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Examining the Association between Racial Residential Segregation, Risky Sexual Behaviors, and Sexually Transmitted Infections.

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EXAMINING THE ASSOCIATION BETWEEN RACIAL RESIDENTIAL SEGREGATION, RISKY SEXUAL BEHAVIORS, AND SEXUALLY TRANSMITTED INFECTIONS

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Khaleeq Lutfi

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To: Dean Tomás R. Guilarte
Robert Stempel College of Public Health and Social Work

This dissertation, written by Khaleeq Lutfi, and entitled Examining the Association between Racial Residential Segregation, Risky Sexual Behaviors, and Sexually Transmitted Infections, having been approved in respect to style and intellectual content, is referred to you for judgment.

We have read this dissertation and recommend that it be approved.

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The dissertation of Khaleeq Lutfi is approved.

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DEDICATION

I dedicate this dissertation to my mother, Michele Davidson, and my wife, Marilia Da Silva. Their continued patience, moral support, and sacrifices have made it possible for me to complete this work.

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ABSTRACT OF THE DISSERTATION

EXAMINING THE ASSOCIATION BETWEEN RACIAL RESIDENTIAL SEGREGATION, RISKY SEXUAL BEHAVIORS, AND SEXUALLY TRANSMITTED INFECTIONS

by

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Sexually transmitted infections (STIs) disproportionately impact non-Hispanic blacks in the United States. Racial differences in sexual networks can contribute to these disparities. Racial residential segregation, the separation of racial groups in a residential context, is a community factor known to influence sexual networks and has been associated with negative health outcomes. Our objective was to examine the association between racial residential segregation (henceforth, referred to as segregation), risky sexual behavior, concurrent partnerships, and STI diagnoses among non-Hispanic blacks. Demographic, sexual behavior, and STI diagnosis data for non-Hispanic blacks 15–44 years of age were obtained from the 2006–2010 National Survey of Family Growth. Segregation and community poverty data were obtained from the U.S. Census. Five distinct dimensions measured segregation, each with a representative index. Multilevel logistic regressions were conducted to test how each of the five indices were associated

with risky sexual behavior, concurrent partnerships, and STI diagnoses. Risky sexual behavior results showed 16.1% (n=588) of participants engaged in risky sexual behavior. The association was stronger for the absolute centralization (adjusted odds ratio [aOR] 2.07; 95% confidence interval [CI] 2.05 – 2.08) and relative concentration indices (aOR 2.05; 95% CI 2.03 – 2.07). This suggests risky sexual behavior is most strongly associated with segregation in neighborhoods with a high density of non-Hispanic blacks and accumulation of non-Hispanic blacks in an urban core. STI diagnosis results showed 7.4% (n=305) of participants reported a STI diagnosis, and segregation was associated with STI diagnosis. The association was strongest measured with the dissimilarity index (aOR 2.41; 95% CI 2.38 – 2.43) and stronger for males. Concurrent partnerships results showed 15.6% (n=645) of participants reported concurrent partnerships. Multilevel analyses showed segregation to be associated with concurrent partnerships with the association strongest measured with the dissimilarity index. Segregation acted as a risk and a protective factor with risky sexual behavior, concurrent partnerships, and STI diagnosis, depending on the segregation measure. Additional work is needed to understand the mechanisms of how specific segregation dimensions influence risky sexual behaviors and sexually transmitted infections.

TABLE OF CONTENTS

ABBREVIATIONS AND ACRONYMS

ACS	American Community Survey
aOR	Adjusted odds ratios
CBSA	Core-based statistical area
CDC	Centers for Disease Control and Prevention
CI	Confidence interval
HIV	Human immunodeficiency virus
NCHS	National Center for Health Statistics
NHB	Non-Hispanic Blacks
NHW	Non-Hispanic Whites
NSFG	National Survey of Family Growth
OR	Odds ratios
RDC	Research Data Center
SAS	Statistical Analysis System
STI	Sexually transmitted infections
U.S.	United States

INTRODUCTION

There are an estimated 20 million new sexually transmitted infections (STI) in the United States (U.S.) each year (CDC, 2016a), and there are more than 110 million prevalent STI, which includes new and existing infections in the U.S. (CDC, 2016a). STIs can lead to cancer, fetal health problems, and reproductive health issues, such as infertility (Satterwhite et al., 2007); they can also facilitate the transmission of human immunodeficiency virus (HIV) (CDC, 2016a). In addition to health consequences, STIs also carry an economic burden in the US with the cost of treating STIs approaching $16 billion each year (Owusu-Edusei et al., 2013). Sexually transmitted infections disproportionately affect the non-Hispanic black population in the United States. In 2015, the HIV diagnosis rate for non-Hispanic blacks was eight times the rate for non-Hispanic whites (44.3 and 5.3 per 100,000, respectively) (CDC, 2016b). Also in 2015, the chlamydia reported case rate was nearly six times higher for non-Hispanic blacks compared to non-Hispanic whites (1,097.6 and 187.2 per 100,000, respectively), and the gonorrhea reported case rate was nearly ten times higher for non-Hispanic blacks compared to non-Hispanic whites (424.9 and 44.2 per 100,000, respectively). The disparities observed among non-Hispanic blacks when compared to non-Hispanic whites were also present when examining by gender. In 2010, the HIV diagnosis rate among non-Hispanic black males was nearly seven times higher than the rate among non-Hispanic white males (103.6 and 15.8 per 100,000, respectively) (CDC, 2013). However, in that same year, the HIV diagnosis rate for non-Hispanic black females was 20.1 times the rate among non-Hispanic white females (38.1 and 1.9 per 100,000, respectively) (CDC, 2013). The gender disparities were smaller for chlamydia diagnosis rates. In 2015,

the chlamydia diagnosis rate for non-Hispanic black males was 6.7 times the rate among non-Hispanic white males (782.0 and 115.4 per 100,000 respectively), and the rate for non-Hispanic black females was 5.4 times the rate among non-Hispanic white females (1,384.8 and 256.7 per 100,000, respectively) (CDC, 2016a). Also in 2015, the gonorrhea diagnosis rate for non-Hispanic black males was 9.6 times the rate among non-Hispanic white males (482.2 and 50.3 per 100,000, respectively), and the rate for non-Hispanic black females was 9.7 times the rate among non-Hispanic white females (371.9 and 38.2 per 100,00, respectively) (CDC, 2016a).

These disparities may be partially attributed to individual behaviors and community factors. Risky sexual behavior increases the likelihood of contracting or transmitting a sexually transmitted infection (Cook et al., 2016). There are a variety of ways to assess risky sexual behavior. Number of partners is a commonly used measure of risky sexual behavior (Gerver et al., 2011; Everett, 2013; Pflieger et al., 2013; Marcus et al., 2015; Pouget et al., 2010) because the more sexual partners an individual has, the more likely they are to encounter an infected partner. Inconsistent condom use and non use of condoms are other commonly used measures of risky sexual behavior (Gerver et al., 2011; Sharma et al., 2017; Crosby et al., 2012) because failing to use a condom at each sexual encounter can lead to transmission of an infection. Concurrent partnerships (i.e. having at least two sexual partners that overlap in time) increase the speed of STI transmission within a sexual network (Adimora et al., 2013; Adimora et al., 2011; Adimora et al., 2007). Differences in sexual networks between non-Hispanic blacks and non-Hispanic whites are also thought to contribute to the observed STI racial disparities (Adimora et al., 2003).

Previous studies have found risky sexual behaviors alone do not account for STI disparities (Dariotis et al., 2011; Hallfors et al., 2007). This indicates community-level factors, in concert with individual behavior, may provide a better way to account for racial disparities experienced by non-Hispanic black communities. A variety of community factors such as poverty, male-to-female sex ratio, percent black, percent female-headed households, and racial residential segregation can impact an individual's risk of acquiring or transmitting a sexually transmitted infection through multiple mechanisms (Adimora & Schoenbach, 2005). For instance, low male-to-female sex ratios are prevalent in non-Hispanic black communities where they disrupt sexual network stability (Adimora et al., 2002; Adimora et al., 2006). Concentrated poverty also impacts sexual networks by removing marriageable non-Hispanic black males from the community through incarceration or unemployment (Adimora et al., 2006; Adimora & Schoenbach, 2005). Racial residential segregation is a community-level factor that has been associated with many other community factors including increased poverty and male-to-female sex ratio (Thomas & Gaffield, 2003) and also disproportionately impacts non-Hispanic black communities.

Racial residential segregation refers to the spatial separation of racial groups in a residential context. This pattern is observed throughout the U.S. and is considered a fundamental cause of racial disparities (Williams & Collins, 2001; Gaskin et al., 2012). Racial residential segregation is also considered to be the backbone of the formation of sexual networks since individuals commonly select sexual partners from their communities (Adimora et al., 2006; Zenilman et al., 1999). Previous research has shown that over 50% of non-Hispanic blacks in the United States reside in geographic areas

considered highly segregated (Massey & Tannen, 2015; Williams & Collins, 2001; Biello et al., 2012), and non-Hispanic black is the racial group most likely to experience high levels of segregation (Parisi, et al., 2015; Biello et al., 2012; Iceland & Sharp, 2013). Racial residential segregation has also been associated with various negative health outcomes among non-Hispanic blacks such as low birth weight, gonorrhea rates, and risky sexual behavior (Bell et al., 2006; Biello et al., 2013; Lutfi et al., 2015; Pugsley et al., 2013; Subramanian et al., 2005).

Five distinct dimensions measure racial residential segregation: evenness, exposure, concentration, centralization, and clustering. Evenness has the least clear relationship with health, but is often included as it is easily computed and is the most commonly used dimension (Massey, 2012). The index of dissimilarity is the representative index for the evenness dimension, and values range from 0.0 to 1.0. The index of dissimilarity measures the percent of non-Hispanic blacks that would have to change residence so the racial composition of a neighborhood is equal to that of the entire metropolitan area (Massey & Denton, 1988). It also measures the departure from evenness so the index of dissimilarity is at its highest when evenness is at its lowest. The exposure dimension measures the extent to which non-Hispanic blacks are exposed to non-Hispanic whites by residing in the same neighborhood. The isolation index is the representative index for the exposure dimension, and values range from 0.0 to 1.0. The isolation index measures the level to which non-Hispanic blacks are exposed only to other non-Hispanic blacks, instead of non-Hispanic whites (Massey & Denton, 1988). The isolation index is at its highest when non-Hispanic blacks are likely to only encounter other non-Hispanic blacks, as in, there are no non-Hispanic blacks sharing a

neighborhood with non-Hispanic whites. The concentration dimension measures the amount of geographic space occupied by non-Hispanic blacks in a metropolitan area (Massey & Denton, 1988). In this case, we will be looking at the amount of space occupied by non-Hispanic blacks compared to the space occupied by non-Hispanic whites. The relative concentration index is the representative index for the concentration dimension with values ranging from -1.0 to 1.0. A value of 0 indicates non-Hispanic blacks and non-Hispanic whites are concentrated to the same extent within a metropolitan area, and a value of 1.0 indicates non-Hispanic blacks are more concentrated than non-Hispanic whites to the maximum (a value of -1.0 indicates the opposite) (Massey & Denton, 1988). The centralization dimension measures the extent to which non-Hispanic blacks reside near a metropolitan area center (Massey & Denton, 1988). The absolute centralization index is the representative index for the centralization dimension with values ranging from -1.0 to 1.0. A value of 0 indicates non-Hispanic blacks are distributed evenly throughout, and a value of 1.0 indicates non-Hispanic blacks all reside near the city center (a value of -1.0 indicates the opposite) (Massey & Denton, 1988). The clustering dimension measures the extent to which non-Hispanic black communities merge together to form larger contiguous communities. The spatial proximity index is the representative index for the clustering dimension (Massey & Denton, 1988). This index can take any real value, but typically ranges from 1.0 to 2.0. A value of 1.0 indicates there is no difference in the level of clustering between non-Hispanic blacks and non-Hispanic whites while values greater than 1.0 indicate non-Hispanic black neighborhoods are closer to one another than non-Hispanic white neighborhoods (Massey & Denton, 1988).

The study objective was to measure racial residential segregation by incorporating multiple dimensions; often times just one or two dimensions are used. This study also aimed to determine the association of individual-level outcomes with racial residential segregation instead of community-level outcomes. The main objective of this dissertation was to examine the association between racial residential segregation and various sexually transmitted infection related outcomes among non-Hispanic blacks 15 – 44 years of age using a nationally representative sample. The first study examined the association between racial residential segregation and risky sexual behavior, measured as two or more partners within the past 12 months and no condom use at last sex. We expect non-Hispanic blacks that reside in areas with high levels of racial residential segregation to be more strongly associated with having engaged in risky sexual behavior during the past 12 months. This relationship was also examined through gender and age stratification, separately, where we expected risky sexual behavior to be more strongly associated younger participants and females. The second study examined the association of racial residential segregation and STI diagnosis within the past 12 months. We hypothesized that STI diagnosis would be more strongly associated with non-Hispanic blacks residing in highly segregated areas compared to non-Hispanic blacks residing in areas that are not highly segregated. This analysis also included stratification by gender and age, where we also expected STI diagnosis to be more strongly associated with younger participants and females. The third study examined the association between racial residential segregation and concurrent partnerships within the past 12 months. It is expected that for non-Hispanic blacks, residence in areas with high levels of racial residential segregation

would be more strongly associated with having engaged in concurrent partnerships compared to residence in non-segregated areas.

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Abstract

Sexually transmitted infections (STIs) including human immunodeficiency virus (HIV) have disproportionately affected the non-Hispanic black population in the United States. A person's community can affect his or her STI risk by the community's underlying prevalence of STIs, sexual networks, and social influences on individual behaviors. Racial residential segregation—the separation of racial groups in a residential context across physical environments—is a community factor that has been associated with negative health outcomes. The objective of this study was to examine if non-Hispanic blacks living in highly segregated areas were more likely to have risky sexual behavior. Demographic and sexual risk behavior data from non-Hispanic blacks aged 15 – 44 years participating in the National Survey of Family Growth were linked to Core-Based Statistical Area segregation data from the U.S. Census Bureau. Five dimensions measured racial residential segregation, each covering a different concept of spatial variation. Multilevel logistic regressions were performed to test the effect of each dimension on sexual risk behavior controlling for demographics and community poverty. Of the 3,643 participants, 588 (16.1%) reported risky sexual behavior as defined as two

or more partners in the last 12 months and no consistent condom use. Multilevel analysis results show that racial residential segregation was associated with risky sexual behavior with the association being stronger for the centralization [aOR (95% CI)][2.07 (2.05 – 2.08)] and concentration [2.05 (2.03 – 2.07)] dimensions. This suggests risky sexual behavior is more strongly associated with neighborhoods with high concentrations of non-Hispanic blacks and an accumulation of non-Hispanic blacks in an urban core. Findings suggest racial residential segregation is associated with risky sexual behavior in non-Hispanic blacks 15 – 44 years of age with magnitudes varying by dimension. Incorporating additional contextual factors may lead to the development of interventions that promote healthier behaviors and lower rates of HIV and other STIs.

Keywords:
Residential segregation; Sexual behavior; NSFG; Census; Non-Hispanic blacks

Introduction

An estimated 19 million new sexually transmitted infections (STIs) each year represent an estimated $16.4 billion burden on the U.S. healthcare system (CDC, 2012). STIs can also lead to reproductive health issues, cancer, fetal health problems, and facilitate the transmission of human immunodeficiency virus (HIV) (Satterwhite et al., 2007). Sexually transmitted infections, including HIV, have disproportionately affected the non-Hispanic black community in the United States. The HIV incidence rate among non-Hispanic black males was 6.6 times higher than that among non-Hispanic white males in 2010 (103.6 vs. 15.8 per 100,000, respectively)(CDC, 2013a). That same year the HIV incidence rate among non-Hispanic black females was 20.1 times higher than

that among non-Hispanic white females (38.1 vs. 1.9 per 100,000 per year, respectively)(CDC, 2013a). From 2007 – 2012, the chlamydia prevalence among non-Hispanic blacks was seven times the prevalence seen among non-Hispanic whites (Torrone et al., 2014). In 2012, the chlamydia incidence rate among non-Hispanic black males was eight times the rate of non-Hispanic white males and six times higher among non-Hispanic black females compared with non-Hispanic white females (CDC, 2013b). From 1999 – 2008, the gonorrhea prevalence among non-Hispanic blacks was nearly five times the prevalence seen among other races (Torrone et al., 2013). In 2012, non-Hispanic black males had a gonorrhea incidence rate sixteen times higher than that of non-Hispanic white males; the non-Hispanic black females rate was fourteen times that of their non-Hispanic white counterparts (CDC, 2013b). In addition to racial disparities, females and younger age groups are disproportionately affected by STIs. Nearly half of all STI incident cases each year are attributable to individuals 15 – 24 years of age (Satterwhite et al., 2013). Similarly in 2012, non-Hispanic black females had chlamydia incidence rates that were twice as high as the rates for non-Hispanic black males (1,613.6 vs. 809.2 per 100,000) (CDC, 2013b).

These large disparities may be partially attributable to individual behavioral and/or community factors. An individual's risky sexual behavior can be defined as an act that increases an individual's risk of contracting or transmitting a sexually transmitted infection. Research has found concurrent partnerships to be more prevalent among non-Hispanic blacks compared to non-Hispanic whites (Adimora et al., 2013). Concurrent partnerships increase the speed of STI transmissions throughout a sexual network

(Adimora & Schoenbach, 2005). 'Number of partners during the last 12 months' is an important measure of risky sexual behavior; it has been demonstrated that the more sexual partners an individual has, the more likely they are to encounter an infected partner (Finer et al., 1999; Gerver et al., 2011). Lack of condom use is another important measure because an individual is not reducing their risk of STI transmission (Finer et al., 1999; Gerver et al., 2011).

Studies have found that individual risky behaviors alone do not fully account for the STI disparities (Hallfors et al., 2007; Dariotis et al., 2011). Community factors such as STI prevalence, poverty, male to female sex ratio, and racial residential segregation can affect an individual's risk of acquiring a sexually transmitted infection through several mechanisms (Adimora & Schoenbach, 2005). A low male-to-female sex ratio exists in many predominately non-Hispanic black communities, and this affects the structure and stability of sexual networks. Fewer males limit the power of women to choose monogamous relationships since males can more easily find another relationship than when the sex ratio is balanced (Adimora & Schoenbach, 2002; 2005). Previous research has found that a lack of males is associated with multiple partners within the last year (Pouget et al., 2010). Along with unemployment, poverty is associated with a lower number of marriageable males that are financially stable enough to support a family (Adimora & Schoenbach, 2005). The importance of community measures becomes more evident as an individual with risky sexual behavior may not encounter an infected person if they reside in a low STI prevalence community. Conversely, communities with a high

STI prevalence create more opportunities for an individual to come into contact with an infected individual via an increased number of infected persons in their sexual network.

Hallfors et al. (2007) found that non-Hispanic blacks are at an elevated STI risk regardless of whether sexual behaviors are risky or not. This implies that within the non-Hispanic black community neighborhood-level factors, in addition to individual behavior, may be more useful to account for racial disparities. The residential environment may operate through pathways such as concentrated poverty, low sex ratio, and STI prevalence (Adimora & Schoenbach, 2005). Residential stability was associated with STD risk (Upchurch et al., 2004) and sexual initiation (Cubbin et al., 2005). However, Browning et al., (2004) found that residential stability was not significantly associated with sexual initiation. Previous research has also associated two or more partners with neighborhood structural inequality (Browning et al., 2008) as well as sex ratio and male incarceration rates (Pouget et al., 2010). These factors measure different aspects of the neighborhood environment. The use of racial residential segregation may provide a more complete depiction of the neighborhood through its associations with physical, economic, and social factors.

Racial residential segregation–the separation of racial groups in a residential context across spatial environments–is a ubiquitous pattern seen in the U.S. population and is considered a primary cause of racial disparities (Williams & Collins, 2001). Non-Hispanic blacks are the racial group most likely to experience high levels of racial residential segregation (Massey et al., 1996) with two thirds of non-Hispanic blacks residing in highly segregated areas (Williams & Collins, 2001). Previous research has

associated residential segregation with negative non-Hispanic black health outcomes (Subramanian et al., 2005; Bell et al., 2006; Acevedo-Garcia et al., 2003; Collins & Williams, 1999). However, the consequences of residential segregation for non-Hispanic whites and Hispanics are not well understood or uniform (Collins & Williams, 1999; Lee & Ferraro, 2007). Evidence suggests high levels of residential segregation may be beneficial to non-Hispanic whites by isolating them from adverse conditions experienced by non-Hispanic blacks in segregated areas (Chang, 2006) and to Hispanics through higher levels of social resources (Lee & Ferraro, 2007). For these reasons, along with the disproportionate STI rates seen in the non-Hispanic black community, non-Hispanic blacks are the focus of this study.

Racial residential segregation is thought to impact risky behavior through direct and indirect pathways. Five distinct dimensions measure racial residential segregation: unevenness, exposure, concentration, centralization, and clustering. Directly, the clustering, concentration and exposure dimensions increase the density and level of contact of non-Hispanic blacks to only other non-Hispanic blacks, increasing transmission risks (Poundstone, et al., 2004). The unevenness dimension is typically included in segregation and health literature for comparability since it is the most often used dimension despite the relationship with health not being as clear as it is for the other dimensions. Indirect pathways through which segregation operates include concentrated poverty (Polednak, 1997), overcrowding, housing deterioration, limited access to care, and social disorganization (Acevedo-Garcia, 2000). Concentrated poverty is associated with the loss of resources out of a neighborhood (Massey & Denton, 1993) resulting in

the deterioration of neighborhood quality. These resources include quality medical care (Walker et al., 2011), quality education (Acevedo-Garcia et al., 2008), and employment opportunities (Poundstone et al., 2004). The loss of quality medical care hinders access to and quality of preventive services (Kim et al., 2010). The loss of quality educational opportunities may limit access to STI prevention courses generally received in schools. The lack of employment opportunities may impact the number of marriageable males, which is associated with partner instability, which is associated with partner concurrency as well as other risky sexual behaviors (Adimora & Schoenbach, 2002; 2005; Pouget et al., 2010). The centralization dimension measures how likely non-Hispanic blacks are to reside in the central city, which is typically the oldest and most deteriorated portion of a metropolitan area (Acevedo-Garcia, 2000). Deteriorated neighborhoods have been associated with negative health behaviors and outcomes such as mortality and gonorrhea rates, possibly due to the lack of a safe environment or suitable health care facilities (Cohen et al., 2003). Social disorganization is thought to encourage behaviors such as drug use (Furstenberg & Hugues, 1997), which has been associated with engaging in risky sexual behaviors (Cooper et al., 2007). Through these direct and indirect pathways, residential segregation may create differential access to economic, educational, and employment resources and exposures to negative environments for non-Hispanic blacks (Polednak, 1997).

Our objective was to examine the association between racial residential segregation and risky sexual behavior for non-Hispanic blacks 15 – 44 years of age using a nationally representative sample. This study hypothesized that risky sexual behavior

would be more strongly associated with people residing in highly segregated areas compared with those residing in non-segregated areas. In addition, from our evaluation of the literature as well as the epidemiologic burden observed, we explored age and gender differences through stratification. We hypothesized that the effects of racial residential segregation would be stronger for younger adults and females due to differences observed in age and gender STI patterns.

Methods

This study uses individual-level demographic and sexual risk behavior data from the National Survey of Family Growth (NSFG) and data on racial residential segregation and community poverty from the United States (U.S.) Census Bureau. The NSFG is administered by the National Center for Health Statistics (NCHS) and is a continuous health survey of men and women between 15 – 44 years of age living in U.S. households. The 2006 – 2010 survey completed a nationally representative sample from 110 primary sampling units (PSUs) generating 22,682 completed interviews resulting in a final sample size of 3,643 non-Hispanic blacks. PSUs are counties or groups of adjoining counties that represent the eight largest metropolitan areas in the United States (each year) as well as 25 smaller metropolitan and nonmetropolitan areas that change each survey year (Lepkowski et al., 2010). Racial residential segregation indices and poverty values were calculated for core-based statistical areas (CBSAs) by the U.S. Census Bureau, using 2010 data for segregation and 2006 – 2010 data for poverty. "CBSA" is a collective term for both metropolitan and micropolitan statistical areas. Metropolitan and micropolitan areas are composed of at least one urban core with a population of at least 50,000 (metro)

or a population between 10,000 and 50,000 (micro) and the surrounding areas that are socioeconomically connected with that urban core.

The variable, CBSA, was used to merge NSFG individual data and U.S. Census Bureau community data. CBSA is a restricted variable; therefore, these data were accessed through the NCHS Research Data Center. To limit disclosure risk, the Research Data Center did not provide the researchers the identity of the specific CBSAs. NSFG participants who did not reside in a CBSA were excluded from the study.

Risky Sexual Behavior

Risky sexual behavior was measured in three ways: "number of partners in the last 12 months," "condom use at last sex," and a composite measure composed of these two. Based on previous literature, "number of partners in the last 12 months" was a dichotomous variable composed of "0 or 1 partner" or "2 or more partners" (Kalichman et al., 2011). Individuals with "two or more partners in the last 12 months" were considered engaging in risky sexual behavior. "Condom use at last sex" was also a dichotomous variable. Responses for condom use were "yes" or "no" with responses of "no" considered engaging in risky sexual behavior. Used alone, "condom use at last sex" does not account for the relationship status of the individual. Anderson et al. (1999) and Anderson (2003) found that unmarried adults were more likely to have used a condom at last sex than married adults. To account for relationship status, a composite measure of risky sexual behavior was created combining the preceding two variables. Risky sexual behavior was henceforth defined as having 2 or more partners in the last 12 months and no condom use at last sex.

Residential Segregation

CBSA was chosen as the area of interest because previous research has shown that CBSAs approximate the housing markets (Wilkes & Iceland, 2004), which allows the measurement of segregation at a level where an individual has strong economic and social connections. In addition, selection into neighborhoods is an important factor when examining geographic health associations and can be accounted for by using CBSA-level segregation indices (Oakes, 2004). When measuring residential segregation, there is the area of interest (CBSA) and its component areas, termed units of analysis. Census tracts are the most commonly used unit of analysis for census-based segregation studies (Wilkes & Iceland, 2004) and residential segregation studies (Fabio et al., 2009). Census tracts are used as proxies for neighborhoods within a CBSA (Bell et al., 2006). To calculate CBSA segregation, the minority and majority population and sometimes land area values are needed for the census tracts and CBSA overall. Iceland, Weinberg, and Steinmetz (2002) provide excellent technical and visual descriptions of the formulas for each segregation index (p.119-123).

We chose to measure residential segregation using Massey & Denton (1988) census-tract derived indices instead of spatial or surface-density derived measures used by Wong (1993) and Kramer et al., (2010). An advantage of using spatial and surface-density measures is that they do not rely on the arbitrary boundaries of the census tract, which assumes homogeneity within its boundaries; they instead use distance-based or egocentric measures to depict an individual's neighborhood. Despite the strength of spatial measures of segregation we chose census-tract derived measures due to their high

correlation with surface-density measures in highly populated metropolitan areas (Kramer et al., 2010), to preserve comparability with the literature, and to use standardized U.S. Census Bureau measures. There are several dimensions of racial residential segregation, and an index for each dimension was chosen based on previous research by Massey & Denton (1988) (Table 1). The index of dissimilarity, a measure of evenness, measures the percentage of non-Hispanic blacks that must change residence for the neighborhood to have the same racial composition as the overall CBSA (Massey & Denton, 1988). The isolation index, a measure of exposure, measures the level of exposure of non-Hispanic blacks to only other non-Hispanic blacks (Massey & Denton, 1988). The relative concentration index measures the amount of physical space taken by non-Hispanic blacks in a CBSA relative to the amount of physical space occupied by non-Hispanic whites (Massey & Denton, 1988). The resulting value is then compared to the ratio that would exist if non-Hispanic blacks were maximally concentrated and non-Hispanic whites were maximally scattered. The absolute centralization index measures the degree to which non-Hispanic blacks are distributed around the CBSA center compared to outlying areas (Massey & Denton, 1988). The spatial proximity index, a measure of clustering, measures the degree to which non-Hispanic black neighborhoods cluster with one another. (For a detailed description of the segregation indices and their formulas, refer to Iceland et al., (2002)).

This study also examines hypersegregation, a dichotomous (hypersegregated or not) variable that measures segregation across multiple dimensions. Residential segregation indices with values greater than or equal to 0.60 are considered highly

segregated. A CBSA is considered hypersegregated if it is highly segregated on at least four of the five dimensions (Massey et al., 1996). Non-Hispanic blacks are the only racial group to experience widespread hypersegregation in the U.S. (Acevedo-Garcia et al., 2003), and it is noted that being highly segregated across multiple dimensions increases the negative influences of segregation.

[*Table 1*]

Individual-level variables

Individual-level variables were age, gender, marital status, educational attainment, and income. Age was grouped as 15 – 24, 25 – 34, and 35 – 44 years; marital status was grouped as married/cohabitating or not married/not cohabitating; and income was grouped as "less than $15,000," "$15,000 – $34,999," "$35,000 – $74,999," and "$75,000 or more" per year. Educational attainment was measured as "no high school diploma and in school," "no high school diploma and not in school," "high school diploma," "some college," and "college degree."

CBSA-level variables

This study has two CBSA-level measures: racial residential segregation and poverty. Racial residential segregation index values are measured as "less than 0.60" and "greater than or equal to 0.60" (Massey et al., 1996; Biello et al., 2012). Poverty is the second community-level measure and is measured as the percentage of a CBSA with a family income below the poverty level. Poverty has four levels: "less than 6.9%,"

"between 6.9% and 8.9%," "between 9.0% and 11.9%," and "12.0% or more." The described poverty levels represent quartiles of the poverty distribution.

Analysis

Bivariate analyses were conducted using the Rao-Scott F-adjusted chi square test statistic to identify statistically significant variables ($p < 0.05$). We performed multilevel logistic regression models using PROC GLIMMIX to examine associations between risky sexual behavior (level 1) and CBSA-level segregation (level 2). The first model separately examined the association of each racial residential segregation measure and risky sexual behavior, generating crude odds ratios (ORs). The second model examined the association of risky sexual behavior and individual-level variables alone. The third model examined the adjusted association of racial residential segregation and risky sexual behavior with individual-level variables included. The first, second, and third models are not shown in tables. Likelihood ratio tests were conducted to assess the best-fit model. The final model examined the association of racial residential segregation and risky sexual behavior with the inclusion of individual-level variables and community poverty. The final model was computed six times, once with each segregation index. In addition, the final model was computed separately as age- and gender-specific models for each racial residential segregation index. NSFG analyses require use of weighting, stratification, and clustering variables due to the complex sampling system. Statistical analyses were conducted using SAS software, Version 9.3 (Cary, NC, USA).

Results

The final sample included 3,643 non-Hispanic blacks 15 – 44 years of age from 2006 – 2010. Descriptive characteristics of participants stratified by risky sexual behavior status are presented in Table 2. A greater proportion of respondents who were younger than 35 years of age, were male, only had a high school diploma, and were not married or cohabitating reported risky sexual behavior (two or more partners within last 12 months and no condom use at last sex) compared to other respondents. Income and CBSA poverty did not have a significant association with risky sexual behavior but were included in the models because of the importance of income and poverty when examining racial residential segregation.

[*Table 2*]

The multilevel logistic regression models in Table 3 were conducted for each segregation index for the risky sexual behavior variable. After adjusting for age, gender, educational attainment, marital status, income, and CBSA poverty, overall racial residential segregation was associated with risky sexual behavior for all indices except hypersegregation, which was protective. Relative concentration and absolute centralization were most strongly associated with risky sexual behavior [adjusted odds ratio (aOR) (95% CI)][2.05 (2.03 – 2.07)] and [2.07 (2.05 – 2.08)] respectively. Non-Hispanic blacks most likely to engage in risky sexual behavior were male, 25 – 34 years of age, with a high school diploma, and not married or cohabitating [Not shown in tables].

Age group stratification

Logistic regression analyses were stratified by age with adjusted associations displayed in Table 3. Counter to our hypothesis, the association of racial residential segregation and risky sexual behavior was not stronger among the 15 – 24 year-old age group. No consistent pattern was present for the residential segregation and risky sexual behavior association. In the 15 – 24 year-old age group, isolation, centralization, and spatial proximity indices were associated with risky sexual behavior. In the 25 – 34 year-old age group, dissimilarity, centralization, and concentration indices were associated with risky sexual behavior. All indices except dissimilarity were associated with risky sexual behavior among the 35 – 44 year-old age group. Hypersegregation was associated with risky sexual behavior only among the 35 – 44 year-old age group.

[*Table 3*]

[*Figure 1*]

Gender stratification

Stratifying by gender, the adjusted association between risky sexual behavior and racial residential segregation was stronger for females than males (Table 3). This result is consistent with our hypothesis, but does differ from the bivariate association presented in Table 2. The centralization and concentration indices were associated with risky sexual behavior for both males and females. For the dissimilarity, isolation, and hypersegregation indices, the aORs indicate that racial residential segregation was more strongly associated with risky sexual behavior for females. For the spatial proximity

index, the aORs indicate that racial residential segregation was more strongly associated with risky sexual behavior for males. Figure 1 displays the gender-stratified aORs in comparison with overall aORs for risky sexual behavior.

Discussion

There are four main findings of this study. First, racial residential segregation, as measured by all indices except hypersegregation, is associated with risky sexual behavior while controlling for CBSA-level poverty. Second, racial residential segregation is most strongly associated with risky sexual behavior when measured by the centralization and concentration indices. Third, the association between risky sexual behavior and racial residential segregation does not vary by age group in a consistent way. Fourth, risky sexual behavior is more strongly associated with racial residential segregation for females than males.

The finding that high levels of racial residential segregation are associated with risky sexual behavior supports our main hypothesis. Higher levels of racial residential segregation are known to concentrate economic, educational, health, and other social disadvantages, which can influence negative health behaviors through elevated risks (Acevedo-Garcia et al., 2003; Adimora & Schoenbach, 2005; Adimora et al., 2009; Biello et al., 2012; Kramer & Hogue, 2009; Poundstone et al., 2004; Williams & Collins, 2001). Previous research has also shown various community measures such as low sex ratio (Adimora, & Schoenbach, 2005; Adimora et al., 2013; Pouget et al., 2010), incarceration rates (Pouget et al., 2010), low collective efficacy (Browning et al., 2004; Browning et al., 2008), discrimination (Adimora & Schoenbach, 2005), and social

disorganization (Cubbin et al., 2005) to be associated with risky health behaviors. Despite different measures of neighborhood context, our results are in agreement with previous literature examining neighborhood context and risky health behaviors. It is worth noting the majority of variables were significantly associated with risky sexual behavior as seen in tables 2 and 3. That may be partially related to the large sample size, resulting in the ability to detect small differences.

Additionally, absolute centralization and relative concentration were more strongly associated with risky sexual behavior than the dissimilarity and isolation indices. The stronger associations for absolute centralization and relative concentration suggest that they may, in concert, influence risky sexual behavior by a high density of non-Hispanic blacks in an urban core. High centralization places non-Hispanic blacks into typically deteriorated high crime inner city neighborhoods (Acevedo-Garcia, 2000), which impact incarceration rates and sex ratio, leading to partner instability (Adimora & Schoenbach, 2005). High concentration creates densely populated non-Hispanic black neighborhoods that yield higher STI transmission rates due to sexual network constraints (Adimora & Schoenbach, 2005; Biello et al., 2012). The dissimilarity index has the least conceptually clear relevance for health outcomes and is not as strongly associated with neighborhood environment (Acevedo-Garcia et al., 2003) as other indices. The dissimilarity index is typically used due to its ease of computation and historical comparability (Massey, 2012). The isolation index may be more conceptually relevant for segregation studies with infectious disease outcomes as it measures the amount of contact non-Hispanic blacks have to other non-Hispanic blacks (Acevedo-Garcia, 2000).

Previous research has associated high gonorrhea rates with high isolation (Thomas & Gaffield, 2003; Biello et al., 2012). These findings suggest that certain dimensions of segregation are more highly related to risky sexual behavior. They also indicate the importance of analyzing multiple dimensions of segregation when examining the role of segregation on health outcomes. Interventions focused on reducing the incidence of non-Hispanic black risky sexual behavior may locate at-risk populations by seeking highly centralized and concentrated populations. These highly centralized and concentrated non-Hispanic black populations are quite common since the majority of non-Hispanic blacks reside in segregated areas. For example, the non-Hispanic black population in major metropolitan areas such as Baltimore, Cincinnati, and St. Louis are highly centralized and concentrated (U.S. Census Bureau, 2012a). Additional research should focus on examining prevention strategies such as increased STI education for adolescents as well as methods to combat partner instability in these areas that may lower the incidence of risky sexual behavior.

Adjusted analyses showed risky sexual behavior was not most strongly associated with racial residential segregation for younger adults. Another factor such as peer influence may be an influential factor as it has been associated with negative outcomes in adolescents (Buhi & Goodson, 2007; DiIorio et al., 2001). Different levels of risk may exist within wider age groups, affecting the risk of the overall age group. When examining younger populations, previous research has chosen smaller age groupings such as 15 – 19 and 20 – 24 (Liddon et al., 2012; Tyler et al., 2014). We attempted to use 5-year age groups, but small cell size issues forced us to create the larger age groups. For

future research, the use of smaller age groupings would allow one to examine the differences between a 16 and a 22 year old, for example. This is important as an individual attending high school is in a much different place in their life compared to an individual who is considered an emerging adult (Arnett, 2000; Lam & Lefkowitz, 2013). An emerging adult refers to late adolescents, college students, and young professionals, groups that carry a significant STI burden. Emerging adults are also known to engage in risky behaviors, possibly to gain experiences before engaging normal adult responsibilities (Lam & Lefkowitz, 2013). In addition, examining measures of peer influence in young adults and adolescents, as well as delving deeper into the emerging adults may provide a more accurate assessment of risky sexual behavior.

Adjusted analyses showed risky sexual behavior was more strongly associated with racial residential segregation for females than males. Females and males residing in the same CBSA may experience the same level of racial residential segregation, but there are likely contextual factors associated with racial residential segregation that affect females more than males. Adimora and Schoenbach (2005) suggest that discrimination, sex ratio, and incarceration rates are contextual factors likely to impact sexual behavior, which have also been associated with racial residential segregation (Kramer & Hogue, 2009; Russell et al., 2012). A low male-to-female sex ratio negatively impacts sexual network STI transmission (Adimora et al., 2006) and supports concurrent partnerships (Adimora et al., 2013; Poundstone et al., 2004).

Limitations

One limitation of this study is the National Survey of Family Growth (NSFG) relies on individual self-report data. Self-reported data may introduce accuracy issues as individuals are asked to recall their sexual history over the last 12 months (number of partners) and whether they used a condom the last time they had sex. Previous research has used 'number of partners within the last three months' (Mustanski et al., 2014) and other research called shorter recall periods more reliable (Napper et al., 2010). A recommendation is to use datasets that ask individuals to recall their sexual history over a shorter time period.

A second limitation is there was low CBSA variability; large portions of the 4,000 individuals were sampled from a small number of CBSAs. This was particularly a problem in the analyses using the spatial proximity index. Only 3.3% (n=131) of non-Hispanic blacks reside in highly segregated CBSAs using the spatial proximity index, those individuals likely resided in the same few CBSAs. The low variability negatively impacts the validity of the spatial proximity measure and can also lead to high population CBSAs being the driving force behind the segregation and poverty information.

A third limitation is we do not know the degree of racial residential segregation to which each participant was exposed. Each participant resided in a CBSA and was associated with a specific level of racial residential segregation. In most instances, CBSAs contain areas that are more and less segregated than the CBSA overall. Therefore, the racial residential segregation to which a participant was exposed may be higher or lower than the level of racial residential segregation for the CBSA overall. The

geographic positioning of these differentially segregated areas within the CBSA is in part what differentiates between the dimensions of segregation.

Lastly, individual and community factors both affect the likelihood that an individual will become infected. However, residence in a low STI prevalence community may make risky sexual behavior less likely to result in STI transmission than risky sexual behavior in a high STI prevalence community. The STI prevalence of a community partnered with the behavioral choices of an individual affect whether an individual encounters an infected individual and subsequently becomes infected. We were not able to incorporate community STI prevalence. In the future, incorporating a community factor such as STI prevalence can only strengthen the study.

Conclusions

Our findings suggest racial residential segregation is associated with risky sexual behavior in non-Hispanic blacks 15 – 44 years of age. The magnitudes of the associations vary by racial segregation index used, but were strongest for the absolute centralization and relative concentration indices. This suggests non-Hispanic blacks residing in urban areas, as opposed to suburban areas, and non-Hispanic blacks residing in areas with a high density of non-Hispanic blacks are at higher risk of engaging in risky sexual behavior. While some U.S. cities have experienced changes in non-Hispanic black residential segregation, the largest U.S. metropolitan areas remain highly segregated (U.S. Census Bureau, 2012b). The data show non-Hispanic black residential segregation is still present at high levels across multiple dimensions. It is important to investigate the mechanisms of how racial residential segregation may lead to risky sexual

behaviors. A better understanding of mechanisms such as peer influence, crowding, and incarceration rates may lead to the development of interventions that promote healthier environments and behaviors and, in turn, lower rates of HIV and STIs in affected populations.

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Tables and figures

Table 1. Description of Residential Segregation Indices with Accompanying Dimensions

Index	Dimension	Range	Description
Dissimilarity	Evenness	0.00 – 1.00	0.0 = maximal integration 1.0 = maximal segregation of non-Hispanic blacks from non-Hispanic whites
Isolation	Exposure	0.00 – 1.00	0.0 = non-Hispanic are most likely to only encounter non-Hispanic whites 1.0 = non-Hispanic blacks are most likely to only encounter other non-Hispanic blacks
Absolute Centralization	Centralization	-1.00 – 1.00	-1.00 = non-Hispanic blacks reside only in outlying areas 0.00 = non-Hispanic blacks reside equally in the CBSA center and outlying areas 1.00 = non-Hispanic blacks reside only in the CBSA center
Relative Concentration	Concentration	-1.00 – 1.00	-1.00 = non-Hispanic whites are maximally concentrated 0.00 = non-Hispanic blacks and non-Hispanic whites are equally concentrated 1.00 = non-Hispanic blacks are maximally concentrated
Spatial Proximity	Clustering	Any real value	1.00 = no differential clustering between non-Hispanic blacks and non-Hispanic whites -Values greater than 1.00 indicate non-Hispanic black neighborhoods are closer to each other than non-Hispanic white neighborhoods

-Values less than 1.00 indicate non-Hispanic black neighborhoods are closer to non-Hispanic white neighborhoods

Source: Massey & Denton, 1988

Table 2. Descriptive characteristics for non-Hispanic black National Survey of Family Growth participants (2006 – 2010) by risky sexual behavior status (n=3,643)

	Risky Sexual Behavior		
Characteristics	**Two or more partners within last 12 months and no condom use at last sex (n=588; 16.1%)**	**All else (n=3,055; 85.5%)**	**P-value**
Age group			
15 – 24 years	210 (36.8)	991 (30.3)	
25 – 34 years	234 (37.6)	1,077 (33.0)	
35 – 44 years	144 (25.6)	987 (36.7)	0.0032
Gender			
Female	317 (45.9)	1,829 (55.4)	
Male	271 (54.1)	1,226 (44.6)	0.0027
Educational Attainment			
No HS dip#/in school	30 (4.4)	249 (6.9)	
No HS dip/out of school	133 (22.5)	608 (19.8)	
HS diploma	214 (36.6)	961 (30.2)	
Some college	118 (22.0)	636 (21.5)	
College degree	93 (14.5)	601 (21.6)	0.0194
Marital status			
Married/cohabitating	91 (20.9)	1,039 (44.7)	
Not Married/not cohabitating	497 (79.1)	2,016 (55.3)	<0.0001
Income			
<$15,000 per year	224 (30.5)	990 (27.7)	
$15,000 – $34,999	165 (28.6)	896 (28.1)	
$35,000 – $74,999	158 (30.9)	870 (31.5)	
$75,000 or more	41 (10.0)	299 (12.7)	0.5742
Percent family poverty of CBSA			
<6.9%	166 (25.4)	754 (22.6)	
6.9% – 8.9%	115 (25.9)	715 (25.2)	
9.0% – 11.9%	158 (24.6)	749 (25.2)	
12.0% or more	124 (24.1)	659 (26.9)	0.6417

Notes: Bivariate analysis conducted using the Rao-Scott F-adjusted Chi square test
[#] HS dip = high school diploma

Table 3. Adjusted odds ratios[†] for risky sexual behavior for non-Hispanic blacks, overall and gender- and age- stratified, National Survey of Family Growth, 2006 – 2010 (n=3,643)

	Risky Sexual Behavior**					
	Dissimilarity, aOR (95% CI)	**Isolation**, aOR (95% CI)	**Absolute Centralization**, aOR (95% CI)	**Relative Concentration**, aOR (95% CI)	**Spatial Proximity**, aOR (95% CI)	**Hypersegregation***, aOR (95% CI)
Overall						
Segregated[#]	1.16 (1.15-1.17)	1.04 (1.03-1.05)	2.07 (2.05-2.08)	2.05 (2.03-2.07)	1.02 (1.00-1.03)	0.864 (0.854-0.873)
Not Segregated	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Males						
Segregated	0.831 (0.822-0.840)	0.699 (0.689-0.709)	1.65 (1.63-1.67)	1.82 (1.80-1.84)	2.51 (2.45-2.57)	0.450 (0.442-0.458)
Not Segregated	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Females						
Segregated	1.63 (1.61-1.66)	1.34 (1.33-1.36)	2.56 (2.52-2.60)	2.06 (2.04-2.09)	0.543 (0.531-0.555)	1.36 (1.34-1.38)
Not Segregated	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
15 – 24 years						
Segregated	0.409 (0.402-0.415)	1.08 (1.07-1.10)	2.53 (2.48-2.57)	0.976 (0.960-0.993)	1.68 (1.64-1.72)	0.861 (0.847-0.876)
Not Segregated	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
25 – 34 years						
Segregated	3.24 (3.20-3.29)	0.813 (0.799-	3.27 (3.22-3.33)	5.05 (4.97-5.12)	0.472 (0.458-	0.749 (0.734-0.764)

Not Segregated	Ref.	0.828) Ref.	Ref.	Ref.	0.486) Ref.	Ref.
35 – 44 years						
Segregated	0.614 (0.601-0.627)	2.53 (2.47-2.58)	2.02 (1.98-2.07)	1.50 (1.47-1.53)	1.59 (1.53-1.64)	1.90 (1.85-1.95)
Not Segregated	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.

Note: aOR = adjusted odds ratios; CI = confidence interval

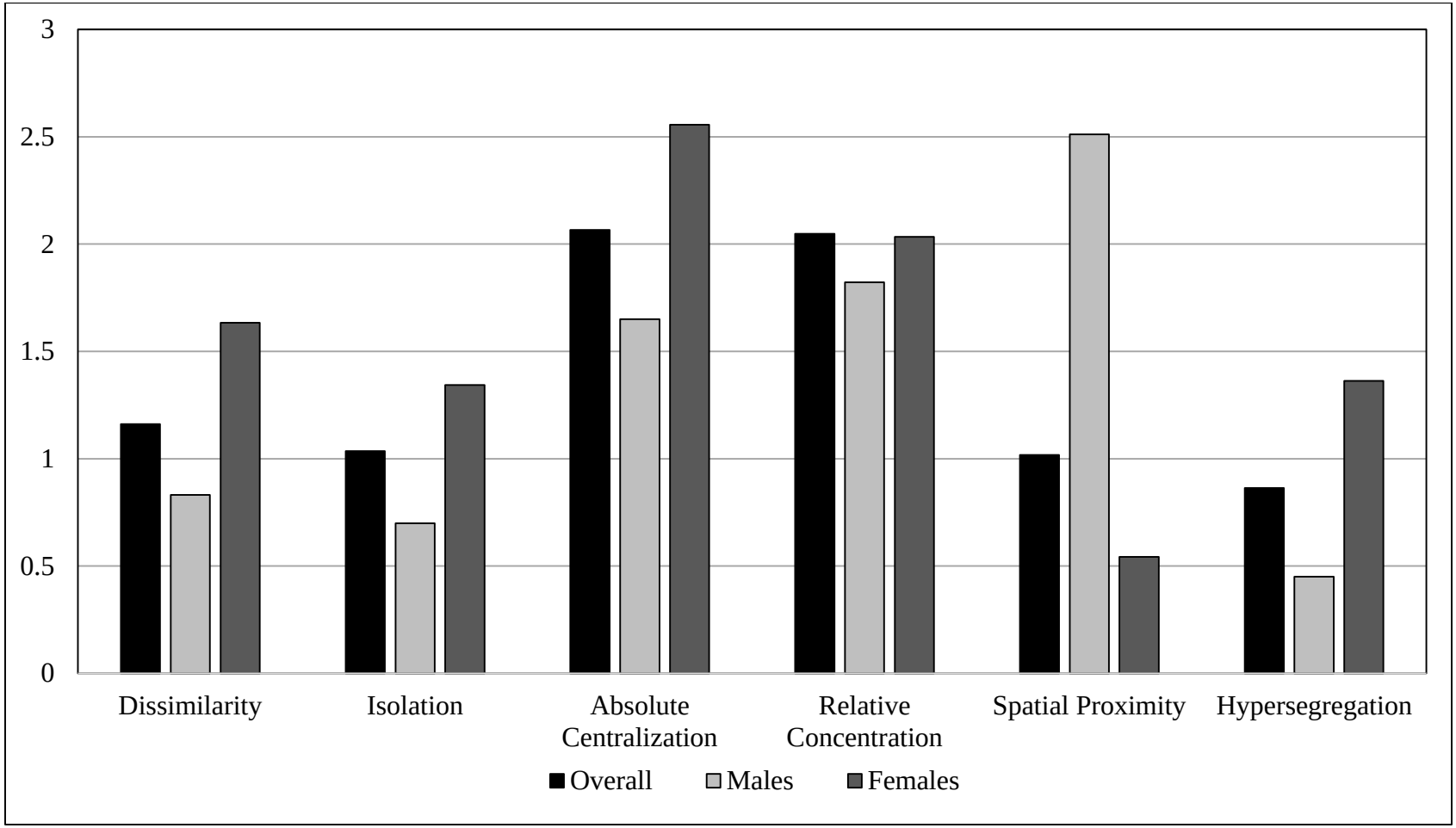
[†]Models adjusted for age group, gender, educational attainment, marital status, income, and CBSA Poverty; Random intercept included to account for CBSA clustering

[#] Segregated refers to an index value greater than or equal to 0.60 // not segregated refers to an index value less than 0.60

* Segregated for this variable refers to being hypersegregated

**aORs for risky sexual behavior modeled using each segregation index, separately

Figure 1. Adjusted odds ratios† for risky sexual behavior for non-Hispanic blacks, overall and gender-stratified, National Survey of Family Growth, 2006 – 2010 (n=3,643)



†Overall models adjusted for age group, gender, educational attainment, marital status, income, and CBSA Poverty
**Adjusted odds ratios for risky sexual behavior modeled using each segregation index, separately

MANUSCRIPT 2

Racial residential segregation and STI diagnosis among non-Hispanic blacks, 2006 – 2010

Abstract

Background: Sexually transmitted infections (STI) disproportionately impact non-Hispanic blacks. Racial residential segregation has been associated with negative socioeconomic outcomes. We sought to examine the association between segregation and STI diagnosis among blacks.

Methods: The National Survey of Family Growth and US Census served as data sources. Five distinct dimensions represent segregation. The association between STI diagnosis and each segregation dimension was assessed with multilevel logistic regression modeling.

Results: 305 (7.4%) blacks reported STI diagnosis during the past 12 months. Depending on the dimension, segregation was a risk factor (dissimilarity aOR 2.41 [95% CI 2.38 – 2.43]) and a protective factor (isolation aOR 0.90 [95% CI 0.89 – 0.91]) for STI diagnosis.

Discussion: Findings suggest that STI diagnosis among blacks is associated with segregation. Additional research is needed to identify mechanisms for how segregation affects STI diagnosis and to aid in the development of interventions to decrease STIs.

Keywords: Residential segregation; NSFG; Non-Hispanic blacks; sexually transmitted infections; poverty

Introduction

Sexually transmitted infections (STIs) disproportionately impact non-Hispanic black (NHB) communities in the United States. In 2015, the chlamydia diagnosis rate among NHBs was 5.9 times the rate among non-Hispanic whites (NHWs) (1,097.6 vs. 187.2 cases per 100,000 population) and the gonorrhea diagnosis rate among NHBs was 9.6 times higher than the rate among NHWs (424.9 cases per 100,000 persons vs. 44.2 cases per 100,000) (CDC, 2016). These disparities may be partially due to community-level factors such as male-to-female sex ratio, percent black, and racial residential segregation. Research has found NHBs are at increased STI risk independent of risky sexual behaviors (Hallfors et al., 2007), indicating community-level factors should be considered in investigations of racial disparities.

Racial residential segregation--the geographical separation of racial groups in a residential context--is considered a primary cause of racial disparities (Gaskin et al., 2012) and will be henceforth referred to as "segregation." In 2010, more than 50% of NHBs in metropolitan areas resided in highly segregated areas (Massey & Tannen, 2015) and NHBs are the racial group most likely to experience high levels of segregation (Massey & Tannen, 2015; Biello et al., 2012; Iceland & Sharp, 2013). In addition, segregation has been associated with negative health outcomes among NHBs (Pugsley et al., 2013; Lutfi et al., 2015; Biello et al., 2013). Segregation may also impact health through concentrated poverty (Massey & Tannen, 2015; Iceland & Hernandex, 2017),

which has been associated with neighborhood disadvantages such as unemployment, crime, and lower quality education opportunities (Iceland & Hernandez, 2017; Quillian, 2012; Kneebone et al., 2016). Previous research has found segregation limits the availability of quality medical care and may make it difficult for residents to care for their health (Gaskin et al., 2012). Through an impact on community resources and economic opportunities (Iceland & Hernandez, 2017; Quillian, 2012; Kneebone et al., 2016), segregation may influence STI diagnoses.

Five conceptually distinct dimensions measure segregation: evenness, exposure, concentration, centralization, and clustering. Evenness has a less clear relationship with health than other dimensions but is included due to its ease of computation and comparability purposes as the most often used dimension (Massey, 2012). Centralization measures the extent to which NHBs reside closer to the city center. The centralization dimension may impact STI diagnoses through overpopulation around the city center. A shortage of health care providers may force residents to wait longer for services or to travel for service (Gaskin et al., 2012). Exposure measures the level of contact NHBs have to only NHBs. With NHB populations having higher rates of perceived discrimination and less trust in health care providers (Gaskin et al., 2012), peer information about providers increases in importance especially when people are only exposed to peers. This factor is especially true in highly segregated areas with fewer physicians and lower quality medical care. Concentration measures the amount of physical space NHBs occupy. Residing in a maximum density area would repeat the negative influence seen with high segregation via exposure. Clustering measures the

extent to which NHB areas join together. NHBs experiencing high levels of clustering might not reside in a high-density neighborhood; they may have moderate level of contact with other racial groups. Increased exposure of other racial groups as peers and an increased population of other racial groups can impact STI diagnosis.

Previous research has examined how segregation is associated with STIs, which were often measured as community rates. Many studies have focused on one particular infection (Biello et al., 2012; Pugsley et al., 2013). To our knowledge there have been no studies that have examined the association between segregation and STI diagnoses at the individual-level in place of county or metropolitan STI diagnosis rates. In addition, few studies have measured segregation and health outcomes with multiple dimensions of segregation and few have focused on adult populations. Here we will examine individual STI diagnoses as our outcome and how they are associated with segregation. We will also include adults of reproductive age and use multiple dimensions to measure segregation in order to account for the different mechanisms through which each dimension may impact STI diagnoses. The study objective was to examine the association between segregation and individual STI diagnosis during the past 12 months for NHBs 15-44 years of age using a nationally representative sample. We hypothesized that STI diagnosis would be associated with high levels of segregation. In addition, we explored the moderating effects of age and gender. We hypothesized the effects of segregation would be stronger for younger adults 15-24 years of age and females due to the epidemiologic patterns.

Methods

Participants

The 2006-2010 National Survey of Family Growth (NSFG) was a continuous survey of men and women 15-44 years of age residing in US households. Restricting those surveyed to that age span focuses on the participants' reproductive years, which is important considering the negative effects of untreated STIs on both the parents and newborns. Conducted from June 2006 to June 2010, this cross-sectional survey generated a nationally representative sample of 22,682 completed interviews of which 4,164 were among NHBs (NCHS, 2012). The final sample size of NHBs was 3,840 after excluding participants not residing in a core-based statistical area (CBSA) (n=283; 6.8%) or with missing STI diagnosis information (n=41; 1.0%). 'CBSA' collectively refers to metropolitan (urban core with a population ≥ 50,000) and micropolitan (urban core with a population 10,000 – 49,999) areas with surrounding areas socioeconomically connected to the urban core (U.S. Census Bureau, 2012). The overall response rate was 77% for all participants.

Data Collection

Demographic and STI diagnosis data were obtained from the NSFG. CBSA-level segregation index values were computed by and obtained from the 2000 US Census (U.S. Census Bureau, 2012). At the time of this analysis, the 2000 US Census represented the most updated source for the multiple segregation index values needed. Community poverty data was obtained from the 2006-2010 American Community Survey (U.S. Census Bureau, 2010).

The CBSA variable was used to merge individual NSFG data with CBSA segregation and poverty data from the 2000 US Census and 2006-2010 American Community Survey, respectively. CBSA is a restricted variable; therefore, these data were accessed through the National Center for Health Statistics Research Data Center (RDC). To limit disclosure risk, the RDC did not provide the researchers the identity of the 110 CBSAs sampled.

Measures

Individual variables

Individual-level variables considered were age, gender, educational attainment, marital status, income, and STI diagnosis. The NSFG asks participants if they were treated or received medication from a doctor or other medical care provider for any STI during the past 12 months. NSFG recent diagnosis questions were asked only of participants if they reported having been treated or received medication for a STI within the past 12 months. In addition, concerning infections within the past 12 months, the NSFG only asked about chlamydia or gonorrhea diagnoses. Using these diagnosis variables would not allow tracking of recent STIs other than chlamydia and gonorrhea. Because it would be unlikely that someone would be treated without a diagnosis, we chose to use the STI treatment variable as a proxy for STI diagnosis. This would allow us to indirectly measure STI diagnosis and account for all STIs.

CBSA variables

CBSA was selected as the area of interest because previous research has shown CBSAs approximate housing markets (Wilkes & Iceland, 2004), allowing the measurement of segregation at a level where each participant has strong economic and social ties. In addition, selection into neighborhoods is important when examining geographic health associations and can be accounted for with CBSA-level segregation indices (Oakes, 2004). Examining segregation focuses on the geographic area of interest (CBSA) and its component areas, called units of analysis. Census tracts are commonly used as units of analysis for census-based segregation studies (Wilkes & Iceland, 2004) and segregation studies (Fabio et al., 2009). Census tracts are viewed as proxies for neighborhoods. We chose to use census-tract derived indices to maintain historical comparability with the literature and to use standardized measures of segregation through the US Census Bureau.

A representative index for each dimension of segregation was chosen based on previous research by Massey and Denton (1988). The index of dissimilarity–evenness dimension–measures the proportion of NHBs needed to change residence for the neighborhood to have the same racial composition as the CBSA (Massey & Denton, 1988). The isolation index–exposure dimension–measures the level of contact NHBs have to only other NHBs (Massey & Denton, 1988). The dissimilarity and isolation index values range from 0.0 to 1.00 with a value of 0.0 indicating maximum integration and 1.00 indicating maximum segregation. The relative concentration index–concentration dimension–measures the amount of physical space occupied by NHBs in a CBSA relative to the amount of physical space occupied by NHWs (Massey & Denton, 1988). The

resulting ratio is compared to the ratio that would exist if NHBs were maximally concentrated and NHWs were maximally scattered. The absolute centralization index–centralization dimension–measures the degree to which NHBs reside near the CBSA center compared residing in outlying areas (Massey & Denton, 1988). Relative concentration and absolute centralization index values range from -1.00 to 1.00. For relative concentration, a value of -1.00 indicates NHWs are maximally concentrated and a value of 1.00 indicates NHBs are maximally concentrated. For absolute centralization, a value of -1.00 indicates NHBs reside only in outlying areas and a value of 1.00 indicates NHBs reside only in the CBSA center. The spatial proximity index–clustering dimension–measures the extent to which NHB neighborhoods cluster, forming larger contiguous areas (Massey & Denton, 1988). The spatial proximity index can take any real value. Values greater than 1.00 indicate NHB neighborhoods are more clustered and values less than 1.00 indicate NHB neighborhoods are more scattered. For a detailed description of segregation indices and their formulas, see Iceland, Weinberg, & Steinmetz (2002).

Segregation index values were dichotomized and values from '0.60-1.00' were considered highly segregated ('1.60-2.00' for the spatial proximity index) (Biello et al., 2012). This study also examines hypersegregation, a dichotomous variable measuring segregation across dimensions. A CBSA is considered hypersegregated if it is highly segregated on at least four of the five dimensions (Massey & Denton, 1988). That is noteworthy as being highly segregated across multiple dimensions increases the negative effects of segregation (Biello et al., 2013). Community poverty was measured as the

percentage of a CBSA with a family income below the federal poverty level. Poverty has been grouped into quartiles based on the CBSA poverty level distribution.

Analysis

Bivariate analyses used the Rao-Scott F-adjusted chi square test statistic to identify statistically significant variables ($p < 0.05$). Multilevel modeling was selected because significant second-level effects were observed in the empty model. Multilevel logistic regression models were performed using the GLIMMIX procedure to examine associations between STI diagnosis during the past 12 months (level 1) and segregation (level 2). The spatial proximity index was excluded from further individual analyses because when examined, it contained very low cell counts for certain cells, preventing our analysis from obtaining valid models. However, the hypersegregation index was still calculated using all the indices. Our best-fit model (through likelihood ratio tests) examined the association of segregation and STI diagnosis with individual-level variables and community poverty included. This final model was first analyzed separately for each segregation index and then separately as age- and gender-specific models for each segregation index. NSFG analyses require the incorporation of weighting, stratification, and clustering variables due to the complex sampling system. Statistical analyses were conducted using SAS software, Version 9.3 (Cary, NC, USA). This study was deemed non-human subjects research by the Florida International University Institutional Review Board.

Results

Table I displays bivariate associations between STI diagnosis status and participant demographics, which included 4,123 NHBs. Those diagnosed with a STI within the last 12 months (n=305; 7.4%) were younger and did not complete high school (Table I). Gender, marital status, income, and community poverty did not have significant bivariate associations but were included in the model-building phase due to their association with segregation and STIs in previous research (Biello et al., 2012; Pugsley et al., 2013).

Using STI diagnosis within the past 12 months as the outcome, multilevel logistic regression models were conducted for all indices (Table II). After adjusting for age group, gender, educational attainment, marital status, income, and CBSA poverty, segregation as measured by all indices was associated with STI diagnosis. However, when measured by the isolation and centralization indices, segregation was protective. The dissimilarity index (adjusted odds ratio [aOR] 2.41; 95% confidence interval [CI] 2.38-2.43) and relative concentration index (aOR 1.55; 95% CI 1.53-1.56) displayed the highest adjusted odds ratios. Hypersegregation (aOR 1.12; 95% CI 1.11-1.14) also served a risk factor for STI diagnosis within the past 12 months.

Gender stratification

Among males, STI diagnosis was associated with elevated segregation across all indices (Table II). Among females, STI diagnosis was also associated with segregation for all indices. However, we found segregation as measured by the isolation index to be protective among females. There was a stronger association between STI diagnosis and

segregation as measured by all the indices, including hypersegregation, for men relative to women.

Age group stratification

The strength of association between elevated segregation and STI diagnosis varied by age group. In the 15-24 year-old age group, segregation was associated with STI diagnosis across all indices with the dissimilarity index and hypersegregation having the strongest associations. However, segregation as measured by the centralization index was protective against STI diagnosis for the 15-24 year-old group. In the 25-34 and 35-44 year-old age groups, all segregation indices, including hypersegregation, were associated with STI diagnosis. Among 25-34 and 35-44 year-olds, the segregation and STI diagnosis association was strongest when using the absolute centralization index.

Discussion

Four main findings were obtained from this study. First, high levels of segregation were associated with STI diagnosis. Second, high levels of segregation were most strongly associated with STI diagnosis when measured by dissimilarity and relative concentration indices. Third, STI diagnosis was more strongly associated with segregation among males. Lastly, we found no pattern of association between segregation and STI diagnosis with age-group stratified analyses.

Finding that high levels of segregation were associated with STI diagnosis is supported by research showing elevated segregation exposes residents to socioeconomic disadvantages impacting an individual's ability to properly care for their health (Biello et al., 2012; Iceland & Hernandez, 2017; Quillian, 2012; Logan & Stults, 2011; Poundstone

et al., 2004; Kramer & Hogue, 2009). Previous research also found segregation to be associated with area-level gonorrhea rates (Biello et al., 2012; Pugsley et al., 2013) and risky sexual behaviors (Lutfi et al., 2015; Biello et al., 2013b).

The finding of a stronger association for the dissimilarity and relative concentration indices with STI diagnosis suggests segregation may be more likely to influence STI diagnosis through a high density of NHBs as opposed to the centralization or isolation of NHBs. The strong associations for the dissimilarity and relative concentration indices with STI diagnosis may be partially due to the increased density of sexual networks in these areas. Dense sexual networks are associated with concurrent partnerships, sexual partnerships that overlap in time, which permit faster STI transmission throughout a network (Adimora et al., 2006). High levels of centralized NHBs may result in overpopulated downtown areas, forcing NHBs to delay health care visits due to a lack of available physicians or having to travel distances for care (Gaskin et al., 2012). Either scenario may lead to NHBs not being diagnosed, which may explain the protective association observed for the absolute centralization index. High levels of isolated NHBs may result in NHBs only coming into contact with one another. With a higher level of mistrust in the healthcare system by NHBs, peer input is important (Gaskin et al., 2012). If the only information received is from skeptical peers, individuals may avoid health care visits altogether. Residing in hypersegregated areas was also a significant risk factor for STI diagnosis. This is important, since the effects of segregation are additive and being segregated across multiple dimensions concentrates the negative effects (Wilkes & Iceland, 2004). These findings reinforce the importance of using

multiple dimensions of segregation when examining associations between segregation and health.

STI diagnosis was more strongly associated with segregation across all indices, including hypersegregation, among males. A stronger association was expected for females because they tend to have more access to the health care system than males (Vaidya et al., 2012). This is especially true of NSFG population, which is in the reproductive age groups when one would expect females to receive STI tests more often through routine pregnancy testing. Other contextual factors related to segregation may differentially affect males and females such as CBSA percent female-headed household or male-to-female ratio. A low male-to-female sex ratio (fewer males than females) may be the result of many factors associated with high levels of segregation, mainly incarceration rates (Poundstone et al., 2004). Males residing in low sex ratio neighborhoods may engage in risky sexual behaviors such as concurrent partnerships (Poundstone et al., 2004) feeling confident in maintaining their primary relationship due to the scarcity of 'suitable' males (Adimora et al., 2006). An increase in the risky sexual behavior of just males in segregated areas may increase their likelihood of STI diagnosis. We also found that high levels of isolation were protective against STI diagnosis for females.

Our fourth finding found no consistent age group pattern for strength of association between segregation and STI diagnosis. The 15-24 year-old group was the only group to display a protective association between segregation and STI diagnosis, which is the likely reason the centralization index is protective against STI diagnosis in

the overall model. The 15-24 year olds had been predicted to have stronger associations based on high STI incidence rates. A possible reason for the segregation and STI diagnosis association not being stronger for the 15-24 year old group for the relative concentration, absolute centralization, and hypersegregation indices may be due to a lack of mobility. Younger age groups may be less mobile and less able to travel for health visits outside of high-density neighborhoods or overpopulated downtown areas as older age groups potentially leading to under diagnosis among younger age groups. This may also explain why the 15-24 year old group had the strongest associations for the dissimilarity and isolation indices but were not as strong for the indices that also incorporate spatial distribution. Future research may wish to explore the use of the dissimilarity and isolation indices to examine associations with STI diagnosis among youth in addition to indices with spatial elements.

Study limitations: First, we used STI treatment as a proxy for STI diagnosis. STI diagnosis questions were only asked of the respondent if they reported STI treatment within the past 12 months. In addition, STI diagnosis questions only asked about gonorrhea and chlamydia within the past 12 months while the STI treatment variable asked about all STIs within the past 12 months. Second, during the modeling phase we observed a significant interaction between age and gender together. When stratifying by age and sex simultaneously, the models failed to converge likely due to the low cell sizes during stratification. Future research may find it beneficial to merge continuous NSFG cycles to increase the sample size when examining only one racial group. Third, we evaluated segregation separately with five different indices, which could lead to an

increase in the Type I error rate. We believe the effect of not accounting for multiple comparisons is minimal and does not impact the overall significance of the main findings given the strength of the associations seen and the narrow confidence intervals. Fourth, several individual and community-level factors could affect the likelihood an individual will be diagnosed with a STI that we were unable to measure, such as proximity to doctor or medical care facility and CBSA regional differences. Regional differences in STI diagnosis rates; for example, the southern region of the US has higher rates of multiple STIs (CDC, 2016; Reif et al., 2017). Therefore, regional differences could confound associations between CBSA segregation and STI diagnosis rates.

Conclusions

Our findings suggest segregation is associated with STI diagnosis among NHBs 15-44 years of age. The strength of association was strongest for the dissimilarity and relative concentration indices. This suggests NHBs residing in areas with a high concentration of NHBs compared to NHWs were more likely to be diagnosed with a STI. Further research into additional factors--such as CBSA regional differences, health insurance status, and male-to-female sex ratio--may aid in creation of interventions, which could impact STI diagnoses in the NHB population.

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Compliance with Ethical Standards

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Conflict of Interest The authors declare that they have no conflict of interest.

Ethical Approval This article does not contain any studies with human participants or animals performed by any of the authors. This study was deemed non-human subjects research by the Florida International University Institutional Review Board.

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Tables and figures

Table I. Descriptive characteristics for non-Hispanic black National Survey of Family Growth participants (2006 – 2010) by sexually transmitted infection (STI) diagnosis status (n=4,123)

	STI diagnosis past 12 months		
Characteristics	**Diagnosed in last 12 months (n=305; 7.4%)**	**Not diagnosed during the last 12 months (n=3,818; 92.6%)**	**P-value**
Age Group			
15 – 24 years	156 (49.9)	1,454 (37.2)	
25 – 34 years	109 (35.5)	1,245 (30.0)	
35 – 44 years	40 (14.6)	1,119 (32.8)	<0.0001
Gender			
Female	198 (54.9)	2,192 (53.6)	
Male	107 (45.1)	1,626 (46.4)	0.7591
Educational Attainment			
No high school diploma/in school	27 (9.4)	532 (13.4)	
No high school diploma/out of school	88 (32.6)	689 (17.6)	
High school diploma	90 (24.7)	1,149 (29.0)	
Some college	59 (16.7)	761 (21.0)	
College degree	41 (16.5)	687 (19.1)	0.0002
Marital			
Married/cohabitating	58 (29.4)	1,081 (36.9)	
Not married/not cohabitating	247 (70.6)	2,737 (63.1)	0.1216
Income			
<$15,000 per year	131 (34.1)	1,239 (28.2)	
$15,000 – $34,999	78 (27.3)	1,120 (28.1)	
$35,000 – $74,999	76 (30.6)	1,095 (31.5)	
$75,000 or more	20 (8.1)	364 (12.2)	0.3352
Percent family poverty of core-based statistical area			
< 6.9%	69 (20.0)	979 (23.3)	
6.9% – 8.9%	77 (28.6)	861 (24.9)	
9.0% – 11.9%	85 (26.3)	935 (25.3)	
12.0% or more	57 (25.1)	842 (26.5)	0.7574

Notes: 1) Bivariate analysis conducted using the Rao-Scott F-adjusted Chi square test

Table II. Adjusted odds ratios[†] for sexually transmitted infection (STI) diagnosis for non-Hispanic blacks, overall and gender- and age-stratified, National Survey of Family Growth, 2006 – 2010 (n=3,840)

	STI diagnosis past 12 months**				
	Dissimilarity, aOR (95% CI)	**Isolation,** aOR (95% CI)	**Relative Concentration**, aOR (95% CI)	**Absolute Centralization**, aOR (95% CI)	**Hypersegregation***, aOR (95% CI)
Overall					
Segregated[#]	2.41 (2.38-2.43)	0.90 (0.89-0.91)	1.55 (1.53-1.56)	0.93 (0.92-0.94)	1.12 (1.11-1.14)
Not Segregated	Ref.	Ref.	Ref.	Ref.	Ref.
Males					
Segregated	2.99 (2.95-3.03)	1.20 (1.18-1.22)	2.42 (2.38-2.46)	1.44 (1.41-1.46)	1.51 (1.48-1.54)
Not Segregated	Ref.	Ref.	Ref.	Ref.	Ref.
Females					
Segregated	1.80 (1.78-1.83)	0.81 (0.73-0.82)	1.87 (1.83-1.90)	1.11 (1.09-1.12)	1.06 (1.04-1.08)
Not Segregated	Ref.	Ref.	Ref.	Ref.	Ref.
15 – 24 years					
Segregated	2.10 (2.09-2.11)	1.55 (1.54-1.57)	1.17 (1.16-1.17)	0.81 (0.81-0.82)	1.61 (1.60-1.63)
Not Segregated	Ref.	Ref.	Ref.	Ref.	Ref.
25 – 34 years					
Segregated	1.21 (1.21-1.22)	1.41 (1.40-1.42)	1.86 (1.84-1.87)	2.41 (2.39-2.44)	1.81 (1.80-1.82)
Not Segregated	Ref.	Ref.	Ref.	Ref.	Ref.
35 – 44 years					
Segregated	1.02 (1.01-1.03)	1.03 (1.02-1.04)	1.42 (1.40-1.43)	4.09 (4.02-4.16)	1.17 (1.16-1.19)
Not Segregated	Ref.	Ref.	Ref.	Ref.	Ref.

Note. aOR = adjusted odds ratio; CI = confidence interval; CBSA = core-based statistical area

[†]Models adjusted for age group, gender, educational attainment, marital status, income, and CBSA Poverty; Age- and Gender-stratified models not adjusted by age and gender, respectively; Random intercept included to account for CBSA clustering

[#] Segregated refers to an index value greater than or equal to 0.60 // not segregated refers to an index value less than 0.60
* Segregation measured as high on four dimensions or more
**aORs for STI diagnosis within the past 12 months modeled using each segregation index, separately

MANUSCRIPT 3

Racial residential segregation and concurrent partnerships among non-Hispanic blacks, 2006 - 2010

Abstract

We examined the association between racial residential segregation and concurrent partnerships. Racial differences in sexual networks contribute to sexually transmitted infection (STI) disparities; specifically, the disproportionate burden borne by non-Hispanic blacks. Racial residential segregation—the residential separation of racial groups—is a community factor known to influence sexual networks. Demographic and concurrent partnership data for non-Hispanic blacks were obtained from the 2006—2010 National Survey of Family Growth. Segregation and community poverty data were obtained from the U.S. Census and American Community Survey, respectively. Multilevel logistic regression models were conducted to test how each of the five indices of racial residential segregation was associated with concurrent partnerships. Of the 4,139 non-Hispanic blacks, 645 (15.6%) reported concurrent partnerships. Racial residential segregation was associated with concurrent partnerships, the association being strongest for the dissimilarity index. We found racial residential segregation acted as both a risk factor and protective factor for concurrent partnerships depending on the segregation index. More work is needed to understand how index choice may influence the direction of association. Moreover, inclusion of additional covariates associated with residential segregation such as percent black and male-to-female ratio would strengthen our

understanding of the association between racial residential segregation and concurrent partnerships.

Keywords: Residential segregation; NSFG; Non-Hispanic blacks; Concurrent partnerships; Poverty

Introduction

Non-Hispanic blacks carry a disproportionate burden of sexually transmitted infections including human immunodeficiency infection (HIV) (CDC, 2016a; CDC, 2016b). Differences in the sexual networks of non-Hispanic blacks compared to non-Hispanic whites are thought to be one of the factors contributing to these disparities (Adimora et al., 2003). Research has found that non-Hispanic black sexual networks have a much higher prevalence of concurrent partnerships (sexual partnerships that overlap in time) than non-Hispanic white sexual networks (Adimora et al., 2003; Adimora et al., 2011). Concurrent partnerships allow sexually transmitted infections to spread throughout a sexual network faster than sequential partnerships (Adimora et al., 2011; Adimora et al., 2007) because transmission to a third person can take place simultaneously without having to wait for one relationship to end and another to begin (Adimroa et al., 2006). Thus, concurrent partnerships are considered an important factor in the spread of sexually transmitted infections (Adimora et al., 2003; Adimora et al., 2011; Adimora et al., 2002).

Community-level factors may shape non-Hispanic black sexual networks and thus the prevalence of concurrent partnerships. For instance, low male-to-female sex ratios, which may be due to high rates of incarceration, are prevalent in non-Hispanic black communities where lack of males disrupts the stability of sexual networks (Adimora et al.,

2006). Males residing in neighborhoods with low male-to-female sex ratios are in a position of power and may engage in concurrent partnerships without feeling they will lose their primary partner (Adimora et al., 2006). Another factor is concentrated poverty, which drains the pool of marriageable non-Hispanic black males either through unemployment or incarceration, and is associated with marital instability (Adimora et al., 2006). Racial residential segregation is a community-level factor that is associated with both increased poverty and a low male-to-female sex ratio (Thomas & Gaffield, 2003) and may, therefore, impact sexual networks and concurrent partnerships.

Racial residential segregation, which is the geographical separation of racial groups residentially across a spatial area, is a main cause of racial disparities (Williams & Collins, 2001; Gaskin et al., 2012). Residential segregation is also considered a determinant in the formation of sexual networks since individuals typically select sexual partners from their neighborhoods (Adimora et al., 2006; Zenilman et al., 1999). Research has found nearly two thirds of non-Hispanic blacks in the United States reside in highly segregated areas (Williams & Collins, 2001; Biello et al., 2012). In addition to the relationship with sexual networks, racial residential segregation has also been associated with multiple negative health outcomes among non-Hispanic black, such as poor self-rated health, low birth weight, higher gonorrhea rates, and risky sexual behavior (Thomas & Gaffield, 2003; Subramanian et al., 2005; Bell et al., 2006; Acevedo-Garcia et al., 2003; Pugsley et al., 2013; Lutfi et al., 2015; Biello et al., 2013). Disproportionate sexually transmitted infection rates, high rates of concurrent partnerships, and residence

in neighborhoods with high levels of racial residential segregation are the impetus for focusing on non-Hispanic blacks in this study.

Five conceptually distinct dimensions measure racial residential segregation: evenness, exposure, concentration, centralization, and clustering. Of these five dimensions, evenness has the least clear relationship with health outcomes but is included for comparability as it is the most often used dimension (Massey, 2012). The exposure dimension measures the amount of contact non-Hispanic blacks have with other non-Hispanic blacks. The concentration dimension measures the amount of geographic space occupied by non-Hispanic blacks. The centralization index measures the spatial arrangement of non-Hispanic blacks around the city or metropolitan area center as opposed to the outskirts or suburban areas. The clustering dimension measures the level to which non-Hispanic black neighborhoods merge together.

The goal of this study was to examine the association between racial residential segregation and concurrent partnerships within the past 12 months among non-Hispanic blacks 15 – 44 years of age. We hypothesized that concurrent partnerships within the past 12 months would be associated with high levels of racial residential segregation.

Methods

2.1. Data Collection

The 2006 – 2010 National Survey of Family Growth (NSFG) was a continuous survey of men and women residing in U.S. households. The NSFG focuses on fertility as well as men's and women's reproductive health, thus so the age of participants was

restricted to 15 – 44 years. Conducted from June 2006 to June 2010, this cross-sectional survey resulted in a nationally representative sample of 22,682 individuals with complete interviews, 4,164 of whom were non-Hispanic blacks (NCHS, 2012). The final sample size was 4,139 after excluding participants that did not reside in a core-based statistical area (CBSA) or had no information on concurrent partnerships (NCHS, 2012). 'CBSA' collectively refers to metropolitan and micropolitan statistical areas. Metropolitan areas have an urban core with a population ≥ 50,000 and micropolitan areas have an urban core with a population 10,000 – 49,999. Urban cores of both areas are socioeconomically connected to their surrounding areas (U.S. Census Bureau, 2012).

Demographic and concurrent partnership information was obtained from the National Survey of Family Growth (NSFG). CBSA-level racial residential segregation indices were computed and made available from the 2000 U.S. Census (U.S. Census Bureau, 2012). Community poverty information is readily available from the 2006 – 2010 American Community Survey (U.S. Census Bureau, 2011). The variable, CBSA, is common to the NSFG, residential segregation, and poverty data and was used to merge these data sources. CBSA is a restricted geography variable; therefore, these data were accessed and analyzed through the National Center for Health Statistics Research Data Center (RDC). To limit disclosure risk, the RDC did not include the identity of the 110 CBSAs included in the data.

2.2. Individual-level variables

Individual-level variables included in the analyses were age, educational attainment, marital status, income, and concurrent partnerships. The NSFG asks participants the

month and year of their first and last sex with their last partner (most recent), second-to-last partner, and third-to-last partner. If the date of first sex with the more recent partner is earlier than the date of last sex with the previous partner and both events took place within the past 12 months, the participant is considered to have engaged in concurrent partners. Previous research has also defined concurrent partnerships in this manner for studies that have examined concurrent partnership as an outcome variable (Adimora et al., 2003; Adimora et al., 2011; Adimora et al., 2007; Adimora et al., 2006; Adimora et al., 2002; Watts & May, 1992; Adimora et al., 2014; Warren et al., 2015; Morris et al., 2015; Adimora et al., 2013; Nunn et al., 2014).

2.3. CBSA-level variables

CBSA was chosen as the geographic area because previous research has shown CBSAs to approximate housing markets (Wilkes & Iceland, 2004), which allows segregation to be analyzed at a geographic level where each NSFG participant has strong economic and social connections. Selection into residential neighborhoods is important when analyzing geographic health measures and can be accounted for through the use of CBSA-level residential segregation indices (Oakes, 2004). The geographic area of interest, the CBSA, is composed of units of analysis. Census tracts represent neighborhoods and are a commonly used unit of analysis for census-based segregation studies (wilkes & Iceland, 2004) and residential segregation studies (Fabio et al., 2009).

Each dimension of racial residential segregation has a representative index based on the research of Massey & Denton (1988) (Massey & Denton, 1988). The evenness dimension, represented by the index of dissimilarity, measures the percentage of non-Hispanic blacks

residing in a neighborhood that must change residence for that neighborhood to match the CBSA racial composition (Massey & Denton, 1988). The exposure dimension, represented by the isolation index, measures the amount of contact non-Hispanic blacks have with other non-Hispanic blacks (Massey & Denton, 1988). The dissimilarity and isolation index values range from 0.0 to 1.00 with a value of 0.0 indicating maximum integration and 1.00 indicating maximum segregation. The concentration dimension, represented by the relative concentration index, measures the physical space occupied by non-Hispanic blacks in a CBSA compared to the space occupied by non-Hispanic whites. That ratio is compared to the ratio that would be present if non-Hispanic blacks were concentrated to the highest extent and non-Hispanic whites were scattered to the maximum extent. The centralization dimension, represented by the absolute centralization index, measures the level to which non-Hispanic blacks live near the center of the CBSA compared to the CBSA outskirts (Massey & Denton, 1988). The relative concentration and absolute centralization indices range from -1.00 to 1.00. A relative concentration value of -1.00 indicates maximal concentration of non-Hispanic whites and a value of 1.00 indicates a maximal concentration of non-Hispanic blacks. An absolute centralization index value of -1.00 indicates non-Hispanic blacks reside farthest from the city center and a value of 1.00 indicates non-Hispanic blacks reside only in the CBSA center. The clustering dimension is represented by the spatial proximity index. This index measures the level of clustering of non-Hispanic black neighborhoods as they form larger contiguous areas (Massey & Denton, 1988). Spatial proximity values greater than 1.00 indicate non-Hispanic black neighborhoods have clustered with one another while values less than 1.00 indicate non-Hispanic black neighborhoods remain scattered. Refer to

Iceland, Weinberg, & Steinmetz (2002) for a detailed description of the indices and their formulae (Iceland et al., 2002).

Racial residential segregation is operationalized as a dichotomous variable with values ranging between '0.60 – 1.00' or '1.60 – 2.00' considered highly segregated depending on the index used (Biello et al., 2012; Massey et al., 1996). This study includes hypersegregation, a dichotomous variable that measures residential segregation across the five dimensions. A CBSA is hypersegregated if at least four of the five representative indices are highly segregated (Massey & Denton, 1988; Massey et al., 1996). Non-Hispanic blacks are the only racial group in the U.S. exposed to widespread hypersegregation (Acevedo-Garcia et al., 2003), which is important as being exposed to high levels of segregation over multiple dimensions has been shown to increase the negative effects of residential segregation (Acevedo-Garcia et al., 2003; Biello et al., 2013). Community poverty is defined as the proportion of a CBSA with family incomes below the federal poverty line. Poverty quartiles were created based on the distribution of CBSA poverty levels.

2.3. Analysis

Rao-Scott F-adjusted chi square tests were conducted to identify statistically significant variables ($p < 0.05$) during bivariate analyses. Multilevel modeling was performed due to the presence of significant second-level effects. Multilevel logistic regressions were conducted with the GLIMMIX procedure to examine the association between concurrent partnerships (individual-level) within the past 12 months and racial residential segregation (CBSA-level) among males and females, separately. Model one examined the

association between residential segregation and concurrent partnerships alone. Model two included model one with the inclusion of individual-level covariates. Model three included model two with the addition of community poverty. The spatial proximity index was excluded from the modeling phase due to very low cell counts, which did not allow the analysis to generate valid models. The NSFG incorporates a complex sampling system that requires the use of weighting, stratification, and clustering variables. Statistical analyses were performed with SAS software, Version 9.3 (Cary, NC, USA). This study was deemed non-human subjects research by the Florida International University Institutional Review Board.

Results

Table 1 displays bivariate associations between concurrent partnerships within the past 12 months and demographics. The sample included 4,139 non-Hispanic blacks 15 – 44 years of age from 2006 – 2010. Overall, 15.6% (n=645) of the participants had concurrent partners within the past 12 months. By gender, 10.6% of females (n=255) and 22.6% of males (n=390) engaged in concurrent partnerships within the past 12 months. Those with concurrent partnerships in the past 12 months were younger, male, and had lower incomes. The CBSA poverty distribution by concurrent partnership status was not significant but was retained in the final model.

Multilevel logistic regression models were conducted for the dissimilarity, isolation, relative concentration, absolute centralization, and hypersegregation indices with concurrent partners in the past 12 months as the outcome variable. The results for models one, two, and three are displayed in Table 2. Among females, for models one and

two, residential segregation was associated with concurrent partnerships for all indices. However, the association was protective against concurrent partnerships for the relative concentration index. For model three, residential segregation was associated with concurrent partners within the past 12 months for the dissimilarity, isolation, relative concentration and absolute centralization indices. The association between residential segregation and concurrent partners within the past 12 months was slightly protective when measured with the relative concentration index and was not significant when measured with the hypersegregation index. The dissimilarity index (adjusted odds ratio [aOR] 1.78; 95% confident interval [CI] 1.75-1.80) displayed the highest adjusted odds ratio.

Among males, for models one and two, residential segregation was associated with concurrent partnerships for all indices. However, the association was protective against concurrent partnerships for the isolation index. For model three, residential segregation was associated with concurrent partners within the past 12 months for all indices. Racial residential segregation was a risk factor for concurrent partnerships within the past 12 months when measured with the dissimilarity and relative concentration indices. However, racial residential segregation was protective against concurrent partners within the past 12 months when measured with the isolation, absolute centralization, and the hypersegregation indices. The dissimilarity index ([aOR]; 95% [CI]) (1.33; 1.32-1.34) displayed the highest adjusted odds ratio for males.

Discussion

There are three main findings from this study. First, we found racial residential segregation was associated with concurrent partnerships within the past 12 months for both males and females. Second, we found among both males and females that residential segregation served as a risk factor and a protective factor for concurrent partnerships within the past 12 months depending on the index chosen. Third, the inclusion of poverty resulted in the best-fit models and also reduced the negative effect of residential segregation for several indices.

Our finding that racial residential segregation was associated with concurrent partnerships within the past 12 months among both males and females is supported by previous research that found racial residential segregation and various other contextual factors can increase the likelihood of risky sexual behaviors (Biello et al., 2012; Adimora et al., 2005; Poundstone et al., 2004; Kramer & Hogue, 2009). Among males, we found that high levels of segregation as measured by the dissimilarity and relative concentration indices were risk factors for concurrent partnerships within the past 12 months. This suggests that residential segregation may influence concurrent partnerships among males in our study through neighborhoods with high densities of non-Hispanic blacks. Previous research has shown a high neighborhood density of non-Hispanic blacks is associated with the concentration of sexual networks (Biello et al., 2012; Adimora et al., 2005), which can increase the likelihood of concurrent partnerships. Among females, we found racial residential segregation, as measured by the dissimilarity, isolation, and absolute centralization indices, were risk factors for concurrent partnerships within the past 12

months. Residential segregation when measured with the isolation index served as a risk factor for concurrent partnerships. In neighborhoods with a high level of residential segregation as measured by the isolation index, non-Hispanic black residents are likely only exposed to each other. Previous research has found that non-Hispanic blacks are the racial group most likely to choose a sexual partner from within their race (Laumann & Youm, 1999), which may concentrate sexual networks resulting in increases in risky sexual behavior. High levels residential segregation as measured by absolute centralization may place non-Hispanic blacks into older overpopulated downtown neighborhoods (Acevedo-Garcia, 2000). These areas are linked to high incarceration rates and low sex ratios, which have been associated with concurrent partnerships (Adimora & Schoenbach, 2005).

We found that residential segregation served as a risk factor and a protective factor for concurrent partnerships within the past 12 months that varied by gender and index chosen. For instance, the isolation index was a risk factor for concurrent partnerships within the past 12 months for females for all models, but was a protective factor among males for all models. This was in agreement with other research examining the association between residential segregation and risky sexual behaviors (Lutfi et al., 2015). In addition, previous research has found an association between metropolitan area gonorrhea rates and residential segregation as measured by the isolation index (Biello et al., 2012; Pugsley et al., 2013) and the dissimilarity index (Biello et al., 2012). We also found residential segregation as measured by the relative concentration index was a risk factor for males for all models, but protective against concurrent partnerships within the past 12

months among females for all models. Based on our observations, there may have been some additional contextual factors beyond residential segregation and community poverty that differentially impact males and females. Inclusion of measures such as 'low male-to-female ratio' or 'percent female-headed households' may have given more information about the environments of these CBSAs beyond segregation, which may help explain some of these gender differences.

We found the inclusion of community poverty resulted in model three being our best-fit model. Among females, both models one (crude association) and two (model one with covariates) were found to be associated with concurrent partnerships for all indices. In the crude model, hypersegregation was a risk factor for concurrent partnerships, but when including poverty, the association was not significant. In addition, the inclusion of poverty also weakened the crude associations when residential segregation was measured with the dissimilarity and relative concentration indices. This effect was expected, as poverty was included partly because it has been associated with residential segregation and neighborhood disadvantages (Massey & Tannen, 2015; Iceland & Hernandez, 2017), as well as concurrent partnerships (Adimora et al., 2013). The inclusion of poverty caused a slight increase in the strength of association between residential segregation and concurrent partnerships when segregation was measured with the isolation and absolute centralization indices. Poverty appears to have a different level of impact on the association of residential segregation and concurrent partnerships depending on the index chosen to represent residential segregation.

Among males, both models one and two were found to be associated with concurrent partnerships for all indices. In the crude models, absolute centralization and hypersegregation were risk factors for concurrent partnerships, but when including poverty residential segregation was a protective factor for both indices. In addition, for the dissimilarity, isolation, and relative concentration indices, the residential segregation and concurrent partnerships association was strengthened. While we also observed this effect of poverty on the residential segregation and concurrent partnerships association among females, this observed influence of poverty was unexpected. Quillian (2012) suggests residential segregation and group-poverty interact within minority communities (Quillian, 2012). Perhaps examining the association between residential segregation and concurrent partnerships with stratification by community poverty would create a clearer picture of community poverty's true influence on this association.

There are limitations of note for this study. First, we did not account for multiple comparisons, which may lead to an increase in Type I errors. However, due to the strength of associations observed we do not believe this had a significant impact on our main findings. Second, this study would have benefitted from the inclusion of additional contextual factors as covariates. Additional factors such as CBSA percent black, CBSA percent female-headed households, and male-to-female sex ratio would only strengthen the analysis, as these measures are associated with residential segregation. Third, a low variability of CBSAs was observed. While this option was not available at the time, merging additional NSFG cycles to increase the number of non-Hispanic black interviews might also increase the spread of CBSAs. Increasing the number of non-

Hispanic black interviews would make it possible to ensure there are adequate numbers for stratification of the analyses. Fourth, we did not account for CBSA regional differences. Racial residential segregation varies markedly by census region. The NSFG geography data are restricted; therefore, the identity of all the CBSAs included was withheld.

Conclusions

Our findings suggest racial residential segregation is associated with concurrent partnerships within the past 12 months among non-Hispanic blacks 15 – 44 years of age, and that the association differs somewhat between males and females. Furthermore, our heterogeneous findings of the association with segregation varying by specific indices suggest that specific segregation patterns affect the risk of concurrency. The dissimilarity and absolute centralization indices had the highest magnitude of association among females. For the absolute centralization index, this suggests non-Hispanic black females residing nearer to the CBSA downtown area were more likely to have engaged in concurrent partnerships within the past 12 months. In addition, the dissimilarity and relative concentration indices had the highest magnitude among males. For the relative concentration index, this suggests non-Hispanic black males residing in neighborhoods with a high density of non-Hispanic blacks relative to non-Hispanic whites are more likely to have engaged in concurrent partnerships with the past 12 months. Further research into CBSA regional differences, male-to-female sex ratio, or CBSA percent female-headed household as covariates or perhaps the main explanatory variable would enhance the current knowledge of the importance of these various measures.

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Tables and figures

Table 1. Descriptive characteristics for non-Hispanic Black National Survey of Family Growth participants (2006 – 2010) by concurrent partner status (n=4,139)

	Concurrent partners within past 12 months		
Characteristics	**Concurrent in last 12 months (n=645; 15.6%)**	**Not concurrent in last 12 months (n=3,494; 84.4%)**	**P-value**
Gender			
Males	390 (60.5)	1339 (38.3)	
Females	255 (39.5)	2155 (61.7)	<0.0001
Age Group			
15 – 24 years	262 (40.6)	1343 (38.4)	
25 – 34 years	229 (35.5)	1136 (32.5)	
35 – 44 years	154 (23.9)	1015 (29.0)	0.0259
Attainment			
No high school diploma/in school	43 (6.7)	515 (14.7)	
No high school diploma/out of school	152 (23.6)	630 (18.0)	
High school diploma	225 (34.9)	1019 (29.8)	
Some college	140 (21.7)	682 (19.5)	
College degree	85 (13.2)	648 (18.5)	<0.0001
Marital			
Married/cohabitating	35 (5.4)	1110 (31.8)	
Not married/not cohabitating	610 (94.6)	2348 (68.2)	<0.0001
Income			
<$15,000 per year	243 (37.7)	1126 (32.2)	
$15,000 – $34,999	193 (29.9)	1020 (29.2)	
$35,000 – $74,999	164 (25.4)	1006 (28.8)	
$75,000 or more	45 (7.0)	342 (9.8)	0.0082
Percent family poverty of core-based statistical area			
< 6.9%	186 (28.8)	862 (24.7)	
6.9% – 8.9%	149 (23.1)	802 (23.0)	
9.0% – 11.9%	144 (22.3)	873 (25.0)	
12.0% or more	141 (21.9)	763 (21.8)	0.1658

Notes: 1) Bivariate analysis conducted using the Rao-Scott F-adjusted Chi square test

Table 2. Odds ratios[†] for concurrent partners among non-Hispanic Black females for various models, National Survey of Family Growth, 2006 – 2010 (n=2,410)

	Concurrent partners past 12 months** OR (95% CI)				
	Dissimilarity	**Isolation**	**Relative Concentration**	**Absolute Centralization**	**Hypersegregation**
Model Number			**Females**		
One					
Segregated[#]	2.35 (2.32-2.37)	1.19 (1.15-1.23)	0.90 (0.89-0.91)	1.36 (1.34-1.38)	1.19 (1.15-1.22)
Not Segregated	Ref.	Ref.	Ref.	Ref.	Ref.
Two					
Segregated	1.85 (1.82-1.87)	1.86 (1.80-1.92)	0.78 (0.77-0.79)	1.72 (1.69-1.74)	1.85 (1.78-1.91)
Not Segregated	Ref.	Ref.	Ref.	Ref.	Ref.
Three					
Segregated	1.78 (1.75-1.80)	1.22 (1.20-1.23)	0.94 (0.93-0.96)	1.55 (1.52-1.57)	0.99 (0.97-1.01)
Not Segregated	Ref.	Ref.	Ref.	Ref.	Ref.

Note. OR = odds ratio; CI = confidence interval; CBSA = core-based statistical area; Random intercept included to account for CBSA clustering

1) Model One: Racial residential segregation and concurrent partnerships

2) Model Two: Model one including individual-level covariates;

3) Model Three: Model two including community poverty

[#] Segregated refers to an index value greater than or equal to 0.60 // not segregated refers to an index value less than 0.60

**ORs for concurrent partners within the past 12 months modeled using each segregation index, separately

Table 2 continued. Odds ratios[†] for concurrent partners among non-Hispanic Black males for various models, National Survey of Family Growth,
2006 – 2010 (n=1,729)

	Concurrent partners past 12 months** OR (95% CI)				
	Dissimilarity	**Isolation**	**Relative Concentration**	**Absolute Centralization**	**Hypersegregation**
Model Number			**Males**		
One					
Segregated[#]	1.13 (1.12-1.14)	0.795 (0.789-0.802)	1.26 (1.24-1.27)	1.045 (1.036-1.053)	1.24 (1.22-1.25)
Not Segregated	Ref.	Ref.	Ref.	Ref.	Ref.
Two					
Segregated	1.37 (1.36-1.38)	0.76 (0.75-0.77)	1.31 (1.26-1.36)	1.17 (1.13-1.20)	1.25 (1.23-1.26)
Not Segregated	Ref.	Ref.	Ref.	Ref.	Ref.
Three					
Segregated	1.33 (1.32-1.34)	0.62 (0.61-0.63)	1.29 (1.27-1.31)	0.88 (0.87-0.88)	0.86 (0.85-0.88)
Not Segregated	Ref.	Ref.	Ref.	Ref.	Ref.

Note. OR = odds ratio; CI = confidence interval; CBSA = core-based statistical area; Random intercept included to account for CBSA clustering
1) Model One: Racial residential segregation and concurrent partnerships
2) Model Two: Model one including individual-level covariates;
3) Model Three: Model two including community poverty
[#] Segregated refers to an index value greater than or equal to 0.60 // not segregated refers to an index value less than 0.60
**ORs for concurrent partners within the past 12 months modeled using each segregation index, separately

CONCLUSIONS

Overall study findings suggest for non-Hispanic blacks, residence in areas with high levels of racial residential segregation is associated with risky sexual behaviors and STI diagnoses. Across all three studies, the magnitudes of association varied by the racial residential segregation index used. In some instances, racial residential segregation served as a protective factor for risky sexual behaviors and STI diagnosis.

In the first study examining the association between racial residential segregation and risky sexual behavior, defined as "two or more partners and no condom use within the past 12 months," the absolute centralization (measures the extent to which non-Hispanic blacks reside in the metropolitan area downtown center compared to suburban areas) and relative concentration (measures the amount of physical space occupied by non-Hispanic blacks compared to non-Hispanic whites) indices were found to have the strongest association with risky sexual behavior. This suggests residing in urban areas with high non-Hispanic black densities may be a stronger influence on the risky sexual behavior of non-Hispanic blacks than residing in areas with uneven non-Hispanic black population distribution and or being isolated from non-Hispanic whites. Examining additional contextual factors that impact urban areas such as crowding and incarceration rates may shed light on the mechanism for how racial residential segregation potentially impacts risky sexual behavior in these environments. Future research should focus on determining what specific aspects of residing in centralized and concentrated areas affect risky sexual behavior so those mechanisms can be addressed.

The second study found racial residential segregation to be associated with STI diagnosis within the past 12 months. That association was found to be strongest when

racial residential segregation was measured using the dissimilarity and relative concentration indices. Similar to the first study, living in areas with a high density of non-Hispanic blacks relative to non-Hispanic whites was more strongly associated with the second study's outcome, STI diagnosis. In addition, residing in areas with high levels of unevenness was also strongly associated with STI diagnosis.

In the third study, racial residential segregation was found to be associated with concurrent partnerships within the past 12 months. The association was strongest for females when measuring racial residential segregation with the dissimilarity and absolute centralization indices. This is similar to what we found in the first study examining racial residential segregation and risky sexual behavior. Additional research into the mechanisms by which high levels of absolute centralization affect sexual behavior and concurrent partnerships for females and males is needed. The racial residential segregation and concurrent partnerships within the past 12 months association was strongest for males when using the dissimilarity and relative concentration indices.

Across all three studies we found the relative concentration and dissimilarity indices to be most strongly associated with our study outcomes. There were differences in the strengths of association between genders as well. These studies have reinforced the importance of the choice of racial residential segregation index to include in potential research. Studies incorporating only one measure of racial residential segregation may be missing out on important information. In addition, examining the impact of including additional contextual factors such as CBSA regional differences, male-to-female sex ratio, and incarceration rates may help explain the mechanisms behind the association of racial residential segregation with risky sexual behaviors and STI diagnosis.

Limitations

There were a number of limitations over these three studies. First, the National Survey of Family Growth relies on self-reported data. This is of importance as participants were asked to recall their sexual history during the past 12 months, including dates. Second, we do not know the exact degree of racial residential segregation to which each participant was exposed. The segregation values were for the metropolitan area, and it is likely that non-Hispanic blacks within a given metropolitan area resided in neighborhoods that are more or less segregated than the metropolitan area overall. Third, we did not account for multiple comparisons, which may lead to an increase in Type I errors. However, given the strength of associations observed, we believe the effect of not accounting for multiple comparisons to be minimal and not impacting the overall significance of main findings. Fourth, a low variability of CBSAs was observed. Merging similar National Survey of Family Growth cycles to increase the number of non-Hispanic black interviews would decrease the likelihood that few participants represent large areas. In addition, merging cycles would also allow greater numbers for additional levels of stratification (i.e. age and gender, simultaneously). Fifth, CBSA regional differences were not accounted for during our analysis. Racial residential segregation as well as sexually transmitted diseases vary markedly by United States Census region (i.e. the South is known to have higher rates for multiple sexually transmitted infections).

Implications

Non-Hispanic blacks continue to have elevated rates of sexually transmitted infections and experience higher levels of racial residential segregation than other racial groups in the United States. Racial residential segregation also has a differential influence

on non-Hispanic blacks and non-Hispanic whites. This dissertation found that racial residential segregation among non-Hispanic blacks partially explains the racial disparities in risky sexual behavior and sexually transmitted infections. This dissertation's results suggest the need to consider the neighborhood context of racial residential segregation in studies aiming to reduce sexually transmitted infections. Furthermore, using measures such as percent black, which do not account for spatial aspects, miss important information regarding the true risk of a population. Interventions tasked with reducing sexually transmitted infections should focus efforts in highly segregated areas in order to account for the spatial and social characteristics such as the concentration or centralization of non-Hispanic blacks and sexual networks of these areas that affect the risk of acquisition or transmission of a sexually transmitted infection. Low male-to-female sex ratio resulting from high incarceration rates may be one mechanism through which racial residential segregation affects sexual networks. Interventions may find success by attempting to offset the negative effects of low male-to-female sex ratios and incarceration rates by increasing social support for those determined to be at-risk.

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