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

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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

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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.

Background

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)[1]. 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 [2], 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 [3] and will be henceforth referred to as "segregation." In 2010, more than 50% of NHBs in metropolitan areas resided in highly segregated areas [4] and NHBs are the racial group most likely to experience high levels of segregation [5–7]. In addition, segregation has been associated with negative health outcomes among NHBs [8–10]. Segregation may also impact health through concentrated poverty [4, 11], which has been associated with neighborhood disadvantages such as unemployment, crime, and lower quality education opportunities [11–13]. Previous research has found segregation limits the availability of quality medical care and may make it difficult for residents to care of their health [3]. Through an impact on community resources and economic opportunities [11–13], 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 [14]. 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 [3]. 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 [3], 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 [6, 8]. 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 using multiple dimensions, 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 [15]. 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 ([16]. 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 [16]. 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 [17].

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 [18], 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 [19]. 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 [18] and segregation studies [20]. 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) [21]. 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 [21]. The isolation index—exposure dimension—measures the level of contact NHBs have to only other NHBs [21]. 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 [21]. 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 [21]. 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 [21]. 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) [22].

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) [6]. 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 [21]. That is noteworthy as being highly segregated across multiple dimensions increases the negative effects of segregation [10]. 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 [6, 8].

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 as 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 [6, 11, 12, 23–25]. Previous research also found segregation to be associated with area-level gonorrhea rates [6, 8] and risky sexual behaviors [9, 26].

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 indicate a high degree of sexual contact among members, and these networks are associated with concurrent partnerships, sexual partnerships that overlap in time, which permit faster STI transmission throughout a network [27]. 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

[3]. 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 [3]. 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 [18]. 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 [28]. 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 [24]. Males residing in low sex ratio neighborhoods may engage in risky sexual behaviors such as concurrent partnerships [24] feeling confident in maintaining their primary relationship due to the scarcity of 'suitable' males [27]. 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 [1, 29]. Therefore, regional differences could confound associations between CBSA segregation and STI diagnosis rates.

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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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)

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

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