & Earls, 2002; Diez-Roux, et al., 1997; Gorman, 1999; O'Campo, Xue & Wang, 1997;

Pearl, Braveman & Abrams, 2001; Rauh, Andrews & Garfinkel, 2001; Roberts, 1997; Sloggett & Joshi, 1994). Far less is known about factors placing groups at risk for SGA births. Further, macro level structures associated with increased likelihood of perinatal morbidity and mortality, rather than the outcome of infant mortality, have not been previously explored in the perinatal literature.

Study Rationale

Lower socioeconomic status (SES) (e.g., median income) and ethnicity have been associated with a variety of health outcomes. SES has been established in the literature as one of the primary determinants of health outcomes (Lynch & Kaplan, 2000). Disparities in life expectancy and health status are widest between Blacks and Whites, with disproportionate mortality related to cardiovascular and cerebrovascular diseases, cancer, homicide, infant death, diabetes, and AIDS among Blacks. Disparities in perinatal outcomes mirror these trends.

Most health disparities persist at all levels of SES despite the disproportionate numbers of minorities represented in lower SES groups in the U.S. Researchers challenging the notion that health differences are solely explained by poverty have found that disparities exist at every level of the social hierarchy, reflecting a social gradient, rather than a threshold, effect (Macintyre, 1994; Marmot, Bobak & Davey Smith, 1995; Wilkinson, 1992). If Black-White differences in health are not simply attributable to group differences in SES, research is needed to understand the factors that influence the relationship between ethnicity and health.

The identification of predisease pathways are an emerging public health priority with research emphasis placed on the linkages between behavioral, psychological and social influences that precede disease/health specific morbidity and mortality (Singer & Ryff, 2001). Among predisease influences are prenatal and early risk factors. The Ecosocial framework provided a macro-level understanding of the processes that generate ethnic health disparities (Krieger, 1994, 1999, 2001). This conceptualization was selected for this study due to its emphasis on social, political and economic processes that account for population patterns of health, disease, and well-being.

Structural Explanations for Ethnic Health Disparities

Residential segregation is the physical separation of ethnic groups in residential contexts or the differentiation of two or more groups among dimensions of a given social space (Acevedo-Garcia & Lochner, 2003). Residential segregation has been primarily conceptualized and studied in the context of the separation of ethnic groups. Residential segregation in this study is specified to reflect the physical separation between Blacks and Whites. Segregation historically reflected individual and group-level discriminatory practices based on racism, and was driven by majority perceptions of minority group inferiority and practices focused on maintaining social distance between defined groups (Pettigrew & Meertens, 1995). Discriminatory policies led by the real estate industry, federal housing authorities and banking institutions sought to ensure the restriction of Blacks from housing choices, which relegated them to substandard residential areas (Williams & Collins, 2001).

Residential segregation has received increased attention as scholars have sought to better understand ethnic health disparities. Residential segregation effects have been examined among primarily Black minority groups. These studies show that greater residential segregation is associated with increased stress and poorer health (Collins & Williams, 1999; Frazier, 1957; Jiobu, 1972; Krivo, 1999; LaVeist, 1989; Poldenak, 1993; 1996; Shihadeh & Flynn, 1996; Wilson, 1980, 1987; Yankauer, 1950). Studies that have explored the effects of residential segregation on non-Black ethnic groups have yielded inconsistent findings (Collins & Williams, 1999; Fang, Madhaven, Bosworth, & Alderman, 1998).

Contextual Factors Associated with Perinatal Outcomes

A relatively small number of studies have examined the association between local area contexts and perinatal outcomes. Studies have focused on the city (Buka et al., 2002; O'Campo, Xue & Wang, 1997; Pearl, Braveman & Abrams, 2001; Rauh et al., 2001; Roberts, 1997) national (Gorman, 1999) and international levels (Sloggett & Joshi, 1994). Evidence from these studies has not been conclusive. Some studies have employed measures of residential composition taken from the U.S. Census Bureau, such as ethnic composition, age and immigrant composition (Gorman, 1999; Roberts, 1997). None have advanced a coherent theoretical framework that considers the macro level structures that shape residential contexts and may be associated with adverse perinatal outcomes. Much of the evidence linking residential disadvantage to adverse perinatal outcomes has been based on conventional regression analysis methods that are not appropriate for data at multiple levels (i.e., individuals nested in residential areas).

Gaps in the Scientific Knowledge

The majority of the compelling evidence supporting the contribution of residential segregation to population health has been limited by cross-sectional and ecological study designs analyzed at individual *or* aggregate levels. Further, contextual factors that may be statistically controlled in the relationship between structural factors and health outcomes often have been excluded in single level studies. Evidence indicates that the relationships between residential contexts/structures and health outcomes are not homogeneous and require more specificity in investigation.

Previously studied health outcomes broadly include self-rated health, life expectancy, all-cause mortality, and infant mortality. Identification of the ways that residential segregation may be associated with different health outcomes requires targeted examination and analysis (Lynch & Davey Smith, 2003). Virtually unexplored is how the effects of residential segregation may vary by dimension and perinatal outcome investigated. Examination of the moderating effects of ethnicity and median income on the relationship between residential segregation and cause-specific health outcomes will contribute to better understanding of whom and under what conditions macro level factors may be protective or adverse.

Research Questions and Hypotheses

The purpose of this study was to investigate the relationship between residential segregation and adverse perinatal outcomes (LBW, preterm delivery and SGA births) in Florida, Georgia, and Louisiana. Specifically this study will determine the independent effect of the level of residential segregation on the likelihood of adverse perinatal outcomes after controlling for contextual and individual factors. The study also determined whether the relationship between level of residential segregation and the likelihood of adverse perinatal outcomes was moderated by ethnicity and median income, respectively.

The following research questions and hypotheses were investigated:

Research Question 1: Is there a relationship between residential segregation and adverse perinatal outcomes among mothers in Florida, Georgia and Louisiana?

Hypothesis 1: The level of residential segregation is positively associated with the likelihood of adverse birth outcomes after controlling for contextual and individual factors.

Hypothesis 1A: The level of residential segregation is positively associated with the likelihood of preterm delivery after controlling for contextual and individual factors.

Hypothesis 1B: The level of residential segregation is positively associated with the likelihood of low birth weight after controlling for contextual and individual factors.

Hypothesis 1C: The level of residential segregation is positively associated with the likelihood of small for gestational age births after controlling for contextual and individual factors.

Research Question 2: Is the relationship between residential segregation and perinatal outcomes moderated by ethnicity?

Hypothesis 2: The relationship between residential segregation and the increased likelihood of adverse perinatal outcomes is moderated by ethnicity.

Hypothesis 2A: The relationship between residential segregation and the increased likelihood of preterm delivery is moderated by ethnicity.

Hypothesis 2B: The relationship between residential segregation and the increased likelihood of low birth weight is moderated by ethnicity.

Hypothesis 2C: The relationship between residential segregation and the increased likelihood of small for gestational birth is moderated by ethnicity.

Research Question 3: Is the relationship between residential segregation and perinatal outcomes moderated by median income?

Hypothesis 3: The relationship between residential segregation and the increased likelihood of adverse perinatal outcomes is moderated by median income.

Hypothesis 3A: The relationship between residential segregation and the increased likelihood of preterm delivery is moderated by median income.

Hypothesis 3B: The relationship between residential segregation and the increased likelihood of low birth weight is moderated by median income.

Hypothesis 3C: The relationship between residential segregation and the increased likelihood of small for gestational age birth is moderated by median income.

Overview of Study Design

The research employed an observational, cross-sectional study design that utilized secondary data. The study was observational in that groups are formed by sample population status for each respective adverse perinatal outcome rather than randomization into treatment and control groups. The study was cross-sectional due to the proposed association between prevalence of adverse perinatal outcomes and prevalence of exposure to residential segregation and groups are not identified on the basis of exposure or outcome. The use of preexisting birth certificate and U.S. Census Bureau data explains the secondary nature of the study.

A multilevel analysis plan was used because the majority of the compelling evidence supporting the contributions of residential segregation to population health trends has been limited by data analyzed at aggregate levels. One of the criticisms of these studies is that they fall prey to the ecological fallacy, which involves making individual inferences based on population or group-level measures (Judge, 1999). The atomistic fallacy is a limitation of research studies which may make inferences regarding variability across units defined at a higher level of analyses based on data collected at a lower level of analysis or solely examine individual characteristics to the exclusion of factors associated the context or structures within which individual risk is generated (Alker, 1969; Curtis & Jones, 1998; Diez-Roux, 1998; Diez-Roux, 2003; Scheuch, 1969). Through utilizing multilevel modeling, individual risk may be simultaneously distinguished from population, contextual risk, minimizing concerns related to the atomistic and ecological fallacies. Finally, multilevel analyses can potentially contribute greatly to public health practice through the identification of risk profiles that account for both individual risk and contextual factors.

Data Sources

Birth certificate records were used to collect information on individual covariates and adverse perinatal outcomes. Selection of southern states was initially based on regional findings which show higher rates of LBW, neonatal and infant mortality in the South (National Center for Health Statistics, 2004). Florida, Georgia and Louisiana were the states analyzed in this study due to their inclusion residential census tract information on live birth certificates. The census tract was the selected unit of analysis because it is a small, relatively permanent statistical subdivision. Designed to be relatively homogeneous with respect to population characteristics, economic status and living conditions, census tracts capture within city variation and the immediacy of social context that is lost in cross-metro analyses (Guest, Almgren, & Hussey, 1998). Census tract information on birth certificates was used to match residential segregation indices and contextual covariates calculated by the 2000 U. S. Census Bureau.

Residential segregation indices and contextual covariates were derived from the U.S. Census Bureau data. The Household and Economics Statistics Division (HESD) of the U.S. Census Bureau provided data on residential segregation indices (Census Bureau of the United States, 2000). The HESD calculated residential segregation through examination of the distribution of populations across census tracts within Metropolitan Areas (MAs) and Primary Metropolitan Statistical Areas (PMSAs) (Census Bureau of the United States, 2000).

The 2000 Neighborhood Change Database (1970-2000) (NCD) (GeoLytics, 2004) provided data on contextual characteristics of residential areas. The NCD included Long Form U.S. Census data from 1970, 1980, 1990 and 2000 at the census tract level. A unique feature of the dataset is that geographical identifiers allow census tracts to be summarized into larger geographical levels including counties and MSAs similar to processes used to calculated residential segregation through the HESD (2004).

Implications for Public Health

This research has several potential implications for perinatal research. First, no identified studies have examined the relative contributions of various dimensions of residential segregation on traditionally studied (LBW and preterm delivery) and more newly investigated perinatal outcomes (SGA). The proportion of variance in each outcome that is explained by each residential segregation dimension is important to better understand the relative roles of structural dimensions of residential segregation factors on perinatal outcomes.

Second, with regard to ethnicity and median income, the majority of studies that have investigated determinants of health, beyond the micro level, have focused on the contextual level rather than investigations of the determinants of residential contexts. Research on the effects of residential areas on child and adolescent development outcomes generally find less powerful residential effects among Blacks when compared to Whites (Brooks-Gunn, et al., 1997). There is some evidence that living in residential areas of high SES enhances educational attainment of Black males if neighbors are also Black (Duncan et al., 1997). Williams & Collins (1995) found that although individual SES greatly mediates the association between ethnicity and health, some ethnic effects on health remain. Others studies found that ethnic differences in health and mortality that persisted after controlling for individual SES, were eliminated upon examination of community socioeconomic factors (Haan, Kaplan, & Camacho, 1997; LeClere, Rogers, & Peters, 1997; Roberts, 1998). While these studies shed light on the role of residential contexts in explaining relative ethnic disadvantage (Jargowsky, 1997; Massey & Denton, 1993; Wilson, 1987) the degree to which ethnicity moderates the effect of residential segregation on perinatal outcomes has been unexplored.

Results have implications for public health advocacy and practice. If residential segregation contributes something unique to the perinatal health of individuals in identified geographical areas, residential *and* individual-focused interventions are critical. The multilevel analysis strategies employed in this study will help to identify multilevel risk profiles to initiate research investigation of how structural factors (e.g. dimensions of residential segregation) contribute to perinatal health outcomes.

This study was developed with careful consideration of delimitations and limitations. Delimitations included are those criterion that are used to determine the geographical level, unit of analysis and characteristics of the population that was studied. Limitations noted are factors that affect the generalizability of findings and include issues related to use of preexisting data. Operational terms used in the study follow listed limitations.

Delimitations

1. The study is limited to investigation of births to women of White and Black, non-Hispanic ethnicity.
2. The study included women delivering in the southern states of Florida, Georgia and Louisiana.
3. The study was limited to states that include census tract of residence in live birth data certificate records.
4. The study included census tracts that are represented in the 2000 U.S. Census Bureau.

Limitations

1. The presence of an association between residential segregation dimensions and adverse perinatal outcomes were examined in the study; causality could not be determined.
2. The study examined data available through live birth certificates and the U.S. Census Bureau; no psychosocial, attitudinal or stress measures were assessed.
3. The study was limited to live births Florida, Georgia, and Louisianna; results cannot be generalized to populations beyond those examined.
4. U.S. Census Bureau data provided sample estimates and were subject to both sampling and non-sampling errors.
5. Live birth certificate data may have been subject to non-sampling error occurring during initial data entry (at the hospital level) and in processing birth certificates at each health department.
6. Live birth data did not contain SES information for individual women (e.g., income level, employment and occupational status of mother).
7. The use of 2000 U.S. Census Bureau data may not have reflected characteristics of women delivering infants in 1999 and 2001.
8. The residential segregation window of exposure associated with increased risk for perinatal outcomes and risk factors prior to time of pregnancy was unknown.
9. Misclassification of low birth weight and gestational age that may have influenced the analysis and reporting of birth outcome trends.

Definitions

Adverse Perinatal Outcomes- pregnancy outcomes that are associated with increased infant mortality and morbidity; preterm delivery; low birth weight; small for gestational age births

Ecosocial- frame of reference (Krieger, 1994, 1999, 2001) which emphasizes social, political and economic processes that account for population patterns of health, disease, and well-being

Low Birth Weight- birth weight <2500 grams

Macro Level- structural factors that shape contextual risk factors and are indicators of broader social, economic or political conditions

Mezzo Level- contextual factors characteristics of the social and physical environment that are a by-product of structural effects; factors operating at the more immediate residential level that affect individual risks and health outcomes

Micro Level-genetic, behavioral, health-related, sociodemographic and socioeconomic factors attributable to individuals

Neighborhood-census tract; small, relatively permanent statistical subdivision; geographical unit that is relatively homogeneous with respect to population characteristics, economic status and living conditions (Guest et al., 1998)

Preterm Delivery- delivery <37 completed weeks of gestation

Residential Segregation- the physical separation of ethnic groups in residential contexts; the differentiation of two or more groups among dimensions of a given social space

Small for Gestational Age Birth- less than the 10^{th} percentile of birthweight for gestational age and sex

CHAPTER TWO: LITERATURE REVIEW

Theoretical Framework

The Ecosocial framework structured explanations for relationships hypothesized in this study. This framework provided a macro-level understanding of the processes that generate ethnic health disparities. This theoretical framework (Krieger, 1994, 1999, 2001) is selected due to its emphasis on social, political and economic processes that account for population patterns of health, disease and well-being. The linkages between primary constructs of this large-scale perspective and the proposed research indicate its relevance to more specific lines of public health inquiry.

Embodiment, a central construct of the Ecosocial perspective, is conceptualized as the biological manifestation of social experiences (Krieger, 1999). This concept is relevant to research investigations of how populations' social and environmental contexts are biologically interpreted and processed. Variations in population health morbidity and mortality are the consequences of embodiment. Pathways of embodiment include the 1) social arrangement of power/property and contingent patterns of production, 2) consumption and reproduction and 3) the barriers and potential human biology enabled by human history, ecological context and individual history of biology and development. This investigation was aligned with the construct of embodiment in that it centered on how residential segregation, with historical and current implications, influenced perinatal outcomes.

The theory stresses the importance of the interplay of exposures at multiple levels (e.g. individual, neighborhood, regional). The multilevel nature of exposures were examined in this study through analysis of three levels. Live birth statistics (individual), census tract contexts (neighborhood) and census-based data used to measure residential segregation (structural) were studied through construction of hierarchical generalized linear models to understand contributions of each to adverse perinatal outcomes.

The Ecosocial perspective provides a framework that supports the relationship between residential segregation and health. This study did not measure all of the factors related to residential segregation that may include perceptions of institutionalized or personally experienced racism and personal preferences regarding integrated residence. The framework does, however, set the stage for increased understanding of the issues that must be considered when examining factors associated with ethnic health disparities.

Conceptual Framework

Residential segregation was conceptualized as a macro level structure that is an important determinant of adverse perinatal outcomes at the micro level guiding this research (Appendix A). Residential segregation is a socially, economically and politically motivated structure when viewed through the Ecosocial frame of reference. The spatial separation of groups (macro level) fostered by historical discriminatory practices relegate, primarily, Black minorities to economic and social contexts that are less health promoting than their majority counterparts. Environmental contexts influence micro level risk factors. The relationship between residential segregation and the likelihood of adverse perinatal outcomes is differentially experienced by ethnic group and median income.

The examination of distinct etiological processes leading to adverse perinatal outcomes is critical to the development of appropriate prevention and intervention strategies. Trends and disparities in perinatal outcomes warrant further examination to determine the differential influences of macro and micro level factors that increase the likelihood of adverse perinatal outcomes in residential areas.

Significance of Perinatal Outcomes

The health status of mothers and infants are critical indicators of the nation's health. Public health professionals view infant mortality as "a measure of community health, economic efficiency, collective moral well being, and future military strength" (Brosco, 1999). Healthy People 2010 objectives to reduce low birth weight to 5.0 % and preterm deliveries to 7.6% are critical because they represent perinatal health indicators that are the leading causes of neonatal death and compromised quality of life to infants and families (United States Department of Health and Human Services, 2000). National infant mortality rates declined 11% between 1995 (7.6 infant deaths per 1,000 live births) and 2001 (6.8 infants deaths per 1,000 live births) (Centers for Disease Control and Prevention, 2005). A decline of 36% would be necessary to achieve the Healthy People 2010 target despite declines for all ethnic groups. Regional findings confirm that LBW rates, neonatal mortality rates and infant mortality rates are highest in the South (National Center for Health Statistics, 2004).

Infants born too soon (preterm) or too small (LBW) are at increased morbidity and mortality risk. Preterm infants account for the relatively high perinatal mortality rate in the U.S. (Lumley, 2003). Preterm infants are 70 times more likely to die than infants born at term (37 to 41 weeks) (Matthews, Menacker & MacDorman, 2002). Preterm delivery has been associated with neurodevelopmental handicaps, chronic respiratory problems and infection (Berkowitz & Paperinik, 1993; United States Department of Health and Human Services, 2000). Individual risks factors for adverse perinatal outcomes include prior delivery of a LBW infant, a female infant, a multiple pregnancy, cigarette smoking, short maternal height, low maternal weight and preeclamptic hypertension (Collins & David, 1997; Control, 2000; Goldenberg et al., 1996). LBW infants are 40 times more likely to die during their first month of life (Health Beat, 1998). LBW has been associated with long-term disabilities such as cerebral palsy, autism, mental retardation, vision and hearing impairments and other developmental disabilities (United States Department of Health and Human Services, 2000).

National Trends in Adverse Perinatal Outcomes

The proportion of infants born with increased morbidity and mortality risk due to traditionally investigated adverse perinatal outcomes of LBW and preterm delivery have increased over the past three decades. LBW rates increased from 7.7% in 2001 to 7.8% in 2002; a 15% increase from rates in the middle of the 1980s (6.8%) (Martin et al., 2003; National Center for Health Statistics, 2002). The preterm birth rate increase from 11.9% in 2001 to 12.1% of all births in 2002. The proportion of preterm births in 2002 has increased 29% since 1981 (9.4 %) and 14% since 1990 (10.6%) (2003). Trends in SGA have been more recently tracked, by ethnicity, and are included in the discussion of disparities in perinatal outcomes.

Significance of Small for Gestational Age Births

The identification and tracking of SGA births by perinatal researchers have been more recent than LBW and preterm delivery, but it is a birth outcome with noteworthy infant mortality and morbidity implications. SGA infants are at increased risk of infant mortality and are more likely to sustain short and long-term disabilities than appropriate for gestational age infants. SGA infants experience a 6-fold risk for neonatal mortality and a nearly 3-fold risk for neonatal morbidity (birth asphyxia, meconium aspiration syndrome, hypoglycemia, and polycythemia) when compared to infants born appropriate for gestational age (Doctor, et al., 2001).The World Health Organization defines SGA as birth weight below the 10^{th} percentile for gestational age and sex (Lee, Chernausek, Hokken-Koelega & Czernichow, 2003). Although term (≥37 weeks) SGA rates have decreased among both Whites and Blacks, preterm (<37 weeks) SGA rates have increased for both groups (Ananth, Demissie, Kramer et al., 2003).

The association between SGA and Intrauterine Growth Retardation (IUGR) is important for identification of infants at increased health risk. IUGR characterizes fetuses that do not achieve their genetically determined potential size due to an unfavorable intrauterine environment (Regev et al., 2003). SGA infants who are pathologically small and at risk for modifiable, poorer outcomes may be the result of IUGR.

The significance of SGA partially lies in the fact that LBW, the strongest predictor of infant survival is constructed of two components: preterm delivery and reduced fetal growth. Preterm and term SGA infants may be overlooked if the LBW measure is employed in isolation. The crude LBW measure examined in the majority of perinatal research does not differentiate between infants born due to short gestation (preterm delivery), SGA or sub-variations of these measures. Further, the measure does not allow for assessment of growth potential and growth achieved. The etiological significance of SGA further strengthens the importance of its inclusion in examinations of risk factors associated with adverse perinatal outcomes to potentially decrease infant morbidity and mortality rates.

Disparities in Perinatal Outcomes

The largest disparities in perinatal outcomes are by ethnicity of mother. Preterm delivery rates were higher among Black women (17.7%) when compared to White women (11%) in 2002, despite a 6% decrease among Black women and an increase of 29% among White women since 1990 (Martin et al., 2003). The rate of term SGA (16%) among Blacks was 1.5 to 2.0 times higher than Whites (9%) in 2000 (Ananth, Balsubramanian, Demissie & Kinzler, 2004), in spite of decreases among both ethnic groups since 1990. While LBW rates have increased for White women (from 5.6%) and rates among Black women have remained relatively unchanged (from 13.6%) since 1990, the LBW rate for Black and White infants in 2002 were 13.4% and 6.9%, respectively (2003).

Explanations for disparities in perinatal outcomes are largely unknown with most research focus placed on factors during pregnancy. Far less is known about how experiences and contexts of women prior to pregnancy may impact perinatal outcomes. Lu and Halfon (2003) present a life course perspective to better understand ethnic disparities in perinatal outcomes. The model emphasizes early programming and cumulative pathway perspectives to model how health trajectories are formed and cumulative life stressors shape risk. This longitudinal conceptualization views reproductive health as a product of development, exposure and coping, with sensitive periods that heighten susceptibility to risk and protective factors. Sensitive periods occur in utero, puberty, and pregnancy and predict initial risk trajectory formation. Trajectories are later altered by cumulative allostatic load through the life course (2003).

Early fetal programming hypotheses examine causal associations between fetal development and later onset of disease. Undernutrition in utero has been associated with increased risk of insulin resistance, hypertension and cardiovascular heart disease in adulthood. Barker's Hypothesis is one of the most frequently cited perspectives surrounding the association between LBW and adult onset of disease. The hypothesis predicts that the highest risk of heart disease and Type 2 diabetes (the insulin resistance syndrome or impaired glucose tolerance) are experienced by infants who experience compromised fetal growth. Increased cortisol levels during intrauterine life are thought to cause the endothelial damage related to cardiovascular disease, as well as insulin resistance, which is related to other parameters of the metabolic syndrome (Clark, 1998; Edwards, Coulter, Symonds, & McMillen, 2001; Phillips, 2001).

The cumulative pathway perspective is associated with how biological consequences of stress can accumulate over time to affect health and function (McEwen,1995). Higher corticotrophin-releasing hormone levels were found in women who have preterm babies compared to women who delivery full term (Wadhwa, Porto, Garite, Chicz-DeMet, & Sandman, 1998; Warren, Patrick, & Goland, 1992). Stress may also increase proinflammatory cytokine production which leads to increased prostaglandin production, increased uterine contractility and preterm labor (Chouros, 1995; Turnball & Rivier, 1999). Because of higher stress levels among Black and Hispanic women in studies of ethnically and socioeconomically diverse samples, some propose that perceived ethnic and gender discrimination and their associated stressors contribute to greater cumulative stress and increased risk of adverse perinatal outcomes (Krieger, Rowley, Herman, Avery, & Phillips, 1993; McLean, Hatfield - Timajchy, Wingo, & Floyd, 1993; Rich-Edwards et al., 2001; Stancil, Hertz-Picciotto, Schramm, & Watt-Morse, 2000).

The life course explanation of reproductive disparities among Black and White women is related to initial trajectories that are lower for Black women due to intergenerational effects related to smaller acceleration and greater deceleration during sensitive periods and greater cumulative exposure to stress and risk factors later in life (Lu & Halfon, 2003). The strength of intergenerational effects is illustrated by a study which found that women who are raised in low socioeconomic conditions and marry into higher socioeconomic positions have higher rates of adverse birth outcomes when compared to women born into high SES (Illsley, 1995). Higher risk of LBW and preterm delivery among high SES Black women after two generations of affluence indicate that high SES may not provide the same level of protection for Blacks (Foster, Bracken, Semenya, Thomas, & Thomas, 2000). These findings indicate that SES and associated living conditions, during both early life and pregnancy, influence perinatal outcomes. This may be particularly relevant for Black women, whose higher SES position is more likely to have been attained within the past generation (Jones, 1998).

While the life course perspective will not be directly tested in this study, it supports heightened understanding of proposed explanations for varying trends in perinatal outcomes among Blacks and Whites. Its emphasis on the social, economic, and biological implications of ethnicity are the foundation upon which the proposed investigation is built. While the window of exposure for the influence of residential segregation on perinatal outcomes is not known, the lifecourse perspective underscores the importance of subsequent longitudinal investigation into how experiences, coupled with contextual and structural factors influence perinatal outcomes.

Individual Factors and Perinatal Outcomes

The majority of etiologic research on infant mortality and morbidity has focused on individual factors. The identification of individual determinants of perinatal outcomes, including maternal age, parity, weight gain, smoking and prenatal care, have been the foundation upon which numerous national and community-based initiatives have been developed (Goldenberg et al., 1996; Schiono, Rauh et al., 1997). Ethnic disparities in perinatal outcomes continue to exist, despite these efforts (Ananth, Balsubramanian, Demissie, & Kinzler, 2004; Guyer, Martin, MacDorman, Anderson, & Strobino, 1997; Martin, Hamilton, Sutton, Ventura, Menacker, & Munson, 2003). While these studies have focused primarily on LBW and preterm delivery, they provide a foundation and rationale upon which the study is built.

Birth Certificate Data Validity

The validity of birth certificate data has been examined due to its importance to researchers and decision-makers in assessment of the status of care delivered to pregnant women, individual risk factors and the birth outcomes of infants. Errors have been noted in coding of birth weight (Brunskill, 1990) and in underestimation of birth defects (Watkins et al., 1996); vaginal births after cesarean section and primary cesarean section rates (Green et al., 1998) and hyaline membrane disease (Hamvas, Kwong, DeBaun, Schramm & Cole, 1998). Findings reveal that variability exists in the specificity, sensitivity and predictive value of birth certificate elements. The agreement between medical records and birth certificates vary widely by the data element in question. The greatest variance between birth certificates and medical records exist in the estimation of maternal medical risk factors, complications of labor and delivery, number of interventions or procedures, congenital anomalies, and measures of prenatal care. Studies examining the relative validity of birth certificate data elements are acknowledged at the onset of this study.

Several noteworthy studies have examined the validity of birth certificate data. An early study of 379 North Carolina birth certificates and maternal medical records revealed: very accurate reporting for birthweight, Apgar scores and method of delivery; fair to good reporting for tobacco use, prenatal care, weight gain during pregnancy, obstetrical procedure and events of labor and delivery; and poor reporting for medical history and alcohol use (Buescher, Taylor, Davis, & Bowling, 1993). Piper et al. (1993) found low sensitivity for maternal medical risk factors, complications of labor and delivery, and abnormal conditions of the newborn in a study that examined the validity of 1998 Tennessee birth certificates. Clark, Chun-Mei, & Burnett (1997) study revealed that birth certificates overestimated prenatal care. Data abstraction from prenatal and intrapartum clinic and hospital records were used to assess birth certificate validity in a study conducted by Dobie et al. (1998). Results showed significant underestimation of complications of pregnancy, number of interventions and procedures, and prenatal visits. Reichman and Hade's (2001) assessment of the validity of birth certificate data between 1989 and 1992 from a sample of high risk New Jersey women revealed that sensitivity was low for maternal medical risk factors, complications of labor and delivery, obstetrical procedures and transfer status. DiGuiseppe, Aron, Ranbom, Harper, & Rosenthal's (2002) examination of the reliability of birth certificate data for women admitted to teaching and non-teaching hospitals in Northeast Ohio between 1993 and 1995 revealed: perfect agreement for measures of prior obstetrical history, delivery type, and infant Apgar scores; substantial agreement for tobacco use, gestational age and prenatal care and; slight to moderate agreement for most maternal risk factors and co morbidities, and many complications of pregnancy and/or labor and delivery.

A recent study by Roohan et al. (2003) assessed the sensitivity, specificity and positive predictive value for birth certificates in four New York State counties. Findings showed that all maternal medical risk factors and risk factors related to pregnancy and lifestyle risk factors had high levels of specificity, but varying levels of sensitivity, primarily attributable to rare conditions that are often not documented on the birth certificate. Similar to results of Piper et al. (1993), Clark et al. (1997) and Debbie et al. (1998), the numbers of prenatal care visits were poorly reported with fewer visits reported on the medical record. Limitations of studies include questionable generalizability due to small geographical region of analysis and hospital variations that may have skewed results.

Explanations for lower sensitivity among certain birth certificate elements are vast and include issues surrounding site variations in data management and self-report bias. Risk factors related to substance abuse, smoking and drinking during pregnancy are also likely to be underreported on both medical records and birth certificate due to self-report. Although medical records are considered in most validation studies as the referent, gold standard, hospital staff have access to a broader number of information sources when completing the birth certificate, including the mother and father. Estimates of prenatal care are speculated to be less accurate on medical records because records are often last updated during the 36th week of pregnancy, when a potential of 4 additional visits may occur by 40 weeks, or full term. Cross-site variations in protocol for collecting data, non-clinical personnel recording data, little or no auditing to ensure data validity and reliability in hospitals are also among explanations for lower sensitivity of specific birth certificate elements. Limited funding warrants targeted standardization efforts for data elements that are found to be less reliable.

Despite noted limitations, birth certificate data is a potentially rich source of information, with wide application for both research and practice and will provide the best means, to date, for examination of the proposed research questions. Birth certificates are among the most recognized and commonly used data sources for research and program planning. More states are implementing error-checking initiatives to improve quality or vital data (Alexander & Petersen, 1997). Birth certificate data cover multiple years and contain large amounts of standardized information about U.S. women and potential risk factors for adverse perinatal outcomes.

Gestational Age Estimation Specificity

Accurate estimation of gestational age has important implications for research and program planning. Resources are allocated and programs are developed and evaluated based on data obtained from vital records. They are used to understand regional trends, to calculate the proportion of preterm delivery, term and post term births in the population and to determine individual newborn's risk status. They are also used in the computation of measures of intrauterine growth and adequacy of prenatal care. Certificates of live births are among the most frequently utilized sources of gestational age data. Prenatal errors in the estimation of gestational age impact clinical decisions regarding delivery timing. Classification of infants as term or preterm, based on live birth certificates may subsequently result in misclassification errors that influence the analysis and reporting of birth outcome trends.

Prior to the 1980s gestational age (GA) was calculated from the date of the last menstrual period (LMP). Subsequently, clinical estimation (CE), particularly early ultrasound examination (EUS), the measurement of the fetal biparietal diameter between 16-18 weeks of gestation, has resulted in differences in methods of gestational age estimation (Blondel et al., 2002). It is widely recognized that EUS-based gestational age estimates result in lower average estimate of GA and a higher prevalence of preterm delivery when compared to LMP gestational age estimations (Alexander, Tompkins, Petersen, Hulsey ,& Mor, 1995; Goldenberg et al., 1989; Hogberg & Larsson, 1997; Kramer, McLean, Boyd, & Usher, 1988; Yang et al., 2002). Due to discrepancies in

LMP and EUS estimates both among and within countries, geographic and temporal trends in preterm and post term birth will remain difficult to interpret. (Blondel et al., 2002).

Limitations of the LMP gestational measure have been reported in the scientific literature (Hall, Carr-Hill, Fraser, Campbell, & Samphier, 1985; Milner, & Richards, 1980; Taffel, Johnson, & Heusser, 1982;). LMP-based measures produce values inconsistent with birth weight (Alexander, Tompkins, & Cornely, 1990; David, 1980). The majority of errors in the estimation of LMP-based gestational age are due to biological errors primarily attributable to inaccurate reporting (identification or recall) of the last menstrual period (LMP), more frequent occurrence of delayed rather than early ovulation, sporadic bleeding during pregnancy and unrecognized abortions (Battaglia, Frazier, & Hellegers, 1966; Joseph et al., 1998; Milner, & Richards, 1974; Treloa, Behn, & Cowan, 1967). These reporting problems have been observed more frequently among women of lower educational and SES. There is also a question regarding the accuracy of this technique, particularly for determining preterm delivery among ethnically diverse populations (Alexander, Kogan, & Nabukera, 1992; Sanders et al., 1991; Spinnato, Sibai, Shaver, & Anderson, 1984). Women who lack information on their LMP are more likely to have adverse pregnancy outcomes (Bueckens, Delvoye, & Robyn, 1984; Wenner & Young, 1974). These studies may be biased in that women who experience adverse birth outcomes are excluded from these studies, underestimating the proportion of adverse perinatal outcomes. When compared to EUS, LMP is more likely to overestimate gestational age with a significant number of errors occurring in either direction. LMP distribution contains a prominent postterm- tail in live birth data, primarily attributable to maternal errors in recognizing or reporting LMP.

The CE measure of gestational age is widely available on state vital record databases. The National Center for Vital Statistics has substituted the CE value for the LMP based gestational age when the LMP date is incomplete or incompatible with birth weight. The extent to which public health planners and researchers follow this strategy is unclear.

The CE measure provides a gestational age distribution that is closer to conventional expectations. Fewer implausible out-of-range values exist and the measure is more highly correlated with BW. Some attributes of the measure are, however, sources of concern. To the extent that the CE measure more closely corresponds to BW and in some or many cases could conceivably have been estimated after delivery based upon knowledge of the BW, the variation in BW for each gestational age decreases. It has been shown that variations in BW by gestational age, for example SGA, are important indicators of morbidity and mortality risk. Any reliance on BW to estimate gestational age could result in overly censored intrauterine growth curves and in the loss of important risk information about the newborn. The CE measure is limited to what is known by the person completing the Certificate of Live Birth. Ultrasound and other obstetric measures, including fundal height and fetal heart tones and pediatric examinations of the physical and neurological characteristics of the newborn are among the types of information used to establish the CE (Alexander, Tompkins, Petersen, Hulsey, & Mor, 1995). It is not clear which methods are given the most emphasis across clinical sites and how availability and use may vary. It may be argued that errors inherent in the LMP-based measure are more random and less influenced by these factors although the LMP-based measure is perceived to be less reliable than the CE measure.

In spite of the evidence on the limitations and strengths of gestational age estimations, the majority of gestational age estimations on birth certificates is based on self-reported LMP, or the difference between the date of delivery and the last menstrual period. Only a small fraction (5%) is based on the CE (Ananth, Balasubramanian, Demissie & Kinzler, 2004; Ananth & Platt, 2004; Taffel, Ventura, & Gay, 1989).

Contextual Factors and Perinatal Outcomes

A relatively small number of studies have focused attention on the association between local area characteristics and birth weight. Socioeconomic characteristics associated with areas of residence (education, income, poverty level and housing value) have been increasingly used to examine social inequalities in health and have been found to be related to mortality and other health outcomes (Diez-Roux et al., 1997). Roberts (1997) found that neighborhood economic hardship and housing costs were positively associated with LBW, while community SES, crowded housing and high percentages of young and African American residents were negatively associated with LBW. Studies have been examined at the city (Buka et al., 2002; O'Campo et al.,, 1997; Pearl, Braveman & Abrams, 2001; Rauh et al., 2001; Roberts, 1997) national (Gorman, 1999) and international levels (Sloggett & Joshi, 1994). None have advanced a coherent theoretical framework that considers the macro level structures that shape residential contexts and effect perinatal outcomes. Much of the evidence linking residential disadvantage to LBW also utilize conventional regression methods that are inappropriate for multilevel data (e.g., individuals nested in residential areas).

Multilevel analyses of determinants of adverse perinatal outcomes reveal distinct risk factors associated with subgroups of preterm delivery and LBW infants. Research findings suggest that LBW and gestational age have differential individual and contextual predictors (English et al., 2003). Others illustrate that individual and population effects on health may vary by ethnicity (Kaufman, Dole, Savitz, & Herring, 2003; Rauh et al., 2001). Most studies have been limited to the investigation of determinants of LBW and preterm delivery.

Significance of Health Disparities

SES and ethnicity have been associated with a variety of health outcomes. Disparities in life expectancy and health status are widest between Blacks and Whites. Blacks have disproportionate mortality from cardiovascular and cerebrovascular diseases, cancer, homicide, infant death, diabetes, and AIDS. These persistent trends help to explain the increased focus of public health research agendas on ethnic disparities in health.

Most public health investigators agree that consideration of social and environmental factors are crucial in investigating the determinants of health outcomes in general, and ethnic health disparities in particular. Genetically determined diseases that are more prevalent among certain ethnic groups (e.g., Crohn's Disease among Whites; Sickle Cell Anemia among Blacks) do exist. These designations, however, are socially constructed and do not capture within-group variability for many health morbidities and mortalities (Cooper et al., 2003; Hessol, 1998; Jones, 2001; Rowley, 1994). Cooper et al. (2003) cited wide variation in susceptibilities to chronic diseases among people of

African-descent in all large continental populations. Palloto, Collins, and David, (2000) found that among American and Caribbean Black women, American women had higher rates of LBW infants.. A comparison of Black women who were American, Haitian, West Indian, Cape Verdean, Hispanic and African revealed that American women were at increased risk for adverse perinatal outcomes (Friedman et al., 1993). Further research indicates that foreign born women have infants with better perinatal outcomes when compared to U.S. born Black mothers (Cabral, Fried, Levenson, Amaro, & Zuckerman, 1990; Fang, Madhavan & Alderman, 1997). These studies indicate the heterogeneity in perinatal outcomes within ethnic groups and the unique contribution of structural and contextual factors to the health of U.S. born Black women.

Most health disparities persist at all levels of SES despite the disproportionate numbers of minorities represented in lower SES groups in the U.S. Researchers challenging the notion that health differences are solely explained by poverty have found that the disparities exist at every level of the social hierarchy, exhibiting a social gradient rather than a threshold effect (Wilkinson, 1992; Macintyre, 1994; Marmot, Bobak, & Davey Smith, 1995). If Black-White differences in health are not simply attributable to group differences in SES, research is needed to understand the factors that influence the relationship between ethnicity and health.

Structural Explanations for Health Disparities

Residential Segregation

Significance

Residential segregation is the physical separation of groups in residential contexts or the differentiation of two or more groups among dimensions of a given social space (Acevedo-Garcia & Lochner, 2003). Residential segregation has received increased attention as scholars have sought to better understand ethnic health disparities. Residential segregation effects have been examined primarily among Black minorities. These studies show that greater segregation leads to increased stress and poorer health. Residential segregation in urban areas has a significant effect on both Black infant and adult mortality rates, after adjusting for other socioeconomic and demographic characteristics (Collins & Williams, 1999; Massey, White & Phua, 1996; Peterson & Krivo, 1999; Poldenak, 1993, 1996; Shihadeh & Flynn, 1996). Research that has explored the effects of residential segregation among Whites have yielded inconsistent findings (Collins & Williams, 1999; Fang, et al., 1998). Residential segregation has historical and current implications for disparate educational attainment, employment opportunities and housing quality that may mediate the relationship between social position and health (Williams & Collins, 2001). Few studies have investigated the association between residential segregation and perinatal outcomes.

Historical Context

Residential segregation reflects decades of individual and group-level discrimination that is based on racism, whose primary goal was to maintain social distance between defined groups (Pettigrew & Meertens, 1995). Historically, segregation was driven by majority perceptions of minority group inferiority with discriminatory policies led by real estate industry, federal housing policy, banking institutions and organizations that sought to ensure the restriction of Blacks from housing choices relegating them to substandard residential areas (Williams & Collins, 2001).

Conceptualization and Operational Dimensions

The broad definition of residential segregation masks the different dimensions by which groups may be segregated. Massey and Denton (1988) conducted a seminal study that has provided the foundation upon which the conceptualization and measurement of residential segregation has been operationalized in subsequent research. Residential segregation is conceptualized across five dimensions: Centralization, Concentration, Clustering, Evenness and Exposure. Centralization is the degree to which members of an ethnic group live near to an urban area. Concentration measures the physical space that is occupied by an ethnic group in a geographical area. Clustering measures the degree to which ethnic minority areas cluster together in space. Evenness represents the degree of spatial separation between ethnic groups. Exposure measures a group's experience of segregation by the degree to which members come into contact with one another or with another designated group. While Evenness and Exposure are correlated, they measure different markers: Exposure, rather than Evenness, is dependent on the relative size of the comparison groups.

Massey and Denton (1988) utilized principal components factor analysis to evaluate 20 residential segregation measures and to categorize them according to the five segregation dimensions. Results indicated that Evenness and Exposure cumulatively explained approximately 72% of the variance in residential segregation. Centralization, Clustering and Concentration segregation dimensions explained only 28% (1988). Evenness and exposure indices are the residential segregation dimensions that were examined in this study.

Index of Dissimilarity.

The Index of Dissimilarity, an evenness dimension of residential segregation, is the degree to which ethnic groups share areas in common. This measure represents the evenness dimension of residential segregation, which is the relative distribution of two groups within a given geographical unit or the degree of spatial separation between groups. The Index is derived from the Lorenz curve, through plotting the cumulative proportion of minority groups against the cumulative proportion of majority groups across areal units (Massey & Denton, 1988). Stated another way, the Index measures the proportion of a given minority group that would have to relocate (move either in or out of a given geographic area) to achieve an even distribution of ethnic groups. Index values ranged from 0-1, with 0 representing no segregation and 1 representing complete segregation (Massey, 1996; Massey & Denton, 1988). Massey and Denton's (1988) analysis of correlation and factor pattern matrices among various evenness indicators showed that little additional information is provided by other measures of evenness compared to that which is included in the Index of Dissimilarity. The Index represents the most comprehensive, frequently examined and easily calculated measure of evenness

(1988).

Current residential segregation researchers believe that the Index of Dissimilarity has less relevance to studies related to health outcomes (Acevedo-Garcia & Lochner, 2003; Acevedo-Garcia, Lochner, Osypuk, & Subramanian 2003) and is less associated with individual and residential indicators when compared to other measures (Denton, 1994). These considerations are used to partially justify the inclusion of two exposure measures: The Isolation Index and the Interaction Index.

Isolation Index.

The Isolation Index , an exposure dimension of residential segregation, measures the degree to which minority group members are exposed to one another (and not the majority group). The index is operationalized as the probability that a randomly drawn minority group member will share an area of residence with another similar minority group member. The index represents the minority-weighted average of each unit's minority proportion with values that ranged from 0 and 1.

This index is utilized in this study due to potential race-specific effects. The Isolation Index is a theoretically relevant dimension of residential segregation that may be an important mechanism through which Black perinatal trends are manifested. Because residential segregation is based on efforts to avoid social contact, the degree of isolation experienced by ethnic minority groups are distinct. Findings have proven more deleterious effects of residential segregation on both individual and areas of residence for Blacks (Acevedo-Garcia & Lochner, 2003; Acevedo-Garcia et al., 2003; Collins & Williams, 1999).

Trends in Residential Segregation

The United States has experienced a steady increase in residential segregation with declines that have only occurred within the last three decades. Residential segregation rose during each decade between 1890 and 1970 (Cutler, Glaeser, & Vigdor, 1999). Segregation began to decline in the 1970s with sharpest average decreases of almost 10% across metropolitan statistical areas (MSAs) (1999).

While national trends indicate that residential segregation has decreased, investigation of trends by ethnicity, MSA size and region are not homogeneous. An examination of residential segregation among Blacks, Hispanics, Asians and Pacific Islanders, American Indians and Alaska Natives from 1990 to 2000 indicated that only Blacks experienced declines across all dimensions described by Massey and Denton (1988). Despite this trend, segregation rates are highest among Blacks (Iceland, Weinberg, & Steinmetz, 2002).

Size of the geographical unit influences levels of residential segregation. The largest MSAs (populations >1,000,000) have higher residential segregation levels when compared to those that are respectively smaller. In turn, mid-sized MSAs (populations of 500,000 to 999,999 persons) are more segregated than smaller MSAs (Glaeser & Vigdor, 2001; Iceland, Weinberg, & Steinmetz 2002).

Regional trends in residential segregation over the past two decades vary. The West is more integrated followed by the South, while the Northeast and Midwest are both highly segregated when measured using the Dissimilarity Index (2002). With regard to change over time, while residential segregation has decreased both nationally and regionally, the South experienced the largest regional reduction, with equal change across the Midwest, Northeast and the West (Glaeser & Vigdor, 2001) between 1990 and 2000.

Investigators attribute declines in residential segregation to a number of factors. First, an increasing number of Blacks reside in MSAs that were previously composed of predominantly White residents; the percentage of census tracts that are <1% Black has decreased from 61.8% in 1960 to 23.1% in 2000 (2001). The argument for the influence of Black movement to White residential areas (rather than White movement into Black residential areas) is supported by a relatively constant number of census tracts with a Black share of at least 80% between 1990 and 2000. Further, MSAs with both rapid declines and large influxes of Black residents have had the most rapidly decreasing levels of residential segregation (7% and 6.4 % average declines, respectively). Interpretation of these findings are that Black flight from areas that are generally more highly segregated result in declines in levels of residential segregation, while new MSAs to which Blacks move are characterized by more integrated settlement patterns (Glaeser & Vigdor, 2001).

Trends in residential segregation indicate that the U.S. has made great strides toward greater integration across the nation. Despite these promising findings, highly segregated areas are characterized by Dissimilarity indices >0.6 and the national Index of Dissimilarity was 0.652 in 2000 (2001). The consequences of this structural force point to the lingering and noteworthy effects that are described in the section that follows.

Consequences of Residential Segregation

Residential segregation has been associated with ethnic disparities in individual well-being (e.g. employment or education) and the contexts of residential areas (e.g. concentrated poverty or poverty exposure) (Galster & Killen, 1995; Galster & Mikelsons, 1995; Logan, 2002; Massey, Condran, & Denton, 1987) across metropolitan areas. Ethnic disparities in the effects of residential segregation at the individual and contextual levels has been hypothesized to account for the poorer health outcomes of Blacks (Acevedo-Garcia & Lochner, 2003; Acevedo-Garcia et al., 2003; Collins & Williams, 1999; Ellen, 2000; Williams, 1997, 2001). Although residential segregation varies across geographical areas and groups, few studies have specifically examined whether health disparities between Blacks and Whites are related to variations in residential segregation.

Employment opportunities.

The negative effects of segregation center on limited opportunities for overall health and well-being. Segregation is associated with more restricted employment, particularly for ethnic minorities (Collins & Williams, 1999; Frazier, 1957; Wilson, 1980, 1987). The determinants of reduced job opportunities include rapid urbanization, industrialization and immigration. The historical migration of Blacks from the South to the Northeast and Midwest was followed by Whites and middle-class Blacks leaving cities to live in the suburbs. A spatial mismatch in urban areas was the result; as urban centers were populated by larger proportions of Black residents, the availability of low-skilled jobs declined and high skilled jobs increased (Kasarda, 1989). This trend has contributed to Black joblessness over time.

Family structure.

Compromised quality of life follows the restricted employment opportunities for minorities, particularly in urban, highly segregated areas. Research linkages between marriage rates, employment opportunities and income for males indicate that high rates of Black male unemployment in segregated urban areas has led to increased rates of female-headed households (Testa, Astone, Krogh, & Neckerman, 1993). The association between employment and marital status for males has long been established (Bishop, 1977).

Housing quality and ownership.

Smaller real estate returns are another consequence of segregation, particularly for Blacks. Despite increases in housing equality in the U.S., fewer Blacks have experienced this primary source of wealth for the American Family. This is due, in part, to the increased number of minorities (particularly Black) in less desirable housing areas (Logan & Alba, 1993; Oliver & Shapiro, 1997).

Owning a home may be an avenue of assimilation for minority groups in mainstream society. Homeownership is a proxy for wealth accumulation and is frequently a prerequisite for living in certain locations, especially suburban areas where the housing stock is predominantly composed of owner-occupied single family homes (Alba & Logan, 1992). In an examination of Black mobility, South and Crowder (1998) demonstrated that homeownership increases the likelihood of moving to a more ethnically integrated residential area.

Inappropriate land uses and maladaptive behaviors.

Neglect and deterioration of physical environments and a disproportionate representation of undesirable land use also characterize highly segregated areas. Policy makers are more likely to cut important spending on social services in areas where residents are unlikely to mount political opposition (Shihadeh & Flynn, 1996; Wallace, 1990, 1991). Withdrawal of fire and police services from such areas can trigger migration of arsonists, drug dealers and other individuals who may initiate high-risk, maladaptive behaviors (Greenberg & Schneider, 1994).

Socioeconomic status.

Trends indicate that middle class status does not alleviate Blacks from the plight of segregation. Education and income level do not substantially change the value of the segregation index for Blacks. In contrast to other minorities (Asian and Hispanic), middle class status does far less to ameliorate segregation effects among Blacks (Denton & Massey 1988, 1993). Darden (1987) calculated residential segregation indices (Measured by the Index of Dissimilarity) by Blacks and Whites within similar income strata in a Kansas City, Missouri metropolitan area in 1980. Residential segregation among the most affluent (those with median income of more than $75,000) Blacks and Whites was nearly 10 points higher than residential segregation in the lowest income categories (1987). Denton and Massey (1988) demonstrated that Black segregation does not vary by affluence when the Black-White Index of Dissimilarity is calculated by income level. Massey and Fischer's (1999) analysis of 1990 income segregation patterns revealed persistently higher levels of segregation for Blacks such that compared to their minority counterparts (e.g. Asian and Hispanics) affluent Blacks were most segregated from non-

Hispanic Whites (1999).

Pathways

Research on ethnicity and SES has found persistent, independent effects of ethnicity on health outcomes (LaVeist, 1999; Polednak, 1996, 1997; Williams, 1996). Discrimination along ethnic lines is a widely recognized, yet newly investigated area in studies of factors related to health disparities. The existence of non-genetic explanations of ethnicity's contribution, independent of SES, are implied by research findings in this area (Kaufman, Cooper, & McGee, 1997; Williams, 2002).

The role of discrimination and related stressors are important in discussions of ethnic health disparities. Discrimination has been a well-documented determinant of the marginalization of ethnic minority and low SES groups (Gee, 2002; Krieger 2001; Ren, Amick & Williams, 1999). The stressors that result from individually experienced and institutionally sanctioned discriminatory practices are important to discussions of health disparities. Stress is a well recognized correlate of physical and mental health (LaVeist, 1993; 2001; Lillie-Blanton & LaVeist, 1996; Link & Phelan, 1995). A socially deprived life experience may also result in psychological stress responses that are deleterious to health (Farmer & Ferraro, 1997; Krieger & Sidney, 1996; Livingston, 1994).

The isolation resulting from increased residential segregation may keep persons within these areas of residence from role models of stable employment and the social networks that may provide health promoting information and behavior. Williams' (1996). framework conceptualizes the influence of societal structures on ethnic discrimination These social structures and institutions differentially influence Whites and ethnic minorities through social stratification, geographic isolation, decreased opportunities for social ties, lack of medical care and ethnic bias (Collins & Williams, 1999; Williams, 1997). The structural conditions in residentially segregated environments may induce cultural responses that weaken the commitment to norms and values that are important for socioeconomic mobility.

Other mechanisms that link residential segregation to health have been identified. Poverty is associated with poorer nutrition and less access to medical services. Increased stress levels associated with poor economic conditions are also related to weaker social support systems in communities characterized by the concentrated poverty that follows segregation (Roberts, 1997). Individual and collective organizational participation that foster social support networks are lower in concentrated poverty areas (Shihadeh & Flynn, 1996). The section that follows describes the association between residential segregation and health outcomes.

Residential Segregation and Health

Adult Mortality

The relationship between residential segregation and adult all-cause mortality has been illustrated in several studies (Collins & Williams, 1999; Hart, Kunitz, Sell, & Mukamel, 1998; Jackson, Anderson, Johnson & Sorlie, 2000; LaVeist, 1992, 1993; Polednak, 1996, 1997). Most investigations employed cross-sectional study designs. Varying geographical units were examined to explore residential segregation and mortality associations.

Polednak's (1993) investigation of all-cause mortality among SMSAs showed that the Black/White ratio of age-adjusted mortality was significantly associated with Black/White residential segregation. A positive association for Black men and women ages 15-44 was also evident. Hart et al.'s (1998) examination of SMSAs showed higher mortality rates for Blacks and Whites in cities characterized by higher residential segregation. Fang et al. (1998) investigated New York City and found that Black mortality rates significantly differed by location, despite higher mortality rates of Blacks compared to Whites. Differences were positively associated with the city's ethnic residential segregation (measured using the Index of Dissimilarity) patterns. Collins and Williams (1999) conducted an authoritative investigation of the effects of ethnic residential segregation (measured using the Index of Dissimilarity and the Index of Social Isolation) on a variety of mortality indicators (age-adjusted all-cause mortality, cancer mortality, cardiovascular disease mortality and homicide). Results demonstrated that residential segregation was negatively related to the health of Whites and Blacks. Patterns of the association were weaker for the former group than they were for the latter (1999). Jackson et al. (2000) investigated census tracts and found that all-cause mortality increased as residential segregation increased in Black (ages 25-44) and non-Black (ages 45-64) populations.

Crime

Positive associations have been found in studies examining the relationship between residential segregation and crime. Results yielded mixed results similar to the studies described above. Positive associations have been demonstrated between residential segregation indices and: all-group homicide rates (Logan & Messner, 1987; Rosenfield, 1986); Black-White differences in homicide rates (Potter, 1991); and Black homicide rates (Peterson & Krivo, 1993). The positive association between segregation and homicide rates also has been shown for Whites and not Blacks (Sampson, 1987).

Shihadeh and Flynn (1996) found a positive association between segregation and Black homicide when using two measures (The Isolation Index and The Index of Dissimilarity). The Isolation Index was a stronger predictor of homicide rates than the Index of Dissimilarity (1996). Investigation of the influence of community violence (measured using the number of violent crimes per 1000 residents in each police district) on perinatal outcomes revealed a significant increase in SGA births in residential areas characterized by higher violence, a characteristic of highly segregated geographical areas (Collins & David, 1997).

Infant Mortality

Research on the association between residential segregation and perinatal outcomes has focused primarily on infant mortality. The earliest empirical investigation of the association between residential segregation and perinatal outcomes demonstrated that both Black and White infant mortality rates were highest in highly segregated areas with a larger proportion of Black residents (Yankauer, 1950). Jiobu's (1972) path analysis also showed that a positive association existed between residential segregation and infant mortality. An investigation of Black-White differences in infant mortality within large and mid-size U.S. cities revealed a positive association between segregation (measured using the Index of Dissimilarity) and Black infant mortality (LaVeist, 1989). This relationship persisted independent of poverty rates. When rates of LBW among Black infants and unwed mothers were controlled for, the association between residential segregation and infant mortality remained. White infant mortality rates were largely unaffected by residential segregation indices (1989).

Two related cross-sectional studies investigated the association between residential segregation and infant mortality in standardized metropolitan statistical areas (SMSAs) using multiple regression analyses. Both demonstrated mixed effects. The initial study (Polednak, 1991) employed mortality data between 1982 and 1986. Findings demonstrated that the residential segregation index (measured using the unevenness of residential distribution of African-Americans) was the only significant predictor of total infant mortality rates for census tracts in each SMSA when other factors (female householder, poverty prevalence and median family income) were included in regression models. Similar results were found in analysis among African Americans (1991). The second study assessed differences in infant mortality rates between Blacks and Whites over a nine-year (1982 - 1991) period (Polednak, 1996). While the 1980 residential segregation index was significantly related to infant mortality from 1982 to 1986, the rate of unmarried Black women (and not the 1990 segregation index) was the only significant predictor of infant mortality from 1989 to 1991. Noteworthy in both studies were high correlations between residential segregation indices and the prevalence of poverty and the rate of unmarried mothers, respectively (1996).

These ecological investigations were characterized by well-recognized limitations. The lack of individual risk factors provided only partial understanding of the context within which identified trends existed. In addition, by utilizing census measures of SES such as the prevalence of poverty and median family income, a population based measure of SES was used as a proxy for the individual level. Notwithstanding, these studies provided a new direction of investigation concerning the role of residential segregation in predicting risk factors for adverse perinatal outcomes.

Studies linking residential segregation to health outcomes suffer from a number of research limitations. First, the effects of residential segregation often differ by ethnic group. Black-White socioeconomic disparities have clear spatial expressions, previously cited at the metropolitan area level along both central-city/suburban lines and across residential areas (Altshuler, Morrill, Wolman, Mitchell & The Committee on Improving the Future of U.S. Cities through Improved Metropolitan Area Governances, 1999). Further, the significantly more adverse socioeconomic and residential quality measures among Blacks when compared to Whites have been attributed to differential effects of residential segregation (Massey, 2001; Massey et al., 1987; Massey & Denton, 1993; Williams & Collins, 2001). Little is known about the effects of residential segregation on perinatal outcomes that increase risk for infant mortality and morbidity risk. Further, whether the differential trends in the adverse effects of residential segregation along ethnic lines are also applicable to disparities in perinatal outcomes remains to be seen. Second, while the influences of residential segregation are manifested at both individual (e.g., education, employment opportunities) and contextual levels (e.g. concentrated poverty) the majority of the research on the residential segregation and health relationship are based on single level, aggregate analyses (Acevedo-Garcia et al., 2003; Acevedo-Garcia & Lochner, 2003; Ellen, 2000). Third, the majority of studies have examined mortality rates as the outcome of interest. The myriad of social and environmental consequences of ethnic residential segregation infer the need for increased investigation of how specific characteristics of segregated areas may be associated with risk for cause-specific health outcomes.

Finally, less is known about for whom and under what conditions residential segregation may be protective. The consequences of residential segregation for non-Black ethnic groups are not well understood. In Polednak's (1993) study, the residential segregation Index of Dissimilarity was positively associated with all cause mortality for Blacks, but inversely related for Whites (Polednak, 1993). Others have suggested that residential segregation will benefit Whites who reside outside of segregated areas (Massey & Denton, 1993). Evidence also shows that segregation is costly for Whites on a broad range of dimensions (Roisman, 1995). Some have found that residential segregation was unrelated or inversely related to mortality for Whites (LaVeist, 1989; Polednak, 1991, 1993, 1996). Others have found that segregation was positively related to homicide rates for Whites but not for Blacks (Sampson, 1985). LeClere et al. (1997) found that residence in segregated areas predicted higher mortality rates for Blacks as well as for Whites.

Research Questions and Hypotheses

The purpose of this study was to investigate the relationship between residential segregation and adverse perinatal outcomes (LBW, preterm delivery and SGA births) in Florida, Georgia and Louisiana. Specifically, this study determined the independent effects of the level of residential segregation on the likelihood of adverse perinatal outcomes after controlling for contextual and individual factors. The study also determined whether the relationship between residential segregation and the likelihood of adverse perinatal outcomes adverse perinatal outcomes is moderated by ethnicity and median income, respectively. The following research questions and hypotheses were investigated:

Research Question 1: Is there a relationship between residential segregation and adverse perinatal outcomes among mothers in Florida, Georgia, and Louisiana?

Hypothesis 1: The level of residential segregation is positively associated with the likelihood of adverse birth outcomes after controlling for contextual and individual factors.

Hypothesis 1A: The level of residential segregation is positively associated with the likelihood of preterm delivery after controlling for contextual and individual factors.

Hypothesis 1B: The level of residential segregation is positively associated with the likelihood of low birth weight after controlling for contextual and individual factors.

Hypothesis 1C: The level of residential segregation is positively associated with the likelihood of small for gestational age births after controlling for contextual and individual factors.

Research Question 2: Is the relationship between residential segregation and perinatal outcomes moderated by ethnicity?

Hypothesis 2: The relationship between residential segregation and the increased likelihood of adverse perinatal outcomes is moderated by ethnicity.

Hypothesis 2A: The relationship between residential segregation and the increased likelihood of preterm delivery is moderated by ethnicity.

Hypothesis 2B: The relationship between residential segregation and the increased likelihood of low birth weight is moderated by ethnicity.

Hypothesis 2C: The relationship between residential segregation and the increased likelihood of small for gestational birth is moderated by ethnicity.

Research Question 3: Is the relationship between residential segregation and perinatal outcomes moderated by income?

Hypothesis 3: The relationship between residential segregation and the increased likelihood of adverse perinatal outcomes is moderated by income.

Hypothesis 3A: The relationship between residential segregation and the increased likelihood of preterm delivery is moderated by income.

Hypothesis 3B: The relationship between residential segregation and the increased likelihood of low birth weight is moderated by income.

Hypothesis 3C: The relationship between residential segregation and the increased likelihood of small for gestational age birth is moderated by income.

CHAPTER THREE: METHODOLOGY

Study Design

The research employed an observational study design that was cross-sectional utilizing secondary data. The study was observational in that groups are formed by sample population status for each respective adverse perinatal outcome rather than randomization into treatment and control groups. The study selected was cross-sectional due to the proposed association between prevalence of adverse perinatal outcomes and prevalence of exposure to residential segregation. The use of preexisting birth certificate and U.S. Census Bureau data explains the secondary nature of the study.

Study Population

The inclusion criteria for the selection of birth certificate data sources were based on regional rates of adverse perinatal outcomes and the availability of data needed to analyze residential segregation effects at the census tract level. Regional findings confirmed that LBW, neonatal mortality rates (death of live born from birth to < 28 days of life) and infant mortality (death of live born before first birthday) rates were highest in the Southern United States (National Center for Health Statistics, 2004) (Table 2).

Table 2

Perinatal Outcomes for the United States and Selected Geographical Divisions

	LOW BIRTH WEIGHT RATE	NEONATAL MORTALITY RATE	INFANT MORTALITY RATE
United States	*7.69	**4.6	**6.9
South Atlantic Delaware, District of Columbia Florida, Georgia, Maryland North Carolina, South Carolina Virginia, West Virginia	*8.63	**5.5	**8.0
East South Atlantic Alabama, Kentucky, Mississippi, Tennessee	*9.45	**5.5	**8.7
West South Central Arkansas, Louisiana, Oklahoma Texas	*8.00	**4.1	**6.7

Source: National Center for Health Statistics, 2004
*Selected Years 2000-2002
**Selected Years 1999-2001

Census tracts were conceptualized as proxies for the residential contexts that shape individual health opportunities and risks. Justification for selection of this level of aggregation is discussed in detail later in this chapter. The Southern United States meeting the criteria for inclusion were Florida, Georgia and Louisiana. These states represent similar demographic profiles and birth trends (Figure 1 and Figure 2). Birth certificate data was examined from January 1, 1999 to December 31, 2001.

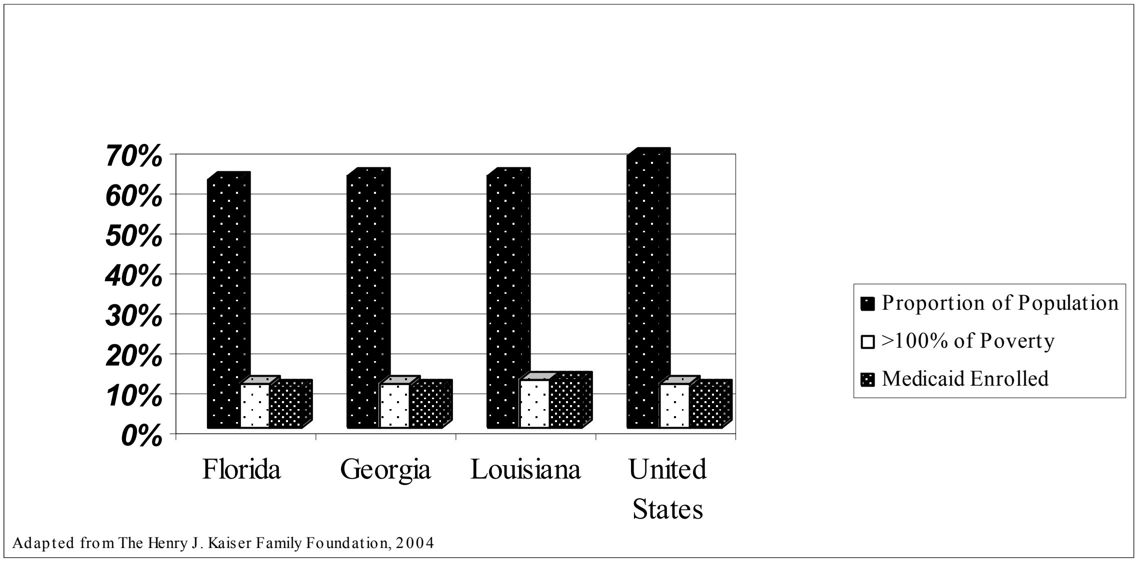


Figure A. Population Characteristics of Whites for Selected States 2002-2003

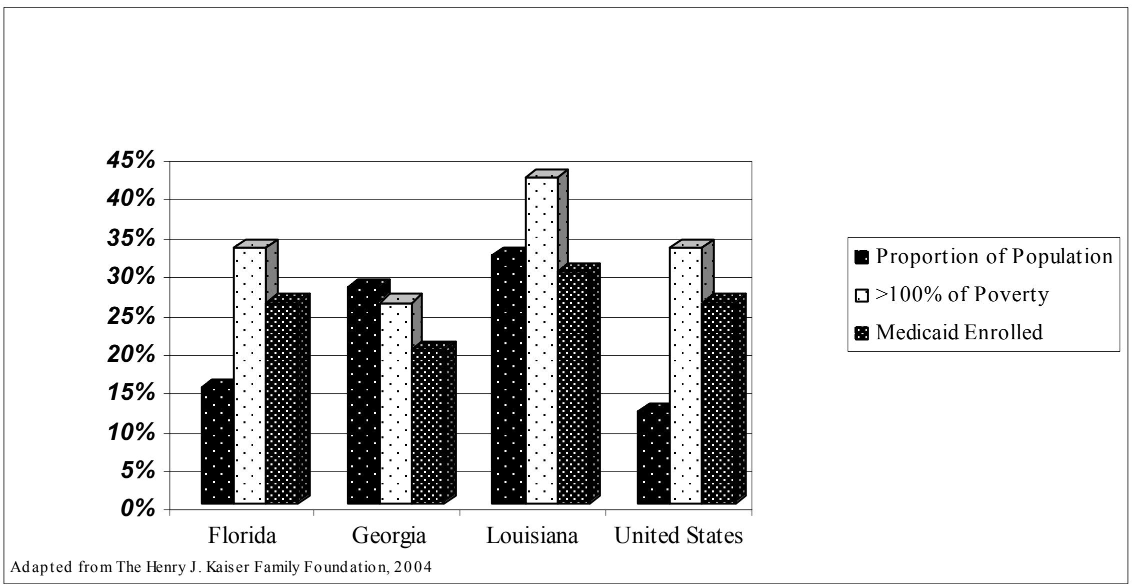


Figure B. Population Characteristics of Blacks for Selected States 2002-2003

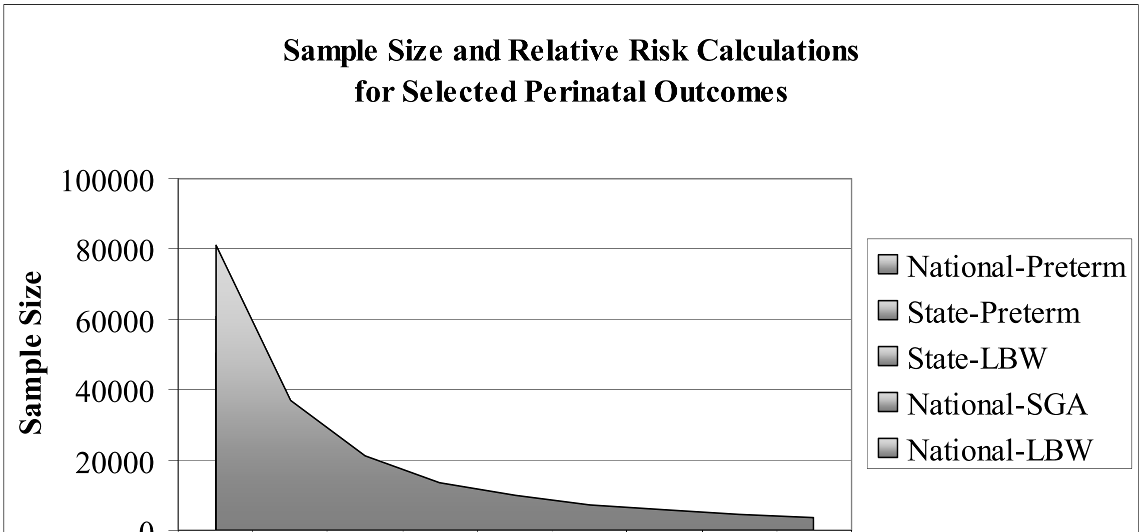
The study population consisted of: non-Hispanic White and Black women; singleton live births; and subjects who are primaparous. The population was restricted to singleton live births to primaparous women in order to control for unique risk factors associated with previous pregnancies and multiple gestations. The decision to exclusively include primaparous women was also driven by the fact that the birth certificates examined provided no information on the structural or contextual factors that characterize prior pregnancies.

Exclusion criteria for study participants included: women who were foreign residents at the time of delivery due to more positive birth outcomes among women who were not born in the U.S. (Cabral et al.,1990; Friedman et al., 1993: Palloto et al., 2000), births to women less than 15 years old or greater than 49 years old since there are very few pregnancies in these extreme age strata; births delivered at greater than or equal to 45 weeks due to increased errors in gestational age at indicated postterm gestations (Kramer, McLean, Boyd, et al., 1988); stillbirths; and births with improbable birthweight and gestational age combinations.

Sample Size

National and state-specific (e.g., Florida, Georgia and Louisiana) power analyses were conducted for each adverse perinatal outcome to determine the required sample size for this study. Assumptions for all analyses included a type 1 error rate of 5% and analyses that would yield 80% power. National and state-specific live birth ratios (5.13:1 and 2.28:1, respectively) were used to represent the proportion of unexposed (White) to exposed (Black) (National Center for Health Statistics, 2002, 2003). The power analyses for SGA births were conducted based on national rates due to no identified state-specific rates in the reviewed literature. National SGA birth rates were taken from a recent study conducted by Ananth, Balasubramanian, Demissie, & Kinzler (2004). Power analyses were conducted using Epi Info version 3.3.2. Figure 3 illustrates sample size computations for each perinatal outcome based on available state and national rates.

Figure C



	0.1	0.15	0.2	0.25	0.3	0.35	0.4	0.45	0.5
National-Preterm	30333	13802	7944	5199	3687	2765	2162	1742	1437
State-Preterm	49665	22546	10311	8453	5989	4481	3494	2814	2317
State-LBW	50460	22980	13235	8669	6157	4622	3615	2916	2408
National-SGA	60834	27628	15870	10366	2344	5499	4291	3451	2844
National-LBW	81229	36903	21204	13584	9814	7356	5738	4622	3813

Relative Risk

Based on the aforementioned power analyses assumptions and calculations, a sample size of 36,903 live births, comprised of at least 6,020 Black neonates, was necessary for this study. This sample size estimation provides the most generous estimate when comparing national and state-specific rates calculated to detect a relative risk difference of 15%.

Nested Data Structure

A three-level nested data structure was used in this study. Level-1 (individual) data was taken from certificates of live birth and contains individual risk factors (control variables) and outcomes variables. Level 2 (contextual) data was composed of census tracts and contains neighborhood risk factors (control variables). Level 3 (structural) data was composed of Metropolitan and Micropolitan Statistical Areas which are used by the U.S. Census Bureau to calculate residential segregation indicators. Each Metropolitan Statistical Area has at least one urbanized area and a population of 50,000 or more persons. Each Micropolitan Statistical Area has at least one urban cluster and a population of at least 10,000 but less than 50,000 persons. Census tracts are the units of analysis for Metropolitan and Micropolitan Statistical Areas. This three-level model can be decomposed into submodels (Byrk & Raudenbush, 2002).

Power Implications for Multilevel Models

Although straightforward and practical techniques for power calculations involving two-level models (Snijders & Bosker, 1993) are available, these procedures are not precisely generalizeable to three-level models. An appropriate method for sample size and power calculations for three-level models would involve conducting a simulation study using applicable estimates (Muthen & Muthen, 2002; Sastry, Ghosh-Dastidar, Adams, & Pebley 2003), preferably from a similar study or pilot study. Estimates are not available to identify and run a simulation study. Instead, published simulation studies and available studies concerning sample size sensitivity in multilevel analysis have been reviewed to provide rules of thumb for these types of models and to help approximate the sample size needed to achieve statistical power of 0.80 (Cohen, 1988). The studies described below serve as instructive guides.

For multilevel models Hox described the “50/20 rule” for researchers interested in evaluating random variance and covariance parameters (1998). There should be at least 50 higher level groups and 20 in each group (amounting to a total sample of approximately 1000 individuals) based on this rule. Similarly, for multilevel structural equation models, Hox (2001) performed a simulation study in which he varied four conditions: 1) balanced versus unbalanced, 2) number of groups (50, 100, and 200), 3) group size (10, 20, 50), and 4) intraclass correlation [low (0.20) versus high (0.33)]. For a balanced design with 50 groups and a 95% confidence interval, there was 92% coverage of the parameter estimates. In addition, with a high intraclass correlation and 50 groups, inadmissible solutions were found in 5.70% of the samples. Hox (2001) ultimately concluded that “a low number of groups are only partially compensated by having large groups, a high ICC, or balanced data (p. 170).”

Based on these studies, there should be at least 50 clusters at level 3 (MSAs). Furthermore, an average of 10 units per cluster is warranted. In other words, there should be a minimum of 10 census tracts per MSA or a total of 1,000 census tracts should be sampled. Applying this rule again, there should be a minimum of 10 individuals per census tract or a total of 10,000 individuals.

The eligibility criteria for this study’s sample was discussed earlier in this chapter. After applying these criteria, the initial sample comprised 298,926 women nested within 5,518 census tracts and 63 metropolitan or micropolitan statistical areas. Individuals (Level 1) without census tract information (Level 2) and census tracts with missing metropolitan or micropolitan area information (Level 3) were then excluded due to HLM statistical software requirements that there are datasets for each level of analysis and linking variables across each level of data. The final sample was 255,548 women nested within 4,360 census tracts and 63 metropolitan or micropolitan districts.

Analyses of geographic variables at each level of analysis indicate the HLM sample size objectives described above have been met based on the following:

- An average of 58.61 individuals per census tract:
  - Minimum number of individuals per census tract: 1.00
  - Maximum number of individuals per census tract: 628.00
  - Standard Deviation: 45.23
  - Census tracts with 10 or more individuals: 95.92%

- An average of 69.21 census tracts per MSA:
  - Minimum number of individuals per census tract: 4
  - Maximum number of individuals per census tract: 689.00
  - Standard Deviation: 120.74
  - MSAs with 20 or more census tracts: 93.65%

- A total of 63 Metropolitan and Micropolitan Areas

Data Sources

Birth certificate records were used to collect information on individual covariates and adverse perinatal outcomes. Birth certificate data is a potentially rich source of information, with wide application for both research and practice and provides the best means, to date, for examination of the research questions. Birth certificate data cover multiple years and contain large amounts of standardized information about U.S. women and potential risk factors for adverse perinatal outcomes. The birth certificate is among the most recognized and commonly used data sources for research and program planning. More states are implementing error-checking initiatives to improve quality of vital records (Alexander & Petersen, 1997).

Residential segregation indices and contextual covariates were obtained from data sources derived from the U.S. Census Bureau. The Household and Economics Statistics Division (HESD) of the U.S. Census Bureau provided data on residential segregation indices (Census Bureau of the United States, 2000). The HESD calculated residential segregation through examination of the distribution of populations across census tracts within Metropolitan Areas (MSAs) and Primary Metropolitan Statistical Areas (PMSAs) (Census Bureau of the United States, 2000).

The 2000 Neighborhood Change Database (1970-2000) (NCD) (GeoLytics, 2004) provided data on contextual characteristics of residential areas. The NCD includes Long Form U.S. Census data from 1970, 1980, 1990 and 2000 at the census tract level. A unique feature of the dataset is that geographical identifiers enable the researcher summarize census tracts into larger geographical levels including counties and MSAs (2004) similar to processes used to calculate residential segregation through the HESD.

Variable Measures

Independent, dependent, potential confounders, and moderating variables included in the analysis are described in this section. The Appendix includes the conceptual model for the proposed relationships among variables. Table 3.1 includes a list of study variables and scales of measurement.

A set of theoretically relevant independent variables at each level were included in the analyses. The measure of concentrated poverty at the census tract level was excluded from the analyses because data were not available for a large number of the census tracts. Two variables were excluded from the analysis due to unacceptably high multicollinearity. In particular, the total proportion of persons below the poverty level was excluded because that variable was not mutually exclusive from the proportion of Whites or Blacks under the poverty level. In addition, the proportion of Whites was found to be highly correlated ($r = -.94$, $p < 0.001$) with the proportion of Blacks residing in census tract. Furthermore, the Isolation Index was perfectly correlated ($r = -1.00$, $p < .001$) with the Interaction Index at the metropolitan area level. For the remaining variables, univariate descriptive statistics were performed.

To aid in the interpretation of the results, some variables were dichotomized. More specifically, highly skewed or kurtotic variables were dichomotized near the median. Each variable that did not meet the assumption of univariate normality were recoded into binary variables. These variables were split so that approximately half of the sample was coded as 0 and the other half coded as 1. For instance the variable that examined the proportion of the population within the census tract that was in correctional facilities possessed a preponderance of zeros and very little variance. Due to the preponderance of zeros and highly skewed distribution, the values were divided at the median value of 0: all 0's were coded 0 and all other values were coded as 1.

There is some debate regarding how to handle ordered categorical variables (Knapp, 1990). Nevertheless, it is common practice to treat ordinal variables with five or more categories as continuous variables. Median income, age of housing and prenatal care variables in the current study met this criterion and were analyzed accordingly. It is important to note that the dichotomization or the creation of artificial categories was purposefully avoided whenever possible because this practice can often decrease effect size and statistical power (MacCallum, Zhang, Preacher, & Rucker, 2002). A list of variables and the coding are provided in Table 3.

Table 3

Variable Descriptions and Scales of Measurement

VARIABLE	SCALE OF MEASUREMENT	LEVEL OF ANALYSIS AND CODING
Independent Variables		**Level 3**
Index of Dissimilarity or Evenness	Continuous	
Isolation Index or Exposure	Continuous	
Proportion of Black	Continuous	
Area Size	Binary	0 = Metropolitan-population >50,000 1 = Micropolitan-population >10,000 to <50,000
Control Variables-Individual Covariates		**Level 1**
Maternal Age 15-19 years 20-24 years 25-29 years 30-34 years ≥ 35 years	Ordinal	5 Categories
Maternal Education <High school High school ≥ High school	Ordinal	3 Categories
Marital Status	Binary	0 = Married 1 = Unmarried
*Prenatal Care Adequacy Intensive Adequate Intermediate Inadequate No Care	Ordinal	5 Categories
Cigarette Use During Pregnancy	Binary	0 = No 1 = Yes
Outcome Variables		
Preterm Delivery	Binary	0=≥37 weeks gestation 1=< 37 weeks gestation
Low Birth Weight	Binary	0=≥2,500 grams 1=<2,500
Small for Gestational Age Birth	Binary	0= ≥ 10^{th} percentile for gestational age and sex 1= < 10^{th} percentile for gestational age and sex

*Represents original coding of variable. Ordinal variable with ≥5 categories treated as continuous because variable dichotomization or creation of artificial categories can often decrease effect size and statistical power (MacCallum, Zhang, Preacher, & Rucker, 2002).

Table 3 (Continued)

VARIABLE	SCALE OF MEASUREMENT	LEVEL OF ANALYSIS AND CODING
Moderating Variable		
Maternal Ethnicity	Binary	0=White 1=Black
Control Variables-Contextual Covariates	**Level 2**	
Total Owner-occupied Homes	Continuous	
Household Vacancy	Binary	0 = ≤ 10% 1 = > 10%
**Age of Housing Built 1999 to March 2000 (≤ 1 year) Built 1995 to 1998 (2-5 years) Built 1990 to 1994 (6-10 years) Built 1980 to 1989 (11-20 years) Built 1970 to 1979 (21-30 years) Built 1960 to 1969 (31-40 years) Built 1950 to 1959 (41-50 years) Built 1940 to 1949 (51-60 years) Built 1939 or earlier (≥61 years)	Ordinal	10 categories
Proportion Female-Headed Households	Binary	0 = ≤ 10% 1 = > 10%
Proportion in Correctional Institutions	Binary	0 = = 0% 1 = > 0%
Proportion of Resident Civilians Unemployed	Binary	0 = ≤ 5% 1 = > 5%
Proportion of Residents with High School Diploma	Continuous	
Proportion of Blacks Below Poverty	Binary	0 = ≤ 10% 1 = > 10%
Proportion of Whites Below Poverty	Binary	0 = ≤ 10% 1 = > 10%
Moderating Variable		
**Median Household Income 0-$24999 $25,000 to $59,999 $60,000 or higher	Ordinal	3 categories

*Represents original coding of variable as measured by U.S. Census Bureau. Ordinal variables with ≥5 categories treated as continuous because variable dichotomization or creation of artificial categories can often decrease effect size and statistical power (MacCallum, Zhang, Preacher, & Rucker, 2002)

Residential Segregation

Residential segregation was measured using the Index of Dissimilarity and the Isolation Index. The selected indicators represented two of the five dimensions described and examined by Massey and Denton (1988): Evenness and Exposure. The Black-White Dissimilarity Index and the Black Isolation Index was measured using residential segregation calculated by the Household and Economics Statistics Division of the U.S. Census Bureau (Census Bureau of the United States, 2000). Residential segregation estimates were calculated through examination of the distribution of populations across census tracts within Metropolitan and Micropolitan Statistical Areas. Indices calculated for non-Hispanic Blacks use non-Hispanic Whites as the reference group. The U.S. Census Bureau has calculated publicly accessible residential segregation indices that were utilized in this study. Formulas used by the U.S. Census Bureau to calculate selected indices are included below.

The formula for the Index of Dissimilarity is the specified as:

$$\frac{\sum_{i=1}^{n} \left[t_i \left| \left(p_i - P \right) \right] \right.}{\left[2TP \left(1 - P \right) \right]}$$

Where,	n	number of areas (census tracts) in the metropolitan area, ranked smallest to largest by land area
	t_i	the total population of area i
	p_i	the ratio of xi to ti (proportion of area I's population that is minority)
	P	the ratio of X to T (proportion of the metropolitan area's population that is minority)
	T	the sum of all t_i (the total population)

The formula for the Index of Isolation is the specified as:

Where, n number of areas (census tracts) in the metropolitan area,

$$\sum_{i=1}^{n}\left[\left(\frac{x_i}{X}\right)\left(\frac{x_i}{t_i}\right)\right]$$

ranked smallest to largest by land area

x_i the minority population of area i

X the sum of all x_i (the total minority population)

t_i the total population of area i

Formulas and definitions are taken from Massey and Denton (1988) and Iceland, Weinberg, & Steinmetz (2002). Dissimilarity measures >0.6 are considered hypersegregated (Glaeser & Vigdor, 2001).

Control Variables

Unlike traditional models that simply include multiple intercorrelated individual-level variables for the purpose of controlling for individual-level confounding, multilevel models allow for simultaneous examination of the association of individual-level and group-level variables with perinatal outcomes. In the full multilevel model, coefficients for individual-level variables quantify how each variable is associated with the outcomes after adjusting for the group characteristics included and moderated by group random effects. Hence, the examination of the association between variables that are "controlled" for and health outcomes are possible through multilevel models (Diez-Roux, 2004).

Hypotheses testing of the main relationship between residential segregation and adverse perinatal outcomes controlled for individual and contextual covariates. Birth certificate data provided information on individual covariates that include: ethnicity; age; education; marital status; prenatal care; and substance use. Contextual covariates were obtained from the 2000 Neighborhood Change Database (1970-2000) (GeoLytics, 2004). The Graduate Index of Prenatal Care Utilization (GINDEX) was used to quantify the adequacy of prenatal care utilization. This index accounts for month that prenatal care began and the total number of prenatal care visits, adjusted for gestational age (Alexander, Kogan & Nabukera, 2002; Alexander & Kotelchuck, 1996). Selected covariates fell into one of three environmental categories: the physical, social, and economic. Physical environmental factors included total owner-occupied homes, housing unit vacancy, and age of housing. The social environment was measured through factors including the percentage of female-headed households and the proportion of residents in correctional facilities. Characteristics of the economic environment included: unemployment rates; residents with a high school degree; total poverty rates; and race-specific poverty rates.

Outcome Variables

Perinatal outcomes examined in this study were LBW, preterm delivery and SGA. LBW was measured as a dichotomous variable of < 2,500 grams and ≥ 2,500 grams. Studies on the reliability of birth certificate data have shown that the birth weight measure is more accurate and complete when compared with medical records (Buescher, Taylor, Davis, & Bowling, 1993). Preterm delivery was measured as a dichotomous variable designated by delivery <37 complete weeks of gestation and term delivery ≥37 complete weeks of gestation. SGA births was a similarly dichotomized variable designated by birthweight that is < 10^{th} percentile of birthweight for gestational age and sex non-SGA birth represented by ≥ 10^{th} percentile of birthweight for gestational age and sex. Birth-weight and gestational age combinations were calculated using an algorithm developed by Alexander Hines, Kaufman, Mor and Kogan (1996).

Alexander et al. (1996) developed an algorithm to provide a U.S. reference for fetal growth, to calculate birth weight-gestational age combinations and to identify combinations that are implausible. Birth weights that appear to be normally distributed may have inaccurate gestational age values leading to errors in preterm classification (David, 1980; Wang, Guyer, & Paige, 1994; Alexander, Tompkins, Altekruse, & Hornung, 1985). For example, infants with the same gestational age may have birth weights that place them at varying risk for SGA. Two infants of the same birth weight may have very different morbidity and mortality risk classifications, contingent upon their gestational age.

In order to account for implausible birth weight-gestational age data, gestational age distributions were examined for births grouped into 125-g birth weight intervals. Birth weights were used as a reference because of its greater reliably than gestational age on vital records. Gestational age values of $\pm$ 2.5 standard deviations from the mean were treated as cut points for implausible birth weight-gestational age combinations. Percentiles of the birth weight distribution were calculated for each completed week of gestational age. A resistant nonlinear smoothing technique, labeled 4325H, was used twice to dampen irregularities due to random variation in the fetal growth percentile curves across gestational age groups (Himes & Hoaglin, 1989; Ryan, Joiner, & Ryan, 1985). This data smoothing process uses a series of running medians and presumes no functional shape of fetal growth curves (Velleman, 1980).

Moderating Variables

The designation of ethnic groups on the birth certificate is an important consideration in this study. The inclusion of non-Hispanic White and Black women in this research is related to heterogeneous *race* and *ethnic* group classifications. Births categorized by *race* may be either Hispanic or non-Hispanic. These groups may not be homogeneous with regard to pregnancy-related risk factors or birth outcomes. For example, while the majority of Hispanic-origin births were to White women, the majority of Black births were to non-Hispanic women (97% and 96%, respectively) in 2003 (Sutton & Matthews, 2004).

The broader structural and contextual forces that contribute to Black-White health disparities are critical to the current study and the limitations of the classification of groups by the term *race* have been carefully considered. Using the term *race* perpetuates a limited conceptualization of health disparities that is based on skin color or genetic predisposition.

Median income was used to represent SES for census tracts within MSAs. Median income was measured in the U.S. Census through division of the income distribution in a geographical area into two groups; one with income above the median and the other below the median. Median income was measured as the aggregate average household income with residential areas.

Level of Aggregation

The geographical unit of analysis was the census tract. Census tracts are geographically defined areas of 3000-5000 persons. This unit of analysis was selected due to the fact that it is a small, relatively permanent statistical subdivision. Census tracts capture within city variation, which can be used to conceptualize and measure the immediacy of social contexts that are lost to cross-metro analyses, and are relatively homogeneous with respect to population characteristics, economic status and living conditions (Guest et al., 1998). A recent study evaluating area based measures used to measure social inequalities found that census tract and block group data consistently detected equivalent and typically stronger socioeconomic gradients than their zip code level counterparts (Krieger et al., 2003). Limitations of other studies examining the impact of areas of residence on birth outcomes have been the size of the geographical unit of analysis. According to Massey and Denton (1988) ethnic groups are more readily available using census tracts and are the level of aggregation most widely used in residential segregation studies.

Analysis Procedures

All statistical analyses were performed using the SAS version 9.0 program. A series of exploratory, descriptive data analyses was performed on all variables described above to assess variable distributions (means, variance, frequency distribution), missing values and the magnitude of outliers. Analyses were performed for the overall population of each census tract, and for Black and White women, respectively. Descriptive and explanatory analysis were also performed separately for each dimension of residential segregation and each adverse perinatal outcome. For continuous variables, univariate analysis (PROC UNIVARIATE) were performed to determine normality. Categorical data were explored through 2 by 2 tables and chi-square analysis (PROC FREQ).

Bivariate analysis were conducted to determine if there are associations between the macro level variables (residential segregation dimensions), micro level individual risk factors (e.g., smoking, maternal age) and each adverse perinatal outcomes overall, and for the total populations of Black and White women separately, including correlations and collinearity. T-tests (PROC TTEST) and Pearson correlations (PROC CORR) were used on parametric continuous data. Nonparametric data were subjected to one-way Wilcoxon and median testing (PROC ANOVA). Odds ratios and chi-square analysis were performed for categorical data (PROC FREQ).

The geographical distribution of each adverse perinatal outcome was calculated. In order to assess the variability of outcome rates, determination of the precision of the true population rates estimation is important. Ninety-five percent confidence intervals were constructed around sample rates in order to assess this variability. The sample mean is a maximum-likelihood estimator of the true population. When applied to small area-data (in this case, the census tract) the maximum-likelihood estimate tends to be quite variable (Biggeri, Marchi, Lagazio, Martuzzi, & Bohning, D., 2000). Bayesian analysis combines sample information with other available information from which inferential procedures are then based.

Multilevel logistic regression was performed following the identification of statistical confounders. Multilevel linear regression was utilized for continuous variables. Independent variables included in analysis included statistically significant contextual and individual factors described above. Multilevel models were used to test whether the level of residential residential segregation was positively associated with increased likelihood of adverse perinatal outcomes after controlling for contextual and individual factors (Hypothesis 1). Models included individual (e.g. maternal characteristics, medical/obstetric conditions), contextual (e.g., median poverty, % incarcerated) and structural factors (e.g., residential segregation). Parameters were considered for both fixed and random effects. This determination was made prior to performing multilevel analysis. Parameters were fixed when all independent variables are present or if the levels present are the only ones of interest (Littrell, 1996). In this analysis, fixed effects were typically those at the individual level that are categorical (i.e., yes/no). Variables were treated as when the levels of an independent variable are considered to represent a sample of the levels available in the population (1996). Proportion Black, median income, or residential segregation indices are examples of random effects in this study because these factors are only a sampling of all possible levels or proportions in the population. The determination of variables that were examined as fixed or random effects occurred prior to performing multilevel analysis.

The lines of inquiry for this investigation centered on simultaneously gauging the unique contributions of residential areas and individual factors on the macro, structural level and the likelihood of adverse perinatal outcomes at the micro level and are the primary justifications for the use of a multilevel analysis procedures. As previously indicated, the use of a multilevel design was also driven by the limited scope of analysis strategies employed in previous research. Research studies at aggregate levels and falling prey to ecological and atomistic fallacies are among the major criticisms of existing studies. Further, while multilevel modeling has been employed to examine mortality, self-rated health, depressive symptoms, and health behaviors (Daly, Duncan, Kaplan, & Lynch, 1998; Deaton, 2001, Fiscella, & Franks, 1997; Lochner, Pamuk Makuc, Kennedy, & Kawachi, 2001), no investigation of influences on perinatal outcomes related to increased risk for infant mortality have been identified. Examining the influences of residential segregation on adverse perinatal outcomes over and above known individual (micro) and contextual (mezzo) is critical to concurrent examination of multiple levels of influence on adverse perinatal outcomes.

The statistical framework of the hierarchical linear model (HLM) is suited for research involving classification and continuous variables, fixed and random effects, individual difference variables, time-variant and invariant covariates or predictors, repeated measures, and naturally occurring hierarchies (e.g., students within teachers, teachers within schools). It is important to note that these models are mathematically equivalent to mixed models, random regression models, random effect models, random coefficient models, multilevel models, and growth curve models. Although the notation and conceptualization can vary, they involve the same basic model (Hedeker, Gibbons, & Flay, 1994).

HLMs are broadly applicable and have several statistical advantages over traditional ANOVA and MANOVA. In particular, HLMs are generally more flexible, handle missing data more effectively, and can yield more precise parameter estimates and standard errors when data are nested. Consequently, this approach can provide more statistical power and improve the ability to make statistical inferences when used appropriately (Burton, Gurrin, & Sly, 1998; Singer & Willett, 2003).

Moderation can also be tested in multilevel models. A significant main effect for a moderator variable indicates the mean response depends upon the moderator variable. The direction of significant moderator effects is assessed by probing simple regression lines (Aiken, 1991; Tien, Sandler, MacKinnon, & Wolchik, 2004). In other words, moderator effects can be assessed by examining the slope of the outcome at different levels of the moderator variables.

Hierarchical Generalized Linear Models

The assumptions of linearity and multivariate normality required for the standard HLM are not always tenable. In these cases, hierarchical generalized linear models (herein referred to as HGLM) have been developed to handle non-normal and nonlinear models (i.e., binary, count, ordinal, and multinomial). Incorporation of such data is done by using one of several link functions to transform the outcome such that the dependent variable is substituted so that it adheres to the assumptions of the linear model.

Hierarchical generalized linear models are mathematically equivalent to the standard HLM when the identity link function is used. The identity link function would be used for a model in which no transformation of the dependent variable is performed. However, in the case of binary outcomes, for instance, it is common to use a logit link function to serve as the distribution of the dependent variable. For a HGLM with a binary outcome, the interpretation is similar to that found in logistic regression where the estimates represent the predicted log-odds which can be converted into an odds ratio by taking the exponent of the estimate.

Individual, census tract, and metropolitan area data were entered into three separate datasets in SPSS 14.0 and imported into HLM 6.0. To run the proposed analysis a multivariate data matrix (MDM) file from the raw data was generated to supply HLM 6.0 with the appropriate information. More specifically, an MDM file was constructed for a three-level hierarchical linear model for cross-sectional data or persons within groups. It is also necessary to sort identification variables before generating the MDM file to connect the different datasets.

Statistical Models

The following models are related to major hypothesis outlined in Chapter 2:

Hypothesis One: The level of residential segregation is positively associated with the likelihood of adverse birth outcomes after controlling for contextual and individual factors.

To test the primary hypothesis concerning the impact of residential segregation variables on birth outcomes, multilevel models were tested for each of the dependent variables using the total sample.

Hypothesis Two: The relationship between residential segregation and the increased likelihood of adverse perinatal outcomes is moderated by ethnicity.

A random intercept model was developed to allow the slope for ethnicity (Level 1) to randomly vary across all structural variables (Level 3) to examine the impact of residential segregation and ethnicity on perinatal outcomes. In other words, Level 3 variables served as predictors of the slope of ethnicity.

Hypothesis Third: The relationship between residential segregation and the increased likelihood of adverse perinatal outcomes is moderated by median income.

A random intercept model was developed to allow the slope for median income (Level 2) to randomly vary across all structural variables (Level 3) to examine the impact of residential segregation and ethnicity on perinatal outcomes. In other words, Level 3 variables served as predictors of the slope of ethnicity.

For each analysis, level-1 and level-2 intercepts was allowed to vary randomly. The level-1 intercept will serve as the outcome for level-2 variables and level 2 intercept will serve as the outcome for level-3 variables.

The basic statistical model can be expressed by the following equations:

<u>Level 1: Individual</u>

log[P/(1-P)] = P0 + P1*(AGE) + P2*(EDUCA) + P3*(MARITAL) + P4*(PRENATAL)
+ P5*(SMOKE) + P6*(ETHNICIT)

where the Prob(Y=1|B) = P

<u>Level 2: Contextual</u>

P0 = B00 + B01*(P_BLACK) + B02*(INCOME) + B03*(OCCUPY)
+ B04*(VACANT) + B05*(HOUSEAGE) + B06*(FEMHOUSE)
+ B07*(CORRECT) + B08*(UNEMPLOY) + B09*(DIPLOMA)
+ B010*(BPOVERTY) + B011*(WPOVERTY) + R0
P1 = B10
P2 = B20
P3 = B30
P4 = B40
P5 = B50
P6 = B60

<u>Level 3: Structural</u>

B00 = G000 + G001(METMIC) + G002(DISSIM) + G003(ISOLA)
+ G004(P_BLACK) + U00
B01 = G010
B02 = G020
B03 = G030
B04 = G040
B05 = G050
B06 = G060
B07 = G070
B08 = G080

B09 = G090
B010 = G0100
B011 = G0110
B10 = G100
B20 = G200
B30 = G300
B40 = G400
B50 = G500
B60 = G600

Strengths and Limitations

Multilevel modeling of the independent effects of residential segregation on the likelihood of adverse perinatal outcomes of women is a major contribution to research on determinants of ethnic disparities, due to studies limited by analysis at individual *or* aggregate levels. Limitations of previous studies also include employing traditional regression analysis techniques. The lines of inquiry for this study centered on simultaneously gauging the unique contributions of the structural level and the likelihood of adverse perinatal outcomes at the micro level.

The study also expands knowledge on the influence of structural factors through investigation of cause-specific outcomes. Health outcomes previously investigating area effects on health outcomes broadly include self-rated health, life expectancy, all-cause mortality, and infant mortality. The etiological precursors of adverse perinatal outcomes are heterogenous and may be differentially influenced by contextual and structural factors. This study was developed to test models that were specific to each birth outcome.

Several assumptions underlie the primary focus of residential segregation research on minority populations. Among them include the notions that (1) the whiter the residential area the better and (2) that Whites exclusively benefit from living in areas with lower numbers of minority residents. Much of the residential segregation literature does not acknowledge that White residential areas may also be segregated. Without discussion of the context outcomes of the segregation of Whites, the analysis of its effects on health outcomes are not complete, pointing to the need for more research examining the effects of segregation on the relationship between ethnicity and health for all groups of interest. Through the identification of pathways through which residential segregation affects populations differently, this investigation may contribute to the development of policies to improve social conditions that shape health outcomes and accompanying ethnic disparities.

There are a number of limitations associated with use of U.S. Census Bureau data and live birth certificates. The decennial nature of U.S. Census is a recognized limitation when used with other sources that capture annual data; 2000 Census Bureau data may not have reflected characteristics of women delivering infants in 1999 and 2001. Both data sources utilized in this study provide no information on psychosocial, attitudinal or stress measures that may be associated with perinatal outcomes. Higher stress levels among Black and Hispanic women in studies of ethnically and socioeconomically diverse samples have led some to conclude that perceived ethnic and gender discrimination and their associated stressors contribute to an increased risk for preterm birth (Rich-Edwards et al., 2001; Stancil 2000). The duration and length of exposure to area of residence were unknown in this study and may have important implications for contextual and structural risk assessment. Measurement at one point in time may underestimate the effects of residential segregation. Limitations related to the use of birth certificate data are acknowledged and have been previously discussed in detail in Chapter Two.

Ethnic misclassification in data collection are also recognized in the proposed study. The rates of infants born to parents of two different ethnicities have increased from 1.4% in the 1970s to 4.3% in 1998 (Atkinson, MacDorman, & Parker, 2001; Parker, 2001). In response to revisions to the Office of Management Bureau's Directive 15, a person could designate more than one category to describe themselves in the 2000 U.S. Census (1977; 1997). While this change was an important move toward acknowledging the fluid and multilevel nature of self identity, most national health surveys only allow individuals to select only one ethnic designation and cited studies indicate that the effect of ethnic misclassification is minimal among Black and Whites.

Maternal and infant ethnic trends are also challenging to measure due to varying data collection methods. An infant's ethnicity is based on the perceived identity of the mother by an unspecified hospital observer. Ethnicity on the Census is self-reported. This presents noteworthy considerations for calculation of birth statistics that are based on the division of number of events (taken from vital statistics), by the population at risk (taken from the U.S Census Bureau resident file) (Dutch & Madams, 1997; Ventura, 2001). Imprecision and variance in data collection existed prior to the inclusion of multiple race designations, but may be further complicated by it (Rosenberg et al., 1999). However, due to relatively small numbers of persons selecting more than one ethnic group, researchers estimate that the biases associated with this change is negligible for Blacks and Whites, when compared to Asian American and Alaska Natives who represent the largest proportion of those selecting more than one ethnic group (Parker, et al., 2004).

CHAPTER FOUR: RESULTS

The following chapter presents results of the study. Univariate and bivariate statistics are reported for each level of data used in multilevel models. Control and moderating variables are described through narrative and illustrative presentation and are followed by discussion of independent variables. Outcome variable distributions are described overall sample and by ethnicity. The chapter concludes with findings for hierarchical generalized linear models used to test research hypotheses.

After applying eligibility criteria for this study, the initial sample comprised 298,926 women nested within 5,518 census tracts and 63 metropolitan or micropolitan statistical areas. Individuals (Level 1) without census tract information (Level 2) and census tracts with missing metropolitan or micropolitan area information (Level 3) were then excluded due to HLM statistical software requirements that there are datasets for each level of analysis and geographical linking variables across each level of data. The final sample consisted of 255,548 women nested within 4,360 census tracts and 63 metropolitan or micropolitan statistical areas.

Tables 4 and 5 compare women included (N=255,548) and excluded (N=43,378) from the final sample by individual covariates. Given the large sample size, significant p-values may not indicate meaningful differences between these groups. Frequencies and percentages infer that included and excluded women were similar with regard to both individual covariates and birth outcomes. This observation is further strengthened by initial decisions to exclude women primarily on missing geographical linking variables and not individual covariates.

Table 4

Analysis of the Distributions of Individual Covariates Amongst Mothers Included and Excluded from Study Sample

	INCLUDED (N = 255,548) N (%)	**EXCLUDED (N = 43,378) N (%)**	**STATISTIC**	***P*-VALUE**
Maternal Age, mean (sd)	24.70 (6.07)	25.21 (6.54)	t = 15.82	<.001
Maternal Age				
15-19 years	61,561 (24.1%)	10,524 (24.3%)	χ^2 = 649.10	<.001
20-24 years	75,871 (29.7%)	11,910 (27.5%)		
*25-29 years	59,013 (23.1%)	8,781 (20.2%)		
30-34 years	40,457 (15.8%)	7,859 (18.1%		
$\geq$35 years	18,646 (7.3%)	4,304 (9.9%)		
[a]Prenatal Care Adequacy, mean (sd)	1.34 (0.74)	1.42 (0.77)	t = 22.28	<.001
Maternal Education				
< High School	50,923 (19.93%)	8,988 (20.72%)	χ^2 = 63.17	<.001
* = High School	79,686 (31.2%)	14,077 (32.5%)		
> High School	124,939 (48.9%)	20,313 (46.8%)		
Marital Status				
*Married	138,934 (54.37%)	22,851 (52.68%)	χ^2 = 42.57	<.001
Unmarried	116,614 (45.63%)	20,527 (47.32%)		
Cigarette Use During Pregnancy				
Yes	23,299 (9.12%)	3,054 (7.04%)	χ^2 = 198.97	<.001
*No	232,249 (90.88%)	40,324 (92.96%)		
Ethnicity				
*White	178,960 (70.03%)	29,661 (68.38%)	χ^2 = 48.00	<.001
Black	76,588 (29.97%)	13,717 (31.62%)		

Note. Ordinal variable with $\geq$ 5 categories treated as continuous because variable dichotomization or creation of artificial categories may threaten effect size and statistical power (MacCallum, Zhang, Preacher, & Rucker, 2002).
[a]Prenatal Care Adequacy, Mean (Standard Deviation). Measured using The Graduate Index of Prenatal Care Utilization Index.
*Reference Group

Table 5

Analysis of the Distributions of Adverse Perinatal Outcomes Amongst Mothers Included and Excluded from Study Sample

	INCLUDED (N = 255,548) N (%)	**EXCLUDED (N = 43,378) N (%)**	**STATISTIC**	***P*-VALUE**
SGA				
Yes	28,995 (11.3%)	5,166 (11.9%)	$\chi^2 = 11.62$	<.001
No	226,553 (88.7%)	38,212 (88.1%)		
LBW				
Yes	20,258 (7.9%)	3,341 (7.7%)	$\chi^2 = 2.59$	> .05
No	235,290 (92.1%)	40,037 (92.3%)		
Preterm				
Yes	24,965 (9.8%)	3,962 (9.1%)	$\chi^2 = 17.14$	<.001
No	230,583 (90.2%)	39,416 (90.9%)		

Univariate Analysis

Control Variables

Individual Covariates

A total of 255,548 women were included in the sample. Overall, 29.97% of the sample was Black and 70.03% were White. The mean age of the sample population was 24.70 years. The marital status of the sample was mixed: 54.37% were married and 45.63% were not married. Completion of high school was reported by 80.07% of the sample.

The prenatal care adequacy was measured using the Graduate Index of Prenatal Care Utilization Index (GINDEX), a measure that accounts for both month that prenatal care began and the total number of prenatal care visits, adjusted for gestational age (Alexander, Kogan & Nabukera, 2002; Alexander & Kotelchuck, 1996). Each unit increase in the GINDEX scale is associated with decreased prenatal care adequacy (scores range from intensive to inadequate). This variable was treated as continuous, because variable dichotomization or creation of artificial categories can often decrease effect size and statistical power (MacCallum, Zhang, Preacher, & Rucker, 2002). Mean prenatal adequacy for women in study was 1.34 (SD 1.34) suggesting the average women in the sample received intensive prenatal care. The majority (90.88%) of women did not smoke during pregnancy.

Table 6 illustrates the distribution of individual covariates overall and by ethnicity. Black and White women significantly differed on the majority of individual covariates. Black women were more likely to be younger than White women and were less likely (OR 1.56, 95% CI: 1.52, 1.60) to have less than a high school education when compared to White women. Black women were more likely to be single (OR 7.65, 95% CI: 7.50, 7.80) and were significantly less likely to receive adequate prenatal care (p=< .001) when compared to White women. With regard to smoking, Black mothers were more likely not to smoke when compared to White women (OR 5.37, 95% CI: 5.12, 5.63).

Table 6

Distributions, P-Values and Unadjusted Odds Ratios for Individual Covariates, Overall Sample and by Ethnicity, for Sample of Florida, Georgia and Louisiana Mothers 1999-2001 (N=255,548)

VARIABLE	TOTAL N=255,548	WHITE (N=178,960)	BLACK (N=76,588)	P-VALUE OR OR (95% CI)
Maternal Age, mean (SD)	24.70 (6.07)	25.77 (6.00)	22.21 (5.46)	**<.001**
Maternal Age, n (%)				
15-19 years	61,561 (24.1%)	31,620 (17.7%)	29,941 (39.1%)	**4.00 (3.91-4.11)**
20-24 years	75,871 (29.7%)	49,676 (27.8%)	26,195 (34.2%)	**2.23 (2.18-2.29)**
25-29 years	59,013 (23.1%)	47,737 (26.7%)	11,276 (14.7%)	1.00
30-34 years	40,457 (15.8%)	34,290 (19.2%)	6,167 (8.1%)	**0.76 (0.74-0.85)**
≥35 years	18,646 (7.3%)	15,637 (8.7%)	3,009 (3.9%)	**0.81 (0.78-0.85)**
Prenatal Care Adequacy Index, mean (sd)	1.34 (0.74)	1.29 (.71)	1.44 (.79)	**<.001**
Maternal Education, n (%)				
< High School	50,923 (19.9%)	28,522 (15.9%)	22,401 (29.2%)	**1.56 (1.52-1.60)**
= High School	79,686 (31.2%)	52,998 (29.8%)	26,688 (34.8%)	1.00
≥ High School	124,939 (48.9%)	97,440 (54.4%)	27,499 (35.9%)	**0.56 (0.55-0.57)**
Marital Status, n (%)				
Unmarried	116,614 (45.63%)	56,823 (31.75%)	59,791 (51.27%)	**7.65 (7.50, 7.80)**
*Married	138,934 (54.37%)	122,137 (68.25%)	16,797 (21.93%)	1.00
Cigarette Use During Pregnancy, n (%)				
No	232,249 (90.88%)	157,552 (88.04%)	74,697 (97.53%)	**5.37 (5.12, 5.63)**
*Yes	23,299 (9.12%)	21,408 (11.96 %)	1,891 (2.47%)	1.00

Note. OR=odds ratio; CI=confidence interval. Means and standard deviations are presented for ordinal variables with ≥5 categories that were treated as continuous because variable dichotomization or creation of artificial categories can often decrease effect size and statistical power (MacCallum, Zhang, Preacher, & Rucker, 2002). Whites serve as referent group for odds ratio comparisons.

Contextual Covariates and Moderating Variable

The distributions of categorical covariates representing census tracts are listed in Table 7. Over half of census tracts were composed of those that had a median income of $25,000-$59,999. Sixty-one percent of the sample lived in census tracts where less than or equal to 10% of homes were vacant. The mean age of housing for census tracts in this study was 21-30 years. Fifty-nine percent of census tracts were composed of homes where greater than 10% of households were female-headed. Individuals in correctional institutions made up 30.32% of census tracts. The majority (69.82%) of the sample lived in census tracts where less than or equal to 5% of the population were unemployed. Sixty percent of census tracts were characterized by more than 10% of Blacks who lived below the poverty level. In contrast, 61.58% of census tracts were composed of less than or equal to 10% of Whites who lived below the poverty level.

Table 7

Distributions of Contextual Covariates in Census Tracts of Residence for Sample of Florida, Georgia and Louisiana Mothers 1999-2001 (N=4360)

VARIABLE	MEAN (SD) OR N (%)
Median Income n (%)	
0-$24999	1,208 (27.71%)
$25,000 to $59,999	2,657 (60.94%)
$60,000 or higher	495 (11.35%)
***Proportion of Owner-Occupied Homes, mean (SD)**	.67 (0.22)
***Age of Housing, mean (SD)**	5.93 (1.51)
***Proportion of Residents with High School Diploma, mean (SD)**	.29 (0.09)
Proportion Female-Headed Households n (%)	
More than 10%	2,582 (59.22%)
Household Vacancy n (%)	
>10%	1,689 (38.74%)
Proportion of Residents in Correctional Institutions n (%)	
>0%	1,322 (30.32%)
Proportion of Resident Civilians Unemployed	
>5%	871 (19.98%)
Proportion of Blacks Below Poverty	
>10%	2,835 (65.02%)
Proportion of Whites Below Poverty	
>10%	1,675 (38.42%)

Note. SD=Standard Deviation
*Continuous Variable

Bivariate analyses were conducted to examine associations between the proportion of Blacks in census tracts and contextual covariates. The continuous, Proportion Black variable was dichotomized at the median. Census tracts with an average proportion of Blacks that was less than or equal to 10% (Low Group) were assigned a value of 0 and census tracts with average proportions of Blacks that was greater than 10% (High Group) were assigned a value of 1. The dichotomized variable served as the primary independent variable and all other level 2 variables served as dependent variables (Table 8).

Continuous variables were analyzed using independent samples t-tests. Analyses revealed significant differences between the High and Low groups for all dependent variables. All findings were statistically significant ($p=<.01$) but due to the large study sample, p-values may not represent significant differences. Sample means are displayed in Table 8. Census tracts representing the High Group had lower average median incomes, a lower mean number of owner-occupied homes, older housing.

Categorical variables for bivariate analysis of contextual variables were subject to chi-square tests. All associations were statistically significant ($p<.01$). The High Group had a higher proportion of female-headed households (85.2%) when compared to the Low Group (31.5%). Similar results were found when groups were compared by the proportion of residents in correctional institutions (Low Group, 28.1%; High Group, 32.4%). Proportions of Blacks and Whites in poverty were higher for the High Group (85.9%, 53.3%, respectively) when compared to the Low Group (42.8%, 22.6%, respectively). These findings point to associations between ethnicity and disparities in economic and physical environments that characterize neighborhoods.

Table 8

Distributions, P-Values and Chi Square Analyses for Contextual Covariates, by Proportion of Black Residents, in Census Tracts of Residence for Sample of Florida, Georgia and Louisiana Mothers 1999-2001 (N=4,360)

VARIABLE	**LOW (≤10%) (n = 2,110)**	**HIGH (>10 %) (n = 2,250)**	**STATISTIC**	***P*-VALUE**
***Median Income, mean (SD)**	8.27 (2.23)	6.01 (2.40)	$t = 32.16$	<.001
Median Income, n (%)				
0-$24999	212 (10.0)	996 (44.3)	$\chi^2 = 744.24$	<.001
$25,000 to $59,999	1,494 (70.8)	1,163 (51.7)		
$60,000 or higher	404 (19.1)	91 (4.0)		
***Proportion of Owner-Occupied Homes, mean (sd)**	0.77 (0.16)	0.58 (0.23)	$t = 31.98$	<.001
***Age of Housing, mean (sd)**	5.46 (1.40)	6.38 (1.47)	$t = -21.29$	<.001
***Proportion of Residents with High School Diploma**	0.29 (0.96)	0.30 (0.78)	$t = -5.47$	<.001
Household Vacancy, n (%)				
≤ 10%	1,342 (63.6)	1,329 (59.1)	$\chi^2 = 9.44$	<.001
> 10%	768 (36.4)	921 (40.9)		
***Proportion of Female-Headed Households n (%)**				
≤ 10%	1,446 (68.5)	332 (14.8)	$\chi^2 = 1303.85$	<.001
> 10%	664 (31.5)	1,918 (85.2)		
Proportion of Resident Civilians in Correctional Institutions n (%)				
= 0%	1,517 (71.9)	1,521 (67.6)	$\chi^2 = 9.51$	<.01
> 0%	593 (28.1)	729 (32.4)		
Proportion of Resident Civilians Unemployed n (%)				
≤ 5%	2,035 (96.4)	1,454 (64.6)	$\chi^2 = 689.79$	<.001
> 5%	75 (3.6)	796 (35.4)		
***Proportion of Blacks Below Poverty, n (%)**				
≤ 10%	1,207 (57.2)	318 (14.1)	$\chi^2 = 888.15$	<.001
> 10%	903 (42.8)	1,932 (85.9)		
Proportion of Whites Below Poverty, n (%)				
≤ 10%	1,634 (77.4)	1051 (46.7)	$\chi^2 = 434.62$	
> 10%	476 (22.6)	1,199 (53.3)		<.001

Note. SD=Standard Deviation. Means and Standard Deviations are included for continuous variables. For all dichotomous variables, the first group serves as referent group.

Independent Variables

Sixty-three metropolitan and micropolitan areas were analyzed in this study. Sixty-five percent of areas were metropolitan statistical areas and 35% of areas were micropolitan statistical areas. The Index of Dissimilarity captures the extent to which Blacks are unevenly distributed relative to an ideal degree of integration with Whites. The mean Dissimilarity Index for the study sample was 0.47 (SD .12; scores ranged from 0.20-0.69). This score indicates that 47% of Black residents of metropolitan and micropolitan statistical areas would have to move to achieve perfect representation and evenness in reference to Whites. Dissimilarity measures greater than 0.06 are considered hypersegregated (Glaeser & Vigdor, 2001). The distribution of Dissimilarity for the study sample was negatively skewed and relatively peaked, or leptokurtic (see Figure D). Leptokurtosis is associated with probability density functions that are peaked and have "fat" tails (Hatcher & Stepanski, 1994).

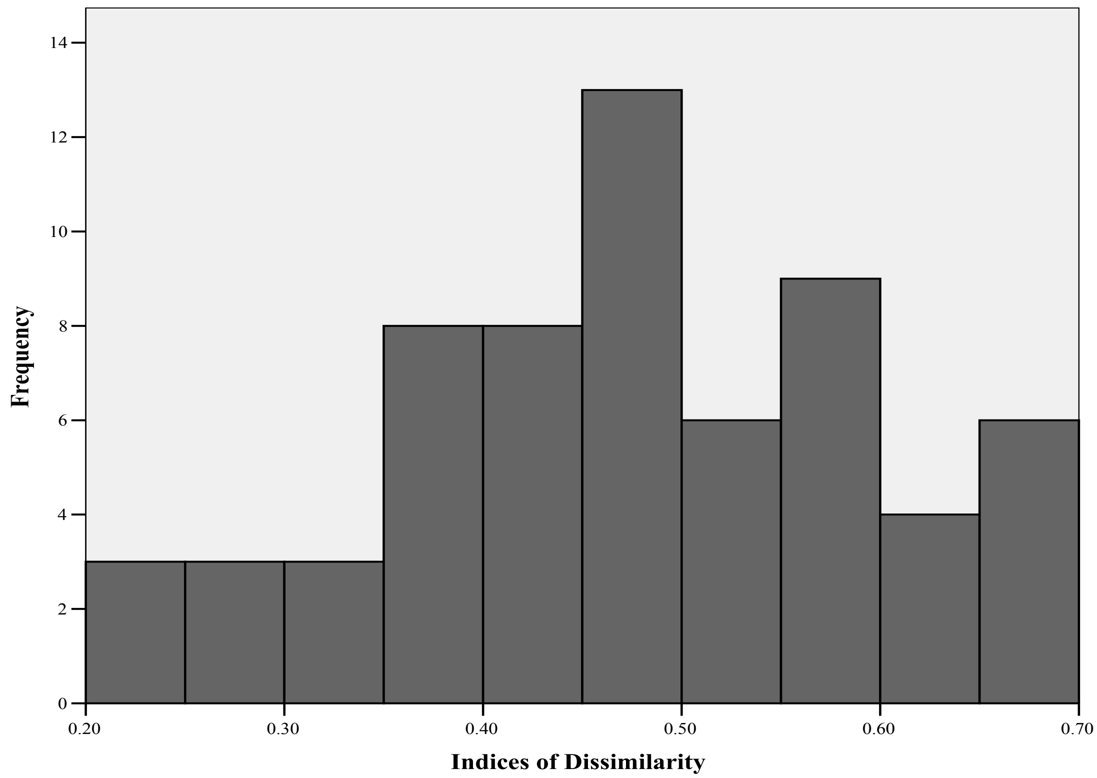


Figure D. Distribution of Dissimilarity Indices for Metropolitan and Micropolitan Statistical Areas occupied by Sample of Florida, Georgia and Louisiana Mothers 1999-2001 (N=63)

Table 9 includes metropolitan and micropolitan areas in order by increasing Dissimilarity. The most dissimilar areas were New-Orleans-Metairie-Kenner, Louisiana (0.69), followed by Chattanooga-Tennessee-Georgia (0.69) and Cape Coral-Fort Myers, Florida (0.67. Least dissimilar areas were Hinesville-Fort Stewart, Georgia (0.20), followed by Statesboro, Georgia (0.24) and Americus, Georgia (0.24).

Table 9

Distribution of Dissimilarity Indices, by Statistical Area Name and Increasing Dissimilarity, for Metropolitan and Micropolitan Statistical Areas occupied by Sample of Florida, Georgia and Louisiana Mothers 1999-2001 (N=63)

METROPOLITAN/ MICROPOLITAN STATISTICAL AREA	DISSIMILARITY
Hinesville-Fort Stewart, GA	0.20
Statesboro, GA	0.24
Americus, GA	0.24
Homosassa Springs, FL	0.25
Douglas, GA	0.27
Fort Walton Beach-Crestview-Destin, FL	0.30
Warner Robins, GA	0.30
Milledgeville, GA	0.32
Dublin, GA	0.34
Waycross, GA	0.37
Hammond, LA	0.37
Minden, LA	0.37
LaGrange, GA	0.38
Thomasville, GA	0.38
Punta Gordo, FL	0.39
Opelousas-Eunice, LA	0.39
Morgan City, LA	0.39
Gainesville, FL	0.41
Palatka, FL	0.41
New Iberia, LA	0.42
Tallahassee, FL	0.43
Bogalusa, LA	0.43
Athens-Clarke County, GA	0.44
Valdosta, GA	0.44
Augusta-Richmond County, GA-SC	0.44
Houma-Bayou Cane-Thibodaux, LA	0.46
Abbeville, LA	0.47
Palm Bay-Melbourne-Titusville, FL	0.47
Dalton, GA	0.47
Panama City-Lynn Haven, FL	0.48
Sebring, FL	0.48
Lafayette, LA	0.49
Ocala, FL	0.49
Crowley, LA	0.49
Natchez, MS-LA	0.49

Table 9 (Continued)

METROPOLITAN/ MICROPOLITAN STATISTICAL AREA	**DISSIMILARITY**
Key West-Marathon, FL	0.49
Ruston, LA	0.49
Pensacola-Ferry Pass-Brent, FL	0.50
Lakeland-Winter Haven, FL	0.51
Gainesville, GA	0.52
Jacksonville, FL	0.53
Macon, GA	0.53
Orlando, FL	0.54
Albany, GA	0.54
Savannah, GA	0.56
Brunswick, GA	0.56
Rome, GA	0.56
Shreveport-Bossier City, LA	0.56
Deltona-Daytona Beach-Ormond Beach, FL	0.56
Vero Beach, FL	0.57
Columbus, GA-AL	0.57
Port St. Lucie-Fort Pierce, FL	0.60
Baton Rouge, LA	0.60
Lake Charles, LA	0.62
Alexandria, LA	0.62
Tampa-St. Petersburg-Clearwater, FL	0.63
Atlanta-Sandy Springs-Marietta, GA	0.64
Sarasota-Bradenton-Venice, FL	0.65
Monroe, LA	0.66
Naples-Marco Island, FL	0.66
Cape Coral-Fort Myers, FL	0.67
Chattanooga, TN-GA	0.69
New Orleans-Metairie-Kenner, LA	0.69

The Isolation Index captures the extent to which Black residents are primarily surrounded by Whites or other Blacks. The mean Isolation Index for the study sample was 0.45 (SD 0.15; scores ranged from 0.04-0.74). This index reveals that the average Black resident lives in a census tract in which the Black share of the population exceeds the overall metropolitan and micropolitan average by approxiamately 45%. The distribution of Isolation for the study sample was negatively skewed and relatively peaked, or leptokurtic (see Figure E).

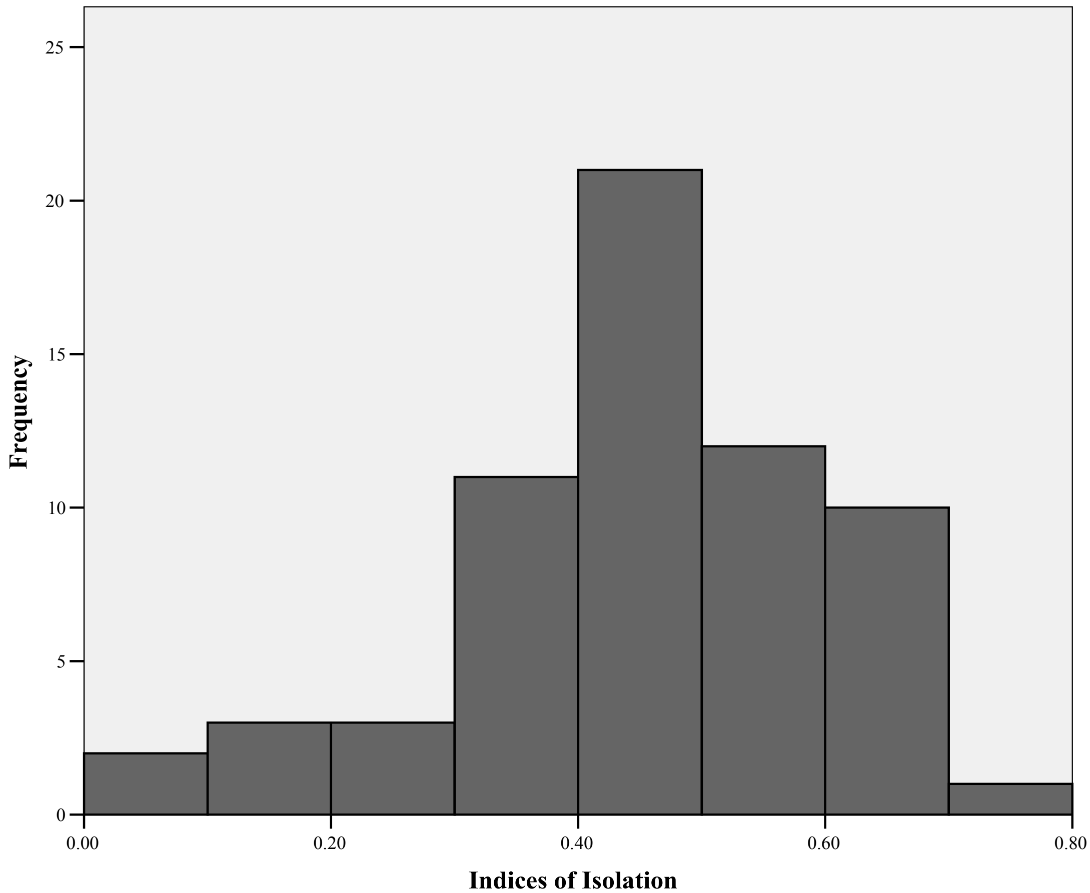


Figure E. Distribution of Isolation Indices for Metropolitan and Micropolitan Statistical Areas Occupied by Sample of Florida, Georgia and Louisiana Mothers 1999-2001 (N=63)

Table 10 includes metropolitan and micropolitan areas in order by increasing Isolation. The most isolated areas were New Orleans-Metairie-Kenner, Louisiana (0.74), followed by Monroe, Louisiana (0.70) and Albany, Georgia (0.69). Homosassa Springs, Florida (0.04) was the least isolated area, followed by Punta Gordo Florida, (0.09) and

Dalton, Florida (0.13).

Table 10

Distribution of Isolation Indices, by Statistical Area Name and Increasing Isolation, for Metropolitan and Micropolitan Statistical Areas Occupied by Sample of Florida, Georgia and Louisiana Mothers 1999-2001 (N=63)

METROPOLITAN/ MICROPOLITAN STATISTICAL AREA	**ISOLATION**
Homosassa Springs, FL	0.04
Punta Gordo, FL	0.09
Dalton, GA	0.13
Fort Walton Beach-Crestview-Destin, FL	0.16
Key West-Marathon, FL	0.18
Palm Bay-Melbourne-Titusville, FL	0.26
Sebring, FL	0.28
Gainesville, GA	0.29
Panama City-Lynn Haven, FL	0.31
Houma-Bayou Cane-Thibodaux, LA	0.32
Douglas, GA	0.33
Ocala, FL	0.34
Abbeville, LA	0.35
Palatka, FL	0.35
Warner Robins, GA	0.35
Statesboro, GA	0.36
Crowley, LA	0.36
Rome, GA	0.38
Pensacola-Ferry Pass-Brent, FL	0.39
Sarasota-Bradenton-Venice, FL	0.40
Lakeland-Winter Haven, FL	0.41
Gainesville, FL	0.41
Waycross, GA	0.41
Deltona-Daytona Beach-Ormond Beach, FL	0.42
Athens-Clarke County, GA	0.42
Hammond, LA	0.42
Naples-Marco Island, FL	0.42
LaGrange, GA	0.45
Orlando, FL	0.46
Vero Beach, FL	0.46
Tampa-St. Petersburg-Clearwater, FL	0.47

Table 10 (Continued)

METROPOLITAN/ MICROPOLITAN STATISTICAL AREA	**ISOLATION**
Morgan City, LA	0.48
Dublin, GA	0.48
Lafayette, LA	0.48
Brunswick, GA	0.48
Minden, LA	0.48
Bogalusa, LA	0.48
New Iberia, LA	0.49
Cape Coral-Fort Myers, FL	0.50
Thomasville, GA	0.50
Port St. Lucie-Fort Pierce, FL	0.51
Hinesville-Fort Stewart, GA	0.51
Tallahassee, FL	0.52
Valdosta, GA	0.53
Jacksonville, FL	0.53
Americus, GA	0.53
Augusta-Richmond County, GA-SC	0.54
Opelousas-Eunice, LA	0.55
Chattanooga, TN-GA	0.56
Milledgeville, GA	0.58
Lake Charles, LA	0.58
Ruston, LA	0.59
Alexandria, LA	0.60
Macon, GA	0.63
Savannah, GA	0.63
Baton Rouge, LA	0.64
Natchez, MS-LA	0.64
Shreveport-Bossier City, LA	0.64
Atlanta-Sandy Springs-Marietta, GA	0.66
Columbus, GA-AL	0.66
Albany, GA	0.69
Monroe, LA	0.70
New Orleans-Metairie-Kenner, LA	0.74

The mean proportion of Blacks in selected metropolitan and micropolitan areas was 0.24 (SD 0.13; scores ranged from 0.03-0.50). The distribution of the proportion of Blacks was positively skewed and relatively flat, or platykurtic (see Figure F). Platykurtosis is associated with probability density functions that are simultaneously peaked and have thin tails (Hatcher & Stepanski, 1994).

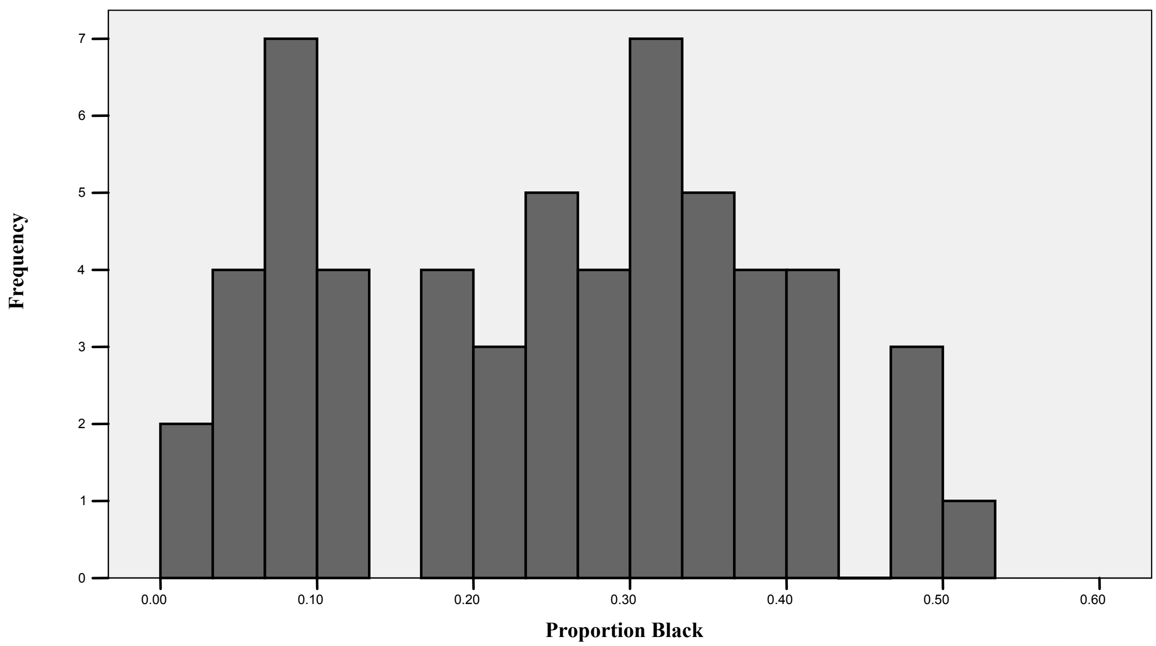


Figure F. Distribution of the Proportion of Blacks for Metropolitan and Micropolitan Statistical Areas Occupied by Sample of Florida, Georgia and Louisiana Mothers 1999-2001 (N=63)

Outcome Variables

Table 11 illustrates the distribution of outcome variables overall and by ethnicity. Overall, 9.12% of the sample delivered low birth weight infants, 9.77% delivered preterm infants, and 11.0% delivered small for gestational age infants. Black women were more likely to experience all adverse perinatal outcomes when compared to White women. Specifically, Black women had more than a two-fold likelihood of having LBW (95% CI: 2.17, 2.30) and SGA infants (95% CI: 2.22, 2.33) and were 1.50 times (95% CI: 1.50, 1.58) as likely to deliver a preterm infant when compared to White women.

Table 11

Distributions and Unadjusted Odds Ratio for Adverse Perinatal Outcomes Overall and by Ethnicity for Sample of Florida, Georgia and Louisiana Mothers 1999-2001 (N=255,548)

VARIABLE	TOTAL (N=255,548) N (%)	OR (95% CI)
LBW (<2,500 grams)		
White	10,721 (5.99%)	1.00
Black	9,537 (12.45%)	**2.23 (2.17-2.30)**
Preterm Delivery (< 37 weeks gestation)		
White	15,309 (8.55%)	1.00
Black	9,656 (12.61%)	**1.54 (1.50-1.58)**
SGA (<10th percentile of birthweight for gestational age)		
White	15,440 (8.63%)	1.00
Black	13,555 (17.70%)	**2.28 (2.22-2.33)**

Note. OR= Odds Ratio. CI=Confidence Interval

The mean LBW infant in the sample weighed 1981.45 grams (birthweight ranged from 500-2498 grams). The mean gestational age among preterm infants in the sample was 33.87 weeks. The distributions of preterm delivery and LBW were negatively skewed and leptokurtic. The majority of SGA births (85.90%) were term deliveries

Bivariate Analysis

Table 12 displays the frequency and percentage of LBW by each individual covariate. Black women were 2.23 times as likely (95% CI: 2.17, 2.30) to have a LBW infant when compared to White women. The mean age of women delivering LBW infants was 24.15 years. The greatest risk of LBW was found among women who were 15-19 years of age (OR 1.66, 95% CI: 1.59, 1.74) and those were at least 35 years old (OR 1.56, 95% CI: 1.47, 1.65). Women with less than a high school education (OR 1.28, 95% CI: 1.23, 1.33) were most likely to have a LBW infant when compared to those who had a high school diploma or higher. Similar findings were illustrated when marital status was examined; unmarried mothers were more likely (OR 1.74, 95% CI: 1.69, 1.79) to have a LBW infant when compared to those who were married. The risk of low birth weight decreased (OR 0.83, 95% CI: 0.81, 0.84) as prenatal care adequacy decreased. This finding may be due to the increased intensity of prenatal care targeted towards those who present with behavioral risk factors such as tobacco use, which increased the likelihood of LBW delivery (OR 1.47, 95% CI: 1.41, 1.54) when compared to non-smokers in this study.

Table 12

Bivariate Analysis of Low Birth Weight Live by Individual Covariates for Sample of Florida, Georgia and Louisiana Mothers 1999-2001 (N=20,258)

VARIABLE	LOW BIRTH WEIGHT (N=20,258)	OR (95% CI)
Ethnicity n (%)		
White	10,721 (52.92%)	1.00
Black	9,537 (47.08%)	**2.23 (2.17-2.30)**
Maternal Age, n (%)		
15-19 years	6,167 (30.4%)	**1.66 (1.59-1.74)**
20-24 years	5,896 (29.1%)	**1.26 (1.21-1.31)**
25-29 years	3,702 (18.3%)	1.00
30-34 years	2,731 (13.5%)	**1.08 (1.03-1.14)**
≥35 years	1,762 (8.7%)	**1.56 (1.47-1.65)**
Maternal Education, n (%)		
< High School	6,349 (26.9%)	**1.28 (1.23-1.33)**
= High School	8,004 (33.9%)	1.00
> High School	9,246 (39.2%)	**0.74 (0.71-0.76)**
Marital Status, n (%)		
Unmarried	8,442 (41.67%)	**1.74 (1.69-1.79)**
Married	11,816 (58.33%)	1.00 (1.00, 1.00)
[a]**Prenatal Care Adequacy, mean (SD)**	1.24 (0.78)	**0.83 (0.81-0.84)**
Cigarette Use During Pregnancy, n (%)		
No	2,530 (12.49%)	1.00
Yes	17,728 (87.51%)	**1.47 (1.41-1.54)**

Note. OR=Odds Ratio. CI=Confidence Interval. SD=Standard Deviation. Means and standard deviations are presented for ordinal variables with ≥5 categories that were treated as continuous because variable dichotomization or creation of artificial categories can often decrease effect size and statistical power (MacCallum, Zhang, Preacher, & Rucker, 2002).
[a]Prenatal Care Adequacy, Mean (Standard Deviation). Measured using The Graduate Index of Prenatal Care Utilization Index.

Table 13 displays the frequency and percentage of preterm delivery by each individual covariate. Black women were 1.54 times more likely to deliver a preterm infant than White women (OR 1.54, 95% CI: 1.50, 1.58). The mean age of women delivering preterm infants was 24.69 years. The greatest risk of preterm delivery was found among women who were 15-19 years of age (OR 1.28, 95% CI: 1.23, 1.33) and those were at least 35 years old (OR 1.40, 95% CI: 1.33, 1.48). Mothers with less than a high school education (OR 1.17, 95% CI: 1.13, 1.21) and those who were unmarried (OR 1.27, 95% CI: 1.24, 1.30) were more likely to have a preterm infant when compared to those who were high school graduates or were married, respectively. Decreased prenatal care adequacy resulted in the decreased likelihood of preterm delivery (OR 0.68, 95% CI: 0.67, 0.69). This finding may be related to increased prenatal care intensity targeted towards those who may be at risk for adverse birth outcomes based on sociodemographic or behavioral factors. Mothers who smoked were more likely to delivery preterm infants than those who did not smoke (OR 1.05, 95% CI: 1.01, 1.10).

Table 13

Bivariate Analysis of Preterm Live Births by Individual Covariates for Sample of Florida, Georgia and Louisiana Mothers 1999-2001 (N=20,258)

VARIABLE	**PRETERM DELIVERIES (N=24,965)**	**OR (95% CI)**
Ethnicity		
White	15,309 (61.32%)	1.00
Black	9,656 (38.68%)	**1.54 (1.50-1-58)**
Maternal Age, n (%)		
15-19 years	6,721 (26.9%)	**1.28 (1.23-1.33)**
20-24 years	6,900 (27.6%)	**1.04 (1.00-1.08)**
25-29 years	5,162 (20.7%)	1.00
30-34 years	3,976 (15.9%)	**1.14 (1.09-1.19)**
≥35 years	2,206 (8.8%)	**1.40 (1.33-1.48)**
Maternal Education, n (%)		
< High School	6,736 (23.3%)	**1.17 (1.13-1.21)**
= High School	9,227 (31.9%)	1.00
≥High School	12,964 (44.8%)	**0.91 (0.89-0.94)**
Marital Status, n (%)		
Unmarried	12,726 (50.98%)	**1.27 (1.24-1.30)**
Married	12,239 (49.02%)	1.00
[a]**Prenatal Care Adequacy, mean (SD)**	**1.16 (0.75)**	**0.68 (0.67-0.69)**
Cigarette Use During Pregnancy, n (%)		
No	2,374 (9.51%)	1.00
Yes	22,591 (90.49%)	**1.05 (1.01-1.10)**

Note. OR=Odds Ratio. CI=Confidence Interval. SD=Standard Deviation. Means and standard deviations are presented for ordinal variables with ≥5 categories that were treated as continuous because variable dichotomization or creation of artificial categories can often decrease effect size and statistical power (MacCallum, Zhang, Preacher, & Rucker, 2002).

[a]Prenatal Care Adequacy, Mean (Standard Deviation). Measured using The Graduate Index of Prenatal Care Utilization Index

Table 14 displays the frequencies and percentages of SGA births by each individual covariate. Black women were 2.27 times as likely (95% CI: 2.22, 2.33) to deliver an SGA infant when compared to White women. The mean age of women delivering SGA infants was 23.64 years. The greatest risk of SGA was found among women who were 15-19 years of age (OR 1.87, 95% CI: 1.80, 1.93) followed by those were 20-24 years of age (OR 1.43, 95% CI: 1.38, 1.49). Those with less than a high school education (OR 1.31, 95% CI: 1.27, 1.35) and those who were unmarried (OR 1.91, 95% CI: 1.86, 1.96) were more likely to have an SGA infant when compared to those with at least a high school diploma or those who were married, respectively. Only for the SGA birth outcome did decreased prenatal care adequacy result in increased risk (1.12, 95% CI: 1.10, 1.14). Smokers were 1.80 times more likely (95% CI: 1.74, 1.87) to deliver an SGA infant when compared to those who did not smoke during pregnancy.

Table 14

Bivariate Analysis of Small for Gestational Age Births by Individual Covariates for Sample of Florida, Georgia and Louisiana Mothers 1999-2001 (N=28,998)

VARIABLE	TOTAL SGA BIRTHS (N=28,998)	OR (95% CI)
Ethnicity, n (%)		
White	15,440 (53.25%)	1.00
Black	13,555 (46.75%)	**2.28 (2.22-2.33)**
Maternal Age, n (%)		
15-19 years	9,249 (31.9%)	**1.87 (1.80-1.93)**
20-24 years	9,078 (31.3%)	**1.43 (1.38-1.49)**
25-29 years	5,108 (17.6%)	1.00
30-34 years	3,496 (12.1%)	1.00 (0.95-1.04)
≥ 35 years	2,064 (7.1%)	**1.31 (1.24-1.37)**
Maternal Education, n (%)		
< High School	9,504 (27.8%)	**1.31 (1.27-1.35)**
= High School	11,860 (34.7%)	1.00
≥High School	12,797 (37.5%)	**0.67 (0.65-0.69)**
Marital Status, n (%)		
Unmarried	11,648 (40.17%)	**1.91 (1.86-1.96)**
Married	17,347 (59.83%)	1.00
[a]Prenatal Care Adequacy, mean (SD)	1.39 (.778)	**1.12 (1.10-1.14)**
Cigarette Use During Pregnancy, n (%)		
No	24,852 (85.71%)	1.00
Yes	4,143 (14.29%)	**1.80 (1.74-1.87)**

Note. OR=Odds Ratio. CI=Confidence Interval. SD=Standard Deviation. Means and standard deviations are presented for ordinal variables with ≥5 categories that were treated as continuous because variable dichotomization or creation of artificial categories can often decrease effect size and statistical power (MacCallum, Zhang, Preacher, & Rucker, 2002).
[a]Prenatal Care Adequacy, Mean (Standard Deviation). Measured using The Graduate Index of Prenatal Care Utilization Index. Each unit increase indicating decreased prenatal care adequacy

Multilevel Modeling Analysis

Hypothesis One: The level of residential segregation is positively associated with the likelihood of adverse birth outcomes after controlling for contextual and individual factors.

Multilevel models were used to determine the association between residential segregation on LBW, preterm birth delivery and SGA birth. In each model, Level 1 variables served as predictors for the outcome, while Level 2 and Level 3 variables served as predictors of the intercept (i.e., the intercept was allowed to vary across the Level 2 and Level 3 variables[2]). Parameter estimates were not appreciably different across outcomes. The intercepts for each model were significant (p <.01), indicating that the grand intercepts were different from zero. This represents the average log odds of each outcome.

Low Birth Weight

Table 15 provides the parameter estimates for the association between residential segregation and LBW. Given the large sample size, there was adequate statistical power to detect small effects. Each variable represented its effect on the average probability of LBW, or the slope of the intercept. There was no statistically significant evidence (p > .05) supporting the relationship between residential segregation indices (Dissimilarity, p=0.49; Isolation, p=0.51), other structural variables (Area Size, p=0.36; Proportion Black, p=0.71) and average LBW, after accounting for other variables in the model.

[2] In a three-level multilevel model, the Level I intercept is set by the researcher to vary randomly across the Levels II and III groups so the extent to which the dependent variable varies across the Level II groups (e.g. neighborhoods) can be assessed.

Median income, the proportion of owner-occupied homes, the proportion of residents with a high school diploma and the proportion of Whites living below the poverty level were significant contextual predictors of LBW ($p < .01$). Findings indicated that both low (0-$24,000) and high (≥ $60,000 or more) median income tertiles were associated with increased risk of LBW (OR 1.12, 95% CI: 1.05, 1.21 and OR 1.14, 95% CI: 1.04, 1.26, respectively). Women who lived in census tracts where greater than 10% of homes were owner-occupied were 1.14 times more likely to have a LBW infant (95% CI: 1.04, 1.26) when compared to those in neighborhoods where <10% of residents were Black. The odds of LBW increased 1.34 times (95% CI: 1.10, 1.62) for each unit increase in the proportion of high school diplomas attained in a census tract. Women living in census tracts where greater than 10% of White residents were in poverty were more likely to have LBW infants (OR 1.06, 95% CI: 1.03, 1.10).

All individual-level variables were significantly associated with LBW ($p<0.01$). Women 35 years old or older were most likely to have a LBW infant (OR 1.65, 95% CI: 1.55, 1.76) when compared to women 25-29 years of age. Mothers with less than a high school education were most likely to have a LBW infant (OR 1.18, 95% CI: 1.12, 1.24) when compared to women with at least a high school education. Unmarried mothers were 1.24 times as likely (95% CI: 1.20, 1.28) as married mothers to deliver a LBW infant. Increased prenatal care adequacy resulted in 1.34 times (95% CI: 1.27, 1.41) the odds of LBW, after accounting for other variables in the model. Smokers were 1.71 times more likely to have a LBW infant when compared to non-smokers (95% CI: 1.63, 1.80). With regard to ethnicity, Black women were 2.20 times as likely (95% CI: 2.11, 2.30) as White women to have a LBW infant in the sample.

Table 15

Parameter Estimates for Total Sample: Multilevel Analysis of the Effects of Residential Segregation on Low Birth Weight for Sample of Florida, Georgia and Louisiana Mothers 1999-2001

	LOW BIRTH WEIGHT	
	OR	**95% CI**
LEVEL 3		
Intercept	**0.01**	**0.01, 0.02**
Area Size		
Metropolitan	1.00	1.00, 1.00
Micropolitan	1.04	.95, 1.15
***Dissimilarity**	0.81	0.42, 1.56
***Isolation**	1.27	0.54, 3.00
***Proportion Black**	1.14	0.53, 2.48
LEVEL 2		
***Proportion Black**	0.99	0.89, 1.09
Median Income		
0-$24,999	**1.12**	**1.05, 1.21**
$25,000-$59,999	1.00	1.00, 1.00
≥$60,000	**1.12**	**1.07, 1.18**
***Proportion of Owner-Occupied Homes**	**1.14**	**1.04, 1.26**
Household Vacancy		
≤ 10%	1.00	1.00, 1.00
> 10%	1.01	0.98, 1.05
***Age of Housing**	1.00	0.99, 1.01
Proportion of Female-Headed Households		
≤ 10%	1.00	1.00, 1.00
> 10%	1.02	0.98, 1.06
Proportion in Correctional Institutions		
> 10%	1.00	1.00, 1.00
> 10%	1.00	0.96, 1.04
Proportion of Resident Civilians Unemployed		
≤ 5%	1.00	1.00, 1.00
> 5%	1.04	0.99, 1.09

Note. OR=Odds Ratio. CI=Confidence Interval.
*Continuous Variable

Table 15 (Continued)

	LOW BIRTH WEIGHT	
	OR	**95% CI**
LEVEL 1		
***Proportion of Residents with High School Diploma**	**1.34**	**1.10, 1.62**
Proportion of Blacks Below Poverty		
≤ 10%	1.00	1.00, 1.00
> 10%	1.03	0.99, 1.06
Proportion of Whites Below Poverty		
≤ 10%	1.00	1.00, 1.00
> 10%	**1.06**	**1.03, 1.10**
Maternal Age		
15-19 years	**0.90**	**0.84, 0.96**
20-24 years	**0.89**	**0.84, 0.95**
25-29 years	1.00	1.00, 1.00
30-34 years	**1.19**	**1.13, 1.25**
≥35 years	**1.65**	**1.55, 1.76**
Maternal Education		
< High School	**1.18**	**1.12, 1.24**
= High School	1.00	1.00, 1.00
> High School	**0.82**	**0.80, 0.84**
Marital Status		
Unmarried	**1.24**	**1.20, 1.28**
Married	1.00	1.00, 1.00
***Prenatal Care Adequacy**	**1.34**	**1.27, 1.41**
Cigarette Use During Pregnancy		
No	1.00	1.00, 1.00
Yes	**1.71**	**1.63, 1.80**
Ethnicity		
Black	**2.20**	**2.11, 2.30**
White	1.00	1.00, 1.00

Note. OR=Odds Ratio. CI=Confidence Interval.
*Continuous Variable

Preterm Delivery

Similar to findings for the LBW model, residential segregation and other structural variables were not associated with the increased likelihood of preterm delivery after controlling for other factors. These findings were illustrated by no statistically significant relationship ($p > .05$) between each residential segregation variable (Dissimilarity, p=0.19; Isolation, p=0.38), other structural variables (Area size, p=0.44; Proportion Black, p=0.84) and preterm delivery (Table 16).

The likelihood of LBW was significantly associated with several contextual and individual variables in this model. The proportion of residents with a high school diploma were significantly ($p<.05$) associated with preterm delivery. The odds of preterm delivery increased 1.54 times (95% CI: 1.21, 1.96) for each unit increase in the proportion of residents with a high school diploma. All individual-level variables were significantly associated with preterm delivery ($p<0.01$). Women 35 years or older were most likely to experience preterm delivery (OR 1.45, 95% CI: OR 1.39, 1.51) when compared women 25-29 years of age. Women with less than a high school education were more likely to have a preterm delivery (OR 1.18, 95% CI: 1.11, 1.25) when compared to women with a high school diploma. Unmarried mothers were 1.17 times more likely (95% CI: 1.12, 1.22) to experience preterm delivery as compared to married mothers. Each unit increase in prenatal adequacy was associated with a 1.59 times the likelihood of preterm delivery (95% CI: 1.48, 1.71). Women who smoked cigarettes during pregnancy were 1.14 times as likely (95% CI: 1.06, 1.22) to have a preterm infant as compared to non-smokers. Blacks were 1.53 times (95% CI: 1.47, 1.59) more likely to have a preterm infant as compared to Whites in the sample, after controlling for other variables in the model.

Table 16

Parameter Estimates for Total Sample: Multilevel Analysis of the Effects of Residential Segregation on Preterm Delivery for Sample of Florida, Georgia and Louisiana Mothers 1999-2001

	PRETERM DELIVERY	
	OR	**95% CI**
LEVEL 3		
Intercept	**0.01**	**0.01, 0.02**
Area Size		
Metropolitan	1.00	1.00, 1.00
Micropolitan	0.95	0.84, 1.07
***Dissimilarity**	0.50	0.22, 1.17
***Isolation**	1.71	0.56, 5.18
***Proportion Black**	1.14	0.38, 3.44
LEVEL 2		
***Proportion Black**	0.97	0.84, 1.12
Median Income		
0-$24,999	1.03	0.95, 1.13
$25,000-$59,999	1.00	1.00, 1.00
≥$60,000	1.04	1.00, 1.08
***Proportion of Owner-Occupied Homes**	1.08	1.00, 1.17
Household Vacancy		
≤ 10%	1.00	1.00, 1.00
> 10%	1.02	1.00, 1.05
***Age of Housing**	0.99	0.98, 1.00
Proportion of Female-Headed Households		
≤ 10%	1.00	1.00, 1.00
> 10%	1.04	1.00, 1.08
Proportion in Correctional Institutions		
> 10%	1.00	1.00, 1.00
> 10%	1.01	0.96, 1.06
Proportion of Resident Civilians Unemployed		
≤ 5%	1.00	1.00, 1.00
> 5%	1.03	0.99, 1.08
***Proportion of Residents with High School Diploma**	**1.54**	**1.21, 1.96**

Note. OR=Odds Ratio. CI=Confidence Interval.
*Continuous Variable

Table 16 (Continued)

Proportion of Blacks Below Poverty		
≤ 10%	1.00	1.00, 1.00
> 10%	1.01	0.98, 1.04
Proportion of Whites Below Poverty		
≤ 10%	1.00	1.00, 1.00
> 10%	1.01	0.98, 1.05
LEVEL 1		
Maternal Age		
15-19 years	**0.93**	**0.89, 0.99**
20-24 years	**0.89**	**0.86, 0.92**
25-29 years	1.00	1.00, 1.00
30-34 years	**1.20**	**1.15, 1.24**
≥35 years	**1.45**	**1.39, 1.51**
Maternal Education		
< High School	**1.18**	**1.11, 1.25**
= High School	1.00	1.00, 1.00
> High School	**0.90**	**0.87, 0.93**
Marital Status		
No	**1.17**	**1.12, 1.22**
Yes	1.00	1.00, 1.00
***Prenatal Care Adequacy**	**1.59**	**1.48, 1.71**
Cigarette Use During Pregnancy		
Unmarried	1.00	1.00, 1.00
Married	**1.14**	**1.06, 1.22**
Ethnicity		
Black	**1.53**	**1.47, 1.59**
White	1.00	1.00, 1.00

Note. OR=Odds Ratio. CI=Confidence Interval.
*Continuous Variable

Small for Gestational Age Birth

No residential segregation (Dissimilarity, p=0.76; Isolation, p=0.69) or structural variables (Area Size, p=0.57; Proportion Black, p=0.22) were significantly associated with SGA births (Table 17). Several contextual variables in this model were significantly associated with SGA. Census tracts with an average income of $0-$24,999 were associated with increased risk of SGA births (OR 1.13, 1.06, 1.21). Each unit increase in the proportion of individuals with at least a high school diploma was associated with an increase an SGA births (OR 1.38, 95% CI: 1.14, 1.67). All individual level factors were significantly associated with SGA with the exception of prenatal care adequacy (OR 1.00, 95% CI: 0.98, 1.02).

Table 17

Parameter Estimates for Total Sample: Multilevel Analysis of the Effects of Residential Segregation on Small for Gestational Age Births for Sample of Florida, Georgia and Louisiana Mothers 1999-2001

	SMALL FOR GESTATIONAL AGE BIRTH	
	OR	**95% CI**
LEVEL 3		
Intercept	**0.06**	**0.05, 0.07**
Area Size		
Metropolitan	1.00	1.00, 1.00
Micropolitan	1.02	0.95, 1.10
***Dissimilarity**	1.08	0.64, 1.82
***Isolation**	0.89	0.49, 1.63
***Proportion Black**	1.45	0.79, 2.69
LEVEL 2		
***Proportion Black**	0.97	0.91, 1.02
Median Income		
0-$24,999	**1.13**	**1.06, 1.21**
$25,000-$59,999	1.00	1.00, 1.00
≥$60,000	**1.07**	**1.03, 1.12**
***Proportion of Owner-Occupied Homes**	**1.09**	**1.03, 1.16**
Household Vacancy		
≤ 10%	1.00	1.00, 1.00
> 10%	0.99	0.96, 1.02
***Age of Housing**	**1.01**	**1.00, 1.03**
Proportion of Female-Headed Households		
≤ 10%	1.00	1.00, 1.00
> 10%	0.98	0.94, 1.02
Proportion in Correctional Institutions		
> 10%	1.00	1.00, 1.00
> 10%	1.00	0.97, 1.03

Note. OR=Odds Ratio. CI=Confidence Interval.
*Continuous Variable

Table 17 (Continued)

	SMALL FOR GESTATIONAL AGE BIRTH	
	OR	**95% CI**
Proportion of Resident Civilians Unemployed		
$\leq$ 5%	1.00	1.00, 1.00
> 5%	1.02	0.98, 1.07
***Proportion of Residents with High School Diploma**	**1.38**	**1.14, 1.67**
Proportion of Blacks Below Poverty		
$\leq$ 10%	1.00	1.00, 1.00
> 10%	1.01	0.97, 1.04
Proportion of Whites Below Poverty		
$\leq$ 10%	1.00	1.00, 1.00
> 10%	1.04	1.01, 1.07
LEVEL 1		
Maternal Age		
15-19 years	1.00	0.94, 1.07
20-24 years	1.02	0.98, 1.06
25-29 years	1.00	1.00, 1.00
30-34 years	**1.09**	**1.05, 1.14**
$\geq$35 years	**1.39**	**1.32, 1.46**
Maternal Education		
< High School	**1.11**	**1.07, 1.14**
= High School	1.00	1.00, 1.00
> High School	**0.82**	**0.80, 0.85**
Marital Status		
Unmarried	**1.18**	**1.14, 1.21**
Married	1.00	1.00, 1.00
***Prenatal Care Adequacy**	1.00	0.98, 1.02
Cigarette Use During Pregnancy		
No	1.00	1.00, 1.00
Yes	**2.06**	**1.95, 2.18**
Ethnicity		
Black	**2.19**	**2.07, 2.33**
White	1.00	1.00, 1.00

Note. OR=Odds Ratio. CI=Confidence Interval.
*Continuous Variable

Findings for the main effects of residential segregation on adverse perinatal outcomes were not supported in multilevel models tested; there were no significant effects ($p > .05$) of segregation on dependent variables after individual and contextual covariates were included in models. Direct effects of contextual and individual effects were weak to moderate. The strongest contextual effect was found for the positive relationship between the proportion of high school graduates and each adverse perinatal outcome. The individual risk factors associated with the greatest risk for adverse perinatal outcomes were maternal ages of 35 years or older, smoking during pregnancy and Black ethnicity.

Hypothesis Two: The relationship between residential segregation and the increased likelihood of adverse perinatal outcomes is moderated by ethnicity.

Hypothesis Two was tested to examine whether residential segregation variables differentially impacted adverse perinatal outcomes conditional by ethnicity. A random intercept model was developed to allow the slope for ethnicity (Level 1) to randomly vary across all structural variables (Level 3) to examine the impact of residential segregation and ethnicity on perinatal outcomes (i.e., Level 3 variables served as predictors of the slope of ethnicity[3]). Significant results were found for the moderating effect of ethnicity on the relationship between neighborhood Isolation and LBW. Statistically significant support was also found for cross-level interactions between ethnicity and statistical area size in the preterm delivery model

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[3] In a three-level multilevel model, the slope of an independent variable is set by the researcher to vary randomly across Level II and III variables in order to assess the extent to which the magnitude of the relationship between the independent variable and the dependent variable varies across neighborhoods.

Low Birth Weight

Table 18 provides the parameter estimates for the moderating effects of ethnicity. For Black women, decreased LBW was associated with each unit increase in the Index of Isolation (OR 0.36, 95% CI: 0.15, 0.87, p=0.02). Cross-level interactions between ethnicity and Area Size, Dissimilarity and Proportion Black, respectively, were non-significant (p>.05).

Table 18

Parameter Estimates for Random Effects of Ethnicity: Multilevel Analysis of Moderating Effects on the Relationship Between Residential Segregation and Low Birth Weight for Sample of Florida, Georgia and Louisiana Mothers 1999-2001

	LOW BIRTH WEIGHT	
	OR	**95% CI**
LEVEL 3		
Intercept	**0.01**	**0.01, 0.02**
Area Size		
Metropolitan	1.00	1.00, 1.00
Micropolitan	1.01	0.89, 1.15
***Dissimilarity**	0.77	0.36, 1.65
***Isolation**	1.49	0.58, 3.84
***Proportion Black**	1.04	0.42, 2.55
LEVEL 2		
***Proportion Black**	1.02	0.92, 1.13
Median Income		
0-$24999	**1.12**	**1.05, 1.20**
$25,000-$59,999	1.00	1.00, 1.00
≥$60,000	**1.13**	**1.08, 1.19**
***Proportion of Owner-Occupied Homes**	**1.14**	**1.04, 1.25**
Household Vacancy		
≤ 10%	1.00	1.00, 1.00
> 10%	1.01	0.98, 1.05

Note. OR=Odds Ratio. CI=Confidence Interval.
*Continuous Variable

Table 18 (Continued)

	LOW BIRTH WEIGHT	
	OR	**95% CI**
LEVEL 3		
***Age of Housing**	1.00	0.99, 1.01
Proportion of Female-Headed Households		
$\leq$ 10%	1.00	1.00, 1.00
> 10%	1.01	0.97, 1.06
Proportion in Correctional Institutions		
> 10%	1.00	1.00, 1.00
> 10%	1.00	0.96, 1.04
Proportion of Resident Civilians Unemployed		
$\leq$ 5%	1.00	1.00, 1.00
> 5%	1.04	0.99, 1.09
***Proportion of Residents with High School Diploma**	**1.35**	**1.11, 1.65**
Proportion of Blacks Below Poverty		
$\leq$ 10%	1.00	1.00, 1.00
> 10%	1.02	0.99, 1.06
Proportion of Whites Below Poverty		
$\leq$ 10%	1.00	1.00, 1.00
> 10%	**1.06**	**1.03, 1.10**
Maternal Age		
15-19 years	**0.90**	**0.84, 0.96**
20-24 years	**0.89**	**0.84, 0.95**
25-29 years	1.00	1.00, 1.00
30-34 years	**1.19**	**1.13, 1.25**
$\geq$35 years	**1.65**	**1.55, 1.76**
Maternal Education		
< High School	**1.18**	**1.12, 1.23**
= High School	1.00	1.00, 1.00
> High School	**0.82**	**0.80, 0.84**
Marital Status		
Unmarried	**1.24**	**1.20, 1.28**
Married	1.00	1.00, 1.00
***Prenatal Care Adequacy**	**1.34**	**1.27, 1.41**
Cigarette Use During Pregnancy		
No	1.00	1.00, 1.00
Yes	**1.72**	**1.63, 1.81**
Ethnicity		
Black	**2.41**	**2.04, 2.85**
White	1.00	1.00, 1.00
MODERATING EFFECTS OF ETHNICITY		
Ethnicity x Area Size		
Metropolitan	1.00	1.00, 1.00
Micropolitan	1.07	0.92, 1.24
Ethnicity x Dissimilarity	1.71	0.86, 3.37
Ethnicity x Isolation	**0.36**	**0.15, 0.87**
Ethnicity x Proportion Black	1.85	0.85, 4.04

Note. OR=Odds Ratio. CI=Confidence Interval.
*Continuous Variable

Preterm Delivery

The preterm model random effect model indicated that while residential segregation indicators did not have a significant effect, one structural, level-3 variable did demonstrate a significant influence on preterm delivery (Table 19). These findings were illustrated by non-significant ($p > .05$) cross-level interactions between each residential segregation variable (Dissimilarity, $p=0.12$; Isolation, $p=0.30$) and preterm delivery. Area size was significantly associated with the likelihood of preterm delivery such that residence in micropolitan statistical areas was associated with increased risk of preterm delivery among Black women when compared to White women (OR 0.87, 95% CI: 0.77, 0.99, $p<.01$). The proportion of Blacks within census tracts was non-significant ($p=0.93$).

Table 19

Parameter Estimates for Random Effects of Ethnicity: Multilevel Analysis of Moderating Effects on the Relationship Between Residential Segregation and Preterm Delivery for Sample of Florida, Georgia and Louisiana Mothers 1999-2001

	PRETERM DELIVERY	
	OR	**95% CI**
LEVEL 3		
Intercept	**0.01**	**0.01, 0.02**
Area Size		
Metropolitan	1.00	1.00, 1.00
Micropolitan	**0.87**	**0.77, 0.99**
***Dissimilarity**	0.43	0.17, 1.11
***Isolation**	1.95	0.62, 6.12
***Proportion Black**	0.94	0.28, 3.12
LEVEL 2		
***Proportion Black**	0.98	0.85, 1.13
Median Income		
0-$24,999	1.03	0.95, 1.12
$25,000-$59,999	1.00	1.00, 1.00
≥$60,000	1.04	1.00, 1.08
***Proportion of Owner-Occupied Homes**	1.08	1.00, 1.16
Household Vacancy		
≤ 10%	1.00	1.00, 1.00
> 10%	1.02	1.00, 1.05
***Age of Housing**	0.99	0.98, 1.00
Proportion of Female-Headed Households		
≤ 10%	1.00	1.00, 1.00
> 10%	1.04	1.00, 1.08
Proportion in Correctional Institutions		
> 10%	1.00	1.00, 1.00
> 10%	1.01	0.96, 1.06
LEVEL 1		
Proportion of Resident Civilians Unemployed		
≤ 5%	1.00	1.00, 1.00
> 5%	1.03	0.99, 1.08
***Proportion of Residents with High School Diploma**	**1.55**	**1.22, 1.97**
Proportion of Blacks Below Poverty		
≤ 10%	1.00	1.00, 1.00
> 10%	1.01	0.98, 1.04
Proportion of Whites Below Poverty		
≤ 10%	1.00	1.00, 1.00
> 10%	1.02	0.98, 1.05

Note. OR=Odds Ratio. CI=Confidence Interval.
*Continuous Variable

Table 19 (Continued)

	PRETERM DELIVERY	
	OR	**95% CI**
Maternal Age		
15-19 years	**0.93**	**0.89, 0.99**
20-24 years	**0.89**	**0.86, 0.92**
25-29 years	1.00	1.00, 1.00
30-34 years	**1.19**	**1.15, 1.24**
≥35 years	**1.45**	**1.39, 1.51**
Maternal Education		
< High School	**1.18**	**1.11, 1.25**
= High School	1.00	1.00, 1.00
> High School	**0.90**	**0.87, 0.93**
Marital Status		
Unmarried	**1.17**	**1.12, 1.22**
Married	1.00	1.00, 1.00
***Prenatal Care Adequacy**	**1.59**	**1.48, 1.71**
Cigarette Use During Pregnancy		
No	1.00	1.00, 1.00
Yes	**1.14**	**1.06, 1.22**
Ethnicity		
Black	**1.33**	**1.06, 1.67**
White	1.00	1.00, 1.00
MODERATING EFFECTS OF ETHNICITY		
Ethnicity x Area Size		
Metropolitan	1.00	1.00, 1.00
Micropolitan	**1.23**	**1.08, 1.41**
Ethnicity x Dissimilarity	1.94	0.84, 4.51
Ethnicity x Isolation	0.47	0.17, 1.33
Ethnicity x Proportion Black	1.94	0.68, 5.57

Note. OR=Odds Ratio. CI=Confidence Interval.
*Continuous Variable

Small for Gestational Age Birth

Table 20 illustrates parameter estimated developed to test moderating effects of ethnicity on the relationship between residential segregation and SGA births. Results did not support Hypotheses Two. Residential segregation (Dissimilarity, p=0.66; Isolation, p=0.10) and other structural variables (Area Size, p=0.46; Proportion Black, p=0.70) were not significantly associated with ethnicity in cross-level interactions.

Table 20

Parameter Estimates for Random Effects of Ethnicity: Multilevel Analysis of Moderating Effects on the Relationship Between Residential Segregation and Small for Gestational Age Births for Sample of Florida, Georgia and Louisiana Mothers 1999-2001

	SMALL FOR GESTATIONAL AGE BIRTH	
	OR	**95% CI**
LEVEL 3		
Intercept	**0.05**	**0.04, 0.06**
Area Size		
Metropolitan	1.00	1.00, 1.00
Micropolitan	1.04	0.95, 1.15
***Dissimilarity**	1.22	0.66, 2.27
***Isolation**	0.90	0.44, 1.83
***Proportion Black**	1.67	0.80, 3.52
LEVEL 2		
***Proportion Black**	1.00	0.95, 1.06
Median Income		
0-$24999	**1.13**	**1.05, 1.20**
$25,000-$59,999	1.00	1.00, 1.00
≥$60,000	**1.08**	**1.04, 1.12**
***Proportion of Owner-Occupied Homes**	**1.09**	**1.02, 1.15**
Household Vacancy		
≤ 10%	1.00	1.00, 1.00
> 10%	0.99	0.97, 1.02
***Age of Housing**	**1.01**	**1.00, 1.03**
LEVEL 3		
Proportion of Female-Headed Households		
≤ 10%	1.00	1.00, 1.00
> 10%	0.97	0.93, 1.02

Note. OR=Odds Ratio. CI=Confidence Interval.
*Continuous Variable

Table 20 (Continued)

	SMALL FOR GESTATIONAL AGE BIRTH	
Proportion in Correctional Institutions		
> 10%	1.00	1.00, 1.00
> 10%	1.00	0.97, 1.03
Proportion of Resident Civilians Unemployed		
≤ 5%	1.00	1.00, 1.00
> 5%	1.02	0.98, 1.07
***Proportion of Residents with High School Diploma**	**1.39**	**1.15, 1.68**
***Proportion of Blacks Below Poverty**		
≤ 10%	1.00	1.00, 1.00
> 10%	1.00	0.97, 1.04
Proportion of Whites Below Poverty		
≤ 10%	1.00	1.00, 1.00
> 10%	**1.04**	1.00, 1.00
LEVEL 1		
Maternal Age		
15-19 years	1.00	0.94, 1.07
20-24 years	1.02	0.98, 1.06
25-29 years	1.00	1.00, 1.00
30-34 years	**1.10**	**1.05, 1.14**
≥35 years	**1.39**	**1.32, 1.46**
Maternal Education		
< High School	**1.10**	**1.07, 1.14**
= High School	1.00	1.00, 1.00
> High School	**0.83**	**0.80, 0.85**
Marital Status		
Unmarried	**1.18**	**1.15, 1.21**
Married	1.00	1.00, 1.00
***Prenatal Care Adequacy**	1.00	0.98, 1.03
Cigarette Use During Pregnancy		
No	1.00	1.00, 1.00
Yes	**2.07**	**1.96, 2.18**
Ethnicity		
Black	**2.82**	**2.24, 3.55**
White	1.00	1.00, 1.00
MODERATING EFFECTS OF ETHNICITY		
Ethnicity x Area Size		
Metropolitan	1.00	1.00, 1.00
Micropolitan	0.95	0.84, 1.08
Ethnicity x Dissimilarity	1.21	0.53, 2.74
Ethnicity x Isolation	0.49	0.21, 1.15
Ethnicity x Proportion Black	1.16	0.55, 2.43

Note. OR=Odds Ratio. CI=Confidence Interval.
*Continuous Variable

Findings indicated mixed findings for the moderating effects of ethnicity on relationships between residential segregation and adverse perinatal outcomes in cross-level interactions. Significant effects were found for the negative association between Isolation and LBW among Black women. A positive relationship was found for the cross level interactions between Areas Size and ethnicity among Black women. These results indicate that the moderating effects of ethnicity may be specific to birth outcome and ethnic group.

Hypothesis Three: The relationship between residential segregation and the increased likelihood of adverse perinatal outcomes is moderated by median income.

To examine Hypothesis Three, a random intercept model was developed to allow the slope for median income (Level 2) to randomly vary across all structural variables (i.e., Level 3 variables served as predictors of the slope of median income). Cross-level interactions examined for each adverse birth outcome model were non-significant ($p > .05$).

Low Birth Weight

Median income did not moderate the relationship between residential segregation and LBW after controlling for other factors in models. Table 21 provides parameter estimates for this model. Median income was not significantly associated with residential segregation (Dissimilarity, p=0.67; Isolation, p=0.75) and structural variables (Area Size, p=0.07; Proportion Black, p=0.94) in cross-level interactions.

Table 21

Parameter Estimates for Random Effects of Median Income: Multilevel Analysis of the Moderating Effect on the Relationship between Residential Segregation and Low Birth Weight for Sample of Florida, Georgia and Louisiana Mothers 1999-2001

	LOW BIRTH WEIGHT	
	OR	**95% CI**
LEVEL 3		
Intercept	0.01	0.01, 0.02
Area Size		
Metropolitan	1.00	1.00, 1.00
Micropolitan	1.12	0.98, 1.28
***Dissimilarity**	0.88	0.44, 1.78
***Isolation**	1.29	0.51, 3.27
***Proportion Black**	1.13	0.49, 2.60
LEVEL 2		
***Proportion Black**	1.00	0.91, 1.11
***Median Income**		
0-$24,999	1.24	0.94, 1.64
$25,000 or more	1.00	1.00, 1.00
***Proportion of Owner-Occupied Homes**	1.07	0.98, 1.16
Household Vacancy		
≤ 10%	1.00	1.00, 1.00
> 10%	1.01	0.98, 1.05
***Age of Housing**	1.01	1.00, 1.02
Proportion of Female-Headed Households		
≤ 10%	1.00	1.00, 1.00
> 10%	1.02	0.98, 1.07
Proportion in Correctional Institutions		
> 10%	1.00	1.00, 1.00
> 10%	1.00	0.96, 1.05
Proportion of Resident Civilians Unemployed		
≤ 5%	1.00	1.00, 1.00
> 5%	1.04	0.99, 1.09
***Proportion of Residents with High School Diploma**	**1.63**	**1.33, 2.00**
Proportion of Blacks Below Poverty		
≤ 10%	1.00	1.00, 1.00
> 10%	1.03	1.00, 1.06
Proportion of Whites Below Poverty		
≤ 10%	1.00	1.00, 1.00
> 10%	**1.06**	**1.02, 1.10**

Note. OR=Odds Ratio. CI=Confidence Interval.
*Continuous Variable

Table 20 (Continued)

	LOW BIRTH WEIGHT	
	OR	**95% CI**
LEVEL 1		
Maternal Age		
15-19 years	**0.90**	**0.84, 0.96**
20-24 years	**0.90**	**0.84, 0.95**
25-29 years	1.00	1.00, 1.00
30-34 years	**1.19**	**1.13, 1.25**
≥35 years	**1.65**	**1.55, 1.75**
Maternal Education		
< High School	**1.18**	**1.12, 1.24**
= High School	1.00	1.00, 1.00
> High School	**0.82**	**0.79, 0.84**
Marital Status		
Unmarried	**1.24**	**1.20, 1.28**
Married	1.00	1.00, 1.00
***Prenatal Care Adequacy**	**1.34**	**1.27, 1.41**
Cigarette Use During Pregnancy		
No	1.00	1.00, 1.00
Yes	**1.71**	**1.63, 1.80**
Ethnicity		
Black	**2.20**	**2.11, 2.30**
White	1.00	1.00, 1.00
MODERATING EFFECTS OF MEDIAN INCOME		
Median Income x Area Size		
Metropolitan	1.00	1.00, 1.00
Micropolitan	0.86	0.73, 1.01
Median Income x Dissimilarity	0.79	0.28, 2.28
Median Income x Isolation	0.83	0.25, 2.75
Median Income x Proportion Black	1.04	0.38, 2.83

Note. OR=Odds Ratio. CI=Confidence Interval.
*Continuous Variable

Preterm Delivery

Findings indicated that median income did not moderate the relationships between residential segregation indicators and preterm delivery (Table 22). Cross-level interactions were non-significant (p >.05) for associations between median income and Dissimilarity (OR 1.19, 95% CI: 0.54, 2.67), Isolation (OR 0.50, 95% CI: 0.22, 1.15), Area Size (OR 0.96, 95% CI: 0.85, 1.09), and the Proportion Black (OR 1.09, 95% CI: 0.32, 3.69), respectively.

Table 22

Parameter Estimates for Random Effects of Median Income: Multilevel Analysis of the Moderating Effect on the Relationship between Residential Segregation and Preterm Delivery for Sample of Florida, Georgia and Louisiana Mothers 1999-2001

	PRETERM DELIVERY	
	OR	**95% CI**
LEVEL 3		
Intercept	0.01	0.01, 0.02
Area Size		
Metropolitan	1.00	1.00, 1.00
Micropolitan	1.00	0.86, 1.16
***Dissimilarity**	0.55	0.23, 1.32
***Isolation**	1.73	0.56, 5.36
***Proportion Black**	1.10	0.35, 3.42
LEVEL 2		
***Proportion Black**	0.98	0.85, 1.13
Median Income		
0-$24,999	**1.20**	**0.92, 1.56**
≥ $25,000	1.00	1.00, 1.00
***Proportion of Owner-Occupied Homes**	1.06	0.99, 1.13
Household Vacancy		
≤ 10%	1.00	1.00, 1.00
> 10%	1.02	1.00, 1.05
***Age of Housing**	0.99	0.98, 1.00

Note. OR=Odds Ratio. CI=Confidence Interval.
*Continuous Variable

Table 22 (Continued)

	PRETERM DELIVERY	
	OR	**95% CI**
Proportion of Female-Headed Households		
≤ 10%	1.00	1.00, 1.00
> 10%	1.05	1.00, 1.09
Proportion in Correctional Institutions		
> 10%	1.00	1.00, 1.00
> 10%	1.01	0.96, 1.07
Proportion of Resident Civilians Unemployed		
≤ 5%	1.00	1.00, 1.00
> 5%	1.03	0.99, 1.08
***Proportion of Residents with High School Diploma**	**1.65**	**1.27, 2.14**
Proportion of Blacks Below Poverty		
≤ 10%	1.00	1.00, 1.00
> 10%	1.01	0.98, 1.04
Proportion of Whites Below Poverty		
≤ 10%	1.00	1.00, 1.00
> 10%	1.01	0.98, 1.05
LEVEL 1		
Maternal Age		
15-19 years	**0.93**	**0.89, 0.99**
20-24 years	**0.89**	**0.86, 0.92**
25-29 years	1.00	1.00, 1.00
30-34 years	**1.19**	**1.15, 1.24**
≥35 years	**1.45**	**1.39, 1.51**
Maternal Education		
< High School	**1.18**	**1.11, 1.25**
= High School	1.00	1.00, 1.00
> High School	**0.90**	**0.87, 0.93**
Marital Status		
Unmarried	**1.17**	**1.12, 1.22**
Married	1.00	1.00, 1.00
***Prenatal Care Adequacy**	**1.59**	**1.48, 1.71**
Cigarette Smoking During Pregnancy		
No	1.00	1.00, 1.00
Yes	**1.14**	**1.06, 1.22**
Ethnicity		
Black	**1.53**	**1.47, 1.59**
White	1.00	1.00, 1.00
MODERATING EFFECTS OF MEDIAN INCOME		
Median Income x Area Size		
Metropolitan	1.00	1.00, 1.00
Micropolitan	0.96	0.85, 1.09
Median Income x Dissimilarity	1.19	0.54, 2.67
Median Income x Isolation	0.50	0.22, 1.15
Median Income x Proportion Black	1.13	0.54, 2.37

Note. OR=Odds Ratio.
*Continuous Variable

Small for Gestational Age Birth

Findings for the random effects of median income on the relationship between residential segregation and preterm delivery were similar to the LBW model for the overall hypothesis, after controlling for other factors in models, including the cross level interaction between residential segregation and median income. Cross level interactions were non-signficant for associations between median income and Area Size (OR 0.89, 95% CI: 0.79, 1.01), Dissimilarity (OR 1.09, 95% CI: 0.51, 2.33), Isolation (OR 0.73, 95% CI: 0.33, 1.61), and the Proportion Black (OR 1.28, 95% CI: 0.66, 2.47), respectively (Table 23).

Table 23

Parameter Estimates for Random Effects of Median Income: Multilevel Analysis of the Moderating Effect on the Relationship between Residential Segregation and Small Gestational Age Birth for Sample of Florida, Georgia and Louisiana Mothers 1999-2001

	SMALL FOR GESTATIONAL AGE BIRTH	
	OR	**95% CI**
LEVEL 3		
Intercept	0.06	0.05, 0.07
Area Size		
Metropolitan	1.00	1.00, 1.00
Micropolitan	1.09	0.98, 1.20
***Dissimilarity**	1.06	0.62, 1.81
***Isolation**	0.96	0.51, 1.81
***Proportion Black**	1.34	0.71, 2.55
LEVEL 2		
***Proportion Black**	0.97	0.91, 1.03
Median Income		
0-$24,999	1.12	0.90, 1.38
≥ $25,000	1.00	1.00, 1.00
***Proportion of Owner-Occupied Homes**	1.05	0.99, 1.12
Household Vacancy		
≤ 10%	1.00	1.00, 1.00
> 10%	0.99	0.96, 1.02
***Age of Housing**	1.02	1.01, 1.03
Proportion of Female-Headed Households		
≤ 10%	1.00	1.00, 1.00
> 10%	0.98	0.94, 1.03
Proportion in Correctional Institutions		
> 10%	1.00	1.00, 1.00
> 10%	1.00	0.98, 1.03
Proportion of Resident Civilians Unemployed		
≤ 5%	1.00	1.00, 1.00
> 5%	1.02	0.98, 1.07
***Proportion of Residents with High School Diploma**	**1.55**	**1.33, 1.79**
Proportion of Blacks Below Poverty		
≤ 10%	1.00	1.00, 1.00
> 10%	1.01	0.97, 1.05
Proportion of Whites Below Poverty		
≤ 10%	1.00	1.00, 1.00
> 10%	1.04	1.01, 1.07

Note. OR=Odds Ratio. CI=Confidence Interval.
*Continuous Variable

Table 23 (Continued)

	SMALL FOR GESTATIONAL AGE BIRTH	
	OR	**95% CI**
LEVEL 1		
Maternal Age		
15-19 years	1.00	0.94, 1.07
20-24 years	1.02	0.98, 1.06
25-29 years	1.00	1.00, 1.00
30-34 years	**1.09**	**1.05, 1.14**
≥35 years	**1.39**	**1.32, 1.46**
Maternal Education		
< High School	**1.11**	**1.07, 1.14**
= High School	1.00	1.00, 1.00
> High School	**0.82**	**0.80, 0.85**
Marital Status		
Unmarried	**1.18**	**1.14, 1.21**
Married	1.00	1.00, 1.00
***Prenatal Care Adequacy**	1.00	0.98, 1.02
Cigarette Smoking During Pregnancy		
No	1.00	1.00, 1.00
Yes	**2.06**	**1.95, 2.18**
Ethnicity		
Black	**2.19**	**2.07, 2.33**
White	1.00	1.00, 1.00
SLOPE OF MEDIAN INCOME		
Median Income x Area Size		
Metropolitan	1.00	1.00, 1.00
Micropolitan	0.89	0.79, 1.01
Median Income x Dissimilarity	1.09	0.51, 2.33
Median Income x Isolation	0.73	0.33, 1.61
Median Income x Proportion Black	1.28	0.66, 2.46

Note. OR=Odds Ratio. CI=Confidence Interval.
*Continuous Variable

Summary of Findings

The results of the study did not support the role of residential segregation on adverse perinatal outcomes (Hypothesis One). While findings did not support the moderating role of median income (Hypothesis Three), findings for the moderating role of ethnicity (Hypothesis Two) were mixed, signaling ethnic group and outcome-specific associations. Black women experience a decreased risk of LBW with increased isolation and increased risk of preterm delivery when they lived in micropolitan areas. In summation, the direct effects of residential segregation on adverse perinatal outcomes were not illustrated after accounting for other variables in models, including the cross level interactions between residential segregation and ethnicity or median income.

Several individual and contextual variables emerged as significantly associated with all birth outcomes although they were weak and modest findings. The proportion of individuals with high school diplomas and the proportion of owner-occupied homes were positively associated with all adverse perinatal outcomes such that each unit increase in contextual variables resulted in an increase in LBW, preterm and SGA births. Median income and the proportion of Whites in poverty were significantly associated with SGA birth and LBW. Single, outcome-specific findings showed the significant influence of the proportion of incarcerated individuals on preterm delivery and the impact of the age of houses in census tracts and SGA birth.

CHAPTER FIVE: DISCUSSION

Major Research Findings

The purpose of this study was to investigate the direct relationship between residential segregation (the physical separation of Blacks and Whites in residential contexts) and adverse perinatal outcomes (LBW, preterm delivery and SGA births) in Florida, Georgia and Louisiana. This study was specifically designed to determine the independent effect of the level of residential segregation on the likelihood of adverse perinatal outcomes after controlling for contextual (i.e. poverty level, unemployment) and individual factors (i.e. prenatal care, substance use). The study also examined whether the direct relationship between the level of residential segregation and each adverse perinatal outcome was moderated by ethnicity and median income, respectively. Multilevel modeling techniques were employed to examine these associations.

This study did not support the majority of postulated hypotheses for the relationships between residential segregation and adverse perinatal outcomes. Residential segregation was not association with LBW, preterm delivery or SGA births, after controlling for factors representing the physical, social and economic environments in communities and the sociodemographic and behavioral risk factors of individuals (Hypothesis 1). Given the large sample size, there was adequate statistical power to detect small effects. The non-significant results indicate that the effect sizes for these independent variables were relatively smaller than could be detected and likely to be negligible.

One significant cross-level interaction was found between ethnicity (Level 1) and segregation (Hypothesis 2). Isolation was associated with decreased risk of LBW among

Black women. Further, Black women in smaller, micropolitan statistical areas (population size between 10,000 and 50,000) were less likely to have preterm infants. Cross-level interactions between ethnicity and other Level 3 variables were non-significant. Non-significant results were also found for the moderating effect of median income on the segregation-adverse perinatal outcome relationship (Hypothesis 3).

Several contextual and individual factors were significantly associated with adverse perinatal outcomes with primarily weak or modest associations. These findings imply that macro level, structural factors may not be important predictors of adverse perinatal outcomes, but that proximate, neighborhood contexts and individual risk factors are critical precursors of perinatal outcomes.

The proportion of individuals with high school diplomas and proportion of owner-occupied homes in census tracts had positive and statistically significant associations with each adverse perinatal outcome in this study. Home-ownership has been positively associated with life satisfaction, psychological health and well-being due to improved social status and personal freedom (Danes & Morris, 1986; Fanie Mae, 1999; Rossi & Weber, 1996). These benefits may be challenged or negated by increased numbers of homeowners who are at risk of losing their homes due to mortgage foreclosure (Rohe, Van Zandt, & McCarthy, 2001). The threats associated with losing one's home have been associated with lower self perceived well-being among persons who are unable to pay their mortgages (Nettleton & Burrows, 1998). These findings may help to explain why an increased proportion of homeowners in census tracts were associated with increased adverse perinatal outcome risk in this study. An explanation for the positive association between the proportion of residents with a high school diploma and the likelihood of adverse perinatal outcomes may be due to the heterogeneity of educational attainment in census tracts and other commorbidities that were not accounted for. For instance, there was no distinction between women of advanced maternal age who postponed childbearing to complete their graduate education and high school graduates who had other sociodemographic or behavioral risk factors.

The majority of individual–level factors were significantly associated with each perinatal outcome in multilevel models. Women who were Black, unmarried, smoked, older and less educated (less than high school diploma) were more likely to experience all adverse perinatal outcomes. These findings are supported by the majority of studies on the role of individual risk factors on perinatal health (Ananth, Balsubramanian, Demissie, & Kinzler, 2004; Goldenberg et al., 1996; Guyer, Martin, MacDorman, Anderson, & Strobino, 1997; Martin, Hamilton, Sutton, Ventura, Menacker, & Munson, 2003; Schiono, Rauh et al., 1997).

The inverse significant association between prenatal care adequacy, LBW and preterm delivery may seem counterintuitive upon initial examination. However, intensive prenatal care services targeted to women at heightened risk for poor outcomes implies that low-risk women had lower prenatal care adequacy, but better perinatal outcomes. There was a positive, significant relationship between small for gestational age births and prenatal care adequacy.

The results of this study offer several implications for future research and practice focused on reducing disparities in health. Findings point to the need for further specification of a comprehensive constellation of variables starting from the onset of pregnancy through to labor and delivery. Due to an increased number of Blacks in poverty, the additional threat of economic segregation (i.e. income inequality) may further attenuate the overall well-being and life experience of Blacks. However, social capital and cohesion, composed of a number of factors, such as how connected groups feel, share resources and perceive the availability of moral support may help to explain for why residential segregation was not associated with an increased likelihood of adverse perinatal outcomes.

Possible Explanations for Research Findings

A possible explanation of current study findings is that ethnic stratification of residential segregation in the United States is overestimated. While residential segregation has decreased both nationally and regionally, the average Index of Dissimilarity across the nation is 0.652, indicating hypersegregation (Glaeser & Vigdor, 2001). Residential segregation may not have significantly affects on adverse perinatal outcomes because segregation is still relatively high across the United States.

The state of residential segregation in the South and residential segregation indices in this study may also shed light on findings in the study. With residential indices greater than 0.60 considered hypersegregated (Glaeser & Vigdor, 2001), the mean Dissimilarity Index for the study sample was 0.47 (scores ranged from 0.20-0.69) and the mean Isolation Index for the study sample was 0.45 (scores ranged from 0.04-0.74). Further, studies indicate that the South is now the second most integrated region, experiencing the largest regional reduction in segregation between 1990 and 2000 (Glaeser & Vigdor, 2001). Generally low residential segregation levels in areas studied may explain no significant associations with adverse perinatal outcomes due to a potentially deleterious effects of segregation when areas are hypersegregated.

A second interpretation of findings centers on the distinction between historic and current influences of residential segregation. Previous studies indicate that, historically, residential segregation had effects on Black mobility, creating ghettos and segregated communities (Massey & Denton, 1993; Sugure, 1996). Since the Housing Act of 1968, residential segregation does not legally constrain Blacks from making housing and neighborhood choices. This explanation points to the greater important of choice, rather than administrative policies, in current discussion of the role of neighborhood residence. These factors were not measured in this study. As described in directions for future research, choice of residence may be tempered by preferences, by both Blacks and Whites, to live among those who are ethnically similar to themselves in order to reduce perceived stresses that may be inherent of living in more integrated neighborhoods.

Evidence of both non-significant and protective effects of segregation in ethnically homogeneous neighborhoods indicate the complexity of macro and contextual factors (Johnson, Drisko, Gallagher & Barela, 1999; O'Campo et al., 1997; Pearl, Braveman, & Abrams, 2001; Rauh, Andrews et al., 2001) and may help to explain differing associations between segregation indicators and each perinatal outcome studied. While many studies on the influence of residential segregation on infant outcomes have demonstrated deleterious effects (Ellen, 2000; LaVeist, 1989; Polednak, 1991), other evidence has shown that segregation may have either protective or non harmful effects in more ethnically homogeneous neighborhoods (Laveist, 1993, 1999; Pickett, Collins, Masi, & Wilkinson, 2005; Roberts, 1997). Pickett and colleagues (2005) found that among Black women in affluent census tracts, those in predominantly Black areas experienced decreased risk of LBW and preterm delivery. The effects of affluence on birth outcomes among Black women were non-significant among those living in ethnically heterogeneous census tracts. Evidence that increased Isolation was associated with decreased likelihood of LBW among Black women (Hypothesis 2) may be due to perceived social support and capital which may buffer against the stressors associated with integration.

The residential segregation level of aggregation employed in this study may represent a distinct effect with magnitude and directionality that differs from dimensions that could be measured at the neighborhood level (census tract). Birth certificate measures of adverse perinatal outcomes were linked to segregation indices at the macro (metropolitan or micropolitan statistical area) level in this study. This level of causation is associated with social, political and economic structures that may represent institutionalized racism. Segregation measured at the contextual level could represent the individual experience of discrimination in daily interactions. Measurement of residential segregation at the contextual level may be more important to individual health outcomes than measures at the macro level.

Inability to fully measure the degree to which income and education may moderate the degree of choice and realized preferences in neighborhood selection is am important methodological explanation for research findings. This study was limited by measures of socioeconomic status at the contextual level (census tract) because this variable was not included on birth certificates. Previous research signals that residential segregation influences communities through deprivation of physical environments as well as limited employment opportunities. These effects are most evident in impoverished, segregated neighborhoods (Jargowsky, 1994, 1996, 1997; Strait, 2006). The degree to which income and education mediate or moderate the associations between residential segregation and individual health may help to more appropriately explicate the context-individual health outcome relationship.

Multilevel model sample size was based on the number of groups and units at the highest level of aggregation tested in hypotheses, the macro level. Published studies that center on sample size sensitivity in multilevel analysis indicate that there should be at least 50 clusters at Level 3 (MSAs) with an average of 10 units per cluster (Hox, 2001). Level 3 consisted of 63 statistical areas, with an average of 69.21 census tracts per area, a sample size, exceeding the threshold required to achieve statistical power of 0.80 (Cohen, 1988). The potential for spurious or unimportant findings must be noted given the large number of Level 1 observations and that individual observations were critical to examining compositional effects. The identified associations may not have existed, but yielded statistics that were expected to occur a certain proportion (alpha) of the time when null hypotheses were true. Further, pseudo-associations may have occurred, making it difficult to detect intermediate variables. These variables could have been excluded from analyses or may have been intermediating in ways that were not tested (Raferty, 1986, 1995).

Finally, findings may indicate that there is no relationship between residential segregation and adverse perinatal outcomes, notwithstanding previously described explanations. However, results provide important insight into the influence of personal and contextual factors on adverse perinatal outcomes utilizing a technique that most comprehensively accounts for multiple levels of exposure. Results indicate that more proximal, downstream factors (individual and contextual) should be considered in efforts to reduce ethnic disparities in perinatal outcomes.

Study Strengths

Multilevel modeling of the independent effects of residential segregation on the likelihood of adverse perinatal outcomes contributes to better understanding of the determinants of health disparities. Most studies examining the impact of residential segregation on population health have been limited by cross-sectional and ecological study designs analyzed at individual *or* aggregate levels. Further, contextual factors that may be controlled for in the relationship between structural factors and health outcomes are often excluded in single level studies. Evidence indicates that the relationships between residential contexts, structures and health outcomes are not homogeneous and require more specificity in investigation. None of the identified studies researching community levels of residential segregation have utilized this analytical approach (Collins et al., 1997; Polednak et al., 1991, 1996).

This research expanded upon existing studies of the associations between place on health outcomes through the simultaneous investigation of three adverse perinatal outcomes associated with increased infant mortality and morbidity. Studies previously investigating area effects on health outcomes broadly include self-rated health, life expectancy, all-cause mortality, and infant mortality. Virtually unexplored is how the effects of place on health may vary by residential segregation dimensions measured and perinatal outcome examined (LBW, preterm delivery and SGA).

This study also sheds light on the unique experience of pregnancy and perinatal outcomes. Study results indicated that contextual and individual factors were the chief contributors to increased risk for adverse perinatal outcomes, rather than macro-level, structural factors that have been significant predictors of mortality and other health outcomes. Findings infer that the effects of residential segregation are unique to the outcome studied.

Study Limitations

Limitations of the data sources utilized in this study were discussed earlier in this study and are summarized in this section. Errors in coding and underestimation of key labor and delivery outcomes in birth certificate data are among noteworthy challenges (Brunskill, 1990; Green et al., 1998; Hamvas, Kwong, DeBaun, Schramm, & Cole, 1998; Watkins et al., 1996). The specificity, sensitivity and predictive value of birth certificates across sites vary in the estimation of maternal medical risk factors, complications of labor and delivery, number of interventions or procedures, congenital anomalies, and measures of prenatal care. Explanations for lower sensitivity among certain birth certificate elements are vast and include issues surrounding site variations in data management and self-report bias. Birth certificate data may also be subject to non-sampling error occurring during initial data entry (at the hospital level) and in processing birth certificates at health departments. The lack of information on psychosocial, attitudinal, or stress measures that have been previously associated with perinatal outcomes (Rich-Edwards et al., 2001; Stancil et al., 2000) are a recognized limitations of birth certificate data.

Individual preferences and values associated with where one chooses to reside were not accounted for in this study. For example, a person may perceive benefits to living in an ethnically homogeneous neighborhood which are not captured by the data employed in this study. It is anticipated that the contribution of this initial investigation is a foundation for future longitudinal examination of the meanings and perceptions of residential structures and contexts to more fully understand the risk or protective effects of residential segregation on perinatal outcomes.

While the decision to employ an observational study design that was cross-sectional and utilized secondary data was constrained by the availability and nature of data at each level of analysis, inherent limitations must be acknowledged. Pocock and Elbourne (2002) indicated that observational studies are not experimental and, as a result, do not involve randomization, the use of entry criteria, and the rigorous use of standard definitions of conditions. The primary limitations of cross-sectional designs are that they preclude any formal conclusions about causality and directionality in the association between residential segregation and adverse perinatal outcomes. The primary challenge associated with the use of secondary data in this study was potentially differing levels of the accuracy of live birth certificate data entry across the three states that were examined.

Like many other studies investigating area variations in health, this study was restricted to the choice of spatial unit (census tract). The census tract was the selected unit of analysis in this study because it is a small, relatively permanent statistical subdivision. Designed to be relatively homogeneous with respect to population characteristics, economic status and living conditions, census tracts capture within city variation and the immediacy of social context that is lost to cross-metro analyses (Guest et al., 1998). Census tract identifiers on birth certificates were used in order to link residential segregation indices and contextual covariates calculated by the U.S. Census Bureau to create a three-level profile for each woman in the study. Altering the geographical unit may have lead to different conclusions regarding the importance of areas on health (Boyle & Willms, 1999).

The data in this research were limited by residential segregation indicators associated with the year of labor and delivery. Nothing is known about whether a woman was new to the census tract indicated on the live birth certificate or whether she was a resident within this community for several years. This limitation of the data may be interpreted as a methodological artifact of the live birth certificate dataset utilized and may have influenced research findings.

Findings from this study offer many opportunities for public health professionals and clinicians to 1) gain increased understanding of past and current biological, psychosocial, and geographical influences on health through both qualitative and quantitative methods, 2) address chronic and emerging health issues, and 3) investigate both clinical and social risk factors over time. Directions for future research in this area among members of this important public health population are described in the section that follows.

Directions for Future Research

The ethnic disparities that persist for the majority of health outcomes in the United States demonstrate the need for expanded investigation of a more comprehensive array of variables that influence birth outcomes at multiple levels. While administrative and geopolitical boundaries most frequently govern the assessment of structural forces (e.g. Isolation Index, Dissimilarity), the internalization and meanings associated with these social, cultural, and political influences are critical to complete assessment of the determinants of and pathways to adverse perinatal outcomes. Pyschosocial and biological assessments, context and duration of current and previous residential exposure, and individuals' perceptions of their neighborhoods are among the measures that should be analyzed in each study of associations between space, place and perinatal outcomes.

Future research should include an assessment of perceived stress to examine how interactions between psychological and structural factors may influence birth outcomes. Previous research suggests that, for some subgroups, psychosocial stress may be a by-product of perceptions of discrimination (Farmer, 1997; Krieger, & Sidney, 1996; Livingston, 1994). Higher stress levels among African American and Hispanic women in studies of ethnically and socioeconomically diverse samples have led some to conclude that perceived racial and gender discrimination and their associated stressors contribute to an increased risk for preterm birth (Rich-Edwards et al., 2001; Stancil et al., 2000). Second, chronic stressors experienced by women of lower SES may also lead to adverse intrapsychic processes (i.e. low levels of personal resilience, self esteem/optimism, mastery belief/sense of personal control) mediated by perceived stress. Further, living in chronically stressful environments appear to erode personal resilience, which may heighten perceived stress, anxiety, a sense of helplessness, a lack of optimism, and depression increasing the risk of poorer birth outcomes.

The biological manifestations of stress and their associations with contextual and structural factors should also be assessed in multilevel studies. Studies supporting the influence of psychosocial factors on fetal development and pregnancy outcomes suggest that the consequences of stress include increased corticotrophin-releasing hormone (CRH) a neuropeptide synthesized primarily in the paraventricular nucleus of the hypothalamus. Higher CRH levels have been found in women who have preterm (Wadhwa et al., 1998). Adverse effects of chronic stress exposure can be seen as early as the prenatal environments. Maternal stress at 18 to 20 weeks' gestation has been found to significantly predict corticotrophin-releasing hormone (CRH) at 28 to 30 weeks gestation, even after controlling for CRH at 18 to 20 weeks (Hobel et al., 1999). Stress may also increase proinflammatory cytokine production, which leads to increased prostaglandin production, increased uterine contractility and preterm labor (Turnbull & Rivier, 1999). Stress may be measured as an objective stimuli, an emotional/biological response, and a perception of control or a combination of these factors.

A number of theoretical issues that may provide fresh avenues of research include determining what constitutes an integrated neighborhood in "real life". The quantitative residential segregation indicators employed in this study are based on ideal values and thresholds of integration. A question that may be investigated is whether having an "equal" number of Blacks and Whites in neighborhoods will necessarily improve health. The degree of political power and governance in residentially segregated neighborhoods may be more significantly associated with birth outcomes than previously utilized indicators (Hart et al., 1998; Williams & Collins, 2001). Investigation of voting records and city government initiatives that are focused on improving neighborhoods will further provide information on the political power of a community. The previous associations between measures of social capital, cohesion, integration and health (House et al., 1988, Kawachi et al., 1996; Wilkinson; 1996) call for assessment and incorporation of these contextual measures in order to strengthen studies in this research field.

The length of time that an individual has lived in a community is critical to better understanding of the impact of residential segregation and should also be assessed in future studies. Similar to the majority of research on the factors associated with perinatal outcomes, the data in this research was limited by residential segregation indicators associated with the year of labor and delivery. Nothing is known about whether a woman was new to the census tract reported on the live birth certificate or whether she was a resident within this community for several years. A longitudinal survey of expectant mothers, for the duration of pregnancy, would allow better understanding of previous place and duration of residence. Perhaps a lifetime of living in neighborhoods that are residentially segregated may be less detrimental to health than more recent residence in a segregated neighborhood due to changes is socioeconomic status or other stressful life events. Other studies in this area could focus on duration and level of residence segregation in the current neighborhood relative to the previous residence. No identified studies on how transitional effects associated with place of residence effect health status have been identified in the public health literature.

Preference for residence in neighborhoods with higher concentrations of residents that are ethnically similar should also be distinguished from housing choice. For instance, Blacks report preferences for neighborhoods that are about half Black and Half White (Farley, et al., 1994; Timberlake, 2000; Zubrinsky & Bobo, 1996). However, surveys do not typically ask respondents about perceived costs of living in integrated neighborhoods. Blacks might prefer to trade residential segregation for increased proximity to close friends and family members (Clark, 1986). Because Blacks tend to be less affluent than Whites on many measures of socioeconomic status, the choice to live among those who are ethnically similar may more often mean that Blacks live among a greater percentages of poorer individuals than Whites do. However, the degree to which social support may buffer against the deleterious effects of residential segregation may help to explain the current research findings. Blacks or Whites who choose to live in ethnically homogeneous neighborhoods may, in essence, be choosing, residential solidarity over residential integration. Residential segregation may not be protective of health, but these key, health enhancing moderators may buffer against its anticipated, deleterious effects.

Variations in protocol for collecting live birth certificate data across sites, non-clinical personnel recording data, and little or no auditing to ensure data reliability in hospitals are among explanations for lower sensitivity of specific birth certificate elements. However, little or no data on perception of neighborhoods, racism, and stress to complement studies that utilize birth certificate data do not bring researchers much closer to understanding and addressing disparities in health. The collection of psychosocial data could be accomplished by administering questionnaires among pregnant women at multiple points during pregnancy, beginning with the first prenatal visit. Cortisol readings would provide insight into the self–reported effect of community level variables on stress. Areas selected for inclusion in these studies could represent a continuum on the residential segregation scale in order to determine the relative influence of residential segregation after controlling for biological samples, survey and administrative data.

Ethnic group heterogeneity in health and patterns of segregation has been identified in research studies and should receive increased attention in multilevel examinations. Several previously described studies have identified variations in health outcomes among Black women of Hispanic, Caribbean and African descent with findings suggesting that the burden of ethnic disparities is not equally shared among Blacks (Cabral, Fried, Levenson, Amaro, & Zuckerman, 1990; Collins, and David, 2000; Cooper et al., 2003; Fang, Madhavan & Alderman, 1997; Palloto, Friedman et al., 1993). Further, patterns of segregation vary as much within as across ethnic subgroups, implying the importance of closer scrutiny of residential patterns across and within groups to assess their varying associations with health (White, Kim, & Glick, 2005). Public health funding and interventions that are developed with increased understanding of both the protective and deleterious effects of cultural contexts and residential mobility are critical to more targeted and effective interventions.

Implications for Public Health

Locally implemented studies are needed in response to this research and others that are limited by state and national datasets. National data collection mechanisms may not provide the full picture of the relationships between adverse perinatal outcomes and place due to the effect of regression to the mean, which may obscure what occurs in neighborhoods. Cultural and regional norms may further color the definitions and experience of residential segregation and other structural factors that are theorized to influence health. Health departments may be the most appropriate vehicle for mandated collection of this data due to the fact that they are publicly governed, and are characterized by more frequent contact between pregnant women and providers than the limited interaction mothers have with hospital personnel who complete birth certificates after labor and delivery.

Despite the emphasis of public health research to avoid victim blaming due the long established influence of forces outside the realm of individual control, most prenatal education and interventions are still primarily tailored in response to individual risk. Findings of this study indicated the importance of a number of contextual factors that were significant predictors of adverse perinatal outcomes. A cognitive-shift among public health practitioners is needed to respond to research study findings in order to arm expectant mothers with tools needed respond to and cope with the residential contexts in which they live. The future research directions described above must be translated to practice through practitioners informed and trained to implement interventions that address the multilevel strengths and challenges faced by the women that they serve.

Conclusion

The complex web of causation associated withvariations in population health requires identification of the spiders, or fundamental causes, that instigate risk for risk factors (Krieger, 1994). In order to draw closer to identifying the determinants and pathways to adverse perinatal outcomes, comprehensive data on biological, social and spatial markers is critical. Further, studies of the association between place and health should incorporate a thorough assessment of residential preferences and experiences. Until more is known about motivations for residential perceptions, our understanding of how place and space influence on health is incomplete.

REFERENCES

Abrams, B., & Newman, V. (1991) Small-for-gestational-age birth: Maternal predictors and comparison with risk factors of spontaneous preterm delivery in the same cohort. *American Journal of Obstetrics and Gynecology, 164*(3), 785-790.

Acevedo-Garcia, D. (2001). Zip code level factors or tuberculosis: Neighborhood environment and residential segregation in New Jersey 1985-1992. *American Journal of Public Health*, 81, 1480-1482.

Acevedo-Garcia, D., & Lochner, K. (2003) Residential segregation and health. In I. Kawachi, & L. Berkman (Eds.) *Neighborhoods and Healt (pp. 265-281).* New York, NY: Oxford University Press, 265-281.

Acevedo-Garcia, D., Lochner, K., Osypuk, T., & Subramanian, S. (2003). Future directions in residential segregation and health research: A multilevel approach. *American Journal of Public Health*, 93(2), 215-221.

Adler, N., Boyce, T., & Chesney, M. (1994). Socioeconomic status and health: The challenge of the gradient. *American Psychologist, 49*(1), 15-24.

Aiken, L. S. (1991). *Multiple regression: Testing and interpreting interactions*. Newbury Park, CA: Sage

Alba, R., & Logan, J. (1992). Assimilation and stratification in the homeownership patterns of racial and ethnic-groups. *International Migration Review, 26*(4), 1314-1341.

Alexander, G. (1992). Validity of postnatal assessments of gestational age: A comparison of Ballard et al. and early ultrasonography. *American Journal of Obstetrics and Gynecology*, 166, 891-895.

Alexander, G., Hines, J., Kaufman, R., Mor, J., & Kogan, M. (1996). A United States national reference for fetal growth. *Obstetrics and Gynecology* 87(2), 87-163.

Alexander, G., Kogan, M., Himes, J., Mor, J., & Goldenberg, R. (1999). Racial differences in birthweight for gestational age and infant mortality in extremely-low-risk US populations. *Paediatric and Perinatal Epidemiology*, 13, 205-217.

Alexander, G., Kogan, M., & Nabukera, S. (2002). Racial differences in prenatal care use in the United States: Are disparities decreasing? *American Journal of Public Health, 92*(12), 1970-1975.

Alexander, G., & Kotelchuck, M. (1996). Quantifying the adequacy of prenatal care: A comparison of indices. *Public Health Reports, 111*(5), 408-416.

Alexander, G., & Petersen, D. (1997). Threats to accurate interpretation of secondary data. In J. Kotch (Ed.), (pp. 395-403). Gaithersburg, MD: Aspen.

Alexander, G., Petersen, D., Powell, E., & Tompkins, M. (1989). A comparison of gestational age reporting methods based on physician estimate and date of last normal menses from fetal death reports, *American Journal of Public Health, 79*(5), 600-602.

Alexander, G., Tompkins, M., Altekruse, J., Hornung, C. (1985). Racial differences in the relation of birth weight and gestational age to neonatal mortality. *Public Health Reports, 100*(5), 539-47.

Alexander, G., Tompkins, M., & Cornely, D. (1990). Factors influencing the relationship between a newborn assessment of gestational maturity and the gestational interval. *Paediatric and Perinatal Epidemiology*, 4, 133-146.

Alexander, G., Tompkins, M., Petersen, M., Hulsey, T., & Mor, J. (1995). Discordance between LMP-based and clinically estimated gestational age: Implications for research, programs and policy. *Public Health Reports, 110*(4), 395-402.

Alker, H. (1969). A typology of ecological fallacies. In L Dogan, M., Rokkam, S., Ed.s. Social ecology. Boston: The MIT Press, 1969, 69-86.

Altshuler, A., Morrill, W., Wolman, H., Mitchell, F., & The Committee on Improving the Future of U.S. Cities through Improved Metropolitan Governances. (1999). Governance and opportunity in metropolitan America. (p. ix; 347). Washington, D.C. National Academy Press.

American Anthropological Association (1997). American Anthropological Association: Response to OMB Directive 15: Race and ethnic standards for federal statistics and administrative reporting. Available at: http://www.aaanet/gvt/ombdraft.htm Accessed May 1, 2005.

Ananth, C., Balasubramanian, B., Demissie, K., & Kinzler, W. (2004). Small-for-gestational-age births in the United States: An age-period cohort analysis. *Epidemiology, 15*(1), 28-35.

Ananth, C., Demissie, K., Kramer, M., & Vintzileos. A. (2003). Small for gestational age births among black and white women: Temporal trends over a recent decade in the United States. *American Journal of Public Health*, 93, 577-579.

Ananth, C., Joseph, K.A., Oyelese, Y., Demissie, K., & Vintzileos. A. (2005). Trends in preterm birth and perinatal mortality among singletons: United States, 1989 through 2000. *Obstetrics and Gynecology., 105*(5), 1084-1091.

Ananth, C., & Platt, R. (2004). Reexamining the effects of gestation age, fetal growth, and maternal smoking on neonatal mortality. *BMC Pregnancy and Childbirth*, 4, 22.

Atkinson, J., MacDorman, M., & Parker, J. (2001). Trends in births to parents of two different races in the United States: 1971-1995. *Ethnicity Disease*, 11, 273-285.

Bandura, A. (1986). *Social Foundations of thought and action: A social cognitive theory*. Englewood Cliffs, N.J.: Prentice-Hall.

Battaglia, F., Frazier, T., & Hellegers, A. (1966). Birth weight, gestational age and pregnancy outcome with special references to high birth weight-low gestational age infants. *Pediatrics*, 37, 417-422.

Beers, M., & Berkow, R. (1999). *The Merck manual of diagnosis and therapy: 17th Edition.* John Wiley & Sons; 17th edition.

Ben-Shlomo, Y., White, I., & Marmot, M. (1996). Does the variation in the socioeconomic characteristics of an area affect mortality? *British Medical Journal*, 312, 1013-1014.

Berkowitz G., & Papernik E. (1993). Epidemiological preterm birth. *Epidemiologic Reviews,* 15, 414–443.

Beuscher, P., Taylor, K., Davis, M., & Bowling J. (1993). The quality of the new certificate data: A validation study in North Carolina. *American Journal of Public Health*. 83, 1163-1165.

Biggeri, A., Marchi, M., Lagazio, C., Martuzzi, M., & Bohning, D. (2000). Non-parametric maximum likelihood estimators for disease mapping. *Statistics in Medicine. 19*(17-18)*,* 2539-54.

Bishop, J. (1977). *Jobs, cash transfers, and marital instability: A review of the evidence.* Madison: Institute for Research on Poverty, University of Wisconsin.

Blakely, T., Lochner, K., & Kawachi, I. (2002). Metropolitan area income inequality and self-rated health-A multilevel study. *Social Science and Medicine, 54*(1), 65-77.

Blondel, B., Morin, I., Platt, R., Kramer, M., Usher, R., & Breart, G. (2002). Algorithms for combining menstrual and ultrasound estimates of gestational age: Consequences for rates of preterm and post term birth. *BJOG: An International Journal of Obstetrics and Gynecology*, 109, 718-720.

Brodish, P., Massing, M., & Tyroler, H. (2000). Income inequality and all-cause mortality in the 100 counties of North Carolina. *Southern Medical Journal 93*(4), 386-391.

Brooks-Gunn, J., Duncan, G., & Aber, J. (Eds.) (1997). *Neighborhood poverty: Context and consequences for children, Vol. 1.* New York: Russell Sage Foundation.

Brosco, J. (1999). The early history of infant mortality rate in America: A reflection upon the past and prophecy of the future. *Pediatrics*, 103, 478-485.

Brunskill, A. (1990). Some sources of error in the coding of birth weight. *American Journal of Public Health, 80*(1), 72-73.

Buekens, P., Delvoye, P., & Robyn, C. (1984). Epidemiology of pregnancies with unknown last menstrual period. *Journal of Epidemiology and Community Health, 38*, 79-80.

Buka, S., Brennan, R., Rick-Edwards, J., Raudenbush, S., & Earls, F. (2002) Neighborhoods support and the birth weight of urban infants. *American Journal of Epidemiology*, 157, 1-8.

Burton, P., Gurrin, L., & Sly, P. (1998). Tutorial in biostatistics: Extending the simple linear regression model to account for correlated responses: An introduction to generalized estimating equations and multi-level mixed modeling. *Statistics in Medicine, 12*, 1261-1292.

Cabral, H., Freid, L., Levenson, S., Amaro, H., & Zuckerman, B. (1990). Foreign -born and Us-born black women: Differences in health behaviors and birth outcomes. *American Journal of Public Health, 80*(1), 70-71.

Centers for Disease Control and Prevention (2005). *Racial/ethnic disparities in infant mortality-United States, 1995-2002*. Morbidity and Mortality Weekly Report, *54*(22), 553-556.

Clark, K., Chun-Mei, F., & Burnett, C. (1997). Accuracy of birth certificate data regarding the amount, timing, and adequacy of prenatal care using prenatal clinic medical records as referents. *American Journal of Epidemiology, 145*, 68-71.

Clark, P. (1998). Programming of the hypthalamo-pituitary-adrenal axis and the fetal origins of adult disease hypothesis. *European Journal of Pediatrics*, 157 (Supplement 1), s7-s10.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. Hillsdale, NJ: Lawrence Erlbaum.

Collins, C. (1985). *Four sociological traditions.* New York, NY: Oxford University Press.

Collins, C., & David, R. (1997). Urban violence and African-American pregnancy outcome: An ecologic study. *Ethnicity and Disease, 7*(3), 184-190.

Collins, C., & Williams, D. (1995). Examining the black-white adult mortality: The role of residential segregation. Abstr. For 25th Public Health Conference on Records and Statistics and the National Committee on Vital and Health Statistics 45thh Anniversary Symposium, July 17-19, Washington, D.C.

Collins, C., & Williams, D. (1999). Segregation and mortality: The deadly effects of racism? *Sociological Forum, 14*(3), 495-523.

Control, C. (2000). Healthy People 2000 review. *National Center for Health Statistics*, 16, 3-9.

Cooper, R., Kaufman, J., & Ward., R. (2003) Race and genomics: Comment. *New England Journal of Medicine, 348*(12), 1166-1170.

Coulton, C., Chou, J., Wang, E., & Su, M. (1996). Geographic concentration of affluence and poverty in 100 metropolitan areas, 1990. *Urban Affairs Review, 32*(2), 186-216.

Cutler, D., Glaeser, E ., & Vigdor, J. (1999) The Rise and Decline of the American Ghetto." *Journal of Political Economy,* 107, 455-506

Daly, M., Duncan, G., Kaplan, G., & Lynch, J. (1998). Macro to micro links in the relation between income inequality and mortality. *Milbank Quarterly*, 76, 315-339.

Daniels, N., Kennedy, B., & Kawachi, I. (2000). *Is inequality bad for our health*? Boston: Beacon Press.

Darden, J. (1987). Socioeconomic Status and Racial Residential Segregation: Blacks and Hispanics in Chicago. *International Journal of Comparative Sociology. 281*(2), 1–13.

Darroch, A., & Marston, W. (1971). The social class basis of ethnic residential segregation: The Canadian Case. *American Journal of Sociology, 77*(3), 491-510.

Davey Smith, G. (1996). Income inequality and mortality: Why are they related? British *Medical Journal*, 313, 987-988.

Davey Smith, G., & Eggers, M. (1996). Commentary: Understanding it all—Health, meta-theories and mortality trends. *BMJ 313(7072), 1584-1585.*

David, R. (1980). The quality and completeness of birthweight and gestational age data in computerized birth files. *American Journal of Public Health*, 70, 964-973.

Deaton, A. (2001). *Health inequality and economic development.* Prepared for Work Group 1 WHO committee. Macroeconomic Health. New Jersey: Princeton University.

Deaton, A., & Lubotsky, D. (2003). Mortality, inequality and race in American cities and states. *Social Science and Medicine, 56*(6), 1139-1153.

Denton, N., & Massey, D. (1988). Residential segregation of Blacks, Hispanics, and Asians by socioeconomic status and generation. *Social Science Quarterly*, 69, 797-817.

Diez,-Roux, A. (1998). Bringing context back into epidemiology: variables and fallacies in multilevel analysis. *American Journal of Public Health*, 88, 216-222.

Diez-Roux, A. (2002). A glossary for multilevel analysis. Journal *of Epidemiology and Community Health*, 56, 588-594.

Diez, Roux, A. (2003). A glossary of multilevel analysis. *Epidemiological Bulletin, 24*(3), 11.13.

Diez-Roux, A. (2004). Estimating neighborhood health effects: The challenges of causal inference in a complex world. *Social Science and Medicine*, 58, 1953-1960.

Diez-Roux A., Link B., & Northridge M. (2000). A multilevel analysis of income inequality and cardiovascular disease risk factors. *Social Science & Medicine, 50*(5), 673-87.

Diez-Roux A., Nieto, F., Muntaner, C., Tyroler, H., Comstock, G., Shahar, E., Cooper L., Watson R., & Szklo, M. (1997). Neighborhood environments and coronary heart disease: a multilevel analysis. American Journal of Epidemiology. 146:48-63.

DiGuiseppe, D., Aron, D., Ranbom L, David, L., Harper, D., & Rosenthal, G. (2002). Reliability of birth certificate data: a multi-hospital comparison to medical ... *Maternal and Child Health Journal*. 6, 169-179.

Dobie, S., Baldwin, L., Rosenblatt, R., Fordyce, M., Androlla, C., & Hart, L. (1998). How well do birth certificates described the pregnancies they report? The Washington State experience with low-risk pregnancies. *Maternal Child Health Journal*, 2, 145-154.

Doctor, B., O'Riordan, M., Kirchner, L., Shah, D., & Hack, M. (2001) Perinatal correlates and neonatal outcomes of small for gestational age infants born at term gestation. *American Journal of Obstetrics and Gynecology, 185*(3), 652-659.

Duncan, G., Connell, J., & Klebanov, P. (1997). Conceptual and methodological issues in estimating causal effects on neighborhoods and family conditions on individual development. In J. Brooks-Gunn, G. Duncan & J. L. Aber (Eds.), Neighborhood poverty: Context and consequences for children. (Volume I). (pp. 219-250). New York: Russell Sage Press

Durch, J., & Madans, J. (2001). Methodological issues for vital rates and population estimates: 1997 OMB standards for data on race and ethnicity. *Vital Health*

Statistics, 31, 1-30.

Durlauf, S. (1996). A theory of persistent income inequality. *Journal of Economic Growth,* 1, 75-93.

Edwards, L., Coulter, C., Symonds, M., & McMillem, I. (2001). Prenatal undernutrition, glucocorticoids, and the programming of adult hypertension. *Clinical Exp. Pharmacology, Physiology*, 28, 938-941.

Ellen, I. (2000). Is segregation bad for your health? The case of low-birth weight. In W. Gale, & J. Pack (Eds.), *Papers in urban affairs* (pp. 203-238). Washington, D.C.: Brookings Institution Press.

English, P., Kharrazi, M., Davies, S., Scalf, R., Waller, L., & Neutra, R. (2003). Changes in the spatial pattern of low birth weight in a southern California county: the role of individual and neighborhood level factors. *Social Science and Medicine*, 56, 2073-2088.

Eshleman, J. (2003). *The family.* 10th Ed. Boston, MA: Allyn and Bacon.

Fang, J., Madhaven, S., & Alderman, M. (1997). Low birth weight: Race and maternal nativity-impact of community income. *Pediatrics*, 103, e5.

Fang, J., Madhaven, S., Bosworth, W., & Alderman, M. (1998). Residential segregation and mortality in New York City. *Social Science and Medicine*, 47, 469-476.

Fannie Mae (1999). Fannie Mae national Housing Survey 1999. Washington, D.C: Fannie Mae.

Farley, R. (1970). The changing distribution of Negroes within metropolitan areas: The emergences of the black suburbs. *American Journal of Sociology*, 75, 512-529.

Farmer, M., & Ferraro, K. (1997). Distress & perceived health: Mechanisms of health decline. *The Journal of Health and Social Behavior*, 39, 298-311.

Figueroa, J., & Breen, N. (1995). Significance of underclass residence on the stage of breast or cervical cancer diagnosis. *AEA Pa. Proc., 85*(2), 112-116.

Fiscella, K., & Franks, P. (1997). Poverty or income inequality as a predictor of mortality: Longitudinal cohort study. *British Medical Journal*, 314, 1724-1727.

Foster, H., Wu, L., Bracken, M., Semenya, K., Thomas, J., & Thomas, J. (2000). Intergenerational effects of high socioeconomic status on low birthweight and preterm birth in African Americans. *Journal of the National Medical Association, 92*(5), 213-221.

Franzini, L., Ribble, J., & Spears, W. (2001). The effects of income inequality and income level on mortality vary by population's size in Texas counties. *Journal of Health and Social Behavior* 42(4), 373-387.

Frazier, E. (1957). *The Black Bourgeoisie.* New York, NY: Simon and Schuster, 15-22.

Fretts, R., Schmittdiel, J., McLean, F., Usher, R., & Goldman, M. (1995). Increased maternal age and the risk of fetal death. *The New England Journal of Medicine, 333*(15), 955-957.

Friedman D., Cohen, B., Mahan, C., Lederman, R ,Vezina, R., & Dunn, V. (1993). Maternal ethnicity and birthweight among blacks. *Ethnicity & Disease*, *3*(3), 255-269.

Frisbie, W., Parker, Forbes, D., & Pullum, S. (1996). Compromised birth outcomes and infant mortality among racial and ethnic groups. *Demography*, 33, 469-481.

Galster, G., & Killen, S. (1995). The geography of metropolitan opportunity: A reconnaissance and conceptual framework. *Housing Policy Debate, 6*(1), 7-43.

Galster, G., & Mikelsons, M. (1995). The geography of metropolitan opportunity: A case study of neighborhood conditions confronting youth in Washington, D.C. *Housing Policy Debate, 6*(1), 73-102.

Gee, G. (2002). A multilevel analysis of the relationship between institutional racial discrimination and health status. *American Journal of Public Health*, 92, 615–623.

GeoLytics (2004). Neighborhood Change Database (1970-2000). Retrieved November 10, 2004, from http://www.geolytics.com

Gerber, E., & de la Puenta, M. (1996) The development and cognitive testing of race and ethnic origin questions for the Year 2000 Decennial Census. *Proceedings of the Bureau of the Census 1996 Annual Conference*. Rosslyn, VA.

Geyer, S., & Peter, R. (2000). Income, occupational position qualification and health inequalities—competing risks? (Comparing indicators of social status). *Journal of Epidemiology and Community Health*, 54, 299-305.

Glaeser, E., & Vigdor, J. (2001). Racial Segregation in the 2000 Census. Promising News. *The Brookings Institution Survey Series*, Washington, D.C.

Goldenberg, R., Cliver, S., Mulvihill, F., Hickey, C., Hoffman, H., Lorraine V., Klerman, Y., & Johnson, M. (1996). Medical, psychological, and behavioral risk factors do not explain the increased risk for low birth weight among black women. *American Journal of Obstetrics and Gynecology*, 175, 1317-1324.

Goldenberg, R., Davis, R., Cliver, S., Cutter, G., Hoffman, G., Dubard, M., & Copper, R., (1993). Maternal risk factors and their influence on fetal anthropometric measurements. *American Journal of Obstetrics and Gynecology, 168*(4), 1197-

1205.

Goldenberg, R., Davis, R., Cutter, G., Hoffman, H., Brumfield, C., & Foster, J. (1989). Prematurity, postdates and growth retardation: The influence of use of ultrasonography on reported gestational age. *American Journal of Obstetrics of Gynecology*, 160, 462-470.

Gorman, B. (1999). Racial and ethnic variation in low birthweight in the United States: Individual and contextual determinants. *Health and Place*, 5, 195-207.

Gravelle, H. (1998). How much of the relation between population mortality and unequal distribution of income is statistical or artifactual. *British Medical Journal, 316*, 382-385.

Green, D., Moore, J., Adams, M., Berg, C., Wilcox, L., & McCarthy, B. (1998). Are we underestimating rates of vaginal birth after previous cesarean birth? The validity of delivery methods from birth certificates. *American Journal of Epidemiology, 147*(5), 581-586.

Greenberg, M., & Schneider, D. (1994). Violence in American cities: Young black males are the answer, but what is the question? *Social Science and Medicine*, 39, 179-187.

Guest, A., Almgren, G., & Hussey, J. (1998). The ecology of race and socioeconomic distress: Infant and working-age mortality in Chicago. *Demography*, 35, 23-34.

Guyer, B., Martin, J., MacDorman, M., Anderson, R., & Strobino, D. (1997). Annual summary of vital statistics-1996. Pediatrics, 100, 905-919.

Haan, M., Kaplan, G., & Camacho, T. (1987). Poverty and health: Prospective evidence from the Alameda County study. *American Journal of Epidemiology, 125*(6), 989-998.

Hall, M., Carr-Hill, R., Fraser, C., Campbell, D., & Samphier, M (1985). The extene and antecedents of uncertain gestation. *British Journal of Obstetrics and Gynaecology*, 92, 445-451.

Hamilton, B., Martin, J., & Sutton, P. (2004). Births: Preliminary Data for 2003. National Vital Statistics Reports. *National Vital Statistics Reports, 53(9*).

Hamvas, A., Kwong, P., DeBaun, M., Schramm, M., & Cole, F. (1998). Hyaline membrane disease is underreported in a linked birth-infant death certificate database. *American Journal of Public Health, 88*(9), 1387-1389.

Hart, K., Kunitz, S., Sell, R., & Mukamel, D. (1998). Metropolitan governance, residential segregation, and mortality among African Americans. *American Journal of Public Health, 88*(3), 434-438.

Hatcher, L., & Stepanski, E. (1994). A step-by-step approach to using the SAS system for univariate and multivariate statistics. SAS Institue, Inc., Cary, North Carolina.

Hattersley, A., & Tooke, J. (1999). The fetal insulin hypothesis: an alternative explanation of the association of low birth weight with diabetes and vascular disease. *The Lancet*, 353, 1789-1792.

Hayes-Bautista,D.E. & Chapa, J. (1987). Lation terminology: conceptual bases for standardized terminology. *American Journal of Public Health, 77*(1), 61-68.

Hedeker, D., Gibbons, R., & Flay, B. (1994). Random effects regression models for clustered data with an example from smoking prevention research. *Journal of*

Consulting and Clinical Psychology, 62, 757-765.

Hessol, N., Fuentes-Afflick, E., & Bacchetti, P. (1998). Risk of low birthweight among black and white parents. *Obstetrics and Gynecology,* 92, 814-822.

Hillemeier, M., Lynch, J., Harper, T., Raghunathan, T., & Kaplan, G. (2003). Relative or absolute standards for child poverty: A state-level analysis of infant and child mortality. *American Journal of Public Health, 93*(4), 652-657.

Himes, J., & Hoaglin, D. (1989). Resistant cross-age smoothing of age-specific percentiles for growth reference data. American Journal of Human Biology, 1, 165-173.

Hobel, C., Dunkel-Shetter, C., Roesch, S., Castro, L., Arora, C. (1999). Maternal plasma cotricotropin-releasing hormone associated with stress at 20 weeks' gestation in pregnancies ending in preterm delivery. *American Journal of Obstetrics and Gynecology, 180*(1), S257-S263.

Hogberg, U., & Larsson, N. (1997). Early dating by ultrasound and perinatal outcome. A cohort study. Acta Obstetrica Gynecologica Scandinavica, 76, 907-912.

House, J., Landis, K., & Umberson, D. (1988) Social relationships and health. *Science*, 214, 540-545.

Hox, J. (1998). Multilevel modeling: When and why? In I. Balderjahn, R. Mathar & M. Schader (Eds.), *Classification, data analysis and data highways* (pp. 147-154). New York: Springer Verlag.

Hox, J. & Maas, C. (2001). The accuracy of multilevel structural equation modeling with psuedobalanced groups and small samples. *Structrual Equation Modeling, 8*(2), 157-174.

Huxley, R., Neil, A., & Collins, R. (2002). Unraveling the fetal origins hypothesis: Is there really and inverse association between birthweight and subsequent blood pressure? *Lancet*, 360, 659-665.

Iceland, J., Weinberg, D., & Steinmetz, E. (2002). Racial and ethnic residential segregation in the United States: 1980-2000. U.S. Census Bureau: Washington, D.C.

Jackson, S., Anderson, R., Johnson, J., & Sorlie, P. (2000). The relation of residential segregation to all-cause mortality: A study in black and white *American Journal of Public Health, 90*(4), 615-617.

Jargowsky, P. (1996). Take the money and run: Economic segregation in U.S. metropolitan areas. *American Sociological Review*, 62, 984-998.

Jargowsky, P. (1997). *Poverty and place: Ghettos, barrios, and the American city.* New York: Russell Sage Foundation.

Jargowsky, P., & Bane, M. (1991). Ghetto poverty in the United States, 1970-1980. In C. Jencks & P. Peterson (Eds.), *The urban underclass*. Washington, DC: The Brookings Institution.

Jencks, C., & Mayer, S. (1990). The social consequences of growing up in a poor neighborhood In Inner-city poverty in America, edited by Laurence E. Lynn, Jr., & Michael, G.H. McGreary. Washington, D.C.: National Academy Press.

Jiobu, R.M. (1972). Urban Determinants of Racial Differentiation in Infant Mortality. *Demography,* 9, 603-615.

Jones, C. (2001). Invites commentary: Race, racism and the practice of epidemiology:

Comment. *American Journal of Epidemiology, 154*(4), 299-304; discussion 305-306.

Johnson, T., Drisko, K., Gallagher, J., & Barela, C. (1999). Low birth weight: A women's health issue. *Women's Health Issues*, 9, 223–230.

Joseph, K., Kramer, M., Marcoux, S., Ohlsson, A., Wen, S., & Allen, A., & Platt R. (1998). Determinants of preterm deliveries rates in Canada from 1981 through 1983 and from 1992 through 1994. *New England Journal of Medicine*, 339, 1434-1439.

Judge, K. (1999). Income distribution and life expectancy: A critical appraisal. In I. Kawachi, B. Kennedy, & R. Wilkinson (Eds.), The society and population health reader, Volume 1: Income inequality and Health. New York, NY: New Press.

Judge, K., & Paterson, I., (2001). *Poverty, income, inequality and health*. Treasury Working Paper. Retrieved October 6, 2004, from http://www.treasury.govt.nz/workingpapers/2001/01-29.asp.

Kahn, R., Wise, P., Kennedy, B., & Kawachi, I. (2000). State income inequality, household income, and maternal mental and physical health: Cross-sectional national survey. *British Medical Journal*, 321, 1311-1315.

Kaplan, G., Palmuk, E., Lynch, J., Cohen, R., & Balfour, J. (1996). Income inequality and mortality in the United States: Analysis of mortality and potential pathways. *British Medical Journal*, 312, 999-1003.

Kaplan, G., Pamuk, E., Lynch, J., Cohen, R. & Balfour, J. (1999). Inequality in income and mortality in the United States: Analysis of mortality and potential pathways. In I. Kawachi, B. Kennedy, R. Wilkinson (Eds.), *The Society and population* *health reader, Volume I: Income Inequality and Health.* New York, NY: New Press.

Kasarda, J. (1989). Urban industrial transition and the underclass. *Annals of the American Academy of Political Social Science*, 501, 26-47.

Kaufman, J., Copper, R., & McGee, D. (1997). Socioeconomic status and health in blacks and whites: The problem of residual confounding and the resiliency of race. *Epidemiology, 8*(6), 621-628.

Kaufman, J., Dole, N., Savitz, D., & Herring, A., (2003). Modeling community-level effects on preterm birth. *Annals of Epidemiology*, 13, 377-384.

Kawachi, I., Colditz, G., Ascherio, A., Rimm, E., Giovannucci, E., Stamfer, M., Willet, W.C. (1996). A prospective study of social networks in relations to total mortality and cardiovascular disease in men in the U.S. *Journal of Epidemiology Community Health*, 50, 245-251.

Kawachi, I., & Kennedy, B. (1997). The relationships of income inequality to mortality: Does the choice of indicator matter? *Social Science and Medicine, 45*, 1121-1127.

Kawachi, I., & Kennedy, B. (1999). Relationship of income inequality to mortality: Does the choice of indicator matter? In I. Kawachi, B. Kennedy, & R. Wilkinson (Eds.), *The society and population health Reader. Volume 1: Income inequality and Health*. New York, N.Y.: New Press, 1999.

Kawachi, I., & Kennedy, B. (2002). *Health of nations. Why inequality is harmful to your health.* New York: New Press.

Kawachi, I., Kennedy, B., Lochner, K., & Prothrow-Stith, D. (1997). Social capital income inequality and mortality. *American Journal of Public Health*, 87, 1491-

1499.

Kawachi, I., Kennedy, B., Lochner, K., & Prothrow-Stith, D. (1999). Social capital, income inequality and mortality. In I. Kawachi, B. Kennedy, & R. Wilkinson (Eds.), *The society and population health Reader. Volume 1: Income inequality and Health*. New York, N.Y.: New Press, 1999.

Kawachi, I., Kennedy, B., & Wilkinson, R. (Eds.) (1999). *The society and population health reader-Income inequality and health.* New York: The New press, 506 pp.

Kawachi, I., Subramanian, S., & Almeida-Filho, N. (2002). A glossary for health. *Journal of Epidemiology and Community Health, 56*(9), 647-652.

Kennedy, B., Kawachi, I., Glass, R., & Prothrow-Stith, D. (1998). Income distribution, socioeconomic status, and self rated health in the United States: Multilevel analysis. *British Medical Journal*, 317, 917-921.

Kennedy, B., Kawachi, I, & Prothrow-Stith, D. (1999). Income distribution and mortality: Cross sectional ecological study of the Robin Hood Index in the United States. In I. Kawachi, B. Kennedy, & R. Wilkinson (Eds.), *The Society and Population Health Reader, Volume I: Income Inequality and Health.* New, NY: New Press.

Kiely, J., Brett, K.,Yu, S., & Rowley, D. (1994). *Low birth weight and intrauterine growth retardation. From data to action. CDC's public health surveillance for women, infants and children.* U.S. Department of Health and Human services: Atlanta, GA

Kissim, E., Herrera, E., & Nakamoto, J. (1993). *Hispanic Responses to Census Enumeration Forms and Procedures.* Report prepared for the Bureau of the

Census. Suitland, MD.

Knapp, T. R. (1990). Treating oridinal scales as interval scales: An attempt to resolve the controversy. *Nursing Research, 39*(2), 121-123.

Kotch, J. (1997*). Maternal and child health: Programs, problems and policy in public health*. Gaithersburg, MD: Aspen Publishers.

Kramer, M. (1987). Determinants of low birth weight: Methodological assessment and meta-analysis. *Bulletin of the World Health Organization*, 65, 663-737.

Kramer, M., McLean, F., Boyd, M., & Usher, R. (1988). The validity of gestational age estimation by menstrual dating in term, preterm, and postterm gestations. *Journal of the American Medical Association*, 260, 3306-3308

Krieger, N. (1992) Overcoming the absence of socioeconomic data in medical records: Validation and application of a census-based methodology. *American Journal of Public Health, 82*(5), 703-710.

Krieger, N. (1994). Epidemiology and the web of causation: Has anyone seen the spider? *Social Science and Medicine, 39*(7), 887-903.

Krieger, N. (1999). Embodying inequality: A review of concepts, measures, and methods for studying health consequences of discrimination. *International Journal of Health Services, 29*(2), 295-352.

Krieger, N. (2001). Theories for social epidemiology in the 21st century: An ecosocial perspective. *International Journal of Epidemiology*, 30(4), 608-677.

Krieger, N., Rowley, D., Herman, A., Avery, B., & Phillips, M. (1993). Racism, sexism, and social class: Implications for studies of health, disease, and well-being. *American Journal of Preventive Medicine*, 9, 82–122.

Krieger, N., & Sidney, S. (1996) racial discrimination and blood pressure: The cardiac study of young black and white adults. *American Journal of Public Health, 86*(10), 1370-1378.

Lang, J., Lieberman, E., & Cohen, A., (1996). A comparison of risk for preterm labor and term small-for-gestational-age birth. *Epidemiology, 7*(4), 369-376.

Laporte, A. (2002). A note on the use of single inequality index in testing the effect of income distribution on mortality. *Social Science and Medicine, 55*(9), 1561-1570.

Last, J..M. (1995). Dictionary of epidemiology. (1995). 3rd ed., New York, NY: Oxford University Press

Laveist, T. (1989). Linking residential segregation and infant mortality disparity in U.S. cities. *Social Science Research*, 73, 90-94.

Laveist, T. (1992). The political empowerment and health status of African-Americans: Mapping a new territory. *American Journal of Sociology, 97*(4), 1080-1095.

LaVeist, T. (1993). Segregation, poverty, and empowerment: Health consequences for African Americans. *The Milbank Quarterly, 71*(1), 41-66.

LaVeist, T. (1995). The color line and the health of African-Americans. *Humboldt Journal of Social Relations, 21*(1), 119-137.

LaVeist, T. (1999). Book review: Anthony P. Polednak. Segregation, poverty and mortality in urban African Americans. *Journal of Health Politics, Policy and Law, 24*(6): 1410-1412.

LeClere, F., Rogers, R., & Peters, K. (1997). Ethnicity and mortality in the United States. Individual and community correlates. *Social Forces*, 76, 169-198.

LeClere, F., & Soobader, M. (2000). The effect of income inequality on the health of selected U.S. demographic groups. *American Journal of Public Health, 90*(12), 1892-1897.

Lee, P., Chernausek, S., Hokkem-Koela, A., & Czernichow, P. (2003). International small for gestational age advisory board consensus development conference statement: Management of short children born small for gestational age, April 24-October 1, 2001. *Pediatrics, 111*(6), 1253-1261.

Lillie-Blanton, M., & LaVeist, T. (1996). Race/ethnicity, the social environment and health. *Social Science and Medicine, 43*(1), 83-91.

Link, B., & Phelan, J. (1995). Social conditions as fundamental causes of disease. *The Journal of Health and Social Behavior,* Spec No, 80-94.

Littrell, R., Milliken, G., & Stroup, W., & Wolfinger, R. (1996). *SAS System for mixed models*. Cary, NC: SAS Institute, Inc.

Livingston, I. (1994). Social status, stress and health: Black Americans at risk. In: I. Livingston, (Ed.), *Handbook of Black American health* (pp. 236-252). Westport, Connecticut: Greenwood Press.

Lobmayer, P., & Wilkinson, R. (2000). Income, inequality and mortality in 14 developed countries. *Sociology of Health & Illness, 22*(4), 401-414.

Lochner, K., Pamuk, E., Makuc, D., Kennedy, B., & Kawachi, I. (2001). State-level income inequality and individual mortality risk: A prospective multilevel study. *American Journal of Public Health*, 91, 385-391.

Logan, J., & Alba, R. (1993). Locational returns to human capital: Minority access to suburban community resources. *Demography*, 30, 243-268.

Logan, J., & Messner, D. (1987). Racial residential segregation and suburban violent crime. *Social Science Quarterly*, 68, 510-527.

Lumley, J. (2003). Recent work on the epidemiology of preterm birth. *Acta Obstetricia et Gynecologica Scandinavica* 84 (6), 541-54.

Lynch, J. (2000). Income inequality and health: Expanding the debate. *Social Science and Medicine*, 51, 1001-1005.

Lynch, J., & Davey Smith, M. (2003). Rates and states: Reflections on the health of Nations. *International Journal of Epidemiology, 32*(4), 663-670.

Lynch, J., Davey Smith, M., Harper, S., Hillemeier, M., & Wolfson, M. (2004). Is income inequality a determinant of population health? Part 1. A systematic review. *The Milbank Quarterly, 82*(1), 5-99.

Lynch, J., Davey Smith, M., Hillemeier, Shaw, T., Raghunthan, & Kaplan, G. (2001). Income inequality, the psychosocial environment and health: Comparisons of wealthy nations. *Lancet,* 358, 194-200.

Lynch, J., Davey Smith, M., Kaplan, G., & House, J. (2000). Income inequality and mortality: Importance to health of individual income, psychosocial environment or material conditions. *British Medical Journal, 320*(7243), 1200-1204.

Lynch, J., Kaplan, G. Pamuk, E., Cohen, R., & Heck, K. (1998). Income inequality and mortality: Importance to health of individual income, psychosocial environment, or material conditions. *British Medical Journal*, 320, 1200-1204.

Lynch, J., Kaplan, G., Pamuk, E., Cohen, R., Heck, K., Balfour, J., et al. (1999). Income inequality and mortality in metropolitan areas of the United States. In I. Kawachi, B. Kennedy, & R. Wilkinson (Eds.), *The society and population health Reader. Volume 1: Income inequality and Health*. New York, N.Y.: New Press, 1999.

MacCallum, R., Zhang, S., Preacher, K., & Rucker, D. (2002). On the dichotomization of quantitative variables. *Psychological Methods, 7*(1), 19-40.

Macinko, J., Shi, L., & Starfield, B. (2004). Wage inequality, the health system and infant mortality in wealthy industrialized countries, 1970-1996. *Social Science and Medicine, 58*(2), 279-292.

Macintyre, S. (1994). Understanding the social patterning of health: The role of the social sciences. *Journal of Public Health Medicine*, 16, 53-59.

Malstrom, M., Sandquist, J., & Johansson, S. (1999). Neighborhood environment and self-reported health status: A multilevel analysis. *American Journal of Public Health, 89*(8), 1181-1186.

Marmot, M. (1999). Epidemiology of socioeconomic status and health: Are determinants within countries the same as between countries? *Annals of New York Academy of Science*, 896, 16-29.

Marmot, M., Bobak, M., & Davey Smith, G. (1995). Explanations for social inequalities in health. In B.C. Amick, S. Levine, A. Tarlov, D.C. Walsh (Eds.), *Society and Health* (pp. 172-210). Oxford University Press.

Marmot, M., & Wilkinson, R. Eds. (1999) *Social determinants of health*. New York: Oxford University Press.

Marmot, M. & Wilkinson, R. (2001). Psychosocial and material pathways in the relation between income and health: A response to Lynch et al. *BMJ, 322*(7296), 1124-1128.

Martin, J., Hamilton, B., Sutton, P., Ventura, S., Menacker, F., & Munson, M. (2003). Births: Final data for 2002. National Vital Statistics Reports, 52(10). Hyattsville,:

MD. National Center for Health Statistics.

Massey, D. (1990). American Apartheid: Segregation and the making of the underclass. *American Sociological Review*, 61, 984-998.

Massey, D. (2001). Residential segregation and neighborhoods conditions in U.S. metropolitan areas. In N. Smelser, W. Wilson, & F. Mitchell (Eds.), *American becoming: Racial trends and their consequences*, *Vol I* (pp. 391-434). Washington, D.C.: National Academy Press.

Massey, D. (1996). The age of extremes: Concentrated affluence and poverty in the twenty-first century. *Demography*, 33, 395-412.

Massey, D., Condran, G., & Denton, N. (1987). The effect of residential segregation on black social and economic well-being. *Social Forces, 66*(1), 29-56.

Massey, D., & Denton, N. (1988). The dimensions of residential segregation. *Social Forces, 76*(2), 281-315.

Massey, D., & Denton, N. (1993). *American apartheid: Segregation and the making of the underclass.* Cambridge, MA: Harvard University Press.

Massey, D., & Eggers, M. (1990). The ecology of inequality: Minorities and the concentration of poverty, 1970-1980. *American Journal of Sociology, 95*(5), 1153-1188.

Massey, D., & Eggers, M. (1993). The spatial concentration of affluence and poverty during the 1970s. *Urban Affairs Quarterly, 29*(2), 299-315.

Massey, D., & Fischer., M. (1999). Does rising income bring integration? New results for Blacks, Hispanics, and Asians in 1990. *Social Science Research* 28, 316-326.

Massey, D., & Fischer, M. (2000). How segregation concentrates poverty. *Ethnic and*

Racial Studies, 23(4), 670-691.

Massey, D., White, M., & Phua, V. (1996). The dimensions of segregation revisited. *Sociological Methods and Research*, 25, 172-206.

Matthews, T., Menacker, F., & Macdorman, M. (2002). Infant mortality statistics from the 2000 period linked birth/Infant data set. *National Vital Statistics Report, 50*(12). Hyattsville, MD: National Center for Health Statistics.

Mayer, S. (2001). *How the growth in income inequality increased economic segregation.* Northwestern University of Chicago Joint Center for Poverty Research in Working Paper #230.

Mayer, S., & Sarin, A. (2005). Some mechanisms linking economic inequality and infant mortality. *Social Science and Medicine*, 60, 439-455.

McLaughlin, D., Stokes, C., & Nonoyama, A. (2002). Residence and income inequality: Effects on mortality among U.S. Counties. *Rural Sociology 66*(4), 579-598.

McLean, D., Hatfield-Timajchy, K., Wingo, P., & Floyd, R. (1993). Psychosocial Measurements: Implications for the Study of Preterm Delivery in Black Women. *American Journal of Preventive Medicine* 9(6), 39-81.

Mellor, J., & Milyo, J. (2003). Is exposure to income inequality a public health concern? Lagged effects of income inequality on individual and population health. *Health Services Research* 38, 137-152.

Messner, S., & Tardiff, K. (1986). Economic-Inequality and levels of homicide-An Analysis of urban neighborhoods. *Criminology 24*(2), 297-317.

Milner, R., & Richards, B. (1974). An analysis of birth weight and gestational age of infants born in England and Wales, 1967 to 1971. *Journal of Obstetrics and Gynecology of the British Commonwealth*, 81, 956-967.

Mokdad, A., Ford, E., Bowman, B., Dietz, W., Vinicor, F., Bales, V., & Marks, J. (2003). Prevalence of obesity, diabetes, and obesity-related health risk factors, 2001. *Journal of the American Medical Association*, 289, 76-79.

Muller, A. (2002) Education, income inequality and mortality: A multiple regression analysis. British Medical Journal, 324(7328), 23-25.

Muthen, B., & Muthen, L. (2002). How to use a Monte Carlo study to decide on sample size and determine power. *Structural Equation Modeling, 4*, 599-620.

Naeye, R. (1983). Maternal age, obstetric complications, and the outcome of pregnancy. *Obstetrics and Gynecology,* 61, 3135-3139.

Martin, J., Hamilton, B., Ventura, S., Menacker, F., & Park, M. (2002). Births: Final data for 2002. National Center for Health Statistics. Hyattsville, M.D.

National Center for Health Statistics (2004). Health, United States, 2004 with chartbook on trends in the health of Americans. Hyattsville, M.D.

Nettleton, S, & Burrows, R. (1998). Housing norms, housing satisfaction and the propensity to move. *Journal of Marriage and the Family*, 38, 309-320.

Newburn-Cook, C., White, D., Svenson, L., Demianczuk, N., Bott, N., & Edwards, J. (2002). Where and to what extent is prevention of low birth weight possible? Western *Journal of Nursing Research, 24*(8), 887-904.

Nguyen, V., & Preschard, K. (2003). Anthropology, inequality, and disease: A review. *Annual Review of Anthropology* *32,* 447-474.

O'Campo, P., Xue, X., & Wang, M. (1997). Neighborhood risk factors for low birthweight in Baltimore multilevel analysis. *American Journal of Public Health*, 87, 1113-1118.

Office of Management and Budget. *Race and ethnic standards for federal statistics and administrative reporting.* Statistical Policy Directive 15, 1977.

Office of Management and Budget Federal Register Notice. *Revisions to the standards for the classification of Federal data on race and ethnicity.* Federal Register 62FR58781-58790, October 30, 1997. Available at: http://www.whitehouse.gov/wh/eop/omb/html/fedreg.html. Accessed May 1, 2005.

Oliver, M., & Shapiro, T. (1997). *Black wealth/White wealth: A new perspective on racial inequality*. New York: Routledge.

Parker, J. (2001). Birthweight trends among interracial black and white infants. *Epidemiology*, 11, 242-248.

Parker, J., Schenker, N., Ingram, D., Weed, J, Heck, K., & Madans, J. (2004). Bridging between two standards for collecting information on race and ethnicity: An application to Census 2000 and vital rates. *Public Health Reports, 119*, 192-205.

Pearl, M., Braveman, P., & Abrams, B. (2001). *The city.* Chicago: University of Chicago Press.

Peterson, R., & Krivo, L. (1993). Racial segregation and black urban homicide. Social Forces, 71, 1001-1026.

Peterson, R., & Krivo, L. (1999). Racial segregation, the concentration of disadvantage, and Black and White homicide victimizations. *Social Forum, 14*(3), 465-493.

Pettigrew, T., & Meertens, R. (1995). Subtle and blatant prejudice in Western Europe. *European Journal of Social Psychology*, 25, 57-75.

Phillips, D. (2001). Programming of adrenocortial function and the fetal origins of adults disease. *Journal of Endocrinological Investment*, 24, 742-746.

Pickett, K., Collins, J., Masi, C., & Wilkinson, R. (2005). The effects of racial density and income incongruity on pregnancy outcomes. Social Science and Medicine, 60(10), 2229-2238.

Piper, J., Mitchel, E., Snowden, M., Hall, C., Adams, M., & Taylor, P. (1993). Validation of 1989 Tennessee birth certificate using maternal and newborn hospital records. *American Journal of Epidemiology*, 137, 758-768.

Piper, J., Xenakis, E., McFarland, M., Elliott, B., Berkus, M., & Langer, O. (1996). Do growth retarded premature infants have different rates of perinatal morbidity and mortality than appropriately grown premature infants? *Obstetrics and Gynecology, 87(*2), 169-174.

Polednak, A. (1991). Black-white differences in infant mortality in 38 standard metropolitan statistical areas. *American Journal of Public Health, 86*(5), 723-726.

Poldenak, A. (1993). Poverty, residential segregation and black/white mortality ratios in urban areas. *Journal of Health Care of the Poor and Underserved*, 4, 363-373.

Poldenak, A. (1996). Segregation, discrimination and mortality in U.S. blacks. *Ethnicity and Disease*, 6, 99-108.

Polednak, A. (1997). Segregation, poverty and mortality in urban African Americans. New York, NY: Oxford University Press.

Pollato, E., Collins, J., & David, R. (2000). Enigma of maternal race and infant birthweight: A population-based study of U.S. born black and Caribbean born black women. *American Journal of Epidemiology*, 151, 1080-1085.

Potter, L. (1991). Socioeconomic determinants of white and black life expectancy differentials. *Demography*, 28, 303-320.

Preston, S.H. (1975). The changing relation between mortality and level of economic development. *Population Studies*, 29, 231-248.

Raferty, A.E. (1986) Choosing models for cross-classifications: comment on Grusky and Hauser. *American Sociological Review,* 51, 145-146.

Raferty, A.E. (1995) Bayesian model selection in social research. *Sociological Methodology 25*, 111-163.

Rauh, V., Howard, F., Andrews, H., & Garfinkel, R. (2001). The contribution of maternal age to racial disparities in birthweight: A multilevel perspective. *American Journal of Public Health*, 91, 1815-1824.

Regev, R., Lusky, A., Dolfin, T., Litmanovitz, I. Arnon, S., & Reichmank, B. (2003). Excess mortality and morbidity among small-for-gestational-age premature infants: A population-based study. *Journal of Pediatrics*, 143, 186-191.

Reichman, N., & Hade, E. (2001) Validation of birth certificate data: A study of women in New Jersey's HealthStart Program. *Annals of Epidemiology*, 11, 186-193.

Reloar, A., Behn, B., & Cowan, D. (1967). Analysis of gestational interval. *American Journal of Obstetrics and Gynecology*, 99, 34-45.

Ren, X., Amick, B., & Williams, D. (1999). Racial/ethnic disparities in health: The interplay between discrimination and socioeconomic status. *Ethnicity and Disease*, 9, 151-165.

Rich-Edwards, J., Krieger, N., Majzoub, J., Sierler, S., Lieberman, E., & Gillman, M. (2001). Maternal experiences of racism and violence as predictors of preterm birth: Rationale and study design. *Paediatric and Perinatal Epidemiology*, 15, S124-S135.

Roberts, E. (1997) Neighborhood social environments and the distribution of low birthweight in Chicago. *American Journal of Public Health*, 87, 597-603.

Rodgers, G. (1979). Income and inequality as determinants of mortality: An international cross-sectional analysis. *Populations Studies*, 33, 343-351.

Rodriguez, C.E., & Cordero-Guzman, J.M. (1992). Place, race in context. Ethnic racial studies. Vol. 15. Pp. 523-543.

Rohe, W., Van Zandt, V., & McCarthy, G. (2001). The social benefits and costs of homwownershp: a critical assessment of the research. Joint Center for Housing Studies of Harvard University: Chapel Hill: NC.

Roisman, F. (1995). The lessons of American apartheid: The necessity and means of promoting residential racial integration. *Iowa Law Review*, 81, 479-525.

Rosenberg H., Maurer, J., Sorlie, P., Johnson, N., MacDorman, M., Hoyert D., Spitler, J., & Scott, C. (1999). Quality of death rates by race and Hispanic origin: A summary of current research, 1999. National Center for Health Statistics. Vital *Health Stat 2*(128). 1999.

Rosenfield, R. (1986). Urban crime rates: Effects of inequality, welfare dependency, region and race. In J. Bryne and R. Sampson (Eds.), *The Social Ecology of Crime*: (pp. 116-130). New York: Springer-Verlag.

Rossi, P., & Weber, E. (The social benefits of homeownership: Empirical evidence from national nurveys. *Housing Policy Debate, 7*(1), 1-35.

Roohan, P., Josberger, R., Acar, J., Dabir, P., Feder, H., & Gagliano, P. (2003). Validation of birth certificate data in New York State. *Journal of Community Health, 28*(5), 335-346

Rowley, D. (1994). Research issues in the study of very low birthweight in African-Americans. *Journal of the National Medical Association, 91*(12), 663-667.

Ryan, B., Joiner, B., & Ryan, T. (1985). *Minitab handbook. 2nd Ed.* Boston: Duxbury Press.

Sampson, R. (1985). Race and criminal violence: A demographically disaggregated analysis of urban homicide. *Crime and Delinquency*, 31, 47-82.

Sampson, R. (1987). Urban black violence: The effect of male joblessness and family disruption. *American Journal of Sociology*, 93, 348-382.

Sanders, M., Allen, M., Alexander, G., Yankowitz, J., Graeber, J., Johnson, T., & Repka, M. (1991). Gestational age assessment in preterm infants weighing less than 1500 grams. *Pediatrics, 88*(3), 542-545.

Sastry, N., Ghosh-Dastidar, B., Adams, J., & Pebley, A. (Eds.). (2003). *The design of a multilevel survey of children, families, and communities: The Los Angeles Family and Neighborhood Survey*. Santa Monica: RAND.

Scheuch, E. (1969). Social context and individual behavior. In: Dogan, M. Rokkam, S. Eds., Social ecology. Boston: The MIT Press, 133-155.

Schiono, P., Rauk, V., Park, M., Lederman, S., & Zuskar, D. (1997). Ethnic differences in birth weight: The role of lifestyle and other factors. *American Journal of Public Health*, 87, 787-793.

Shihadeh, E., & Flynn, N. (1996). Segregation and crime: The effect of black isolation on the rates of black urban violence. *Social Forces*, 74, 1325-1352.

Siegrist, J., & Marmot, M. (2004). Health inequalities and the psychosocial environment-two scientific challenges. *Social Science and Medicine*, 58, 1463-1473.

Singer, J. (1998). Using SAS PROC MIXED to fit multilevel models, hierarchical models and individual growth models. *Journal of Educational and Behavioral Statistics, 24*(4), 323-355.

Singer, B., & Ryff, C. (Eds.) (2001). New horizons in health: An integrative approach. Washington, D.C.: National Academies Press.

Singer, J., & Willett, J.. (2003). *Applied longitudinal data analysis: Modeling change and even occurrence*. New York: Oxford University Press.

Sloggett, A., & Joshi, H. (1994). Higher mortality in deprived areas: Community or personal disadvantage? *British Medical Journal*, 309, 1470-1474.

Snijders, T., & Bosker, R.(1993). Standard errors and sample sizes for two-level research. *Journal of Educational Statistics, 18*(3), 237-259.

Soobader, M, & LeClere, F. (1999). Aggregation and the measurement of income inequality: Effects on morbidity. *Social Science and Medicine, 48*(6), 733-744.

South, S., & Crowder. K. (2000). The declining significance of neighborhoods? marital transitions in community context. *Social Forces*, 78, 1067-1099**.**

Spinnato, J., Sibai, B., Shaver, D., & Anderson, G. (1984) Inaccuracy of Dubowitz gestational age in low birth weight infants. *Obstetrics and Gynecology*, 63, 491-495.

Stancil, T., Hertz-Picciotto, I., & Schramm, M., & Watt-Morse, M. (2000). Stress and pregnancy among African American women. *Paediatric and Perinatal Epidemiology,* 14, 127-135.

Strait, J. (2006). An epidemiology of neighborhood poverty: Causal factors of infant mortality among Blacks and Whites in metropolitan United States. *The Professional Geographer, 58*(1), 39-53.

Subramanian, S., Blakely, T., & Kawachi, I. (2003). Income inequality as a public health concern: Where do we stand? Commentary on “Is exposure to income inequality a public health concern?” *Health Services Research*, 38, 153-167.

Subramanian, S., Acevedo-Garcia, D., & Osypuk, T. (2005). Racial residential segregation and geographic heterogeneity in black-white disparity in poor self-rates health in the U.S.: A multilevel statistical analysis. *Social Science and Medicine*, *60*(8), 1667-1679.

Subramanian, S., Kawachi, I., & Kennedy, B. (2001). Does the state you live in make a difference? Multilevel analysis of self-rated health in the U.S. *Social Science and Medicine,* 53, 9-19.

Sugure, T. (1996). *The Origins of the Urban Crisis: Race and Inequality in Postwar Detroit.* Princeton, NJ: Princeton University Press, 1996).

Sutton, P., & Matthews, M. (2004). Trends in characteristics of births by state: United States, 1990, 1995, and 2000-2002. *National Vital Statistics Reports, 52*(19). Hyattsville, Maryland: National Center for Health Statistics.

Taeuber, K., & Taeuber, A. (1964). The Negro as an immigrant group: Recent trends in racial and ethnic segregation in Chicago. *American Journal of Sociology*, 69, 374-382.

Taffel, S., Johnson, D., & Heuser, R. (1982). A method of imputing length of gestation on birth certificates. *Vital and Health Statistics, 2*(93), 1-11.

Taffel, S., Ventura, S., & Gay. G. (1989). Revised U.S. certificate of birth--new opportunities for research on birth outcome. *Birth* 16(4), 188-93.

Testa, M., Astone, N., Krogh, M., & Neckerman, K. (1993). Employment and marriage among inner-city fathers. In W. Wilson (Ed.), *The ghetto underclass*. Newberry Park, CA: Sage Publications.

Tien, J., Sandler, I., MacKinnon, D., & Wolchik, S. (2004). How did it work? Mediation in the context of a moderated prevention effect for children of divorce. *Journal of Consulting and Clinical Psychology, 72*(4), 617-624.

Turnbull, A., & Rivier, C. (1999). Regulation of the hypothalamic-pituitary-adrenal axis by cytokines: Actions and mechanisms of action. *Physiological Reviews*, 79, 1-71. U.S. Department of Health and Human Services (2000). *Healthy People 2010*. 2nd Ed. With Understanding and Improving Health and Objectives for Improving Health. 2 vols. Washington, DC: U.S. Government Printing Office.

United States Department of Health and Human Services (2000). *Healthy People 2010: Understanding and Improving Health.* Washington: GPO.

Velleman, P. (1980). Definition and comparison of robust nonlinear data smoothing algorithms. *Journal of the American Statistical Association*, 75, 609-615.

Wadhwa, P., Culhane, J., Rauh, V., Barve, S., Hogan, V., Sandman, C., Hobel, C.J., Chicz-DeMent, A., Dunkel-Schetter, C., Garite, T.J., & Glynn, L. (2001). Stresses, infection and preterm birth: A biobehavioral perspective. *Paediatric and Perinatal Epidemiology*, 15, 17-29.

Wadhwa P., Porto, M., Chicz-DeMet, A., & Sandman, C. (1998). Maternal CRH levels in the early third trimester predict length of gestation in human pregnancy. Ameican Journal of Obstetrics and Gynecology, 179, 1079-1085.

Wagstaff, A., & van Doorslaer (2000). Income inequality and health: What does the literature tell us? *Annual Review of Public Health,* 21, 543-567.

Waitzman, N., & Smith, K. (1998). Separate but lethal: the effects of economic segregation on mortality in metropolitan America. *The Milbank Quarterly, 76*(3), 341-373.

Waldmann, R. (1999). Income distribution and infant mortality. In I. Kawachi, B. Kennedy, & R. Wilkinson (Eds.), *The Society and Population Health Reader, Volume I: Income Inequality and Health.* New, NY: New Press.

Wallace, R. (1990). Urban desertification, public health and public order: Planned shrinkage, violent death, substance abuse and AIDS in the Bronx. *Social Science and Medicine*, 31, 801-813.

Wallace, R. (1991). Expanding couples shock fronts of urban decay and criminal behavior: How U.S. cities are becoming hollowed out. *Journal of Quantitative Criminology*, 7, 333-356.

Wang, X., Guyer, B., & Paige, D. (1994). Differences in gestational age-specific birthweight among Chines, Japanese and white Americans. *International Journal of Epidemiology*, 23, 119-128.

Watkins, M., Edmonds, L, McClearn, A., Mullins, L., Mulinare, J., & Khoury, M. (1996). The surveillance of birth defects: The usefulness of the revised U.S. standard birth certificate. *American Journal of Public Health, 86*(5), 731-734.

Warren, W., Patrick, S., & Goland, R. (1992). Elevated maternal plasma corticotropin-releasing hormone levels in pregnancies complicated by preterm labor. *American Journal of Obstetrics and Gynecology,* 166, 1198–204.

Wen, W., Goldenberg, R., Cutter, G., Hoffman, R., & Cliver, S. (1990). Intrauterine growth retardation and preterm delivery: Prenatal risk factors in an indigent population. *American Journal of Obstetrics and Gynecology*, 162, 213-218.

Wenner, W., & Young, E. (1974). Nonspecific date of last menstrual period. *American Journal of Obstetrics and Gynecology*, 120, 1071-1079.

White, M., Kim, A., Glick, J. (2005). Mapping social distance: Ethnic residential segregation in a multiethnic metro. *Sociological Methods and Research, 43*(2), 173-203.

Wilcox, L., & Marks, J. (Eds). (1994). *From data to action: CDC's public health surveillance for women, infants and children.* Atlanta, GA: Center for Disease Control and Prevention.

Wilkinson, R. (1992). Income distribution and life expectancy. *British Medical Journal,* 304, 165-168.

Wilkinson, R. (1996). *Unhealthy societies: The afflictions of inequality*. London: Routledge.

Wilkinson, R. (1997). Health inequalities: Relative or absolute material standards? *British Medical Journal,* 314, 591-595.

Wilkinson, R. (1999). Health hierarchy and social anxiety. *Annals of New York Academy of Science, 896*, 48-63.

Wilkinson, R. (2000). *Mind the Gap*. London: Weidenfeld & Nicolson.

Williams, D. (1994). The concept of race in Health Services Research: 1996 to 1990. *Health Services Research, 29*(3), 261-274.

Williams, D. (1996). Racism and health: A research agenda. *Ethnicity and Disease*, 6, 1-6.

Williams, D. (1997). Race and health: Basis questions, emerging directions. *Annals of Epidemiology,* 7, 322-333.

Williams, D. (2001). Race and health: Trends and policy implications. In J.A., Auerbach, & B. Krimgold (Eds.), *Income, socioeconomic status and health: Exploring the relationships.* Washington, D.C.: National Policy Association and the Academy for Health Services Research and Policy.

Williams, D. (2002). Racial/ethnic variations in women's health: The social embeddedness of health. *American Journal of Public Health, 92*(4), 588-597.

Williams, D., & Collins, C. (1995). US socioeconomic and racial differences in health: Patterns and explanations. *Annual Review of Sociology*, 21, 349-386.

Williams, D., & Collins, C. (2001). Racial residential segregation: A fundamental cause of racial disparities in health. *Public Health Reports*, 116, 404-416.

Wilson, W. (1980). *The declining significance of race.* Chicago, IL: The University of Chicago Press.

Wilson, W. (1987). *The truly disadvantaged: The inner city, the underclass, and public policy in Chicago*. University of Chicago.

Yang, H., Kramer, M., Platt, R., Blondel, B., Breart, G., Morin, I., Wilkins, R., & Usher, R. (2002). How does early ultrasound scan estimation of gestational age lead to higher rates of preterm birth? *American Journal of Obstetrics and Gynecology,* 186, 433-437.

Yankauer, A. (1950). The relationship of fetal and infant mortality to residential segregation. *American Sociological Review*, 15, 644-648.

Zambonato, A., Pinherio, R., Horta, B., & Tomasi, E. (2004). Risk factors for small for gestational age births among infants in Brazil. *Revista de Saude Publica, 38*(1), 1-4.

Zeitlin, J., Ancel, P., Surel-Cubizolles, M., & Papiernik, E. (2001). Are risk factors the same for small for gestational age versus preterm births? *American Journal of Obstetrics and Gynecology, 185*(1), 208-215

APPENDIX A: CONCEPTUAL MODEL OF THE RELATIONSHIP BETWEEN RESIDENTIAL SEGREGATION AND PERINATAL OUTCOMES

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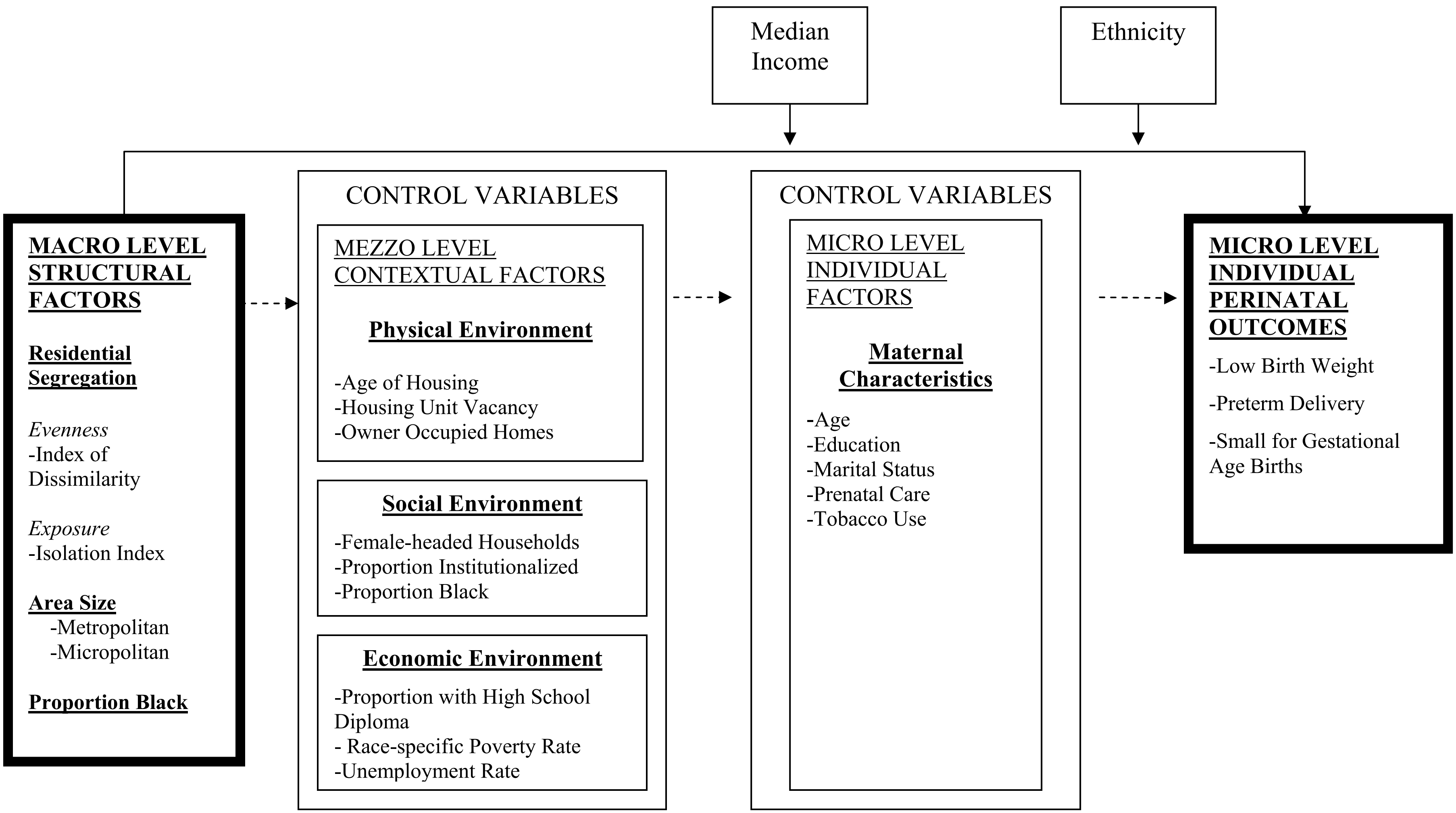

ABOUT THE AUTHOR

Tabia Henry Akintobi received a Bachelor's Degree in English from the University of Miami in 1997 and a Master's of Public Health from the College of Public Health, at University of South Florida in 1999.

Tabia lives in Conley, Georgia with her husband, Adebayo, and daughter, Ifelola. She will expand her role as Senior Researcher at the Morehouse School of Medicine Prevention Research Center, in Atlanta, Georgia, after graduation.