HHS Public Access

Author manuscript

Ethn Health. Author manuscript; available in PMC 2024 July 02.

Published in final edited form as:

Ethn Health. 2014 ; 19(5): 479–499. doi:10.1080/13557858.2013.846300.

Institutional racism, neighborhood factors, stress, and preterm birth

Dara D. Mendez[a,*], **Vijaya K. Hogan**[b], **Jennifer F. Culhane**[c]

[a]Department of Epidemiology, University of Pittsburgh, Pittsburgh, PA 15261, USA

[b]Department of Maternal and Child Health, University of North Carolina, Chapel Hill, NC 27599, USA

[c]NCS CHOP Study Center, University of Pennsylvania, Philadelphia, PA 19104, USA

Abstract

Objective.—Racial/ethnic disparities in the risk of preterm birth may be explained by various factors, and previous studies are limited in examining the role of institutional racism. This study focused on the following questions: what is the association between preterm birth and institutional racism as measured by residential racial segregation (geographic separation by race) and redlining (black–white disparity in mortgage loan denial); and what is the association between preterm birth and reported stress, discrimination, and neighborhood quality.

Design.—We used data from a clinic-based sample of pregnant women (n = 3462) participating in a stress and pregnancy study conducted from 1999 to 2004 in Philadelphia, PA (USA). We linked data from the 2000 US Census and Home Mortgage Disclosure Act (HMDA) data from 1999 to 2004 and developed measures of residential redlining and segregation.

Results.—Among the entire population, there was an increased risk for preterm birth among women who were older, unmarried, tobacco users, higher number of previous births, high levels of experiences of everyday discrimination, owned their homes, lived in nonredlined areas, and areas with high levels of segregation measured by the isolation index. Among black women, living in a redlined area (where blacks were more likely to be denied mortgage loans compared to whites) was moderately associated with a decreased risk of preterm birth (aRR = 0.8, 95% CI: 0.6, 0.99).

Conclusion.—Residential redlining as a form institutional racism and neighborhood characteristic may be important for understanding racial/ethnic disparities in pregnancy and preterm birth.

Keywords

redlining; segregation; racism; preterm birth; pregnancy; health disparities

[*]Corresponding author. ddm11@pitt.edu, The initial analyses for this manuscript were conducted while the primary author was at the University of North Carolina, Chapel Hill.

Background

Preterm birth and neighborhood contexts

Racial and ethnic disparities in rates of preterm birth and low birth weight are a persistent problem in the USA (Mathews and MacDorman 2008; Hogan et al. 2001; Culhane and Elo 2005). Preterm birth, defined as less than 37 weeks gestation, is a leading cause of infant mortality in the USA. There are also significant racial disparities in infant mortality where black women in the USA are almost twice as likely to have an infant death and deliver preterm compared to white women (Martin et al. 2010). Risk factors such as individual income and prenatal care usage may be associated with preterm birth and infant mortality, but these factors do not completely explain the racial disparity. Preterm birth and disparities in perinatal outcomes are a result of a complex interplay of biological, physiological, behavioral, environmental, and social factors that has led investigators to consider determinants at multiple levels (i.e., individual, family, community, and society) (Hogan and Ferre 2001; Hogue and Vasquez 2002).

The community or neighborhood context may provide additional insight in understanding racial disparities in preterm birth and other perinatal outcomes (Bell et al. 2006; Buka et al. 2003; Culhane and Elo 2005; Diez Roux 2001; Farley et al. 2006; Grady 2006; Mason et al. 2009; Messer et al. 2006; O'Campo et al. 2008; Schempf et al. 2011). Many researchers argue that neighborhood environments influence maternal reproductive health and birth outcomes even when accounting for individual characteristics (Culhane and Elo 2005). Adverse neighborhood conditions such as inadequate housing, neighborhood poverty, neighborhood violence, exposure to toxins and pollution, and the lack of social services may also negatively influence pregnancy and birth outcomes as a result of stress, material deprivation, and isolation (O'Campo et al. 1997; Culhane and Elo 2005; Schempf, Strobino, and O'Campo 2009; Zapata et al. 1992; Buka et al. 2003; Paul et al. 2008). Additionally, health-promoting resources such as access to quality health care and social services, grocery stores and recreational facilities may influence health behaviors such as diet, physical activity and entry into prenatal care, ultimately influencing pregnancy and birth outcomes (Schempf, Strobino, and O'Campo 2009; Culhane and Elo 2005; Landrine and Corral 2009; Weinick, Zuvekas, and Cohen 2000).

Institutional racism and the neighborhood context

In addition to disparities in rates of preterm birth and related perinatal outcomes, there are also disparities in neighborhood environments. For example, communities of color and people of low-income communities are more likely to live in neighborhoods with limited employment opportunities, be exposed to solid waste facilities, and have less access to grocery stores compared to whites or those of a higher income, and communities of color are likely than white communities to be exposed to these conditions even at similar income levels (Williams and Collins 2001). Racially and socioeconomically disparate neighborhoods are the result of historical and contemporary racism and inequitable policies and practices and are central for understanding racial/ethnic disparities in health (Osypuk and Acevedo-Garcia 2010).

Institutional racism refers to overt and covert policies, practices, and laws that reinforce racial inequality, white superiority and subordination of certain racial groups in relation to access to resources, opportunities, and power (Williams and Collins 2001; Jones 2000; Carmichael and Hamilton 2001). Residential redlining is a specific institutional practice, and focus of this study, which was the illegal practice of banks and financial institutions systematically denying mortgage loans, or provide loans with worse terms, to individuals and groups within an area based on race or socioeconomic status (Courchane and Zorn 2008; Hillier 2003; Lacker 1995; Satter 2009). Historically, the term 'redlining' was coined by community groups in the 1960s because appraisal maps were color coded red by banks and lenders who refused to provide loans or provided loans with worse terms to communities of color (Hillier 2003).

To counteract and regulate historic and current discriminatory practices, the Home Mortgage Disclosure Act (HMDA) of 1975 was instituted. Lenders report information about the types of loans provided to consumers, which is included in the HMDA data collection process. In 1989, the Congress expanded the HMDA data to include information about loan denial as well as the sex, race, and income of the applicant. The HMDA is a mechanism for measuring housing discrimination through 'redlining,' a practice where lending institutions are biased in regard to loan appropriations to minority groups (Gee 2002; FFIEC 2006; Massey 2000). Although the HMDA of 1975 and the Fair Housing Act of 1968 were enacted to 'prohibit discrimination at any stage of the lending or home insurance process' (Hillier 2003), the practice of 'redlining' exists today in the form of denial of loans and 'reverse redlining' through subprime lending (Fernandez 2007). Home buyers in minority neighborhoods are more likely to receive subprime loans compared to white communities in recent years although median income levels were comparable and credit histories were similar (Fernandez 2007). Additionally, blacks tend to receive smaller returns on an investment in a home than whites do (Williams and Collins 2001).

Residential redlining and mortgage discrimination resulted in racial disparities in wealth attainment through homeownership, declines in property values, a pattern of neighborhood and housing deterioration and abandonment, and in some cases, the removal of entire communities (Massey and Denton 1993; Williams and Collins 2001; Satter 2009; Gotham 2000). Populations and individuals of color affected by these redlining practices were also likely to be limited in their choices of where to live, placing them in neighborhoods with adverse conditions or denying them the capital to improve their housing and neighborhoods (Massey and Denton 1993; Satter 2009). Residential redlining and discrimination in mortgage lending also reinforced racial residential segregation over time (hereafter: segregation) (Massey and Denton 1993).

Segregation is a term used to describe the geographic separation of racial/ethnic groups in an area (Massey and Denton 1988). Residential redlining and segregation reinforce disparate residential environments through differential spending and placement of services in neighborhoods based on race (Williams and Collins 2001). As a result, resources are directed toward homogeneous, all white communities, resulting in inequitable neighborhood environments and opportunities (Gotham 2000; Williams and Collins 2001; Satter 2009). Previous studies have found that segregation has led to racial disparities in the

socioeconomic conditions of neighborhoods, employment and educational opportunities, and access to resources such as quality housing, grocery stores, and health care services (Pickett and Pearl 2001; Williams and Collins 2001; Masi et al. 2007; Culhane and Elo 2005; Wilson 1987).

Redlining, segregation, and preterm birth disparities

Residential redlining and segregation are profound features of racial inequality in America and must be considered when deconstructing how neighborhood context contributes to health disparities (Osypuk and Acevedo-Garcia 2010). Numerous studies have cited the association between segregation and pregnancy and birth outcomes, including related behaviors such as prenatal care usage, smoking, and diet (Bell et al. 2007; Buka et al. 2003; Culhane and Elo 2005; Farley et al. 2006; Grady 2006; Laraia et al. 2007, 2004; Masi et al. 2007). Based on prior work, there are four key mechanisms describing the associations between segregation and health disparities (Kramer and Hogue 2009; Landrine and Corral 2009), and we describe how these mechanisms can be applied to understand the associations between redlining, segregation, and preterm birth disparities. The four key mechanisms are: (1) redlining and segregation influences individual socioeconomic status, which influences birth outcomes; (2) redlining and segregation modified social capital for a geographic region (i.e., city) and racial/ethnic groups within the region; (3) redlining and segregation produces and reinforces unhealthy neighborhood environments; and (4) redlining and segregation modifies individual behaviors related to pregnancy and birth as well influences stress pathways (Kramer and Hogue 2009). All four mechanisms are interrelated, and we focus on the third and fourth mechanisms for this paper.

Inequitable neighborhood conditions and opportunities as a result of segregation and redlining influence maternal and infant health directly and indirectly through the social environment, service environment, and physical conditions (Osypuk and Acevedo-Garcia 2010; Culhane and Elo 2005; Mendez, Hogan, and Culhane 2011). This could come in the form of exposure to adverse social environment such as crime or violence, lacking or limited access to health or social services, decaying infrastructures, and increased exposure to environmental toxicants (Galster 2012; Culhane and Elo 2005). For example, racially segregated cities are more likely to have higher rates of crime and violence influencing birth outcomes (Kramer and Hogue 2009; Masi et al. 2007).

The regulation of institutions and related resources as a result of inequitable policies across neighborhoods in a region are also important (Galster 2012). As described earlier, redlined neighborhoods were not only denied access to capital to improve neighborhood conditions, these same neighborhoods had limited opportunities in other sectors such as employment and education. Ultimately, these neighborhood conditions may influence individual behaviors. For example, high rates of crime may inhibit outdoor physical and recreational activity, and segregated neighborhoods with limited food options would influence diet and energy intake (Kramer and Hogue 2009; Dubowitz et al. 2008).

Living in redlined and segregation neighborhoods may also be stressful due to a disproportionate exposure to adverse neighborhood conditions. Chronic stress can result in dysregulation of internal systems. Also known as allostasis, the biological systems work

to maintain stability or homeostasis through this change and conflict (McEwen and Seeman 1999). As a result of this conflict, the body goes through a process of 'wear' and 'tear' from the repeated cycles of allostasis generating a build-up of effect known as 'allostatic load.' The allostatic load influences several aspects of the individual's physiology including the regulation of biological functions, disruption of these same functions, and disruption of the mediators that may influence this regulation process. Allostatic load can ultimately have long-term effects (McEwen and Seeman 1999). The physiologic load created by chronic exposure to stress over time can lead to an enhanced inflammatory response, initiating early delivery, contributing to preterm birth, compromised fetal development, and poorer health among pregnant women (James 1994; Baum, Garofalo, and Yali 1999; McEwen and Seeman 1999; Culhane et al. 2002; Paul et al. 2008). Prior work has found that redlining was positively associated with stress among black and Hispanic pregnant women (Mendez, Hogan, and Culhane 2013). On the contrary, living in redlined and segregated neighborhoods may be protective or even buffer other stressful stimuli or discrimination as a result of social support, political empowerment, and resulting in positive birth outcomes (Mendez, Hogan, and Culhane 2013; Bell et al. 2006; Pickett et al. 2005; LaVeist 1993).

Study purpose

Our research team is not aware of any studies that examine the association between residential redlining and birth outcomes. One of the first studies to examine redlining/mortgage discrimination and health/mental health was conducted among Chinese Americans (Gee 2002). The researchers found that among their study population, redlined neighborhoods included more whites, fewer Chinese Americans, and individuals with a higher socioeconomic status. They also found that Chinese Americans living in 'redlined' neighborhoods were more likely to report experiences of discrimination, have better general health, better mental health, and lower distress compared to those residing in other areas (Gee 2002).

The present study applies a new measure and approach in understanding institutional racism overlooked in prior work using HMDA data (Mendez, Hogan, and Culhane 2011). This study examines the association between redlining and preterm birth and also examines multiple indices of segregation to develop a fuller understanding of potential segregation effects; whereas most health studies only use one segregation measure. Finally, our team examined if reported stress, discrimination, and neighborhood quality were associated with preterm birth. The two main hypotheses were: (1) Redlining and segregation would be positively associated with a higher risk of preterm birth; (2) Reported stress, discrimination, and poor neighborhood quality would also be positively associated with a higher risk of preterm birth. Investigating redlining and segregation as important aspects of the neighborhood context in light of individual factors related to preterm birth will enhance our understanding of preterm birth disparities and potential community and neighborhood interventions (Walton 2009).

Methods

Data sources and population

The study included a cohort of pregnant women from the Stress Pregnancy and Evaluation Community Project (SPEAC). These were women who gave birth between 1999 and 2004 in Philadelphia, PA. The purpose of SPEAC was to investigate the relationship between chronic maternal stress and bacterial vaginosis (BV) for pregnant women. The women were enrolled at the time of their first prenatal clinic visit. The women received prenatal care from one of eight Philadelphia, PA District Health Centers and two hospital-based clinics. Inclusion criteria were singleton gestation, less than 20 weeks gestation, intrauterine pregnancy, and English or Spanish speaking. The average gestational age at the time of recruitment was 14.8 weeks. Female interviewers conducted a baseline survey which included information about the participants' health, behaviors, reports of stress and discrimination, and demographic information. Participants' addresses were collected during the interview and were geocoded and assigned administrative units such as census tracts. Finally, vital birth records were linked with SPEAC survey data after the women gave birth. Additional details about this original study are found elsewhere (Culhane et al. 2002, 2001). Of the 5641 women eligible for the study, 4908 consented to participate, and 4880 women completed the baseline survey. Women who had miscarriages, still births or abortion, and did not have a birth certificate were excluded from the analytic sample ($n = 678$). We also excluded women with addresses that could not be geocoded due to missing or invalid addresses ($n = 198$). Of these women, we excluded women who did not identify their race or who identified their race other than non-Hispanic (NH) white, NH black, or Hispanic ($n = 125$) and with missing information on key variables for this analysis ($n = 423$). The final analytic sample included 3462 women. Hispanic women who were excluded from the study had a lower preterm birth rate (6.6%) compared to those included in the study, and white women who were excluded were less likely to smoke (56%) compared to the white women included. Compared to the data of vital birth records of women in Philadelphia who gave birth in 2001 ($n = 22,680$), the entire population of women in this study were younger, more likely to be black, less educated, and less likely to be married (Elo et al. 2009).

We linked the survey data from SPEAC with data from the HMDA and the US Census. HMDA is an administrative database created by the Federal Reserve Board that collects yearly information from banks and other lending institutions providing mortgage loans. We used the HMDA data to construct redlining indices for each census tract in Philadelphia for years 1999–2004 (Mendez, Hogan, and Culhane 2011). HMDA data contains yearly loan dealings from financial institutions throughout the USA and includes information about type and amount of loan, census tract of the property, loan disposition, and characteristics of the applicant. This study excludes (1) incomplete loan applications that were not processed by lending institutions and therefore could not be part of a measure for loan disposition bias; (2) properties that were not owner-occupied; (3) home improvement loans; and (4) multi-family units (Gee 2002). The analysis for this study only includes mortgage loans with information about the applicant's race and only those identified as black or white race. There was an average of 16,527 loans per year (1999–2004) included in this study. Redlining indices were created for each census tract in Philadelphia County and later linked with the

census tracts in which the women lived who participated in SPEAC. The method for creating the index is described in more detail in the following and elsewhere (Mendez, Hogan, and Culhane 2011). We used the 2000 US Census to derive several measures of residential segregation and the percentage black of the neighborhood. The Institutional Review Board at the University of North Carolina, Chapel Hill (Public Health Nursing) approved the original secondary analysis.

Neighborhood definition

The smallest neighborhood unit included in the HMDA database is the census tract, and smaller administrative boundaries such as blocks or point data such as the actual location of the properties included in the HMDA are not available. We used the census tract as a proxy for the neighborhood or residential environment for the women in the study. Prior studies examining neighborhood characteristics and specific outcomes such as preterm birth and maternal behaviors have found similar effects across neighborhood geographies (i.e., block groups, census tracts, and noncensus-defined boundaries), indicating the utility of census-based boundaries in the neighborhoods' perinatal health research (Messer, Vinikoor-Imler, and Laraia 2012; Culhane et al. 2004).

The addresses of women in SPEAC were collected during entry into the study (first trimester), and these addresses were geocoded and assigned census tracts based on the US 2000 Census boundaries. There were a total of 312 census tracts represented and an average of 11 women per census tract. The range of number of women per tract was 1–73, where 7% of the census tracts had less than five women.

Measures

Neighborhood measures

Redlining index.: The redlining indices were derived solely from the HMDA. Redlining is operationalized as the black–white disparity in loan denial, and was derived using multilevel modeling techniques (Mendez, Hogan, and Culhane 2011). We calculated a tract-specific black–white disparity in the odds of loan denial. Applying a multilevel (random effects) model allowed us to pool across all census tracts rather than applying a census tract stratified model. We controlled for loan amount, income, and sex in the models. Loans that were missing information about the applicant's race were not included in the analysis. In the census tracts of interest for this study, less than 10% of the loans were missing information on race. The final redlining index places each census tract along a continuum of mortgage loan discrimination. The previous study investigating redlining and general health among Chinese Americans categorized the redlining index at the point where minority loan applicants were disfavored by 40% (index of 1.4) compared to whites based on indicators of neighborhood poverty and deprivation (Gee 2002). We applied this cut point but also examined other cut points for the final redlining index presented in this study.

In this study, redlining denotes a neighborhood measure of the black–white disparity in mortgage loan denial. Consequently, redlined neighborhoods can also represent white, homogeneous neighborhoods that excluded black and minority populations. The measurement of redlining in this study may differ somewhat from historical redlining

because neighborhoods that were redlined historically were typically low income or minority neighborhoods that could not receive loans or similar investments. In the present study, redlined neighborhoods could be low income or minority neighborhoods that were denied loans, but they could also be high income or white neighborhoods where individual loan applicants of color could not acquire loans to enter new homes in those neighborhoods.

Residential segregation.: The segregation measures were calculated at the census tract level using 2000 US Census data. The *Percentage Black* was a measure of the percentage of black residents with a range of 0–100%. The *Index of Dissimilarity* quantifies the proportion of blacks that would have to change their area of residence to achieve an even distribution of the population in census tracts. This index measures the level of evenness or differential distribution of groups across geographic units. The *Exposure Index*, also known as the interaction index, measures the extent to which members of a minority group (e.g. blacks) are exposed to members of a majority group (e.g. whites). The *Isolation Index* describes the extent to which members of minority group X are only exposed to one another. Further definitions and calculations for these indices can be found elsewhere (Massey and Denton 1988). These indices range from 0 to 1, with the lower values indicating lower levels of segregation. The measures were examined in the continuous form as well as categories.

Self-reported measures

Discrimination.: Participants were asked about *experiences of discrimination* based on everyday experiences of discrimination and major experiences of discrimination. Respondents were asked to rate the frequency of day-to-day experiences of discrimination because of ‘race, ethnicity, income level, social class, sex, gender, age sexual orientation, physical appearance or religion’ (Forman, Williams, and Jackson 1997). These experiences were rated on a 6-point scale ranging from ‘never’ to ‘almost every day.’ The summative total of scores across these items ranged from 0 to 43. This was referred to as the *everyday discrimination* measure. Respondents were also asked to answer ‘yes’ or ‘no’ to two questions about *major experiences of discrimination*. Those questions were: (1) ‘For unfair reasons, do you think that you have ever not been hired for a job?’ and (2) ‘Have you ever been unfairly stopped, searched, questioned, physically threatened or abused by police?’ These two questions were added together, resulting in 0, 1 or 2 major events. This was referred to as the *major discrimination* measure.

Stress.: Participants were asked to complete a 14-item self-report Cohen Perceived Stress Scale (CPSS), which measures the degree to which a respondent appraises stressful circumstances along dimensions of unpredictability, uncontrollability, and overload (Cohen, Kamarck, and Mermelstein 1983; Cohen, Doyle, and Baum 2006). CPSS is suggested for examining the role of appraised stress in the etiology of disease (Cohen, Kamarck, and Mermelstein 1983). The CPSS has good internal reliability and fair test-retest reliability among college and community samples as well as samples of pregnant women (Cohen, Kamarck, and Mermelstein 1983; Culhane et al. 2001, 2002). Examples of questions included in this scale are, ‘You have felt that you were unable to control the important things in your life,’ ‘You have felt nervous or “stressed”’ and ‘You have felt that you were on top of things.’ Participants answers are based on a Likert scale to what degree the item relates

to them in the past month (0 = never, 1 = almost never, 2 = sometimes, 3 = fairly often or 4 = very often). A total CPSS is computed by summing across all items. Exploratory factor analysis was applied resulting in one factor, a weighted eigenvalue of 6.1, which explained 74% of the variance. This sample's scores ranged from 0 to 52 (median = 24) with a Cronbach's alpha of 0.81. We examined several specifications (e.g., continuous) for operationalizing the scale and applied a two-level version of the scale categorized as above or below/equal to the median for reporting purposes.

Neighborhood quality.: Respondents answered specific questions about the quality of their neighborhoods. The neighborhood quality scale was derived from previous work on perceptions of neighborhoods in urban areas (Coulton, Korbin, and Su 1996; Elo et al. 2009). The scale included three core domains: crime and safety, physical disorder, and social disorder (Elo et al. 2009; Coulton, Korbin, and Su 1996). The participants were asked, 'Please tell me how often these things are a problem or are found in your neighborhood.' Examples of neighborhood factors were 'litter or trash on the sidewalks,' 'vacant buildings', and 'gunshots in the neighborhood.' The neighborhood quality factors were on a 10-point scale where 1 was rarely/not worried and 10 was frequently/very worried. A sum score was created for the 19 neighborhood quality factors for a range of scores of 1–190.

Covariates—Several covariates were selected based on conceptual and theoretical models and were also considered to confound the relationship between preterm birth and neighborhood environment (Berkowitz et al. 1998). Since model convergence was not compromised, we controlled for all of the following covariates, regardless of statistical significance or percent changes in estimates.

Maternal Race/Ethnicity.: SPEAC participants were asked to identify their race, which also included an option of Hispanic ethnicity. The classifications included in this study are as follows: non-Hispanic white; non-Hispanic black; Hispanic/Latina; other. From this point forward, non-Hispanic white women will be referred to as white and non-Hispanic black women will be referred to as black. We also included *age at interview*. Total household *income* was operationalized as income from jobs, public assistance, unemployment, SSI, from family/friends or other sources. This was a categorical variable where respondents chose an income range that best fit their circumstances. *Education* was categorized as less than high school, high school/GED, or post-high school. *Marital status* was categorized as married/living as married or not married/not living as married. Variables such as *tobacco and alcohol usage* during pregnancy and *previous live births* were also included. Finally, two additional variables were included: *housing tenure*/*home ownership*, whether a person owned their home (homeowner), was a private renter, or was a public renter/received housing assistance, and *number of years lived in the neighborhood*, which was a continuous measure of total number of years a person lived in the neighborhood during the time of the study. These variables were included to account for potential selection bias due to movement in and out of neighborhoods (Manley and van Ham 2012).

Primary outcome

Preterm birth.: The primary outcome of interest, preterm birth, was based on the estimation of gestational age from the ultrasound and medical records when available. If the medical record information was not available, the linked birth record was used. Since birth records have known limitations, medical records are ideal for capturing gestational age as well as other maternal factors (DiGiuseppe et al. 2002). If none of these sources were available, a phone call to the participant was conducted. Preterm birth was defined as less than 37 weeks completed gestation and was dichotomized to indicate whether or not the birth was preterm. The preterm birth outcome for this study includes both spontaneous and medically indicated preterm birth.

Statistical analyses

First, we conducted bivariate analyses (chi-squared tests) to examine preterm birth in association with individual behavioral and demographic characteristics, redlining, segregation, and self-reported neighborhood quality, discrimination, and stress. We also assessed for effect measure modification by race. Then we assessed for multicollinearity by examining correlations between the various self-reported measures and the institutional neighborhood measures (i.e., redlining and segregation).

Next, we then estimated a null model to calculate the intraclass correlation. The intraclass correlation was less than 5% for each racial/ethnic group. As a result, we estimated risk ratios of the association between residential redlining and segregation and preterm birth using log binomial regression in which individuals were nested within census tracts. We fit a series of models with each individual self-reported measure (i.e., discrimination, stress, and neighborhood quality) and neighborhood-level factor entered in the model separately. The models were adjusted for maternal age, marital status, education, total household income, alcohol, and tobacco use during pregnancy, and previous live births. We then examined the interaction (effect measure modification) between housing type/tenure and redlining for the entire study population to examine the association between redlining and preterm birth by housing type and then again stratified by race (three-way interaction) to explore potential selection bias due to neighborhood mobility (Manley and van Ham 2012). Finally, we examined interactions between, housing type/tenure, race and the various segregation measures depending on the model specifications to address potential variability in the effects of redlining and segregation by housing type/tenure and by race. As a result, we report race-stratified models. We used SAS (Cary, NC) version 9.2 for all analyses.

Results

Descriptive results

The study population included women with a range of income levels but with a greater percentage in the lower income categories, a large representation of black women, more than half with a high school education or greater, less than a quarter married, more than half aged 20–29, almost 40% nulliparous, about 20% smoked cigarettes during pregnancy, and almost one-third used alcohol (Table 1). The majority of the population did not report discrimination, reported a moderate amount of stress, and about one-third reported their

neighborhoods to be poor quality. The majority of the women did not own their homes, and the mean number of years having lived in their neighborhoods was highest among black women (8.0) followed by white women (7.1) and then Hispanic women (3.0). About 22% of the study population lived in neighborhoods with some degree of redlining (index greater than 1.4) and more than half lived in census tracts with 50% or more percentage of blacks (other segregation indices are also presented in Table 1).

Table 1 also presents the bivariate relationship between preterm birth and various individual and neighborhood characteristics by race/ethnicity. Black women were two times as likely to have a preterm birth compared to white women. Among black women, advanced age, use of tobacco during pregnancy, poor neighborhood quality, owning a home, and living in a nonredlined area was associated with a higher risk of preterm birth. Among white women, major discrimination was associated with preterm birth, and there were no significant associations among Hispanic women. Among the entire population, there was also a slight increased risk for preterm birth among women who were older, unmarried, tobacco users, higher number of previous births, high levels of experiences of everyday discrimination, lived in nonredlined areas, and areas with high levels of segregation measured by the isolation index (results not shown).

Among black women, redlining was negatively correlated with segregation measured by the exposure index but positively associated with all other forms of segregation (Table 2). Among white women, redlining was negatively correlated with percentage black and the isolation index. Among Hispanic women, redlining was negatively correlated with the exposure index and positively correlated with the index of dissimilarity. Those living in redlined neighborhoods were less likely to be married, less likely to smoke, more likely to report poor neighborhood quality, and more likely to live in neighborhoods with a higher percentage of black residents compared to those living in nonredlined neighborhoods (results not shown).

Multivariate results

In the unadjusted models, black women were more likely to have a preterm birth compared to both white and Hispanic women (RR = 1.93; 95% CI: 1.29, 2.91 and RR = 1.77, 95% CI: 1.34, 2.37, respectively) (results not shown). We then fit a series of models that examined each self-reported and each neighborhood-level measure separately. The self-reported measures (i.e., discrimination, stress, and neighborhood quality) were not associated with preterm birth after adjustment for covariates (Table 3). Redlining and segregation showed little to no association with preterm birth for most racial/ethnic groups after adjustment for important covariates. However, for black women, redlining was moderately associated with a lower risk of preterm birth (RR = 0.8; 95% CI: 0.6, 1.0). In examining the interaction between housing type and redlining, we found no significant relationship between redlining and preterm birth by housing type among the entire population of women (homeowners: RR = 1.1; 95% CI: 0.7, 1.8; private renters: RR = 0.8; 95% CI: 0.6, 1.0; public/social renters: RR = 1.0; 95% CI: 0.4 2.4; results not shown). We also examined the association between redlining (and each of the segregation measures) and preterm when stratified by race and housing type and found no association.

Discussion

This study examined whether redlining and segregation were positively associated with preterm birth and if individual reported measures of discrimination, stress, and neighborhood quality were positively associated with preterm birth. We found that redlining and segregation was not associated with preterm birth among white and Hispanic women. However, redlining was associated with a slightly lower risk of preterm birth among black women. We also found that self-reported poor neighborhood quality was associated with preterm birth among black women only.

This is the first study of our knowledge to specifically examine institutional racism in the form of residential redlining (mortgage disparities) in association with preterm birth. One prior study found that Chinese Americans living in redlined neighborhoods reported more discrimination and had better general and mental health (Gee 2002). The Chinese Americans living in the redlined areas were also of a higher socioeconomic status and may have lived in more privileged areas than their counterparts and had better overall health despite individual experiences with discrimination.

Although unexpected, we found a similar association between redlining and the lower risk of preterm birth among the black women in our population. Similar to Gee's study, the redlined areas in the present study were positively associated with a higher percentage of black residents among our population. In ancillary analyses, we found that redlined areas ranged in their neighborhood racial composition and did not tend to have a higher percentage of white residents. Our bivariate analyses showed that among black women, those owning a home had a higher risk of preterm than private and public/social renters. However, ancillary analyses showed that public/social renters were more likely to live in redlined neighborhoods compared to private renter and homeowners. This suggests that redlining confers an association with preterm birth that differs by racial/ethnic group as a result of geographic sorting by race. Redlining was inversely associated with exposure segregation among black women possibly indicating that black women living in redlined neighborhoods were less likely to be exposed to whites. Additionally, residence in redlined areas may serve as a potentially protective factor for infant health due to neighborhood cohesion or social support and buffering experiences of stress and discrimination, similar to studies that found a potentially protective effect in the case of segregation (LaVeist 1992; Pickett et al. 2005). Although we found no association between segregation and birth outcomes in this study, previous studies have found associations between segregation and birth outcomes(Grady 2006; Gee 2002; Bell et al. 2006, 2007; Osypuk and Acevedo-Garcia 2008; LaVeist 1992).

Residence in particular neighborhoods is not merely a product of individual preferences but a result of political and social forces that drive living conditions and ultimately health (Satter 2009; Massey and Denton 1993; Osypuk and Acevedo-Garcia 2010). As a result, confounding as a result of 'selection' into neighborhoods, structural confounding, is important to consider in evaluating the associations between redlining, segregation, and preterm birth (Oakes 2006; Messer, Oakes, and Mason 2010). This issue seems most prevalent in the present study when examining the limited distribution of white women among census tracts with greater than 50% black residents. Although propensity score

matching approaches have been used in prior studies to address such issues, it does not address potential limitations in data as a result of 'selection' into types of neighborhoods (Diez Roux 2004). There may also be residual confounding by unmeasured factors that may influence a person's neighborhood selection, particularly in the context of segregation (Mason et al. 2009; Osypuk and Acevedo-Garcia 2010). In this study, we attempted to address potential neighborhood selection issues by examining the association between redlining and preterm birth by tenure group and found not differences in association. However, we did find that tenure/home ownership was associated with preterm birth among black women only, but that home owners had a higher risk of preterm birth than renters.

We also examined various individual-level measures related to stress such as perceived stress, discrimination, and neighborhood quality. Although numerous studies have found an association between stress and birth outcomes (Collins et al. 1998, 2004; Dole et al. 2003, 2004), the present study found no association between stress and preterm birth among all racial/ethnic groups. The Cohen Perceived Stress Scale used in this study was initially validated among predominantly college white populations (Cohen, Kamarck, and Mermelstein 1983) and may not capture dimensions of stress among a predominately low-income pregnant population. The discrimination scale used in this study was a conglomerate of previous discrimination scales and was nonspecific in that it captured discrimination based on several social markers, not just racial discrimination. This lack of specificity makes it difficult to detect if the respondent had been primarily discriminated against because of their race, gender, sexual orientation, or some other social classification. Previous studies investigating discrimination and preterm birth and low birth weight have been specific to racial discrimination, and some of these studies have found an association (Collins et al. 2004, 2000; Mustillo et al. 2004; Rosenberg et al. 2002; Giurgescu et al. 2011; Dominguez et al. 2008). We also found that negative perceptions of neighborhood quality were not associated with preterm birth. Prior studies have examined this association with mixed results. One study found that negative perceptions of neighborhood quality did not increase the risk among black women but did among white women (Dole et al. 2004). However, another study found that negative neighborhood perceptions were associated with very low birth weight among African-American women (Collins et al. 1998). These differences could be due to the neighborhood perceptions scales used as well as differences in interpretation and reporting of neighborhood.

Strengths and limitations

In this study, we were limited in the operational definition of neighborhood due to the data provided in the HMDA and the measure for redlining. However, in related analyses, the study team explored census and noncensus-based boundaries for other neighborhood characteristics such as segregation and found similar results. Census tracts as administrative units may not truly reflect neighborhood boundaries, but previous studies have found that census tracts are suitable for estimating neighborhood effects on birth outcomes and the choice of administrative unit did not significantly affect the magnitude or direction of the neighborhood preterm birth relationship (Messer and Kaufman 2006; Mason et al. 2009; Kramer et al. 2010; Messer, Vinikoor-Imler, and Laraia 2012).

Secondly, since the study cohort is a clinic-based sample, women may be excluded who do not seek prenatal care or have access to prenatal care. To address this issue, participants were recruited from both public and private clinics for a range of socioeconomic backgrounds. However, the population of white women in this study are younger, less educated and more likely to use tobacco and alcohol compared to other pregnant women in Philadelphia and nationally. As described earlier, women in our study were generally younger, more likely to be black, less educated, and less likely to be married compared to the overall population of births to women in Philadelphia in 2001 (Elo et al. 2009). The preterm birth rate from 2001 to 2002 for black, white, and Hispanic women in the metropolitan Philadelphia area is 15.7, 8.1, and 11.8%, respectively, which was slightly lower than the rate of our population of white women. Finally, the individual and neighborhood measures included in this study may be specific to preterm birth subtypes such as preterm labor versus medically induced preterm birth (Berkowitz et al. 1998). This study included all preterm births, regardless of indication.

Despite these limitations, we applied a new measure of institutional racism in the form a redlining index to understand its association with preterm birth. We also applied a new approach in constructing the redlining index using multilevel regression models to capture the black–white disparity in mortgage lending at the community level (Mendez, Hogan, and Culhane 2011). Many health studies rely on US Census data when developing neighborhood, contextual variables such segregation, and this study applied an administrative data-set, the HMDA database that could be applied in future health studies.

Conclusion

In summary, we found that residential redlining was associated with a lower risk of preterm birth among black women. Further work should explore whether this association holds among larger, population-based samples, in other geographic regions, and over time. Future studies should also examine whether residence in redlined areas confers a protective effect among black women specifically in light of residential segregation patterns. We also found that segregation was not associated with preterm birth among any racial/ethnic group. However, both redlining and segregation provides insight about the neighborhood context in which pregnant women live, particularly as it relates to racial/ethnic disparities in adverse birth outcomes. Future studies should consider the application of this redlining index as well as other forms of institutional racism in other geographical areas and in longitudinal studies among population-based samples of pregnant women.

References

Baum A, Garofalo JP, and Yali AM. 1999. “Socioeconomic Status and Chronic Stress. Does Stress Account for SES Effects on Health?” Annals of the New York Academy of Sciences 896: 131–144. doi:10.1111/j.1749-6632.1999.tb08111.x. [PubMed: 10681894]

Bell JF, Zimmerman FJ, Almgren GR, Mayer JD, and Huebner CE. 2006. “Birth Outcomes Among Urban African-American Women: A Multilevel Analysis of the Role of Racial Residential Segregation.” Social Science & Medicine 63 (12): 3030–3045. doi:10.1016/j.socscimed.2006.08.011. [PubMed: 16997438]

Bell JF, Zimmerman FJ, Mayer JD, Almgren GR, and Huebner CE. 2007. “Associations Between Residential Segregation and Smoking During Pregnancy Among Urban African-American Women.” Journal of Urban Health 84 (3): 372–388. doi:10.1007/s11524-006-9152-4. [PubMed: 17226080]

Berkowitz GS, Blackmore-Prince C, Lapinski RH, and Savitz DA. 1998. "Risk Factors for Preterm Birth Subtypes." Epidemiology 9 (3): 279–285. doi:10.1097/00001648-199805000-00011. [PubMed: 9583419]

Buka SL, Brennan RT, Rich-Edwards JW, Raudenbush SW, and Earls F. 2003. "Neighborhood Support and the Birth Weight of Urban Infants." American Journal of Epidemiology 157 (1): 1–8. doi:10.1093/aje/kwf170. [PubMed: 12505884]

Carmichael S, and Hamilton CV. 2001. "Black Power: The Politics of Liberation in America." In Racism: Essential Readings, edited by Cashmore E and Jennings J, 111–121. London: Sage Publications.

Cohen S, Doyle WJ, and Baum A. 2006. "Socioeconomic Status is Associated With Stress Hormones." Psychosomatic Medicine 68 (3): 414–420. doi:10.1097/01.psy.0000221236.37158.b9. [PubMed: 16738073]

Cohen S, Kamarck T, and Mermelstein R. 1983. "A Global Measure of Perceived Stress." Journal of Health and Social Behavior 24 (4): 385–396. doi:10.2307/2136404. [PubMed: 6668417]

Collins JW Jr., David RJ, Handler A, Wall S, and Andes S. 2004. "Very Low Birthweight in African American Infants: The Role of Maternal Exposure to Interpersonal Racial Discrimination." American Journal of Public Health 94 (12): 2132–2138. doi:10.2105/AJPH.94.12.2132. [PubMed: 15569965]

Collins JW Jr., David RJ, Symons R, Handler A, Wall S, and Andes S. 1998. "African-American Mothers' Perception of Their Residential Environment, Stressful Life Events, and Very Low Birthweight." Epidemiology 9 (3): 286–289. doi:10.1097/00001648-199805000-00012. [PubMed: 9583420]

Collins JW Jr., David RJ, Symons R, Handler A, Wall SN, and Dwyer L. 2000. "Low-income African-American Mothers' Perception of Exposure to Racial Discrimination and Infant Birth Weight." Epidemiology 11 (3): 337–339. doi:10.1097/00001648-200005000-00019. [PubMed: 10784254]

Coulton C, Korbin J, and Su M. 1996. "Measuring Neighborhood Context for Young Children in an Urban Area." American Journal of Community Psychology 24 (1): 5–32. doi:10.1007/BF02511881.

Courchane MJ, and Zorn PM. 2008. "Dawning of a New Age: Examination for Discrimination in Lending." Banking & Financial Services Report 27 (10): 1–9.

Culhane JF, and Elo IT. 2005. "Neighborhood Context and Reproductive Health." American Journal of Obstetrics and Gynecology 192 (Suppl. 5): S22–S29. doi:10.1016/j.ajog.2005.01.071. [PubMed: 15891708]

Culhane J, Elo IT, Hillier AE, Smith T, and McCollum KF. Dec 2004. "An Investigation of the Association Between Three Methods of Assessing Neighborhood-level Exposures and Risk of Preterm Birth: 427; Poster Session III." American Journal of Obstetrics and Gynecology 191 (Suppl. 6): S123.

Culhane JF, Rauh V, McCollum KF, Elo IT, and Hogan V. 2002. "Exposure to Chronic Stress and Ethnic Differences in Rates of Bacterial Vaginosis Among Pregnant Women." American Journal of Obstetrics and Gynecology 187 (5): 1272–1276. doi:10.1067/mob.2002.127311. [PubMed: 12439519]

Culhane JF, Rauh V, McCollum KF, Hogan VK, Agnew K, and Wadhwa PD. 2001. "Maternal Stress is Associated With Bacterial Vaginosis in Human Pregnancy." Maternal and Child Health Journal 5 (2): 127–134. doi:10.1023/A:1011305300690. [PubMed: 11573838]

Diez Roux AV 2001. "Investigating Neighborhood and Area Effects on Health." American Journal of Public Health 91 (11): 1783–1789. doi:10.2105/AJPH.91.11.1783. [PubMed: 11684601]

Diez Roux AV 2004. "Estimating Neighborhood Health Effects: The Challenges of Causal Inference in a Complex World." Social Science & Medicine 58 (10): 1953–1960. doi:10.1016/S0277-9536(03)00414-3. [PubMed: 15020010]

DiGiuseppe DL, Aron DC, Ranbom L, Harper DL, and Rosenthal GE. 2002. "Reliability of Birth Certificate Data: A Multi-hospital Comparison to Medical Records Information." Maternal and Child Health Journal 6 (3): 169–179. doi:10.1023/A:1019726112597. [PubMed: 12236664]

Dole N, Savitz DA, Hertz-Picciotto I, Siega-Riz AM, McMahon MJ, and Buekens P. 2003. “Maternal Stress and Preterm Birth.” American Journal of Epidemiology 157 (1): 14–24. doi:10.1093/aje/kwf176. [PubMed: 12505886]

Dole N, Savitz DA, Siega-Riz AM, Hertz-Picciotto I, McMahon MJ, and Buekens P. 2004. “Psychosocial Factors and Preterm Birth Among African American and White Women in Central North Carolina.” American Journal of Public Health 94 (8): 1358–1365. doi:10.2105/AJPH.94.8.1358. [PubMed: 15284044]

Dominguez TP, Dunkel-Schetter C, Glynn LM, Hobel C, and Sandman CA. 2008. “Racial Differences in Birth Outcomes: The Role of General, Pregnancy, and Racism Stress.” Health Psychology 27 (2): 194–203. doi:10.1037/0278-6133.27.2.194. [PubMed: 18377138]

Dubowitz T, Subramanian SV, Acevedo-Garcia D, Osypuk TL, and Peterson KE. 2008. “Individual and Neighborhood Differences in Diet Among Low-income Foreign and U.S.-born Women.” Womens Health Issues 18 (3): 181–190. doi:10.1016/j.whi.2007.11.001. [PubMed: 18222706]

Elo IT, Mykyta L, Margolis R, and Culhane J. 2009. “Perceptions of Neighborhood Disorder: The Role of Individual and Neighborhood Characteristics.” Social Science Quarterly 90 (5): 1298–1320. doi:10.1111/j.1540-6237.2009.00657.x. [PubMed: 20174462]

Farley TA, Mason K, Rice J, Habel JD, Scribner R, and Cohen DA. 2006. “The Relationship Between the Neighbourhood Environment and Adverse Birth Outcomes.” Paediatric & Perinatal Epidemiology 20 (3): 188–200. doi:10.1111/j.1365-3016.2006.00719.x. [PubMed: 16629693]

Fernandez M. 2007. “Study Finds Disparities in Mortgages by Race.” The New York Times, October 15.

FFIEC (Federal Financial Institutions Examination Council). 2006. Frequently Asked Questions About the New HMDA Data. http://www.federalreserve.gov/newsevents/press/bcreg/bcreg20060403a1.pdf.

Forman TA, Williams D, and Jackson J. 1997. “Race, Place, and Discrimination.” Perspectives on Social Problems 9: 231–261.

Galster GC 2012. “The Mechanism(s) of Neighborhood Effects: Theory, Evidence, and Policy Implications.” In Neighborhood Effects Research: New Perspectives, edited by van Ham M, Manley D, Bailey N, Simpson L, and Maclennan D, 23–56. London: Springer.

Gee GC 2002. “A Multilevel Analysis of the Relationship Between Institutional and Individual Racial Discrimination and Health Status.” American Journal of Public Health 92 (4): 615–623. doi:10.2105/AJPH.92.4.615. [PubMed: 11919062]

Giurgescu C, McFarlin BL, Lomax J, Craddock C, and Albrecht A. 2011. “Racial Discrimination and the Black-white Gap in Adverse Birth Outcomes: A Review.” Journal of Midwifery & Women’s Health 56 (4): 362–370. doi:10.1111/j.1542-2011.2011.00034.x.

Gotham KF 2000. “Racialization and the State: The Housing Act of 1934 and the Creation of the Federal Housing Administration.” Sociological Perspectives 43 (2): 291–317. doi:10.2307/1389798.

Grady SC 2006. “Racial Disparities in Low Birthweight and the Contribution of Residential Segregation: A Multilevel Analysis.” Social Science & Medicine 63 (12): 3013–3029. doi:10.1016/j.socscimed.2006.08.017. [PubMed: 16996670]

Hillier AE 2003. “Redlining and the Home Owners’ Loan Corporation.” Journal of Urban History 29 (4): 394–420. doi:10.1177/0096144203029004002.

Hogan VK, and Ferre CD. 2001. “The Social Context of Pregnancy for African American Women: Implications for the Study and Prevention of Adverse Perinatal Outcomes.” Maternal and Child Health Journal 5 (2): 67–69. doi:10.1023/A:1011360813893. [PubMed: 11573840]

Hogan VK, Njoroge T, Durant TM, and Ferre CD. 2001. “Eliminating Disparities in Perinatal Outcomes–Lessons Learned.” Maternal and Child Health Journal 5 (2): 135–40. doi:10.1023/A:1011357317528. [PubMed: 11573839]

Hogue CJ, and Vasquez C. 2002. “Toward a Strategic Approach for Reducing Disparities in Infant Mortality.” American Journal of Public Health 92 (4): 552–556. doi:10.2105/AJPH.92.4.552. [PubMed: 11919050]

James SA 1994. “John Henryism and the Health of African-Americans.” Culture, Medicine and Psychiatry 18 (2): 163–182. doi:10.1007/BF01379448. [PubMed: 7924399]

Jones CP 2000. “Levels of Racism: A Theoretic Framework and a Gardener’s Tale.” American Journal of Public Health 90 (8): 1212–1215. doi:10.2105/AJPH.90.8.1212. [PubMed: 10936998]

Kramer MR, and Hogue CR. 2009. “Is Segregation Bad For Your Health?” Epidemiologic Reviews 31: 178–94. doi:10.1093/epirev/mxp001. [PubMed: 19465747]

Kramer MR, Cooper H, Drews-Botsch C, Waller L, and Hogue C. 2010. “Do Measures Matter? Comparing Surface-density-derived and Census-tract-derived Measures of Racial Residential Segregation.” International Journal of Health Geographics 9 (1): 29. doi:10.1186/1476-072X-9-29. [PubMed: 20540797]

Lacker JM 1995. “Neighborhoods and Banking.” Economic Quarterly 8 (1/2): 13–38.

Landrine H, and Corral I. 2009. “Separate and Unequal: Residential Segregation and Black Health Disparities.” Ethnicity & Disease 19 (2): 179–184. [PubMed: 19537230]

Laraia B, Messer L, Evenson K, and Kaufman JS. 2007. “Neighborhood Factors Associated With Physical Activity and Adequacy of Weight Gain During Pregnancy.” Journal of Urban Health 84 (6): 793–806. doi:10.1007/s11524-007-9217-z. [PubMed: 17710552]

Laraia BA, Siega-Riz AM, Kaufman JS, and Jones SJ. 2004. “Proximity of Supermarkets is Positively Associated With Diet Quality Index For Pregnancy.” Preventive Medicine 39 (5): 869–875. doi:10.1016/j.ypmed.2004.03.018. [PubMed: 15475018]

LaVeist TA 1993. “Segregation, Poverty, and Empowerment: Health Consequences for African Americans.” Milbank Quarterly 71 (1): 41–64. doi:10.2307/3350274. [PubMed: 8450822]

LaVeist TA 1992. “The Political Empowerment and Health Status of African Americans: Mapping a New Territory.” American Journal of Sociology 97: 1080–1095. doi:10.1086/229862.

Manley D, and van Ham M. 2012. “Neighborhood Effects, Housing Tenure, and Individual Employment Outcomes.” In Neighborhood Effects Research: New Perspectives, edited by van Ham M, Manley D, Bailey N, Simpson L, and Maclennan D, 147–173. London: Springer.

Martin JA, Hamilton BE, Sutton PD, Ventura SJ, Matthews TJ, and Osterman MJK. 2010. “Births: Final Data for 2008.” National Vital Statistics Reports 59 (1): 1–105.

Masi CM, Hawkley LC, Piotrowski ZH, and Pickett KE. 2007. “Neighborhood Economic Disadvantage, Violent Crime, Group Density, and Pregnancy Outcomes in a Diverse, Urban Population.” Social Science & Medicine 65 (12): 2440–2457. doi:10.1016/j.socscimed.2007.07.014. [PubMed: 17765371]

Mason SM, Messer LC, Laraia BA, and Mendola P. 2009. “Segregation and Preterm Birth: The Effects of Neighborhood Racial Composition in North Carolina.” Health & Place 15 (1): 1–9. doi:10.1016/j.healthplace.2008.01.007. [PubMed: 18359264]

Massey D. 2000. “Residential Segregation and Neighborhood Conditions in U.S. Metropolitan Areas.” In America Becoming: Racial Trends and Their Consequences, edited by Smelser NJ, Wilson WJ, and Mitchell F, 391–434. Washington, DC: National Academy Press.

Massey D, and Denton N. 1988. “The Dimensions of Residential Segregation.” Social Forces 67 (2): 281–315.

Massey D, and Denton NA. 1993. American Apartheid: Segregation and the Making of the Underclass. Cambridge, MA: Harvard University Press.

Mathews TJ, and MacDorman MF. 2008. “Infant Mortality Statistics From the 2005 Period Linked Birth/Infant Death Data Set.” National Vital Statistics Reports 57 (2): 1–32.

McEwen BS, and Seeman T. 1999. “Protective and Damaging Effects of Mediators of Stress. Elaborating and Testing the Concepts of Allostasis and Allostatic Load.” Annals of the New York Academy of Sciences 896: 30–47. doi:10.1111/j.1749-6632.1999.tb08103.x. [PubMed: 10681886]

Mendez DD, Hogan VK, and Culhane JF. 2011. “Institutional Racism and Pregnancy Health: Using Home Mortgage Disclosure Act Data to Develop an Index for Mortgage Discrimination at the Community Level.” Public Health Reports 126 (Suppl. 3): 102–114. [PubMed: 21836743]

Mendez DD, Hogan VK, and Culhane JF. 2013. “Stress During Pregnancy: The Role of Institutional Racism.” Stress Health 29 (4): 266–274. [PubMed: 23055409]

Messer LC, and Kaufman JS. 2006. “Using Census Data to Approximate Neighborhood Effects.” In Methods in Social Epidemiology, edited by Oakes J and Kaufman JS, 209–236. San Francisco, CA: Jossey-Bass.

Messer LC, Kaufman JS, Dole N, Savitz DA, and Laraia BA. 2006. “Neighborhood Crime, Deprivation, and Preterm Birth.” Annals of Epidemiology 16 (6): 455–462. doi:10.1016/j.annepidem.2005.08.006. [PubMed: 16290179]

Messer LC, Oakes JM, and Mason S. 2010. “Effects of Socioeconomic and Racial Residential Segregation on Preterm Birth: A Cautionary Tale of Structural Confounding.” American Journal of Epidemiology 171 (6): 664–673. doi:10.1093/aje/kwp435. [PubMed: 20139129]

Messer LC, Vinikoor-Imler LC, and Laraia BA. 2012. “Conceptualizing Neighborhood Space: Consistency and Variation of Associations for Neighborhood Factors and Pregnancy Health Across Multiple Neighborhood Units.” Health Place 18 (4): 805–813. doi:10.1016/j.healthplace.2012.03.012. [PubMed: 22551891]

Mustillo S, Krieger N, Gunderson EP, Sidney S, McCreath H, and Kiefe CI. 2004. “Self-reported Experiences of Racial Discrimination and Black-White Differences in Preterm and Low-birthweight Deliveries: The CARDIA Study.” American Journal of Public Health 94 (12): 2125–2131. doi:10.2105/AJPH.94.12.2125. [PubMed: 15569964]

O’Campo P, Burke JG, Culhane J, Elo IT, Eyster J, Holzman C, Messer LC, Kaufman JS, and Laraia BA. 2008. “Neighborhood Deprivation and Preterm Birth Among Non-Hispanic Black and White Women in Eight Geographic Areas in the United States.” American Journal of Epidemiology 167 (2): 155–163. doi:10.1093/aje/kwm277. [PubMed: 17989062]

O’Campo P, Xue X, Wang MC, and Caughy M. 1997. “Neighborhood Risk Factors for Low Birthweight in Baltimore: A Multilevel Analysis.” American Journal of Public Health 87 (7): 1113–1118. doi:10.2105/AJPH.87.7.1113. [PubMed: 9240099]

Oakes JM 2006. “Commentary: Advancing Neighbourhood-effects Research–Selection, Inferential Support, and Structural Confounding.” International Journal of Epidemiology 35 (3): 643–647. doi:10.1093/ije/dyl054. [PubMed: 16556642]

Osypuk TL, and Acevedo-Garcia D. 2008. “Are Racial Disparities in Preterm Birth Larger in Hypersegregated Areas?” American Journal of Epidemiology 167 (11): 1295–1304. 10.1093/aje/kwn043 [PubMed: 18367470]

Osypuk TL, and Acevedo-Garcia D. 2010. “Beyond Individual Neighborhoods: A Geography of Opportunity Perspective For Understanding Racial/Ethnic Health Disparities.” Health Place 16 (6): 1113–1123. doi:10.1016/j.healthplace.2010.07.002. [PubMed: 20705500]

Paul K, Boutain D, Manhart L, and Hitti J. 2008. “Racial Disparity in Bacterial Vaginosis: The Role of Socioeconomic Status, Psychosocial Stress, and Neighborhood Characteristics, and Possible Implications for Preterm Birth.” Social Science & Medicine 67 (5): 824–833. doi:10.1016/j.socscimed.2008.05.017. [PubMed: 18573578]

Pickett KE, and Pearl M. 2001. “Multilevel Analyses of Neighbourhood Socioeconomic Context and Health Outcomes: A Critical Review.” Journal of Epidemiology & Community Health 55 (2): 111–122. doi:10.1136/jech.55.2.111. [PubMed: 11154250]

Pickett KE, Collins JW Jr., Masi CM, and Wilkinson RG. 2005. “The Effects of Racial Density and Income Incongruity on Pregnancy Outcomes.” Social Science & Medicine 60 (10): 2229–2238. doi:10.1016/j.socscimed.2004.10.023. [PubMed: 15748671]

Rosenberg L, Palmer JR, Wise LA, Horton NJ, and Corwin MJ. 2002. “Perceptions of Racial Discrimination and the Risk of Preterm Birth.” Epidemiology 13 (6): 646–652. doi:10.1097/00001648-200211000-00008. [PubMed: 12410005]

Satter B. 2009. Family Properties: Race, Real Estate, and the Exploitation of Black Urban America. New York: Henry Holt and Company.

Schempf AH, Kaufman JS, Messer LC, and Mendola P. 2011. “The Neighborhood Contribution to Black-White Perinatal Disparities: An Example from Two North Carolina Counties, 1999–2001.” American Journal of Epidemiology 174 (6): 744–752. doi:10.1093/aje/kwr128. [PubMed: 21771918]

Schempf AH, Strobino D, and O’Campo P. 2009. “Neighborhood Effects on Birthweight: An Exploration of Psychosocial and Behavioral Pathways in Baltimore, 1995–1996.” Social Science & Medicine 68 (1): 100–110. doi:10.1016/j.socscimed.2008.10.006. [PubMed: 18995941]

Walton E. 2009. “Residential Segregation and Birth Weight Among Racial and Ethnic Minorities in the United States.” Journal of Health and Social Behavior 50 (4): 427–442. doi:10.1177/002214650905000404. [PubMed: 20099449]

Weinick RM, Zuvekas SH, and Cohen JW. 2000. “Racial and Ethnic Differences in Access to and Use of Health Care Services, 1977 to 1996.” Medical Care Research and Review 57 (Suppl. 1): 36–54. [PubMed: 11092157]

Williams DR, and Collins C. 2001. “Racial Residential Segregation: A Fundamental Cause of Racial Disparities in Health.” Public Health Reports 116 (5): 404–416. [PubMed: 12042604]

Wilson WJ 1987. The Truly Disadvantaged. Chicago: University of Chicago Press.

Zapata BC, Rebolledo A, Atalah E, Newman B, and King MC. 1992. “The Influence of Social and Political Violence on the Risk of Pregnancy Complications.” American Journal of Public Health 82 (5): 685–690. doi:10.2105/AJPH.82.5.685. [PubMed: 1566947]

Key messages

1. Residential redlining was associated with a lower risk of preterm birth among black women.
2. Residential segregation was not associated with preterm birth among this sample of women.
3. The complex relationships between institutional racism, neighborhood factors, and stress are important for understanding pregnancy and birth outcomes, particularly racial and ethnic disparities.

Table 1.

Prevalence of preterm birth according to participant characteristics for non-Hispanic black, non-Hispanic white, and Hispanic women, SPEAC 1999–2004.

	NH black women		NH white women		Hispanic women	
Characteristic	***N* births (%)**	**% Preterm**	***N* births (%)**	**% Preterm**	***N* births (%)**	**% Preterm**
Total *N* births	2371	14.9	300	7.7	791	8.3
Individual-level characteristics						
Age						
Less than 20	611 (25.8)	12.8	73 (24.3)	6.9	187 (23.6)	9.6
20–29	1343 (56.6)	14.5	182 (60.7)	7.1	489 (61.8)	7.2
30 or more	417 (17.6)	19.2	45 (15.0)	11.1	115 (14.5)	11.3
	$p = 0.007$		$p = 0.45$		$p = 0.83$	
Income						
< $5,000	376 (15.9)	14.1	34 (11.3)	5.9	304 (38.4)	10.2
$5,000–9,999	342 (14.4)	20.2	29 (9.7)	3.5	141 (17.8)	7.8
$10,000–19,999	624 (26.3)	13.0	84 (28.0)	10.7	180 (22.8)	6.7
$20,000–29,999	525 (22.1)	15.2	66 (22.0)	3.0	95 (12.0)	5.3
$30,000–39,999	297 (12.5)	13.5	38 (12.7)	10.5	50 (6.3)	14.0
$40,000+	207 (8.7)	14.0	49 (16.3)	10.2	21 (2.7)	0
	$p = 0.35$		$p = 0.45$		$p = 0.45$	
Education						
Less than HS	776 (32.7)	15.6	117 (39.0)	10.3	396 (50.1)	7.8
HS Grad/GED	1139 (48.0)	14.5	133 (44.3)	6.8	268 (33.9)	10.8
Post-HS	456 (19.2)	14.5	50 (16.7)	4.0	127 (16.1)	4.7
	$p = 0.54$		$p = 0.14$		$p = 0.66$	
Marital status						
Married/cohabiting	395 (16.7)	14.9	84 (28.0)	4.8	361 (45.6)	8.8
Not married	1976 (83.3)	14.9	216 (72.0)	8.8	430 (54.4)	7.9
	$p = 0.96$		$p = 0.24$		$p = 0.63$	
Tobacco use						
No	1914 (80.7)	14.1	141 (47.0)	7.1	692 (87.5)	8.7
Yes	457 (19.3)	18.2	159 (53.0)	8.2	99 (12.5)	6.1
	$p = 0.03$		$p = 0.73$		$p = 0.38$	
Alcohol use						
No	1562 (65.9)	14.4	132 (44.0)	9.1	604 (76.4)	9.1
Yes	809 (34.1)	15.7	168 (56.0)	6.6	187 (23.6)	5.9
	$p = 0.40$		$p = 0.35$		$p = 0.16$	
Previous live births						
None	997 (42.1)	14.8	133 (44.3)	7.5	335 (42.4)	8.4
One	649 (27.4)	12.2	95 (31.7)	6.3	245 (31.0)	9.0
Two or more	725 (30.6)	17.2	72 (24.0)	9.7	211 (26.7)	7.6

Characteristic	NH black women		NH white women		Hispanic women	
	N births (%)	% Preterm	*N* births (%)	% Preterm	*N* births (%)	% Preterm
	$p = 0.23$		$p = 0.65$		$p = 0.79$	
Everyday discrimination						
None (0)	1062 (44.8)	15.1	168 (56.0)	7.7	394 (49.8)	9.9
Low (1–10)	879 (37.1)	13.1	93 (31.0)	7.5	273 (34.5)	6.7
Medium (11–20)	316 (13.3)	16.5	30 (10.0)	10.0	97 (12.3)	7.2
High (21+)	114 (4.8)	21.9	9 (3.0)	0	27 (3.4)	7.4
	$p = 0.20$		$p = 0.83$		$p = 0.22$	
Major discrimination						
No events	1933 (81.5)	14.7	260 (86.7)	6.5	659 (83.3)	8.2
One event	369 (15.6)	15.2	32 (10.7)	12.5	122 (15.4)	9.0
Two events	69 (2.9)	17.4	8 (2.7)	25.0	10 (1.3)	10.0
	$p = 0.57$		$p = 0.03$		$p = 0.72$	
Stress (CPSS)						
Below median (<24)	1331 (56.1)	14.9	144 (48.0)	9.7	329 (41.6)	9.4
Above median (≥24)	1040 (43.9)	14.8	156 (52.0)	5.8	462 (58.4)	7.6
	$p = 0.96$		$p = 0.20$		$p = 0.35$	
Poor neighborhood quality (self-reported)						
1	410 (17.3)	16.1	97 (32.3)	14.4	165 (20.8)	6.1
2	368 (15.5)	16.9	60 (20.0)	1.7	144 (18.2)	9.7
3	387 (16.3)	17.3	41 (13.7)	4.9	110 (13.9)	9.1
4	332 (14.0)	13.0	42 (14.0)	4.8	123 (15.6)	6.5
5	285 (12.0)	12.6	30 (10.0)	6.7	77 (9.7)	10.4
6	414 (17.5)	13.0	20 (6.7)	5.0	119 (15.0)	8.4
7	175 (7.4)	13.7	10 (3.3)	10.0	53 (6.7)	11.3
	$p = 0.05$		$p = 0.14$		$p = 0.39$	
Housing tenure/type						
Homeowner	282 (11.9)	18.8	41 (13.7)	5.2	96 (12.1)	5.2
Private renter	1875 (79.1)	14.7	253 (84.3)	8.7	669 (84.6)	8.8
Public/social renter	214 (9.0)	11.2	6 (2.0)	11.5	26 (3.3)	11.5
	$p = 0.02$		$p = 0.18$		$p = 0.20$	
Number of years in neighborhood, M (SD)		8.0 (8.6)		7.1 (8.1)		3.0 (5.0)
For term infants, M (SD)		8.1 (8.7)		7.1 (8.0)		3.0 (4.9)
For preterm infants, M (SD)		7.0 (8.0)		7.7 (9.2)		2.5 (5.1)
	$p = 0.03$		$p = 0.77$		$p = 0.37$	
Neighborhood-level characteristics						
Total *N* tracts	277		131		153	
Redlining, M (SD)	2.0 (0.74)		1.88 (0.82)		1.84 (0.69)	
For term infants, M (SD)		2.01 (0.74)		1.88 (0.82)		1.84 (0.68)
For preterm infants, M (SD)		1.95 (0.75)		1.93 (0.77)		1.85 (0.76)
	$p = 0.17$		$p = 0.79$		$p = 0.93$	

Characteristic	NH black women		NH white women		Hispanic women	
	N births (%)	% Preterm	*N* births (%)	% Preterm	*N* births (%)	% Preterm
Redlining						
Other (≤1.4)	457 (19.5)	18.2	80 (26.9)	8.8	220 (28.1)	9.1
Redlined (>1.4)	1882 (80.5)	14.1	218 (73.2)	7.3	563 (71.9)	7.6
	$p = 0.03$		$p = 0.69$		$p = 0.50$	
Segregation:						
Percent black						
0–25%	293 (12.4)	14.0	241 (80.3)	6.6	473 (59.8)	8.7
>25–50%	299 (12.6)	15.4	30 (10.0)	20.0	241 (30.5)	5.8
>50–75%	263 (11.1)	17.9	10 (3.3)	0	24 (3.0)	16.7
>75–100%	1516 (63.9)	14.4	19 (6.3)	6.3	53 (6.7)	13.2
	$p = 0.85$		$p = 0.83$		$p = 0.39$	
Dissimilarity[a]						
Very low	453 (19.1)	14.6	55 (18.3)	7.3	305 (38.6)	8.5
Low	844 (35.6)	16.0	45 (15.0)	4.4	244 (30.9)	9.0
Moderate	910 (38.4)	14.1	113 (37.7)	7.1	198 (25.0)	7.6
High	164 (6.9)	14.0	87 (29.0)	10.3	44 (5.6)	6.8
	$p = 0.57$		$p = 0.39$		$p = 0.22$	
Exposure[a]						
Very low	2058 (86.8)	14.5	72 (24.0)	6.9	564 (71.3)	8.5
Low	88 (3.7)	18.2	25 (8.3)	16.0	39 (4.9)	10.3
Moderate	148 (6.2)	18.9	65 (21.7)	6.2	110 (13.9)	6.4
High	77 (3.3)	11.7	138 (46.0)	7.3	78 (9.9)	9.0
	$p = 0.53$		$p = 0.77$		$p = 0.79$	
Isolation[a]						
Very low	234 (9.9)	14.1	219 (73.0)	6.4	423 (53.5)	8.8
Low	83 (3.5)	9.6	13 (4.3)	15.4	95 (12.0)	8.4
Moderate	265(11.2)	19.3	34 (11.3)	14.7	162 (20.5)	4.9
High	1789 (75.5)	14.5	34 (11.3)	5.9	111 (14.0)	11.7
	$p = 0.89$		$p = 0.42$		$p = 0.98$	

[a]Segregation indices are coded as Very low (≤0.3), Low (>0.3 and ≤0.4), Moderate (>0.4 and ≤0.6), and High (>0.6).

Table 2.

Spearman correlation coefficients (confidence intervals) of redlining and segregation indices, SPEAC 1999–2004.

	Correlations with residential redlining		
	NH black women	**NH white women**	**Hispanic women**
Percent black	0.16 (0.12, 0.20)	−0.27 (−0.37, −0.16)	0.002 (−0.07, 0.07)
Black dissimilarity index	0.24 (0.20, 0.28)	0.50 (0.41, 0.58)	0.28 (0.21, 0.34)
Black exposure index	−0.16 (−0.19, −0.12)	0.14 (0.03, 0.25)	−0.26 (−0.33, −0.20)
Black isolation index	0.14 (0.10, 0.18)	−0.06 (−0.17, 0.06)	0.08 (0.008, 0.15)

Table 3.

Adjusted[a,b] risk ratios (RR) of the association between individual characteristics, neighborhood characteristics, and preterm birth among non-Hispanic black, non-Hispanic white, and Hispanic women, SPEAC 1999–2004.

	NH black	NH white	Hispanic
Individual characteristics [b]			
Everyday discrimination[c]	1.1 (1.0, 1.2)	0.9 (0.7, 1.2)	0.9 (0.6, 1.2)
Major discrimination[c]	1.0 (0.8, 1.3)	1.2 (0.9, 1.7)	1.1 (0.6, 1.9)
Stress (CPSS) [less than median(ref)]	0.9 (0.8, 1.2)	0.8 (0.6, 1.1)	0.8 (0.5, 1.4)
Poor neighborhood quality[c]	1.0 (0.9, 1.0)	1.0 (0.9, 1.1)	1.1 (0.9, 1.2)
Neighborhood characteristics [b]			
Redlining[d]	0.8 (0.6, 1.0)	0.8 (0.6, 1.2)	0.8 (0.5, 1.3)
Percent black[e]	1.0 (0.9, 1.1)	1.1 (0.9, 1.3)	1.1 (0.8, 1.4)
Segregation: dissimilarity[f]	1.0 (0.8, 1.1)	1.0 (0.8, 1.2)	1.0 (0.7, 1.3)
Segregation: exposure[f]	1.0 (0.9, 1.1)	0.9 (0.8, 1.1)	0.9 (0.7, 1.2)
Segregation: isolation[f]	1.0 (0.9, 1.1)	1.1 (0.9, 1.2)	1.0 (0.8, 1.2)

[a] Models were adjusted for age, marital status, education, total household income, alcohol and tobacco use, previous live births, homeownership, and number of years lived in the neighborhood.

[b] Each neighborhood factor or individual self-reported measure (i.e., discrimination, stress, and neighborhood quality) were entered into the model separately.

[c] Corresponds to a one unit change (increase) in variable of interest.

[d] Redlining was coded as a dichotomous variable of living in a redlined area versus other area. The referent category are those living in 'Other'/ nonwhite-lined areas.

[e] Corresponds to a 25% unit change (increase) in variable of interest.

[f] Segregation indices correspond to a unit increase from Very Low (≤0.3) to Low (>0.3 and ≤0.4), Moderate (>0.4 and ≤0.6), and High (>0.6).